

# Comparative biometrics of Saurel *Trachurus trachurus* (Linnaeus, 1758) (Perciformes Carangidae) in the Algerian coast lines

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## ABSTRACT

During 2012–2013, a comparative biometric study was conducted on a coastal marine teleost fish of the Carangidae family *Trachurus trachurus* (Linnaeus, 1758). The comparison is made on the basis of seven samples obtained along the Algerian coastline. From East to West: El-kala, Annaba, Skikda, Collo, Jijel, Algiers, and Oran, carrying out 36 morphometric and meristic measurements on each fish. ANOVA Fixed-Variance Analysis of Variance shows the existence of significant differences between the seven sites for 36 variables, as well as the existence of a sexual dimorphism for 22 measured variables and the absence of significant differences for 14 variables out of a total of 36 studied variables. The comparison between the seven sites by MANOVA multivariate statistical tests confirms the results obtained by the ANOVA.

## KEY WORDS

Algerian littoral; biometric study; *Trachurus trachurus*; univariate statistical test.

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## INTRODUCTION

The study of the biometric or morphometric characters of the pelagic fish Saurel *Trachurus trachurus* (Linnaeus, 1758) (Perciformes Carangidae) by using morphometric and meristic measured variables on samples obtained along the Algerian littoral is the object of our research. In addition, it is the subject of numerous studies devoted to the various aspects of the biology of this species, *T. trachurus*, among which we may mention those of Letaconoux (1951), Macer (1977), Porumb & Porumb (1979), Korichi (1988), Arias & Drake (1990), Benzohra & Millot (1995), Choulika (2002), Mézédjri (2003), Grimes (2010), Slamene et al. (2012).

This study deals with the biometric comparison of seven sites of the Algerian littoral. Thus, the existence of a sexual dimorphism between males and females of the fish.

## MATERIAL AND METHODS

### *Data collection*

This study is carried out on fishes caught by using sardine nets and purse seines as fishing gear, trawlers, and small crafts.

The biometric study is based on seven samples obtained on the Algerian coast. From East to West:

El-kala, Annaba, Skikda, Collo, Jijel, Algiers, and Oran (Fig. 1).

A minimum sample of 30 individuals is taken into consideration at each site, respecting as much as possible all present size classes. Each individual is wrapped in a plastic film immediately after collection to avoid damage, and it is put in the freezer at  $-20^{\circ}\text{C}$ . In the laboratory, a series of 36 morphometric and meristic measurements are made on each fish (Table 1; Fig. 2). These measurements were made on the basis of previous studies to obtain as much information as possible on these fishes studied. All metric measurements are made, to the nearest millimeter, using a dry point compass. The meristic measurements are made, under a binocular loupe, by means of a count. Sex determination was performed after fish dissection.

### Statistical data analyses

*Univariate statistical analyses.* To describe well the different characteristics obtained in the sites, we calculated some basic statistical parameters such as the arithmetic mean ( $\bar{x}$ ), the variance ( $s^2$ ), and the standard deviation ( $s$ ).

To compare the averages for each of the 36 characteristics between the seven sites, we used the one-way, fixed-ranking model of the variance analysis. The gender factor is completely hierarchical to the site factor. This test consists in comparing the averages of several populations at random, simple and

independent random samples (Dagnélie, 1970, 2006).

This ANOVA univariate analysis of variance analysis was used to compare, on one hand, between the 7 sites, and on the other hand, between the sexes in the sites, the averages of the 36 variables.

The calculations are performed by using the Minitab software GLM procedure (Minitab s.s., 2013) for each of the 36 variables at the 7 sites.

*Multivariate statistical analyses.* The multivariate variance analysis or the dispersion analysis aim to compare the averages of more than two populations for several variables.

This method is an extension of the univariate variance analysis, in which we have several variables that were observed simultaneously on the same individuals.

