Comparative Biometrics of a Teleost Fish, Boops boops (Linnaeus, 1758) (Perciformes Sparidae) of the Algerian coast lines

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ABSTRACT

Algeria is a country characterized by its diversified ichthyological fauna of economic and ecological importance, which deserves to be valorized by a scientific study. Due to this, our study is dedicated to the comparative biometry of the Boops boops (Linnaeus, 1758) (Perciformes Sparidae), between seven sites located on the Algerian coastline from north-east to north-west: El-kalla, Annaba, Skikda, Collo, Jijel, Algiers, Mostaganem. This study is made due to the total absence of reliable and exploitable information concerning the morphometric and meristic characteristics of this Algerian coast fish. The comparative study was carried out using thirty-six morphometric and meristic variables. The analytical approach carried out shows that environment factors have an influence and effect, not only on the diversity of living beings, but on the morphological variation in the same species. In addition, the statistical approach allowed a spatiotemporal evaluation of the biometry of the B. boops from the seven sites. As a first step, all the univariate statistical analyzes carried out, suggest significant differences between the seven sites, as well as a possible sexual dimorphism. Also, the analysis of variance at a fixed model classification criterion shows, with respect to the site factor, very significant to very highly significant differences between the seven sites for thirty variables out of thirty-six; for the sex factor, there are no significant differences for thirty-two variables out of thirty-six. Other models have been studied. Thus, in general, the general linear model MANOVA confirms the results obtained by the ANOVA.

KEY WORDS *Boops* boops; Mediterranean Sea; Algerian coast lines; ANOVA; MANOVA.

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INTRODUCTION

The biology or morphology of *Boops boops* (Linnaeus, 1758) (Perciformes Sparidae) has been studied in many areas: Tunisian coasts (Anato & Ktari, 1986), Moroccan (Zoubi, 2001a, b; Zoubi et al., 2004), Spanish (Zuniga, 1967), northwestern

Mediterranean (Trangridis & Filippouzis, 1991; Sanchez-Velasco & Norbis, 1997), and Greece (Karpouzi et al., 2000). In Algeria, the study of the biology of the fish is limited in some works we quote that were carried out on the coasts of Bou-Ismail (Chali-Chabane, 1988) and Béni-Saf (Djabali et al., 1991). On the coast of Skikda, data on the biology or biometry of the *B. boops* fish and its ecology are missing.

As a result, our study attempts to answer a need for information on the *B. boops* biometrics of the Algerian coast, by comparing its biometric parameters of the samples taken from seven sites located on the Algerian coastline from East to West: El-Kalla, Annaba, Skikda, Collo, Jijel, Algiers, and Mostaganem. The biometric study is based on statistical processing of morphometric and meristic variable data measured on samples of the fish.

MATERIAL AND METHODS

The biometric study is based on samples of the *B. boops* fish taken from seven sites located along the Algerian coastline from north-east to north-west: El-kalla, Annaba, Skikda, Collo, Jijel, Alger, and Mostaganem.

A sample of 30 individuals (from 2.5 to 4 kg) is taken into consideration in each site, respecting as much as possible all size classes present. The details are given in Table 1. Each individual is wrapped in plastic film immediately after collection to avoid damage, and is put in the freezer at -20 °C. In the laboratory, a series of 36 morphometric and meristic measurements are made on each fish (Fig. 1).

Any statistical study can be broken down into at least two phases: the collection or collection of data, on one hand, and their analysis or interpretation, on the other.

Data collection has been dealt with in the previous paragraph. As for statistical analysis, it can be broken down into two stages, one deductive or descriptive and the other inductive.

The purpose of descriptive statistics is to measure and present the observed data in such a way that it can easily be seen, for example in the form of tables or graphs.

Statistical inference makes it possible to study or generalize under certain conditions the conclusions thus obtained by means of statistical tests by taking certain risks of error which are measured using the theory of probabilities.

