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MORPHOMETRIC ANALYSIS OF *MURAENA HELENA* AND *CONGER CONGER* IN THE COASTAL WATERS OF NORTHERN TUNISIA

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MURAENA HELENA
CONGER CONGER
NORTH COAST OF TUNISIA
MORPHOMETRIC CHARACTERISTICS
PRINCIPAL COMPONENT ANALYSIS

ABSTRACT. – This study examined morphometric characteristics of 237 *M. helena* and 123 *C. conger* individuals collected from three sites located in the north coast of Tunisia (Bizerte, Ghar el melh and Haouaria). In *M. helena*, males seems larger than females; total length ranged from 494 to 1050 mm and from 490 to 976 mm, for males and females, respectively. Also the morphometric segregation is different between males and females according to the capture site. Morphological analysis showed that for males, the population of Ghar el melh presents a morphometric divergence. However, for females the population of Haouaria presents the higher values. The length of *C. conger* ranged from 490 to 1110 mm. Individuals of Ghar el melh and Haouaria presented similar morphometric characteristics, these two populations being morphologically different from Bizerte population.

INTRODUCTION

The Mediterranean moray eel, *Muraena helena* Linnaeus, 1758 presents a wide distribution in the eastern Atlantic extending north to the British Isles and south to Senegal and Cape Verde (Smith & Böhlke 1990), including the Canary Islands, Madeira and the Azores (Randall & Golani 1995). In the Mediterranean Sea, *M. helena* is a demersal species, inhabiting coastal marine waters on rocky bottoms (Fischer *et al.* 1987). In the Tunisian marine waters, this species is frequently captured in the northern coast, while rarely from the southern areas (Bradai *et al.* 2004).

The European conger, *Conger conger* (Linnaeus, 1758) is widely distributed in the north-eastern Atlantic, its distribution ranges from Norway to Senegal, including the Canary Islands, Madeira and the Azores. This species has been reported throughout the Mediterranean and the western Black Sea (Bauchot & Saldanha 1986, Jardas 1996). This benthic species prefers sandy and rocky bottoms of the continental shelf (Fischer *et al.* 1987). In the north coast of Tunisia, it lives at depth between 80 and 300 m (Azzouz 1974).

Both species have been the subject of several biological studies in the Atlantic and the Mediterranean Sea. Particularly, data about the morphology of these two Anguilliformes have been reported by Jiménez *et al.* (2007) and Casadevall *et al.* (2017).

Many authors have conducted studies on the morphometric characteristics of fish (Sedaghat *et al.* 2012, Langer *et al.* 2013, Brraich & Akhter 2015, Manorama & Ramanujam 2016, Aryani *et al.* 2017). Ihssen *et al.* (1981) reported that morphometric and meristic studies provided useful results for the identification of marine fish stocks and the description of their spatial distribution. Variations in fish size have important implications for various aspects of fishery science and fish population dynamics (Erzini *et al.* 1997).

The current study was conducted on the northern coast of Tunisia. The marine area of northern Tunisia is located in the western basin of the Mediterranean. The coasts are influenced by the Atlantic currents. The continental shelf is relatively small, often steep and bristling with rocky cracks and deep channels (Bradai *et al.* 2004). Our objective was to study, compare and describe the morphology of different populations of *M. helena* and *C. conger* in order to update the morphological information of these two species, which is crucial for their fishery management.

MATERIALS AND METHODS

Fish collection: A total of 237 specimens of *Muraena helena* and 123 specimens of *Conger conger* were collected between March 2015 and April 2016. Specimens were caught from three sites (Bizerte, Ghar el melh and Haouaria) located in the north coast of Tunisia (Fig. 1). For each site, the sampling is composed of 45 males and 34 females of *Muraena helena* and 41 females of *Conger conger*. The data concerning the depth of the sampling were collected directly from the fishermen on the basis of their observations during the fishing process. Specimens were caught using longlines at depths of 50 to 100 m.

