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Morphological Variability, Between Two Sites in Mediterranean Population of the European Anchovy: (*Engraulis encrasicolus)*

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Abstract: During the year 2003, a compared biometric study is carried out on a pelagic fish of the family of Engraulidea the European anchovy *Engraulis encrasicolus*. The comparison is made between two samples; the first comes from the gulf of Skikda (Algerian East coasts) and the second from the Gulf of Lions (South-western coasts of France). This study shows the existence of a sexual dimorphism and this for all two sites. Indeed, on a whole of 35 measured variables, the analysis of the univariate variance with two criteria of classification (ANOVA), highlights the existence of a sexual dimorphism for eight variables (four variables are cephalic measurements; three are body measurements and one meristic variable). The comparison between the two sites by means of statistical tests multivariate MANOVA, leads to the existence of differences very highly significant between the two sites (Algerian East coasts and South-western coasts of France).

Key words: *Engraulis encrasicolus*, compared biometrics, univariate statistical tests, multivariate statistical tests, algerian east coasts

INTRODUCTION

The study of the morphological characters, by using morphometric or meristic variables has a long tradition in ichthyology. It is always useful to announce that the European anchovy *Engraulis encrasicolus* already has been the subject of a number of morphometric studies, which we can quote, those of Fage (1911 and 1920); Aleksandrov (1927), Mayorova (1934), Quignard *et al.* (1973), Shevchenko (1981), Djabali and Hemida (1989), Junquera and Perez-Gandaras (1993), Prouzet and Metuzals-sebedio (1994), Tudela (1999). This research is inspired mainly by early studies and treats a compared biometrics between the Gulf of Stora in Skikda (Algerian East coasts) and the Gulf of Lions in France Fig. 1.

MATERIALS AND METHODS

Data-gathering: This compared biometric study is carried out starting from two samples, the first coming from the Gulf of Stora, Algerian East costs and the second comes from the Gulf of Lions South-western coasts of France. A sample of 30 individuals is taken into account, in each site, in order to respect all the classes of sizes present. Each individual is wrapped in a plastic film immediately after the collection to avoid damages, and then it is put at the freezer at a temperature of -20°C. At the laboratory a series of 36 morphometric and meristic measurements are carried out on each fish Table 1 and Fig. 2. These measurements are made on the basis of preceding studies, in order to obtain a maximum of information on studied fishes. All metric measurements are carried out, with the millimetre meadows,using dividers. Meristic measurements are made, under binocular magnifying glass, by means of a counting. The determination of the sex was carried out after dissection of fishes.

Statistical analyses of the data

Univariate statistical analyses: In univariate statistical analysis, we calculated for each variable the basic statistical parameters which are: the arithmetic mean ($\bar{x}$) and the Standard deviation (S).

The analysis of variance with two criteria of classifications (ANOVA), models arranged hierarchically fixes (sex in site), is carried out to compare, for each variable, the sites and the sexes between them.

Multivariate statistical analyses: The comparison of the two sites between them, for the whole of the studied variables, is carried out using the multivariate analysis of variance by using three statistical tests which are: Wilk' S, Lawley-Hotteling and Pillai'S.

All calculations are carried out with software MINITAB of statistical analysis data and processing, version 13.31 for Windows (X, 2000).

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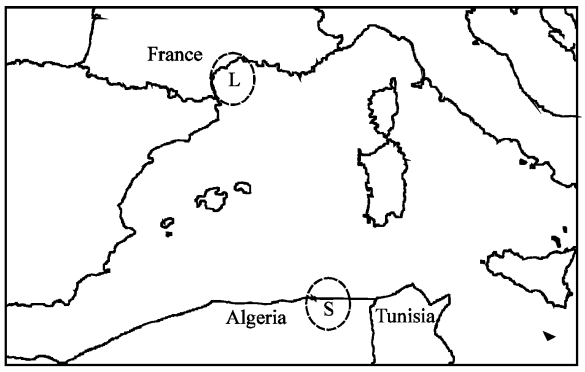

Fig. 1: Location where anchovy samples were obtained(S) Gulf of Stora, (L) Gulf of Lions