For our work, all the calculations were performed for each variable and for each of the 7 sites, using a DELL-type microcomputer and using the Minitab version 16.1 statistical analysis and statistical processing software (X, 2011).

Univariate statistical analyzes

<u>Description of the data.</u> To better describe the different characteristics obtained by site, we calculated some basic statistical parameters such as the arithmetic mean (x), which is a parameter of central position and trend, the standard deviation (s), which measures the dispersion of the data around the mean, the minimum (x_{min}) and maximum (x_{max}) values which both give an idea of the extent of the data, and finally the size (n) which informs us about the importance of the data processed.

<u>Cross-site comparison of average characteris-</u> <u>tics: Variance analysis test.</u> To compare the averages for each of the 36 characteristics among the seven sites, we used the one-way variance analysis test or the fixed model classification factor. This test consists in comparing the averages of several populations from random, simple, and independent sample data (Dagnelie, 1970, 2006).

The test is performed either by comparing the value of F_{obs} with the corresponding theoretical value $F_{(1-\alpha)}$, extracted from the Fisher's F-table for a significance level $\alpha = 0.05$ or 0.01 or 0.001 and for k1 and k2 degrees of freedom, either by comparing the value of the probability p with always the



Fig.1 : Morphometric measurements made on each fish.

different values of (α), for values $\alpha = 0.05$ or $\alpha = 0.01$ or $\alpha = 0.001$ (Mezedjri & Tahar 2007; 2008a, 2008b).

Depending on whether this hypothesis of equality of means is rejected at the level $\alpha = 0.05$, 0.01 or 0.001, it is conventionally said that the difference observed between the means is significant, highly significant or very highly significant. These differences of one, two or three asterisks are generally marked (Dagnelie, 1970, 2006).

This test was used to compare, on one hand, between the seven sites, the averages of each of the 36 variables and, on the other hand, to compare between the two sexes in each site, the averages of the 36 presumed variables (Mezedjri & Tahar, 2008a, b).

Calculations are made using the Minitab software GLM procedure (X, 2011) for each of the 36 variables at the 7 sites.

Multivariate statistical analyzes

<u>Comparison between sites for all characteris-</u> <u>tics: multivariate MANOVA variance analysis test.</u> The comparison between the 7 sites for all 36 variables studied and between the two sexes in the 7 sites for all the variables measured, was performed by using multivariate analyses of variance using three statistical tests, that are: Wilk's lambda, Lawley-Hotteling, and Pillai's trace (Dagnelie, 1970, 1986, 2006).

This method is an extension of the univariate variance analysis, in which we have several variables that were observed simultaneously on the same individuals (or sites). The three tests cited above and proposed by Palm (2000) and Dagnelie (1970, 2006) are all asymptotically equal in power, and no test can be recommended in a systematic way, preferably to others (Dagnelie, 1986). According to Huberty (1994), the Wilk's test is the most popular.

RESULTS AND DISCUSSION

Results of univariate statistical analyzes

<u>Calculation of basic statistical parameters</u>. To better describe the different variables that characterize the individuals studied in two different sites,

Morphometric variables				
Number	Code	Description		
1	Lt	Total length		
2	Lf	Fork length		
3	Ls	Standard length		
4	Lpan	Pre-anal length		
5	Lppv	Pre-pelvic length		
6	Lppc	Pre-chest length		
7	Lcep	Cephalic length		
8	Lpdo	Pre-dorsal length		
9	Dopv	Dorsal / pelvic distance		
10	Doan	Dorsal / anal distance		
11	Doca	Dorsal / caudal distance		
12	Lman	Length of the mandible		
13	Lmax	Maxillary length		
14	Poor	Distance poste orbitaire		
15	Dor	Orbital position distance		
16	Pror	Pre-orbital distance		
17	Lpop	Preoperative length		
18	Lain	Inorbital width		
19	Lcra	Skull length		
20	Mist	Mandible / Isthmus length		
21	Lapc	Distance between pectoral insertions		
22	Hpc	Height of the pectoral		
23	Hpv	Height of the pelvic		
24	Hdo	Height of the dorsal		
25	Han	Anal height		
26	Hpdc	Height of the peduncle		
27	Bado	Base of the dorsal		
28	Baan	Base of the anal		
29	Dopc	Dorsal / pectoral distance		
30	Pcpv	Pectoral / pelvic distance		
31	Pvan	Pelvic / anal distance		
32	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	Ryp	Number of rays of the left chest		
36	Ryn	Number of left pelvic rays		

Table 1. Morphometric and meristic variables studied.