Body measurements: In the laboratory, nine morphometric characteristics were measured for *Muraena helena* and 11

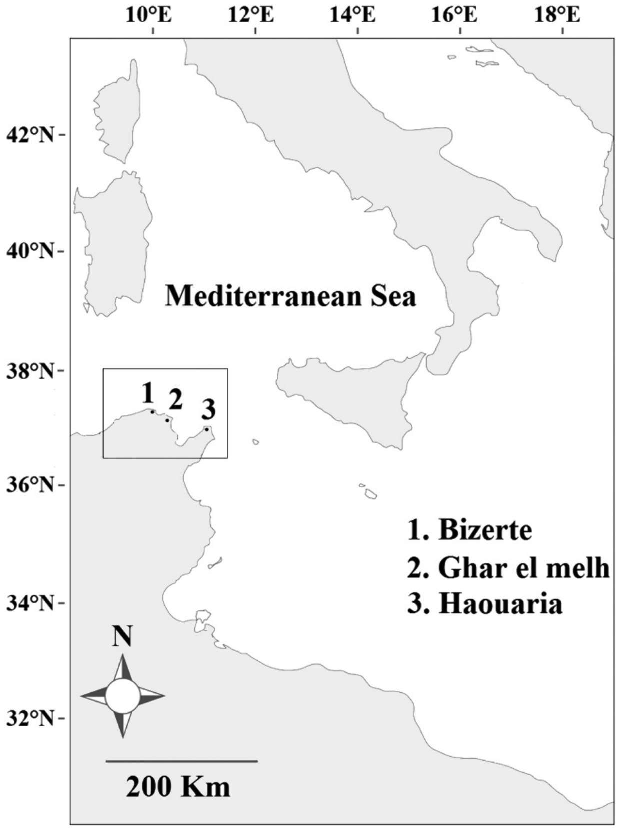

Fig. 1. – Map of the study areas showing sampling sites. ♂: males, ♀: females.

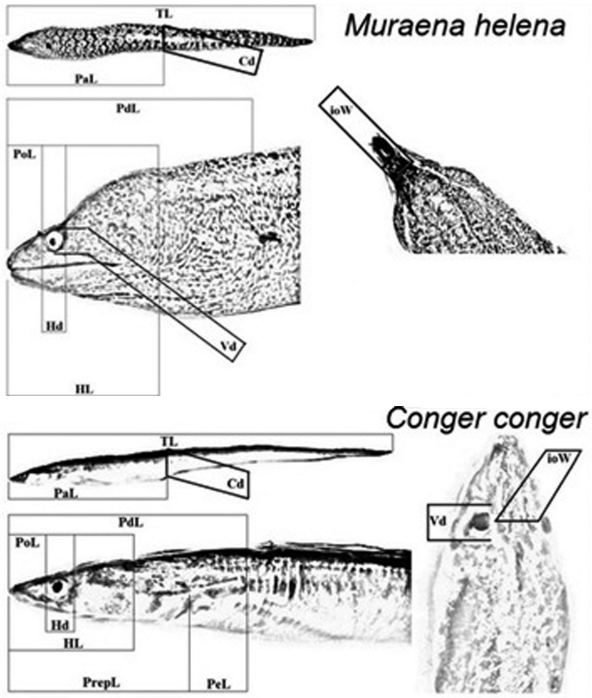

Fig. 2. – Location of measurements on *Muraena helena* and on *Conger conger* (see text for abbreviations). SSD, Sum of Squared Deviations; ddl, degrees of freedom; F, value for testing the hypothesis that the group means for that effect are equal; Pr > F, significance probability value associated with the F value; S, significant; NS, not significant; HS, highly significant.

Table I. - Morphometric characteristics of *M. helena* by sex (see text for abbreviations).

