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Some morphometric and meristic parameters of the Moroccan Atlantic anchovy *Engraulis encrasicolus* (Linnaeus, 1758)

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ABSTRACT

This study was conducted to investigate some morphometric and meristic parameters of anchovies *Engraulis encrasicolus* caught in the Moroccan Atlantic coast. The fish samples were monthly collected from commercial catches between January to May 2017. 344 individuals were collected from the principal ports of the Moroccan Atlantic Ocean, with significant climatic changes and different geographical situations. The ports under study are: Larach, Assilah, Casablanca, Agadir, and Laâyoune. To study the possibility of local disparity, two nearby ports were chosen, Larach and Assilah, with a distance less than 50 km. An abundance of females was observed for all samples, with a maximum total length of 144 mm. Twenty-two morphometric characters were measured, and four meristic characters were counted for every individual. The correlation test results showed a strong correlation between the total length and the other morphological characters, except those related to the head of the individuals. A significant difference was found for all variables concerning the three factors: age, sex and port. After studying the variation of individuals with the port factor, all the samples overlap, so we couldn't distinguish a different group along the two axes. These results are consistent with the meristic study results. Comparing our results with those of other researchers, it appears that the morphological variation found is mainly related to environmental changes.

INTRODUCTION

The European anchovy, *Engraulis encrasicolus* **(Linnaeus, 1758)** is a pelagic fish, belonging to family Engraulidae. The most remarkable morphometric character is the elongation of the snout, which is pointed forming a kind of rostrum over a mouth, exceeding the posterior edge of the eye **(Hemida, 1987; Laloë & Alassane, 1989)**.

Anchovy is a small gregarious fish found in many seas and oceans of the world. With rapid growth associated with a short life, it is exceptional to find individuals exceeding 3 years **(Quéro, 1984)**.

In Morocco, detections of anchovies in the Mediterranean Sea are limited to few individuals in the eastern part. In the North Atlantic Ocean, anchovy shows a discontinuous distribution with low amounts.

The most important quantity is in Assilah and Rabat, in the offshore of Casablanca and the South of El Jadida. At the Central Atlantic zone, the distribution of anchovies is very extensive on the continental shelf. The concentration maximums are reached at Agadir area, between Tantan and FoumAgouitir, and between Laayoune and Boujdor. However, anchovy distribution is generally low and is limited between Dakhla and Lagouira, especially at Cap Barbas **(Demir, 1965)**.

Anchovy is the subject of few scientific studies in Morocco, among which the reproduction of the Atlantic coastal species of Morocco was reported **(Furnestin & M. Furnestin, 1953)**. In addition, the importance of hydrological parameters in the distribution of eggs and larvae of small pelagics of southern Morocco and the Moroccan Atlantic was assessed in the study of **Berraho *et al.* (2005)**. Furthermore, **Kada *et al.* (2009)** reported the contribution to the identification, biological, and dynamic characterization of anchovy in the lagoon of Nador. While, a study was conducted on the reproduction of anchovy *Engraulisencrasicolus* (Actinopterygii, Engraulidae) in the central area of the Moroccan Atlantic coast **(Baali *et al.*, 2017)**.

The morphological and biological characters of the anchovy are different; this difference allowed **Fage (1920)** to classify the anchovy *Engraulis encrasicolus* into two major populations; namely, the Atlantic population and the Mediterranean population. Most researchers who worked on this species used these morphological variations to distinguish different population and local populations **(Arne, 1931; Jose maria & francisco, 1952; Jean & Marie, 1953; Arrignun, 1966; Shevchenko, 1980; Hemida, 1987; Alexander, 1996)**.

The present study aimed at comparing geographically distant populations of anchovy *Engraulis encrasicolus* from the Moroccan Atlantic coast based on conventional morphometry and meristics.

MATERIALS AND METHODS

Study Area

Morocco is a maritime country with peculiarities that have qualified it to be a unique country. Morocco is known for its geographical location, the presence of two maritime sides, its coasts extending over 3500 km, as well as the particularity and the originality of its maritime water, which constitute an exclusive economic area.

