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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 bi-

ology 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

Description of the data. 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.

Cross-site comparison of average characteristics: Variance analysis test. 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

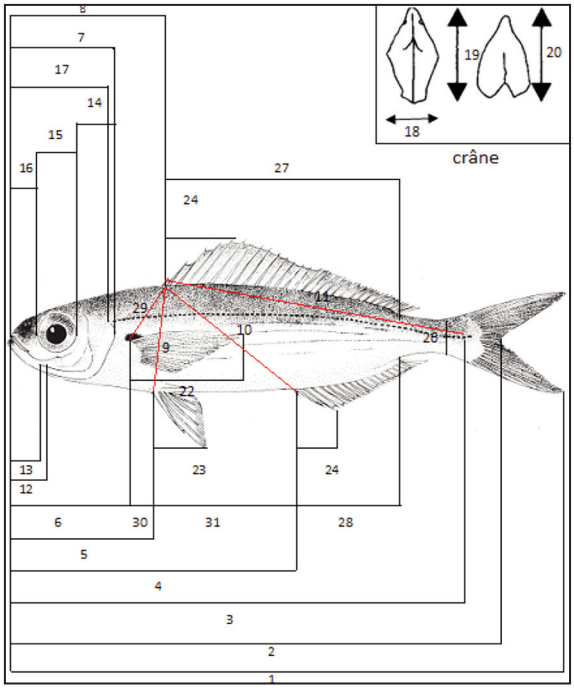

Fig.1 : Morphometric measurements made on each fish.

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

Depending on whether this hypothesis of equality of means is rejected at the level α = 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

Comparison between sites for all characteristics: multivariate MANOVA variance analysis test. 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

Calculation of basic statistical parameters. 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	Ryp	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

	Factor site		Factor sexe	
Variables	**Fobs**	**P**	**Fobs**	**P**
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
Hpc	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	0.873 ns
Bado	11.61	0.000 ***	1.35	0.226 ns
Baan	16.33	0.000 ***	1.64	0.124 ns
Dopc	9.34	0.000 ***	0.62	0.736 ns
Pcpv	10.48	0.000 ***	1.98	0.059 ns
pvan	7.26	0.000 ***	2.05	0.050 *
Cæc	23.37	0.000 ***	0.29	0.958 ns
Brin	12.79	0.000 ***	0.48	0.851 ns
Brsu	3.98	0.001 ***	0.67	0.701 ns
Rypc	16.11	0.000 ***	0.85	0.544 ns
Rypv	2.96	0.008 **	1.30	0.249 ns

$p > \alpha = 0.05$: (ns) not significant differences
$p \leq \alpha = 0.05$: (*) just significant differences
$p \leq \alpha = 0.01$: (**) highly significant differences
$p \leq \alpha = 0.001$: (***) very highly significant differences
ddl: degrees of freedom
SCE: sum of squared deviations
CM: middle square
Fobs: F 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.

Tests	Observed value of the test	Fobs	DL	P
Wilks'	0.02235	5.191	216; 1247	0.000 ***
Lawley-Hotelling	5.94605	5.707	216; 1244	0.000 ***
Pillai's	2.64014	4.671	216; 1284	0.000 ***
$p \leq \alpha = 0{,}001$: (***) 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	P
Wilks'	0.28418	1.155	252; 1451	0.062ns
Lawley-Hotelling	1.40953	1.159	252; 1451	0.057ns
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 north-west: 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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REFERENCES

Anato C.B. & Ktari M.H., 1986. Age and growth of *Boops boops* L. of the tunisian coast. Bulletin de l'Institut National Scientifique et Technique d'Océanographie et de Pêche de Salammbô, 13: 33–54.

Chalabi-Chabane F., 1988. Contribution à l'étude biologique et dynamique de la bogue, *Boops boops* (Linnaeus, 1758) de la baie de Bou-Ismail. Thèse de magistère Institut des sciences de la mer et de l'aménagement du littoral, Algérie, 111 pp.