	♂ Bizerte (n = 45)				♂ Ghar el melh (n = 45)				♂ Haouaria (n = 45)			
Parameters	Min	Max	Mean	Sd	Min	Max	Mean	Sd	Min	Max	Mean	Sd
TL	583	990	707.82	13.95	494	1009.2	785.17	15.4	510	1050	719.05	18.90
HL	47.44	86.51	60.90	1.3	39.41	5.12	65.85	1.63	43.11	92.62	61.69	1.68
PdL	51.29	121.54	74.08	2.15	48.45	119.72	82	2.05	49.71	136.50	78.13	2.59
Vd	5.27	9.65	7.55	0.14	4.92	10.96	7.41	0.19	5.10	10.01	7.35	0.17
Hd	5.84	9.51	7.93	0.11	4.76	11.36	7.95	0.20	6.09	9.77	7.74	0.17
PoL	13.73	25.6	18.48	0.40	12.24	31.54	20.52	0.57	13.68	27.58	19.03	0.56
ioW	6.25	16.15	9.96	0.28	6.53	18.61	11.22	0.34	6.59	16.04	10.13	0.34
Cd	32.87	75.44	46.57	1.39	27.47	97.24	56.65	1.79	26.62	76.63	48.69	1.69
PaL	273	502	347	7.94	224	552	381.53	9.18	243	493	352.12	10
	♀ Bizerte (n = 34)				♀ Ghar el melh (n = 34)				♀ Haouaria (n = 34)			
Parameters	Min	Max	Mean	Sd	Min	Max	Mean	Sd	Min	Max	Mean	Sd
TL	524	840	672.14	13.74	490	842	690.88	12.58	520	976	743.82	16.61
HL	38.8	73.61	56.55	1.38	41.18	78	56.96	1.28	47.61	92.24	63.51	1.60
PdL	49.05	84.79	67.91	1.74	50.91	83.95	69.50	1.33	60.45	104.83	77.50	1.80
Vd	5.12	7.8	6.92	0.1	4.72	8.03	6.60	0.14	5.63	10.06	7.43	0.18
Hd	6.18	9.21	7.5	0.13	6.15	8.69	7.44	0.10	5.64	12	7.93	0.18
PoL	12.23	21.59	16.76	0.41	12.90	22	17.17	0.39	13.63	24.27	18.71	0.45
ioW	6.14	12.49	8.90	0.24	6.08	12	9.12	0.21	5.90	15.69	10.39	0.32
Cd	29.09	61.95	44.39	1.37	32.33	66	46.24	1.17	36.82	78.56	52.56	1.96
PaL	250	420	325.73	7.38	224	423	331.5	7.51	230	500	367.94	9.60

characteristics for *Conger conger* (Fig. 2). Abbreviations are as follows: TL: total length (to the nearest 0.1 cm), HL: head length, Cd: caudal depth, PdL: predorsal length, Vd: vertical eye diameter, Hd: horizontal eye diameter, ioW: interorbital width, PoL: preorbital length, PaL: preanal length, PrepL: prepectoral length, and Pel: pectoral length (to the nearest 0.1 mm).

Data analysis: The collected data were processed by classical statistical methods (Scherrer 1984). We used the distribution parameters (average) and the dispersion parameters (minimum, maximum and standard error). The Mann-Whitney U tests were used to compare means of the morphometric indices between males and females of *Muraena helena*.

The means of the original morphometric measurements were calculated to compare the degree of differentiation of each morphometric characteristics for each population. This analysis is followed by Duncan's test.

Data were submitted to Principal Component Analysis (PCA). This method consists in determining a system of hierarchical reference axes in such a way that, when we reduce the very high dimension of our matrix, the information loss is minimal (Daget 1976). So the reduced space on which we will project the observation points must be such that it will include the maximum of information provided by the initial matrix. Thus, the purpose of PCA is to extract most of the information contained in the data table and to provide an image representation that becomes easier to interpret (Foucart 1982, Zaïem 1988, Sanders 1989, Saporta 1990). The proximity between individuals is interpreted in terms of the similarity of the behavior with respect to the variables and the proximity between variables is expressed in terms of correlation. The level of significance α established was 0.05. For all data analysis, statistical analyses and comparisons were estimated using IBM SPSS Statistics 22 program.

RESULTS

Muraena helena

We examined the morphological variability (9 morphometric traits) among individuals collected from the three sampling locations. Among the 237 individuals, 135 were males and 102 females. The minimum, maximum, mean value and standard error of all parameters are shown in Table I. Body measurements show that this is a species that grows to a large size. Males show higher values than

Table II. – Analysis of variance for body measurements of *M. helena* between the three sites.