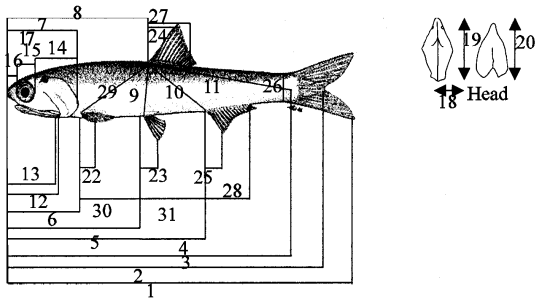

Fig. 2 : Morphometric measurements taken on each fish

RESULTS

In our results, we must mention that the variable (Rypv: number of left pelvic fin rays) was excluded from the analysis, since all individuals from the tow sites presented the same count (always 7).

Calculation of the basic statistical parameters: Generally, the results obtained using software MINITAB are given averages, for the various variables, slightly higher for the males compared to those of the females for the site of gulf of Stora (Skikda), whereas we notice the reverse for the Gulf of Lions (France).

Univariate Analysis variance ANOVA: The comparison on the one hand, of the two sites between them and, on the other hand, of the two sexes between them is carried out, and that for each variable, using the univariate analysis variance with two fixes criteria of classification (site and sex) model arranged hierarchically. The factor sex is completely arranged hierarchically with the factor site .The results obtained by order GLM of software MINITAB are expressed in Table 2. With regard to the factor site, we note that there are significant differences between the two sites, Gulf of Stora and the Gulf of Lions

Table 1: Morphometric and meristic variables studied

No	Code	Description
Morphometric measurements		
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	Distance dorsal/pelvic
10	Doan	Distance dorsal/anal
11	Doca	Distance dorsal/caudal
12	Lman	Mandible length
13	Lmax	Maxillary length
14	Poor	Distance post-orbital
15	Dor	Diameter orbital
16	Pror	Length pre-orbital
17	Lpop	Length pre-operculum
18	Lain	Width inorbital
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 Base
28	Baan	Anal Base
29	Dopc	Distance dorsal/pectoral
30	Pcpv	Distance pectoral/pelvic
31	Pvan	Distance pelvic/anal

Table 2: Results of the comparison sexes and the sites between them obtained by ' ANOVA for each of the 35 studied variables

		Factors			
		Sites		sexes (sites)	
No	Variables	F	P	F	P
1	Lt	84.17	0.000 ***	2.18	0.124 ns
2	Lf	90.21	0.000 ***	1.46	0.242 ns
3	Ls	82.76	0.000 ***	1.68	0.197 ns
4	Lpan	87.05	0.000 ***	1.97	0.151 ns
5	Lppv	55.59	0.000 ***	2.72	0.076 ns
6	Lppc	38.87	0.000 ***	3.49	0.039 *
7	Lcep	37.88	0.000 ***	3.21	0.049 *
8	Lpdo	76.16	0.000 ***	2.01	0.145 ns
9	dopv	20.00	0.000 ***	1.06	0.355 ns
10	doan	58.08	0.000 ***	3.45	0.040 *
11	doca	76.59	0.000 ***	1.47	0.241 ns
12	Lman	12.77	0.000 ***	2.42	0.100 ns
13	Lmax	25.51	0.000 ***	1.95	0.154 ns
14	Poor	14.90	0.000 ***	0.88	0.420 ns
15	Dor	11.17	0.002 **	0.19	0.826 ns
16	Pror	0.04	0.844 ns	2.63	0.083 ns
17	Lpop	63.64	0.000 ***	3.99	0.025 *
18	Lain	1.31	0.257 ns	1.16	0.323 ns
19	Lcra	47.98	0.000 ***	0.10	0.905 ns
20	Mist	54.89	0.000 ***	5.55	0.007 **
21	Lapc	4.84	0.033 *	1.30	0.281 ns
22	Hpc	35.65	0.000 ***	4.16	0.022 *
23	Hpv	1.56	0.218 ns	2.41	0.100 ns
24	Hdo	1.53	0.222 ns	0.97	0.386 ns
25	Han	0.42	0.521 ns	0.86	0.431 ns
26	Hpdc	16.48	0.000 ***	0.61	0.547 ns