Common anchovy is distributed in the northeast Atlantic from Morocco to the North and Baltic seas **(Bohdan & Mirosła, 2004)** and in the Mediterranean and the Black seas **(Quéro, 1984)**. It is particularly abundant in the bay of Biscay, along the Spanish coast **(Re *et al.*, 1983)** and in Moroccan Atlantic seas.

The Moroccan Atlantic coast is influenced by a coastal upwelling through which it is divided into four zones (**INRH, 2012**) as follows:

Zone 1 between 32.2 et 35.6°N, characterized by a low upwelling in this area.
The upwelling presents a strong seasonality, with a very low activity during the cold season.
Zone 2 between 28 et 32°N. The upwelling in this area is higher compared to the first area.
Zone 3 between 25. 5°N and 28 °N. The intensity of the upwelling increases slightly compared to the previous zone.
Zone 4 between 21.3 ° N and 25.5 ° N. This zone is very disturbed, where it meets the North Atlantic Central Water and the South Atlantic Central Water. The upwelling index in this area is the most unstable and the highest of all areas.

In our study, samples were taken from five ports on the Atlantic coast of Morocco, with a different geographical situation: Assila, Larach, Casablanca, Agadir, and Laayoune that are presented in Fig. (1).

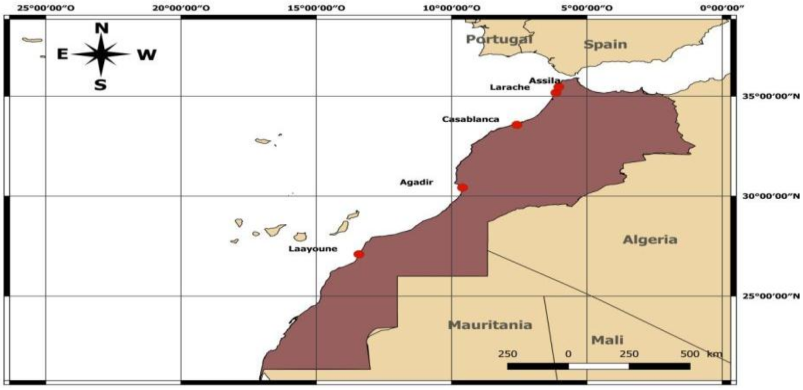

Fig. 1. Sampling locations of Anchovy in the Moroccan Atlantic coast

1.1 Sampling Methods

A number of 344 individuals of anchovy were measured for the morphometric and meristic study. The sampling was carried out from January to May 2017. Sampling with a number not less than 80 individuals in every port forms the strategy of the current study, but after analysis, some individuals were not considered because they have fewer body parts. Table (1) summarizes details of the samples. Sampling operations were conducted from commercial capture; measurements were usually taken after captures immediately.

1.2 Morphological analysis

1.2.1 Morphometric and meristic study

Twenty-two morphometric measurements (Fig. 2) were selected based on previous studies **(Arrignun, 1966 ; Quignard *et al*., 1973; Laloë & Alassane, 1989; Tudela, 1999; Kada *et al.*, 2009)**. Only the total length and the fork length were measured using an ichthyometer, the other measurements were taken with the image j software 1.50b **(Abràmoff, 2004; Schneider *et al.*, 2012)**. Four meristic variables were chosen to achieve reasonably reliable counts with less error risk **(Tudela, 1999)**. The meristic and morphometric variables measured for the individuals are shown in Table (2).

1.3.2 Data analysis:

Morphometric and meristic data was analyzed using:

Pearson correlation is used to measure the correlation between different variables and to determine their correlation values **(Hogg & Allen, 1978)**

The principal component analysis (PCA) is used to determine the existence of a significant difference between the morphometric characters of individuals in the different sampling stations **(Husson, 2017)**.

The multivariate analysis of covariance (MANCOVA) is used to test intra-sample homogeneity; it was carried out separately on each sample with sex, port, and age as factors **(Linda, 2013)**. To determine the age factor, individuals were grouped in two categories: larger or smaller than 115mm; this size according to **Pertierra (1992)** corresponds to the individuals of one year.