The comparison of the 7 sites and between sexes in the sites for all 36 studied variables, was performed by using MANOVA multivariate variance analysis using three statistical tests which are: Wilk's lambda, Lawley-Hotelling, and Pillai's trace (Dagnélie, 1970, 1986, 2006).

The three tests cited above and proposed by Palm (2000) and Dagnélie (1970, 2006) are all asymptotically equal in power and no test can be recommended in a systematic way, in preference to others (Dagnélie, 1986). According to Huberty (1994), the Wilk's test is the most popular.

All calculations were performed by a statistical analysis of Minitab Version 16 and statistical processing software (Minitab s.s., 2013).

The bibliography consulted for this work, in addition to the one mentioned, is listed as follows: Letaconnoux (1951); Macer (1977); Porumb & Porumb (1979); Korichi (1988); Arias & Drake (1990); Benzohra & Millot (1995); Choulika (2002); Mézédjri (2003); Grimes (2010); Slamene et al. (2012); FAO (2013); Abla et al. (2018).

## RESULTS AND DISCUSSION

### Univariate statistical analyses

To better describe the different variables that characterize individuals (fish) studied in seven different sites and for each gender, we calculated some basic statistical parameters such as arith-



Figure 1. Location of study sites of the Algerian littoral: El Kala Gulf (1), Gulf of Annaba (2), Gulf of Skikda (3), Gulf of Collo (4), Gulf of Jijel (5), Bay of Algiers (6), Gulf of Oran (7).

metric mean ( $\bar{x}$ ), which is a position parameter and central tendency, the standard deviation ( $s$ ) which measures the dispersion of data around the mean ( $\bar{x}$ ), and the number that tell us about the importance of the data processed. The results of the description of the data obtained for the various variables and for a total of 334 studied fishes comparing between the seven sites of the Algerian coastline shows that the number of males is greater than the number of females for the sites of the Gulf of El-kala, Skikda, and Collo, while we note the opposite for the sites of the Gulf of Annaba, Jijel, Algiers, and Oran.

In contrast, the results obtained for the description of data by sex (sites) shows that the averages for the different variables are slightly higher for females than for males, except for the Gulf of Skikda, in which we note the reverse, with the averages of males higher than females. This may suggest a possible sexual dimorphism.

The comparison, firstly of the seven sites between them and, secondly, of both sexes in each site between them, was performed, and for each variable, using the univariate analysis of variance with two criteria fixed classification (sex and site) hierarchical model. The use of the univariate analysis variance ANOVA, and the results are obtained by using the GLM command of the MINITAB software.

The results of the ANOVA applied to each of the 36 variables measured are included in Table 2 to the comparison between the sites and between two sexes in the sites.

We now have to compare between the seven sites the equality of the averages of each measured characteristic.

Examination of Table 2 shows the existence of very highly significant differences between the 7 sites for all 31 morphometric measured variables and the meristic variables with the exception of one variable: Brsu, where the differences are highly significant at the level  $\alpha = 1\%$ .

Moreover, the examination of Table 2 shows the absence of significant differences for 14 out of 36 variables. The variables that show significant differences at the  $\alpha = 5\%$  level are Lt, Lppc, Lcep, Lpdo, Poor, Pror, Lcra, Lapc., Hpv, Hdo, Hpdc, Baan, dopc, pcpv, pvan. Variables where the differences are highly significant are: Lf, Lppv, Dopv, Lpop, Bado. The variables doan and Hpc have very highly significant differences at the level  $\alpha = 0.1\%$ .