Parameters	Source of variability	ddl	SSD	Mean square	F	Pr > F	Significance level
Males							
TL	Area	2	157233.27	78616.63	6.61	< 0.05	S
HL	//	//	635.36	317.68	2.93	> 0.05	NS
PdL	//	//	1411.21	705.6	3.01	> 0.05	NS
Vd	//	//	0.923	0.46	0.34	> 0.05	NS
Hd	//	//	1.21	0.6	0.48	> 0.05	NS
PoL	//	//	100.49	50.24	4.1	< 0.05	S
ioW	//	//	42.1	21.05	4.31	< 0.05	S
Cd	//	//	2539.32	1269.66	10.51	< 0.0001	HS
PaL	//	//	31253.78	15626.89	4.21	< 0.05	S
Females							
TL	Area	2	93936.02	46984.01	6.65	< 0.05	S
HL	//	//	1036.55	518.27	7.41	< 0.0001	HS
PdL	//	//	1797.04	898.52	9.79	< 0.0001	HS
Vd	//	//	11.93	5.96	7.69	< 0.0001	HS
Hd	//	//	4.85	2.42	3.28	< 0.05	S
PoL	//	//	71.76	35.88	5.94	< 0.005	S
ioW	//	//	43.85	21.93	9.01	< 0.0001	HS
Cd	//	//	1248.37	624.18	7.69	< 0.0001	HS
PaL	//	//	35615.31	17807.65	7.72	< 0.0001	HS

Table III. – Multiple comparisons of means between body measurements in *M. helena* (Duncan's test). $\bar{X}$estimated average.

Parameters	Bizerte		Ghar el melh		Haouaria	
	$\bar{X}$	Group	$\bar{X}$	Group	$\bar{X}$	Group
Males						
TL	707.82	A	785.17	B	719.05	A
PoL	18.48	A	20.52	B	19.03	A
ioW	9.96	A	11.22	B	10.13	A
Cd	46.57	A	56.65	B	48.69	A
PaL	347	A	381.53	B	352.12	A
Females						
TL	672.14	A	690.88	A	743.82	B
HL	56.55	A	56.96	A	63.51	B
PdL	67.91	A	69.50	A	77.50	B
Vd	6.92	A	6.60	A	7.43	B
Hd	7.50	A	7.44	A	7.93	B
PoL	16.76	A	17.17	A	18.71	B
ioW	8.90	A	9.12	A	10.39	B
Cd	44.39	A	46.24	A	52.56	B
PaL	325.73	A	331.50	A	367.94	B

Table IV. – Matrix of correlation coefficients between five measurements variables in *M. helena*.

Parameters	TL	PoL	ioW	Cd	PaL
		Males			
TL	0				
PoL	0.93619	0			
ioW	0.84338	0.86395	0		
Cd	0.89783	0.88555	0.87187	0	
PaL	0.97431	0.92234	0.83637	0.87794	0
		Females			
TL	0				
PoL	0.9003	0			
ioW	0.76544	0.7196	0		
Cd	0.80887	0.8192	0.73177	0	
PaL	0.95348	0.86382	0.75792	0.78063	0

Table V. – Absorption of change from the first two axes and their meaning in relation to the five measurement variables.

Sex	Males		Females	
Components	Axis 1	Axis2	Axis 1	Axis 2
Own values	4.56	0.21	4.24	0.32
% of total variation	91.31	4.24	84.94	6.53
% accrued	91.31	95.55	84.94	91.47
Variable components				
TL	0.97	–0.17	0.96	–0.14
PoL	0.96	–0.07	0.93	–0.19
ioW	0.92	0.34	0.85	0.50
Cd	0.94	0.11	0.89	0.01
PaL	0.96	–0.19	0.94	–0.13

females; Mann-Whitney U test shows that for parameters TL, HL, PdL, Vd, Hd, Cd and PaL, there is a significant difference between males and females (M-W, U = 237, p < 0.05). PoL shows a highly significant difference between the two sexes (M-W, U = 237, p < 0.0001). However, ioW shows no difference (M-W, U = 237, p > 0.05).