The covariance analysis (ANCOVA) is used to test the among-sample homogeneity of each variable for the entire set of samples **(ABDI, 1987)**.

The analysis of the present data were carried out using the **software R (R Core Team, 2018)**

Kruscal-Wallis test is used to examine the revelation of the existence of the effect of geographical division on meristic characteristics **(Mili, 2004)**.

1.3 Sex-ratio

The anchovy does not present sexual dimorphism; the determination of the sex was made by direct examination of the gonads after opening the abdominal cavity **(Mili, 2004)** (Table 1)

$$\text{Femininity rate \%} = \frac{Number\ of\ females}{Total\ samples}$$

$$\text{Masculinity rate \%} = \frac{Number\ of\ males}{Total\ samples}$$

$$\text{Sex-ratio} = \frac{Number\ of\ males}{Number\ of\ females}$$

Table 1. Samples used in the morphometric and meristic study

Sample	Sex	N	Length range(mm)	Mean length (mm)	Femininity/ Masculinity rate %	Sex-ratio
Agadir	Males	25	108.75-120.96	120,96	38%	
	Females	41	105.49-138.481	119,26	62%	
	Total	**66**	**102.91-138.481**	**117,60**		0,61
Assila	Males	26	108.12-144.09	123,672	38%	
	Females	43	108.12-144.091	123.90	62%	
	Total	**69**	**108.12-144.091**	**123,672**		0,60
Laayoune	Males	36	83.75-126.66	102.19	53%	
	Females	32	85.53-121.95	102.98	47%	
	Total	**68**	**83.75-126.66**	**102.56**		1,13
Larach	Males	15	109.89-129.14	119.69	21%	
	Females	55	111.77-144.10	127.32	79%	
	Total	**70**	**109.89-144.10**	**125.64**		0,27
Casablanca	Males	16	105.79-119.78	112.86	23%	
	Females	54	103.13-129.15	115.17	77%	
	Total	**70**	**103.13-129.15**	**114.65**		0,30