Sites	Males			Females		
	n	Lt min	Lt max	n	Lt min	Lt max
El-kala	33	13.20	18.20	5	14.60	16.60
Annaba	16	15.30	24.70	10	14.60	24.50
Skikda	26	17.20	22.70	15	15.70	21.50
Collo	30	14.00	21.00	4	15.80	19.00
Jijel	19	13.80	21.30	21	14.40	22.00
Alger	17	14.80	21.30	21	14.50	21.90
Mostaganem	13	13.70	17.80	30	14.80	19.00

Table 2. Description of the data for each site.

we calculated some basic statistical parameters such as the arithmetic mean (x) which is a parameter of central position and trend, the difference type (s), that measures the dispersion of the data around the mean (x), the minimum values (Lt_{min}) and maximum values (Lt_{max}), which both give an idea of the extent of the data, and finally inform us about the size and the importance of the collected samples.

The biometric study was conducted using *B. boops* samples taken from seven different sites on the Algerian coast. We have inventoried a total of 261 individuals including 154 males, of which their total length Lt varies between 24.70 cm and 13.20 cm, 106 females, of which their Lt varies between 24.50 cm and 14.40 cm, and only two fish of indeterminate sex (Table 2).

It is noted that the total length Lt of the males is greater than that of the females for the sites of the gulf of El-kalla, Annaba, Skikda, and Collo whereas for the sites of the gulf, Jijel, Mostaganem, and the bay of Algiers it is reversed.

MANOVA multivariate analysis of variance

The analysis of variance has several variables or dispersion analysis, essentially to compare the averages of more than two populations for several variables (Dagnelie, 2000).

This is an extension of the univariate variance analysis, in which we have several variables that were observed simultaneously on the same individuals. Dagnelie (2000) and Palm (2000) provide several tests to perform the multivariate analysis of variance which are: the Wilk's Lambda test, Pillai's Trace, and Lawley-Hotelling. However, all these tests are asymptotically equal in power, and no test can be recommended in a systematic way, in preference to others (Dagnelie, 2000). According to Huberty (1994), the Wilk's test is the most popular.

The Minitab MANOVA command applied to the data of the two sites to perform multivariate variance analysis has two fixed classification criteria and whose sex factor is hierarchical at the site factor gives the results of the two following Tables 4, 5.

CONCLUSIONS

The aim of this work was to study the biometry of the *B. boops* taken from seven sites located along