Table II presents the results of the analysis of variance for males and females between the three sites. The comparative results revealed significant differences between the three populations. These differences affect five parameters for males and nine for females. Multiple comparisons of means between sampling sites are presented in Table III (Duncan's test). According to the Duncan's test, the population of Ghar el melh shows a morphometric divergence in males. Whereas in females the divergence characterizes the population of Haouaria.

We subjected our variables to PCA. For both sexes, we used the five most discriminating parameters (TL, PoL, ioW, Cd and PaL). The matrix of correlation coefficients between variables shows positive values (Table IV).

The PCA shows that the first two axes for males and females represent, respectively 95.55 % and 91.47 % of the total variance. In descending order according to the importance of each axis, we find that the first is the most discriminating, while the following axes provide secondary information. We can therefore focus on axes 1 and 2 and neglect the others (Table V). For males, the axis 1 absorbs 91.31 % of the total variation; the five variables indicate positive correlations. The positive values on this axis project the populations of Ghar el melh with the highest values of all parameters. On the negative side of the same axis, we find the population of Bizerte. Axis 2 absorbs 4.24 % of the total variation. It is defined primarily by the variable (ioW), which shows a very high positive correlation. On the positive side is projected the population of Ghar el melh, which shows the highest values of the interorbital width (ioW), on the negative side values of this axis, we find the two populations of Bizerte and Haouaria. For females, axis 1 absorbs 84.94 % of the total variation; the five variables indicate positive correlations.

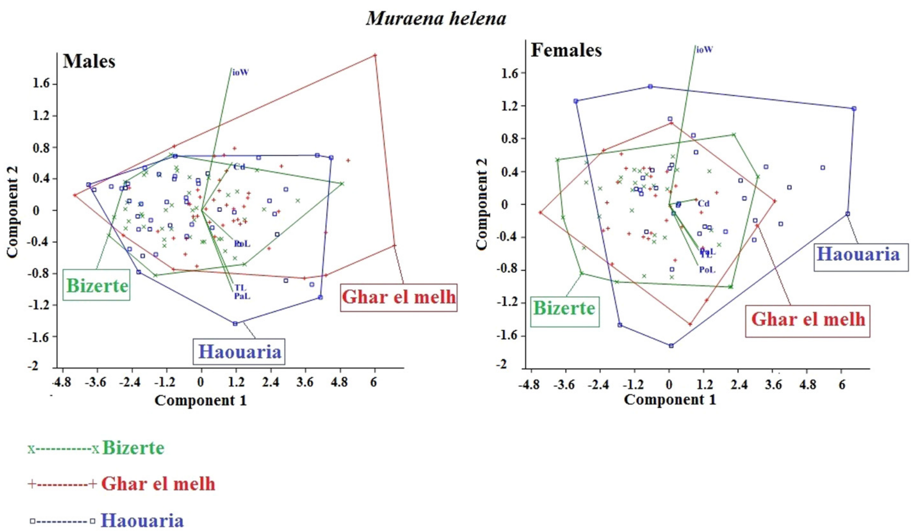

Fig. 3. – Principal Component Analysis (PCA) of morphometric characteristics of *M. helena*.

Table VI. – Morphometric characteristics of *C. conger*. ♀, females.

	♀ Bizerte (n = 41)				♀ Ghar el melh (n = 41)				♀ Haouaria (n = 41)			
Parameters	Min	Max	Mean	Sd	Min	Max	Mean	Sd	Min	Max	Mean	Sd
TL	490	970	664.17	17.38	523	1033	741	16.46	545	1110	753.02	21.64
Vd	7.56	15.26	10.30	0.25	4.16	16.79	11.29	0.33	8.07	19.50	11.98	0.40
Hd	8.67	20.66	14.36	0.37	10.75	20.09	15.19	0.34	10.49	23.91	15.97	0.39
PrepL	20.31	147.63	99.15	3.30	75.18	180	112.86	3.23	42.62	180	112.05	3.64
ioW	8.82	24.05	15.18	0.51	11.82	28.05	17.44	0.59	10.93	27.32	17.92	0.65
PoL	18.19	37.91	25.11	0.69	17.14	40.97	28.14	0.76	20.20	41.56	29.24	0.76
PdL	93.31	220	140.04	4.28	14.28	233	150.96	6.56	10.79	251	125.52	10.81
PaL	195	410	276.01	7.82	150	440	308.63	8.89	220	500	318.82	10
PeL	20.75	52.22	33.29	1.02	25.29	56.39	37.70	1.09	24.93	59.96	37.63	1.30
HL	59.87	126.51	83.68	2.54	54.62	135.24	91.03	2.50	69.98	139.81	96.26	2.64
Cd	22.07	60.09	36.42	1.54	31.88	76.56	45.60	1.75	25.46	77.15	45.81	1.80