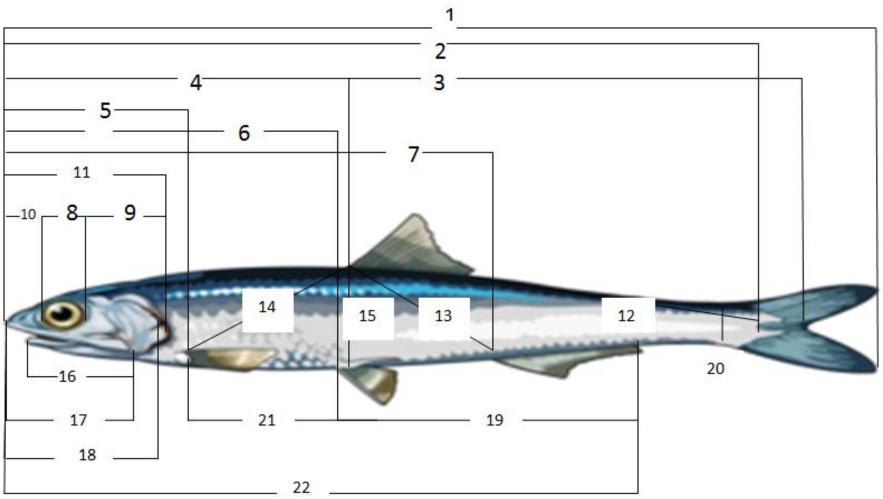

Fig. 2. Morphometric measurements taken on individuals

Table 2. Morphometric and meristic variables

Number	Name	Description
Morphometric measurements		

1	TL	Total length
2	SL	Standard length
3	FL	Fork length
4	SNDO	Distance between snout and insertions of dorsal fins
5	SNPC	Distance from the tip of snout to insertion of left pectoral fins
6	SNPV	Distance from the tip of snout to insertion of left pelvic fins
7	SNAN	Distance from the tip of snout to insertion of anal fins
8	ORW	Orbital width
9	OROP	Distance between orbit and operculum
10	SNOR	Snout length
11	SNOP	Distance between Snout and operculum
12	DOCA	Distance between dorsal and caudal fins
13	DOAN	Distance between insertions of dorsal and anal fins
14	PCDO	Distance between insertions of left and dorsal fins
15	PVDO	Distance between insertions of pelvic and dorsal fins
16	SNMAN	Mandible length
17	SNMAX	Maxillary length
18	SNPOP	Distance from tip of snout to pre-operculum
19	ANL	The base length of anal fins
20	PEDH	Peduncle height
21	PCPV	Distance between insertion of left pectoral and pelvic fins
22	PVAN	Distance between insertions of left pelvic and anal fins
Meristic data:		
1	ND	Number of fin rays on dorsal fin
2	NA	Number of soft rays on anal fin
3	NV	Number of soft rays on pelvic fin
4	NP	Number of soft rays on pectoral fin

RESULTS

2.1 Sex-ratio

The total femininity rate % was higher than the muscularity rate% for the four study areas, with 62% in Agadir and Assilah, 79% in Larach and 77% in Casablanca. Except for Laayoune, the sex ratio was equal to 1.13, with a low dominance of males (Table 1)

2.2 Morphometric data

The Pearson correlation matrix shows an important correlation of total length with other metric variables, except for five, viz. orbital width ORW, snout length SNOR, mandible length SNMAN, maxillary length SNMAX and distance from the tip of snout to pre-operculum SNPOP with the following values: 0.4423, 0.3706, 0.4415, 0.4005 and 0.3753, respectively (Table 3).

The principal component analysis (PCA) expresses a percentage of 59.45% variance with the first component factor (Dim 1) of the overall variance. While, the second component factor (Dim2) explained 11,70%. Fig. (3) shows that, all variables express a positive correlation with the first component.

In addition, Fig. (4) shows the groups of individuals compared to an additional quantitative variable that is the PORT. Every population is presented by a different color. The ellipses that represent the five populations overlap concerning the two axes.

Table 3. Results of Pearson correlation of length versus morphometric characters

Morphometric measurement	**Correlation of Pearson relative to the total length (TL)**
TL	1.0000000
SL	0.9900833
FL	0.9522933
SNDO	0.9016229
SNPC	0.7559248
SNPV	0.8728372
SNAN	0.9460956
ORW	0.4423823
OROP	0.7424531
SNOR	0.3706254
SNOP	0.6652685
DOCA	0.9492563
DOAN	0.8415083
PCDO	0.8399883
PVDO	0.7650580
SNMAN	0.4415530
SNMAX	0.4005162
SNPOP	0.3753229
ANL	0.6398663
PEDH	0.5270020
PCPV	0.5358360
PVAN	0.6938963

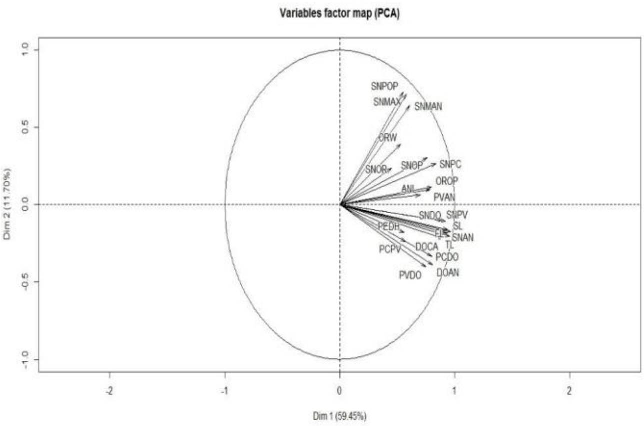

Fig. 3. Principal component analysis of morphometric variables

The MANCOVA analysis performed on all the samples showed that the port and age factors were highly significant (P <0.001), and the sex factor was significant (P <0.01) as shown in Table (4).