	Fac	ctor site	Factor sexe		
Variables	Fobs	Р	Fobs	Р	
Lt	15.33	0.000 ***	1.92	0.067 ns	
Lf	12.40	0.000 ***	1.63	0.128 ns	
Ls	14.24	0.000 ***	2.17	0.038 *	
Lpan	12.11	0.000 ***	1.85	0.079 ns	
Lppv	12.49	0.000 ***	1.10	0.366 ns	
Lppc	13.31	0.000 ***	0.58	0.772 ns	
Lcep	9.02	0.000 ***	1.48	0.174 ns	
Lpdo	11.34	0.000 ***	1.28	0.259 ns	
Dopv	3.77	0.001 ***	1.04	0.407 ns	
Doan	7.21	0.000 ***	1.47	0.177 ns	
Doca	7.42	0.000 ***	2.01	0.054 ns	
Lman	1.90	0.081 ns	1.12	0.350 ns	
Lmax	5.93	0.000 ***	0.36	0.926 ns	
Poor	9.19	0.000 ***	1.36	0.221 ns	
Dor	0.35	0.910 ns	0.54	0.807 ns	
Pror	8.57	0.000 ***	0.49	0.839 ns	
Lpop	11.91	0.000 ***	0.74	0.640 ns	
Lain	3.33	0.004 **	0.42	0.887 ns	
Lcra	18.23	0.000 ***	0.52	0.818 ns	
Mist	9.48	0.000 ***	6.97	0.000 **	
Lapc	7.17	0.000 ***	1.11	0.356 ns	
Нрс	14.77	0.000 ***	0.81	0.580 ns	
Hpv	7.98	0.000 ***	0.96	0.461 ns	
Hdo	3.60	0.002 **	1.01	0.426 ns	
Han	3.13	0.006 **	2.22	0.033 *	
Hpdc	3.94	0.001 ***	0.44	0.8/3 ns	
Bado	11.01	0.000 ***	1.35	0.226 ns	
Baan	10.33	0.000 ***	1.64	0.124 ns	
Dopc	9.34	0.000 ***	0.62	0.730 ns	
Рсру	10.48	0.000 ***	1.98	0.059 IIS	
pvan Cma	7.20	0.000 ***	2.03	0.050	
Cæc Drin	23.37	0.000 ***	0.29	0.938 Hs	
DIIII Bron	3.08	0.000	0.48	0.031 ms	
Disu	16 11	0.001	0.07	0.701 ms	
Rype	2 96	0.000 **	0.85	0.344 ms 0.240 ms	
Kypv 2.90 0.008 $++$ 1.50 0.249 ns					
$p \le \alpha = 0.05$: (*) just significant differences					
$p \le \alpha = 0.01$: (**) highly significant differences					
$p \le \alpha = 0.001$: (***) very highly significant differences					
ddl: degrees of freedom					
SUE: sum of squared deviations					
Fobs: E value of Fisher					

Table 3. Results of the analysis of variance at a fixed model classification criterion of the comparison, between sites and sexes (sites), of the means of each of the 36 variables.

_	Observed			
Tests	value of	Fobs	DL	P
	the test			
Wilks'	0.02235	5.191	216; 1247	0.000 ***
Lawley-	5.94605	5.707	216; 1244	0.000 ***
Hotelling				
Pillai's	2.64014	4.671	216; 1284	0.000 ***
$p \le \alpha = 0,001$: (***) very highly significant differences				

Table 4. MANOVA for Sites. Multivariate tests used to test the equality of mean vectors between sites.

Tests	Observed value of the test	Fobs	DL	Р
Wilks'	0.28418	1.155	252; 1451	0.062ns
Lawley-	1.40953	1.159	252; 1451	0.057ns
Hotelling				
Pillai's	1.13044	1.150	252; 1505	0.067ns
$p > \alpha = 0.05$: (ns) differences not significant				

Table 5. MANOVA for Sexes (Sites). Multivariate tests used to test the equality of mean vectors between the two sexes in the sites.

the Algerian coastline from north-east to northwest: El-kalla, Annaba, Skikda, Collo, Jijel, Alger, Mostaganem.

The comparative biometric study between the seven sites showed that the application of the generalized linear model or the analysis of the variance to a criterion of ANOVA fixed model classification carried out for each of the 36 variables measured to compare between the seven sites and between the two sexes, showed that:

• Regarding the site factor, we find that there are highly to very highly significant differences for 34 out of 36 variables. The 4 variables where the differences are highly significant are: Rypv, Lain, Hdo, and Han, the 2 variables that do not show significant differences are: Dor and Lman.

• For the sex factor, there are no significant differences for 32 out of 36 variables. Variables with significant differences at the $\alpha = 5\%$ level are: Ls, Han, and Pvan. The Mist variable (mandible-isthmus) has very highly significant differences at the $\alpha = 0.1\%$ level.

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