The positive values on this axis project the populations of Haouaria with the highest values of all parameters.. On the negative side of this same axis, we find the population of Bizerte. Axis 2 absorbs 6.53 % of the total variation. It is defined primarily by the variable (ioW), which shows a very high positive correlation. On the positive side is projected the population of Haouaria which shows the highest values of interorbital width (ioW), on the negative side of this axis, we find the two populations of Bizerte and Ghar el melh as can be seen in Fig. 3.

Table VII. – Analysis of variance for body measurements between the three sites for *C. conger*. SSD, Sum of Squared Deviations; ddl, degrees of freedom; F, value for testing the hypothesis that the group means for that effect are equal; Pr > F, significance probability value associated with the F value; S, significant; HS, highly significant.

Parameters	Source of variability	ddl	SSD	Mean square	F	Pr > F	Significance level
TL	Area	2	190544.69	95272.35	6.69	< 0.05	S
Vd	//	//	58.59	29.29	6.22	< 0.05	S
Hd	//	//	53.05	26.52	4.64	< 0.05	S
PrepL	//	//	4859.03	2429.51	6.17	< 0.05	S
ioW	//	//	176.28	88.14	6.20	< 0.05	S
PoL	//	//	372.22	187.61	8.32	< 0.0001	HS
PdL	//	//	9739.27	4869.63	5.60	< 0.05	S
PaL	//	//	41009.54	20504.77	6.23	< 0.05	S
PeL	//	//	522.42	261.21	4.84	< 0.05	S
HL			3276.21	1638.10	6.07	< 0.05	S
Cd			2358.73	1179.36	9.88	< 0.0001	HS

Conger conger

Study of morphometric characteristics of *C. conger* was carried out on 123 females, captured from Bizerte, Ghar el melh and Haouaria. Morphometric parameters are represented in Table VI.

Table VII presents the results of the analysis of the variance between the three sites. The results of the analysis of the variance show significant differences for the parameters TL, Vd, Hd, PrepL, ioW, PdL, PaL, PeL and HL, and highly significant differences for the two variables PoL and Cd between the three study areas. This analysis is reinforced by Duncan's test (Table VIII). The two populations of Ghar el melh and Haouaria show morphometric similarities whereas the population of Bizerte forms an isolated group. For the parameter Hd, the population of Ghar el melh constitutes an intermediate group between the two other populations. We used the seven

Table VIII. – Multiple comparisons of means between body measurements for *C. conger* (Duncan's test). $\bar{X}$ estimated average.

Parameters	Bizerte		Gar El Melh		Haouaria	
	$\bar{X}$	Group	$\bar{X}$	Group	$\bar{X}$	Group
TL	664.17	A	741	B	753.02	B
Vd	10.30	A	11.29	B	11.98	B
Hd	14.36	A	15.19	AB	15.97	B
PrepL	100.41	A	112.86	B	114.49	B
ioW	15.18	A	17.44	B	17.92	B
PoL	25.11	A	28.14	B	29.24	B
PdL	140.04	A	157.74	B	159.91	B
PaL	276.01	A	308.63	B	318.82	B
PeL	33.29	A	37.63	B	37.70	B
HL	83.68	A	91.03	B	96.26	B
Cd	36.42	A	45.60	B	45.81	B

Table IX. – Matrix of correlation coefficients between six measurements variables of *C. conge*

Parameters	TL	Hd	ioW	PoL	PaL	HL	Cd
TL	0						
Hd	0.85921	0					
ioW	0.87094	0.81998	0				
PoL	0.94192	0.85496	0.88947	0			
PaL	0.9605	0.86792	0.88515	0.94633	0		
HL	0.92417	0.85786	0.85252	0.94167	0.92716	0	
Cd	0.89207	0.78695	0.85643	0.84183	0.88012	0.83098	0

Table X. – Absorption of change from the first two axes and their meaning in relation to the six measurement variables.