Table 4. Results of the MANCOVA performed on all samples, including all morphometric variables

	Df	**Wilks**	**Approximate F**	**Pr(>F)**
PORT	4	0.04346	17.1625	< 2.2e-16 ***
SEX	1	0.87418	2.0609	0.003887 **
AGE	1	0.62966	8.4213	< 2.2e-16 ***
Residuals	336			

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’

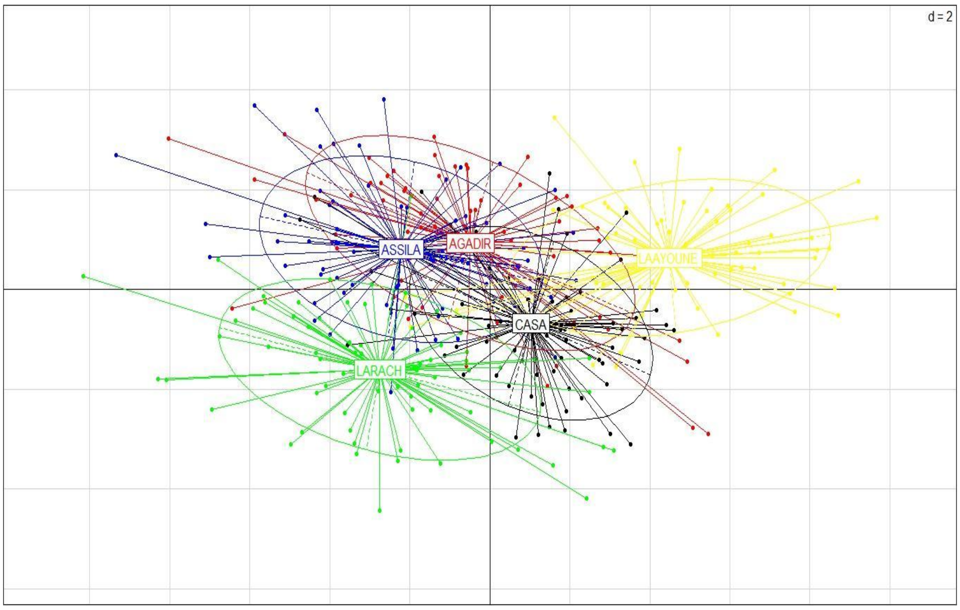

Fig. 4. Principal component analysis of morphometric variables for the five ports (Agadir, Assilah, Larach, Casablanca, and Laayoune)

The ANCOVA analysis for every variable related to the factors of port, sex, age, and the interaction between the three show a significant difference. They are presented in Table (5) as follows:

- For the **port** factor, 18 variables showed a significant difference with P<0,001.
- For the **age** factor, 15 variables showed a significant difference with P<0,001, and 6 variables with a non-significant difference, they all related to the head measurements.
- For the **sex** factor, 7 variables showed a significant difference with P<0,001, and 10 variables with a non-significant difference.

2.3 Meristic data

The Kruskal-walis test is used to examine the revelation of the existence of the effect of geographical division on meristic characteristics cited in (Table 2). The Kruskal-walis test at a 5% threshold shows that there is no significant difference between the five studied areas (Table 6).

Table 6. Kruskal Wallis test of meristic characteristics

Kruskal-Wallis Test	Chi-squared	Df	P-value
	1218.2	3	P< 2.2e-16

DISCUSSION

The feminine rate is dominant in all the ports, except for Laâyoune, the sex ratio equals 1.13. This dominance was observed in anchovy (*Engraulis encrasicolus*) on the Atlantic coast in the study of **Coupe and Jean (1950)** and in the region of Algeria in **Hemida (1987)**. Additionally, **Mouna *et al.* (2018)** found that female individuals are abundant during the warmest months (April to August) in the central area of the Moroccan Atlantic coast.

Thus, there is a female dominance in small and large sizes. **Hemida (1987)** explained this dominance by high natural mortality in males. For **Mili (2004)**, this phenomenon is due to the high vulnerability of females to fishing gear. Moreover, **Arrignun (1966)** recorded the dominance of females on the Oranie coast, especially during the breeding period (May-June) and noted the appearance of a high proportion of males from July until October.