Number	Code	Description
<b>Morphometric measurements</b>		
1	Lt	Total length
2	Lf	At fork length
3	Ls	Standard length
4	Lpan	Length pre-anal
5	Lppv	Length pre-pelvic
6	Lppc	Length pre-pectoral
7	Lcep	Cephalic length
8	Lpdo	Length pre-dorsal
9	Dopv	Dorsal / pelvic distance
10	Doan	Dorsal / anal distance
11	Doca	Dorsal / Caudal Distance
12	Lman	Mandible length
13	Lmax	Maxillary length
14	Poor	Distance post-orbitaire
15	Dor	Diameter Orbital
16	Pror	Length Pre-orbital
17	Lpop	Length pre-operculum
18	Lain	Inorbital Width
19	Lcra	Head width
20	Mist	Length mandible / isthmus
21	Lapc	Distance between pectoral insertions
22	Hpc	Pectoral Height
23	Hpv	Pelvic Height
24	Hdo	Dorsal Height
25	Han	Anal Height
26	Hpdc	Peduncle Height
27	Bado	Dorsal Height
28	Baan	Anal Height
29	Dopc	Distance dorsal/pectoral
30	Pcpv	Distance pectoral/pelvic
31	Pvan	Distance pelvic/anal
<b>Meristic counting</b>		
32	Cæc	Cæc Number of pyloric caecum
33	Brin	Number of lower gill rakers of the 1st left branchial arch
34	Brsu	Number of upper gill rakers of the 1st left branchial arch
35	Rypc	Number of rays of the left chest
36	Rypv	Number of left pelvic rays

Table 1. Morphometric and meristic variables studied.

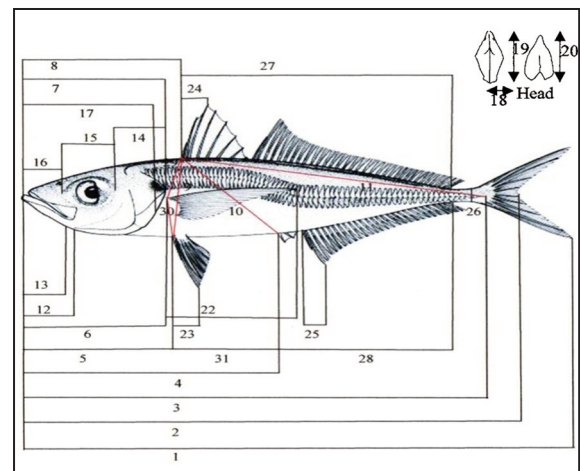


Figure 2. Morphometric measurements taken on each fish.

This leads us to conclude the existence of a sexual dimorphism between males and females for the 22 variables mentioned above.

### Multivariate statistical analyses

The MINITAB MANOVA command applied to the data obtained from the seven sites to perform the multivariate analysis with two fixed classification criteria and whose sex factor is hierarchical in the site factor, gives the results represented by Tables 3, 4.

For each of the two tables, the three Wilk's, Lawley-Hotelling, and Pillai's tests yield the same results. That is to say, the examination of Table 3 shows that the 3 tests conclude that there are very highly significant differences between the 7 sites, for all the morphometric and meristic observed characters on the *T. trachurus*.

In addition, the examination of Table 4 shows that the 3 tests lead to the absence of significant differences between the two sexes for each of the 7 sites for all 36 studied variables.

In the first case as in the second case, the MANOVA tests completely confirm the results of the univariate analysis of variance (ANOVA) obtained previously.

The significant differences found between the seven sites depend on several factors. It may be related to the dominant ecological factors in each region or they can also be due to the sampling period. The climate, the hydrodynamics, and water courses in each region are a source of nutrients for phytoplankton, which is the base of the trophic chain. In addition, the temperature differences between the different chosen stations can lead to significant differences and impact on reproduction.

### CONCLUSIONS

This work deals with morphometry (biometrics) of the Carangid pelagic fish on the Algerian coastline from East to West, Saurel *T. trachurus*.