Components	Axis 1	Axis2
Own values	6.28	0.22
% of total variation	89.81	3.27
% accrued	89.81	93.08
Variable components		
TL	0.97	0.01
Hd	0.91	–0.28
ioW	0.93	0.14
PoL	0.96	–0.06
PaL	0.97	–0.008
HL	0.95	–0.12
Cd	0.91	0.32

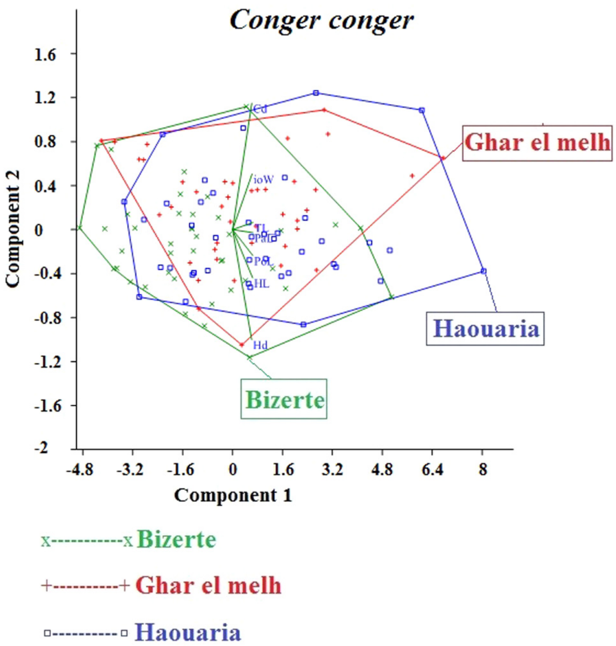

Fig. 4. – Principal component analysis (PCA) of morphometric characteristics of *C. conger*.

most discriminating parameters (TL, Hd, ioW, PoL, PaL, HL and Cd) according to the variance analysis and Duncan's test. The matrix of correlation coefficients between variables shows positive values (Table IX).

The PCA shows that the two first axes comprise 93.08 % of the total variance. According to the importance of each axis, we find that the axis 1 and 2 are the most discriminating, while the remaining axes provide secondary information; for this reason, we only use these axes (Table X). Axis 1 absorbs 89.81 % of the total variation; the seven variables indicate positive correlations. On the negative side of axis 1, we find the population of Bizerte. Populations of Ghar el melh and Haouaria are on the positive side of this axis with the highest values of all parameters. The axis 2 absorbs 3.27 % of the total variation; it is defined mainly by the parameter Cd. On the positive side of this axis, Cd attracts the two populations Ghar el melh and Haouaria. The variable Hd pushes the two populations of Bizerte and Ghar el melh towards the negative side of this axis (Fig. 4).

DISCUSSION

Our samples came from three different sites (Bizerte, Ghar el melh and Haouaria) located in the north coast of Tunisia.

Nine body parameters were measured. The comparison of the means of the different variables by the Mann-Whitney U test shows significant differences between the two sexes; males are bigger than females. Similar results have been reported for other Anguilliformes (Cau & Manconi 1983, Holmgren & Wickström 1993, Casadevall *et al*. 2017). We recorded a highly significant difference between the two sexes concerning the following parameters: pre-orbital length (PoL), vertical eye diameter (Vd) and horizontal eye diameter (Hd). There is a phenotypic differentiation between males and females of the same species (Dimijian 2005).