The maximum average length was 14,4 cm it was a female of Larach and Assilah, and the minimum average length was 8,37 cm for a female in Laâyoune, where small anchovies are mostly found in individuals collected at Laayoune. No individuals exceeded 14,4 cm, while **Mouna and Yahyaoui (2020)** assessed 18 cm as the maximum size of the anchovies collected from the central area of the Moroccan Atlantic coast.

Pearson's correlation matrix showed a significant correlation of total length with the other morphometric characteristics, except for five variables, with traits related to the heads of individuals: ORW, SNOR, SNMAN, SNMAX, and SNPOP.

In Algeria, **Mezedjri and Tahar (2007)** detected a significant difference of two morphometric characters related to the head comparing between the two sexes. On the contrary, **Tudela (1999)** addressed 7 chosen sites between the Spanish and the Italian coast, in spite of their proximities, and noted significant differences, whereas the MANOVA did not present any significant difference between sexes. For the rest of the variables, our study confirms those which have shown that the main morphological characters of anchovy are related to size either in the opposite direction or in growth **(Jean & Marie, 1953; Arrignun, 1966)**.

PCA shows a significant difference in 5%, all linear measurements showed a positive linear correlation with the first principal components (Dim1). The second principal components (Dim2) showed a negative linear correlation with (TL), (SL), (FL), (SNDO), (SNPV), (SNAN), (DOCA), (DOAN), (PCDO), (PVDO), (PEDH) and (PCPV).

(SNOP), (SNMAX), (SNMAN), (ORW), and (SNOP) are correlated with each other; all these variables are related to the individual's head.

Tudela (1999) found a significant difference at 0.1% between 14 variables (including 12 of referring to head measurements) and sex. And to maintain possible allometric differences among samples and between sexes, standardization was carried out separately on males and females for each of the seven groups analyzed. The reference size chosen was 110 mm, since this value was found to be within the size-ranges of the 14 groups under consideration. No correlation was found between size and the first factor of the PCA. And when the PCA is applied to the raw data matrix without standardization, a strong correlation has been observed. The two ports "ASSILAH" and "LARACH " are very close at 49 Km, but between "AGADIR" and "ASSILAH " there is more than 790 km distance.

The comparison of the groups of individuals with "PORTs", AGADIR and ASSILAH show a major overlap, that makes ASSILAH closer to AGADIR than LARACH.

LAAYOUNE, who is a little isolated from other groups, showed a difference in morphological characters compared to other populations.

Univariate analysis of variance (ANOVA) shows a significant difference between the five sites for all morphometric variables. The results of multivariate analysis of variance (MANOVA) confirm those obtained by univariate analysis.

Regarding the sex factor, the ANOVA shows that 12 morphometric variables "TL, SL, FL, SNDO, SNPV, SNPC, SNAN, SNOR, DOCA, DOAN, PCDO, PVDO" make it possible to confirm differences between the two sexes for five sites.

For the age factor, 15 morphometric variables make it possible to show significant differences between five sites except 7: variables (SNMAX, SNPOP, ANL, PEDH, PCPV, PVAN).

Tudela (1999) used a MANCOVA to test the homogeneity between all the samples, and between each pair. And an ANCOVA test to test inter-sample homogeneity.

For both tests, standard length was considered as a covariate and sex as a second factor. Examination of the significance of the sex factor in each sample showed that sexual dimorphism was limited to samples from two areas. The results found are:

- MANCOVA analysis carried out on all the samples showed that samples and the sex factor were highly indicative, and between every two pairs confirmed the high morphology heterogeneity of the samples.
- For ANCOVA a very significant difference was also found between samples for almost all variables

After studying the variation of individuals with the port factor, all the populations overlap so we can't distinguish a different group along the two axes. These results are consistent with the meristic study results.