The comparative biometric study between seven sites (El-kala, Annaba, Skikda, Collo, Jijel, Algiers, and Oran) shows that the use of the generalized linear model or the ANOVA analysis applied to each of the 36 measured variables, whether for the site factor or the sex factor in site, reveals the significant

Factors					
		Sites		Sexes (sites)	
n°	Variables	F	P	F	P
1	Lt	71.10	0.000***	2.63	0.012*
2	Lf	72.59	0.000***	2.82	0.007**
3	Ls	53.18	0.000***	0.90	0.504 ns
4	Lpan	55.66	0.000***	2.01	0.054 ns
5	Lppv	52.19	0.000***	2.97	0.005**
6	Lppc	65.96	0.000***	2.41	0.021*
7	Lcep	63.10	0.000***	2.31	0.026*
8	Lpdo	55.00	0.000***	2.67	0.011*
9	dopv	27.04	0.000***	2.93	0.006**
10	doan	40.53	0.000***	3.98	0.000***
11	doca	52.25	0.000***	0.90	0.511 ns
12	Lman	18.17	0.000***	1.38	0.212 ns
13	Lmax	4.20	0.000***	0.99	0.437 ns
14	Poor	44.59	0.000***	2.67	0.011*
15	Dor	29.16	0.000***	0.99	0.436 ns
16	Pror	31.55	0.000***	2.16	0.038*
17	Lpop	48.57	0.000***	2.82	0.008**
18	Lain	19.72	0.000***	1.58	0.142 ns
19	Lcra	42.55	0.000***	2.16	0.038*
20	Mist	33.87	0.000***	1.30	0.250 ns
21	Lapc	40.77	0.000***	2.14	0.040*
22	Hpc	52.32	0.000***	3.77	0.001***
23	Hpv	27.33	0.000***	2.33	0.026*
24	Hdo	33.29	0.000***	2.44	0.019*
25	Han	8.59	0.000***	1.35	0.226 ns
26	Hpdc	37.38	0.000***	2.06	0.048*
27	Bado	60.95	0.000***	2.82	0.008**
28	Baan	42.96	0.000***	2.13	0.041*
29	dopc	38.12	0.000***	2.23	0.032*
30	pcpv	26.96	0.000***	2.13	0.040*
31	pvan	48.74	0.000***	2.11	0.043*
32	cæc	11.94	0.000***	1.75	0.098 ns
33	brin	5.55	0.000***	0.73	0.646 ns
34	brsu	3.02	0.007**	0.73	0.644 ns
35	rypc	17.78	0.000***	0.88	0.520 ns
36	rypv	6.05	0.000***	0.88	0.520 ns

Table 2. Results of the comparison sexes and the sites between them obtained by ANOVA for each of the 36 studied variables. Note: p > 5% = not significant differences, \*p = 5% significant differences, \*\*p = 1% significant differences, \*\*\*p = 0.1% significant differences, F = value of observed F of the ANOVA, P = Probability.



Tests	Value observed of the test	Fobs	P
Wilks'	0.00711	7.879	0.000 ***
Lawley-Hotelling	9.10063	9.155	0.000 ***
Pillai's	3.10427	6.664	0.000 ***

Table 3. Multivariate tests used to test the equality of the vectors of average between the sites. \*\*\*p = 0.1% significant differences, F = value of the  $F_{obs}$ , P = Probability.

Tests	Value observed of the test	Fobs	P
Wilks'	0.31937	1.087	0.181 ns
Lawley-Hotelling	1.28436	1.107	0.134 ns
Pillai's	1.02225	1.068	0.236 ns

Table 4. Multivariate tests used to test the equality of the vectors of average between two sexes in the sites. ns: p >5% : not significant differences, F = value of the  $F_{obs}$ , P = Probability.

differences existed between the seven sites for all 36 variables.

However, for the sex factor, we concluded that there were no significant differences for 14 variables out of 36 and the existence of significant differences for all 22 variables.

We can conclude as possible a sexual dimorphism between males and females of these 22 variables mentioned above.

Multivariate statistical tests confirm the previous univariate results and show that there are significant differences between sites, whereas for all seven sites, there are no significant differences between the two sexes.

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