For males, the analysis of variance of nine parameters allowed us to identify some differences between the three populations (Bizerte, Ghar el melh and Haouaria). TL, PoL, ioW and PaL show significant differences ($p < 0.05$), while Cd presents a higher significant difference ($p < 0.0001$). According to Duncan's test, two distinct groups appear; A: Bizerte and Haouaria and B: Ghar el melh. PCA justifies these findings since the population of Ghar el melh differs morphologically from group A (Bizerte and Haouaria). Ghar el melh individuals show the highest body measurements.

For females, analysis of variance shows differences between the three populations (Bizerte, Ghar el melh and

Haouaria). All the parameters are discriminating. TL, Hd and PoL present significant differences ($p < 0.05$), whereas HL, PdL, Vd, ioW, Cd and PaL show highly significant differences ($p < 0.0001$). Duncan's test reveals two clear groups; A: Bizerte and Ghar el melh and B: Haouaria. PCA using five parameters (TL, PoL, ioW, Cd and PaL) confirms these results. The population of Haouaria differs morphologically from group A (Bizerte and Ghar el melh). Females of Haouaria show the greatest sizes.

The variation of the parameters (TL, PoL, Cd and PaL) is linked to the sex (Mann-Whitney U test, $p < 0.05$), to the characteristics of the habitat, such as temperature, turbidity, availability of food and currents (Barlow 1961, Dynes *et al.* 1999) and to the commercial value of the species; according to the sites of capture, the populations showing the largest dimensions are the least exploited. The variation of the interorbital width (ioW) is independent to the sex (Mann-Whitney U test, $p > 0.05$) and it is correlated to the width of the head (Costa *et al.* 2003).

The number of distinctive parameters varies between males and females: five parameters in males and nine in females. Influence of environmental factors on morphometric characteristics is clearest in the coastal habitats, because these areas are more influenced by environmental changes and human activity.

Samples of *C. conger* did not include males. The absence of males has been reported in Atlantic coastal waters (Sbaihi *et al.* 2001, O'Sullivan *et al.* 2003). Similar results were also obtained in the west coast of the Iberian Peninsula (Correia *et al.* 2009), and in the Adriatic Sea (Matić-Skoko *et al.* 2012), where samples studied included a reduced number of males. The absence of males in our samples can be explained by the fact that females and males exhibit different migratory habits during their life cycle (Matić-Skoko *et al.* 2012).

Analysis of variance reveals differences between samples from the three sites. Nine parameters show significant differences ($p < 0.05$) and two variables (PoL and Cd) present highly significant differences ($p < 0.0001$). Duncan's test indicates the existence of two morphological groups; the population of Bizerte forms a separate group and individuals of Ghar el melh and Haouaria constitute together the second group. The PCA confirmed these results; females of Ghar el melh and Haouaria show the greatest measures, these two coastal localities are more favorable for the growth of *C. conger* than Bizerte.

For *C. conger,* the PCA was defined by seven parameters (TL, Hd, ioW, PoL, PaL, HL and Cd), the different morphometric characteristics are probably due to environmental factors such as climatic and nutritive conditions of habitat (Chaklader *et al.* 2016, Chakravorty *et al.* 2016). Environmental conditions can influence the development of distinctive morphometric characteristics or the adaptations of fish populations (Murta 2000, Imre *et al.* 2002, Sreekanth *et al.* 2012). Axis 2 of PCA is defined by two remarkable parameters, Cd and Hd. The Cd has been projected on the positive side of this axis. The variation in caudal depth could be a consequence of phenotypic plasticity in response to hydrological conditions of habitat (Imre *et al.* 2002). On the negative side, the parameter Hd is projected. The variation in eye diameter can reflect an adaptive behavior in fish species (Sajina *et al.* 2013). It can be attributed to the light intensity and turbidity of the habitat (Matthews 1988).

Individuals of both species in Bizerte represent the smallest sizes. This morphological peculiarity can be explained by the anthropogenic factors. Indeed, Bizerte city is bigger than Ghar el melh and Haouaria and the fishing activity there represents a greater socioeconomic importance.

CONCLUSION

This study provided additional information on the morphometric characteristics of *M. helena* and *C. conger* in Tunisia. It would be interesting to complete analyzes to explain the morphometric segregation of individuals between the different capture sites in order to propose a rational fisheries management.

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