The Kruskal Wallis test shows that there is not a significant difference between the five localities for the four meristic characters (number of dorsal fins, number of anal fins, number of pelvic fins, and number of pectoral fins) mentioned in the comparison.

According to **Junquera and Perez-Gándaras (1993)**, meristic data were not as effective as morphometric data in the discrimination of anchovy from northern Spain and the Bay of Biscay.

Morphometry and meristics are two types of morphological characteristics most used to differentiate between species, and populations **(Mouna *et al.*, 2020).**

Tudela (1999) carried out a morphological and meristic analysis to study the variation of the anchovy (*Engraulis Encrasicolus*) collected from representative sites in the northwestern Mediterranean Sea, a region inhabited by a homogeneous population of this species.

Morphometric and meristic data indicated an interaction between the biology of the species and its environment.

The variation in these traits at the start was thought to be entirely genetic, now both genetic and environmental **(Steven and Kevin, 1999).** So morphological variation may reflect genetic and/or environmental differences between localities.

It is also used as well as a stock identification tool, **Steven and Kevin (1999), Silva (2003) and Erguden *et al*.(2009)** used distance and morphometric data to study variation in the northeast Atlantic sardine (*Sardina pilchardus*). This method indicated that *Sardina pilchardus* from southern Iberia (Southern Portugal, Gulf of Cadiz) and northern Morocco has a distinct morphology compared to other regions.

The anchovy *Engraulis Encrasicolus* belongs to the small pelagic group, which is made up of all small fishes that spend most of their adult stage on the surface or in the high sea. These species are completely free from the bottom and are independent of the Nature of the substrate **(Laloë and Samba, 1990)**.

Table 5: Results of ANOVA for each morphometric variable, performed on all samples.

Variable	Port		Age		Sex		Interaction PORT:AGE: SEX	
	F(4,327)	P	F(1,327)	P	F(1,327)	P	F(1,327)	P
TL	142.3598	< 2.2e-16 ***	156.5635	< 2.2e-16 ***	18.5102	2.235e-05 ***	1.2167	0.27082
SL	153.6353	< 2.2e-16 ***	154.3030	< 2.2e-16 ***	19.8508	1.151e-05 ***	1.0920	0.29680
FL	119.6572	< 2.2e-16 ***	123.1552	< 2.2e-16 ***	13.1503	0.0003333 ***	0.9467	0.3312675
SNDO	73.9508	< 2.2e-16 ***	100.1184	< 2.2e-16 ***	10.4351	0.001362 **	0.1110	0.739253
SNPC	35.8895	< 2.2e-16 ***	45.6085	6.61e-11 ***	5.7150	0.01739 *	0.0253	0.87375
SNPV	62.0178	< 2.2e-16 ***	94.1126	< 2.2e-16 ***	13.9832	0.0002177 ***	0.9263	0.3365366
SNAN	114.7630	< 2.2e-16 ***	123.2688	< 2.2e-16 ***	19.6330	1.282e-05 ***	0.0092	0.92383
ORW	23.7068	< 2.2e-16 ***	14.9095	0.000136 ***	1.7922	0.181585	0.0621	0.803302
OROP	34.3934	< 2.2e-16 ***	48.9501	1.491e-11 ***	3.7513	0.05363	1.3374	0.24833
SNOR	3.7390	0.0054408 **	13.2610	0.0003149 ***	7.2871	0.0073063 **	1.2185	0.2704747
SNOP	28.7494	< 2.2e-16 ***	17.9418	2.965e-05 ***	3.5343	0.0609994	0.4340	0.5105101
DOCA	162.9673	< 2.2e-16 ***	118.5134	< 2.2e-16 ***	17.0989	4.515e-05 ***	1.5786	0.20986
DOAN	151.0798	< 2.2e-16 ***	46.4740	4.488e-11 ***	8.9233	0.003028 **	2.5545	0.110943
PCDO	68.1794	< 2.2e-16 ***	81.4661	< 2.2e-16 ***	10.6086	0.001244 **	0.9826	0.322281
PVDO	135.6855	< 2.2e-16 ***	56.3119	5.905e-13 ***	12.8312	0.0003927 ***	0.4564	0.4997678
SNMAN	42.2002	< 2e-16 ***	5.6679	0.01784 *	1.6002	0.20675	0.6223	0.43078
SNMAX	4.8829	0.000776 ***	0.0397	0.842188	0.5697	0.450940	0.0011	0.974075
SNPOP	4.8135	0.0008739 ***	0.0277	0.8679284	0.4866	0.4859224	0.0004	0.9841206
ANL	4.2212	0.002402 **	0.0291	0.864762	0.4800	0.488912	0.0000	0.996072
PEDH	4.4009	0.001769 **	0.0437	0.834497	0.5345	0.465224	0.0009	0.976367
PCPV	4.7398	0.0009915 ***	0.0214	0.8837394	0.6908	0.4064853	0.0027	0.9588700
PVAN	4.3003	0.0021 **	0.0329	0.8562	0.5019	0.4792	0.0000	0.9948