Dagnélie P., 1970. Théorie et méthodes statistiques: applications agronomiques (vol. 2). Gembloux, Presses agronomiques, 451 pp.

Dagnélie P., 1986. Analyse statistique à plusieurs variables. Gembloux, Presses agronomiques, 362 pp.

Dagnélie P., 2006. Statistique théorique et appliquée. Tomme 2: Inférences à une et à deux dimensions. Bruxelles-université De Boeck et Larcier, 659 pp.

Djabali F., Brahim B. & Mamas S., 1991. Empirical equations for the estimation of natural mortality in Mediterranean teleosts. Naga. ICLARM, Q. 16: 35–37.

Huberty C.J., 1994. Applied discriminate analysis. New York, Wiley, 466 pp.

Karpouzi V.S., Stergion K.I. & Moutopoulos D.K., 2001. Relationships between maximum girth and body length for several marine fishes. Aristotle University, Scool of Biology. Departement of Zoology, Thessaloniki, Greece. Bulletin de la Commission Internationale pour l'Exploration Scientifique de la mer Méditerranée, 36: 1–285.

Mezedjri L. & Tahar A., 2007. Morphological variability, between two sites in Mediterranean population of the European anchovy: *Engraulis encrasicolus*. Journal of Fisheries International, 2: 65–68. DOI: jfish.2007.65.68

Mezedjri L. & Tahar A., 2008a. Détermination d'un dimorphisme sexuel chez deux populations d'*Engraulis encrasicolus* (Linné, 1758) en utilisant la statistique descriptive univariée. Actes du Workshop International sur la gestion des ressources halieutiques GRH 2007. Numéro spécial décembre 2008. Revue semestrielle des sciences de la mer, Pélagos, ISMAL, 106–112.

Mezedjri L. & Tahar A., 2008b. Influence des facteurs environnementaux sur la variabilité morphologique de l'anchois Européen *Engraulis encrasicolus* (Linné, 1758) entre le golfe de Skikda (Algérie) et le golfe du Lion (France). Actes du Workshop International sur la gestion des ressources halieutiques GRH 2007. Numéro spécial décembre 2008. Revue semestrielle des sciences de la mer, Pélagos, ISMAL, 137–144.

Minitab 16 Statistical Software, 2011. [Computer software]. State College, PA: Minitab, Inc. (www.minitab.com).

Palm R., 2000. L'analyse de la variance multivariée et l'analyse canonique discriminante: principes et applications. Notes de statistique et d'informatique 2000/1, Gembloux, 40 pp.

Sanchez-Velasco L. & Norbis W., 1997. Comparative diets and feeding habitats of *Boops boops* and *Diplodus sargus* larvae, two sparid fishes co-occuring in the northwestern Mediterranaen. Bulletin of Marine Science, 61: 821–835.

Trangridis A. & Filippouzis N., 1991. Use of length-frenquency data in the estimation of growth parameters of three Mediterranean fish species: bogue (*Boops boops* L.), picarel (*Spicara smaris* L.) and horse markere (*Trachurus trachurus* L.). Fisheries Research, 12: 283–297.

Zoubi A., 2001a. Étude de la biologie de croissance des principaux stocks démeseaux de la Méditerranée Marocaine. Institut National de Recherche Halieutique (INRH), Casablanca, Maroc, Rapport commission international mer Méditerranée, 36: 341 pp.

Zoubi A., 2001b. Biologie de la reproduction des principaux espèces démersales de la Méditerranée Marocaine. Institut National de Recherche Halieutique (INRH), Casablanca, Maroc, Rapport commission international mer Méditerranée, 36: 340 pp.

Zoubi A., Berraho A. & Shafee M.S., 2004. Étude des possibilités d'aménagement des Sparidés dans la région méditerranéenne Marocaine. Rapport commission international mer Méditerranée, 37: 465 pp.

Zuniga L.R., 1967. Estudio del Creciniento de la boga en el Levante Espagnole. Investigacion Pesquera, 31: 383–418.