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’

The influence of environmental variations in sea surface temperature (SST), chlorophyll-a concentration, precipitation, and sea level on their biology and fluctuations in their availability and abundance has been put into evidence in many fisheries around the world **(Belveze and Erzini, 1983; Fréon, 1988; Binet, 1995; Csirke, 1995),** highest concentrations of most species in this group are found in highly productive coastal upwelling areas. **(Stephenson *et al.*, 2015)**

Feuilloley (2020) examined whether environmental changes were the cause of the decrease in the condition and size of small pelagic, in the Mediterranean Sea, the Gulf of Lions.

The results found indicate that the environmental conditions have been changed in the Gulf of Lions which affected the production of plankton and consequently the community of small pelagic.
Also, **Patti *et al.(* 2004), Lloret *et al*. (2004), Basilone *et al.* (2004), Lafuente *et al.* (2005), Santojanni *et al.* (2006)** and **Ma *et al.* (2019)** used the monthly SST as an indicator of thermal conditions in the Chinese seas to explore regional marine thermal variation and their relationship to catches of small pelagic fish. The results obtained indicate that the small pelagic fish of the Chinese seas have been largely affected by the changing climatic conditions.

Studies conducted in the Mediterranean Sea are focused on the biology of anchovies and the variability of yields, and their link with environmental conditions, which can affect different stages of their life. Thus, habitat conditions have been linked to the growth, reproduction, abundance, recruitment, and landings of anchovy **(Basilone *et al.*, 2004; Lloret *et al.*, 2004; Patti *et al*., 2004; Santojanni *et al.*, 2006; Ma *et al.*, 2019)**.

Turan *et al.* (2004) studied the morphometric structure of the anchovy (*Engraulis encrasicicolus*) in the Black Sea, the Aegean Sea, and the northeastern Mediterranean Sea. He considered that the distinction model detected among the anchovy samples suggests a direct relationship between the extent of morphometric divergence and geographic separation.

Mahmoud *et al.* (2010) also studied the relationship between age, growth, diet, and environmental parameters for anchovy (*Engraulis encrasicolus)* in the bay of Bénisaf (South-west of the Mediterranean Sea, west coast of Algeria) and there was a significant relationship between SST and anchovy size at 1 year of age.
Our samples are taken in different geographical areas, so different hydrological characteristics (water surface temperature, salinity, current, etc.), all allowed us to link the difference found especially to the environmental variations of the fishing areas.

CONCLUSION

The anchovy *Engraulis encrasicolus* (L, 1758) is represented by two major breeds: the Atlantic race and the Mediterranean race. Within each race, we define a set of groups or populations characterized by metric and meristic criteria that differentiate them from other groups. According to the study carried out on the variability of some morphometric and meristic characters, we can notice that there is a gradient of anchovy variability from north to south through Casablanca, however, we have an exception of Larach and Assilah. These characters vary with port, age, and sex.

This study shows a significant difference in morphometric characters of anchovy (*Engraulis encrassicholus*) between the five sites studied. This variability is mainly due to environmental and genetic factors.

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