Table 2: Continued

27	Bado	29.64	0.000 ***	2.51	0.092 ns
28	Baan	29.61	0.000 ***	3.84	0.028 *
29	dopc	77.20	0.000 ***	2.47	0.095 ns
30	pcpv	57.66	0.000 ***	2.04	0.141 ns
31	pvan	78.40	0.000 ***	0.27	0.763 ns
32	cæc	3.35	0.073 ns	0.10	0.905 ns
33	brin	56.99	0.000 ***	4.07	0.023 *
34	brsu	17.25	0.000 ***	2.64	0.082 ns
35	rypc	7.71	0.008 **	0.89	0.416 ns

NB: ns: 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

Table 3: Multivariate tests used to test the equality of the vectors of averages between the two sites (Gulf of Stora and the Gulf of Lions). MANOVA for sites

Criteres	Test star	F	DL	P
Wilk's	0.05403	7.004	(35.14)	0.000***
Lawley-hotlling	7.50947	7.004	(35.14)	0.000***
Pillar's	0.94597	7.004	(35.14)	0.000***

*** p = 0,1%. Significant differences, F = Value of observed F of the ANOVA, p = probabiliy

Table 4: Multivariate tests used to test the equality of the vectors of averages between the two sexes in the two sites. MANOVA for (sites)

Critéres	Test stat	F	DL	P
Wilk's	0.12256	0.743	(70.28)	0.841 ns
Lawley-Hotlling	3.8626	0.717	(70.26)	0.862 ns
Pillar's	1.28146	0.764	(70.30)	0.822 ns

ns = p>5%: Not significant differences, F = Value of observed F of the ANOVA, P = probabiliy

for 29 variables out of 35. The 6 variables in which the differences are not significant are: Pror, Lain, Hpv, Hdo, Han and cæc. Concerning to the factor sex, there are not significant differences for 27 variables out of 35. The variables presenting significant differences at the level α = 5% are: Lppc, Lcep, doan, Lpop, Hpc, Baan and brin. The variable (mandible-isthmus) Mist gives significant differences on the level α = 1%.

DISCUSSION

The compared study of biometry of the European anchovy *Engraulis encrasicolus* in the Gulf of Stora, Algerian East coasts with that of the same species of the Gulf of Lions in France, northern bank western of the occidental Mediterranean reveals.

After a description of the obtained data from two samples we note that generally, the averages of all variables of the sample of the Gulf of Stora are slightly lower than those of the Gulf of Lions. Also, the averages of the different variables show that males are higher than females in the Gulf of Stora, whereas for the Gulf of Lions the averages of the females are higher than those of the males. This allows believing in a possible sexual dimorphism.

The use of the univariate Analysis of Variance (ANOVA) shows that on a whole 31 morphometric measured variables, only 26 variables gives significant differences between the two sites, whereas the 5 other variables (Pror, Lain, Hpv, Hdo and Han) do not give any significant differences.

All the meristic variables make it possible to deduce significant differences between the two sites except the variable (CAEC) which does not give any significant information.

Concerning the factor sex, the ANOVA shows that only morphometric variables (Lppc, Lcep, doan, Lpop, Hpc, Baan and Mist) and the meristic variable (brin) makes it possible to deduce differences between the two sexes for two sites.

The results of the Multivariate Analysis of Variance (MANOVA) confirm those obtained by the univariate analyses. For the factor site, there are significant differences, whereas for the factor sex and the whole of the measured variables (morphometric and meristic) we do not have significant differences between the males and the females.

Tudela (1999) obtains for a whole of 7 sites chosen, in spite of their proximities, significant differences, whereas the MANOVA does not present any significant differences between sexes for the unit of the selected sites.

The differences between the Gulf of Stora and the Gulf of Lions can be related to the dominating ecological factors in each area. They can be also due to the factor time relating to the period of sampling. Our results join those obtained by Tudela (1999).

CONCLUSION

Multivariate statistical analyses

MANOVA: The analysis of the variance to several variables or dispersion analysis has an objective to compare the averages of more than two populations for several variables (Dagnelli, 200). It is an extension of the univariate analysis of variance, when we have several variables which are observed simultaneously on the same individuals. Dagnelie (2000) and Palm (2000) give several tests to carry out of multivariate analysis of variance which are: The Wilk'S Lambda, Pillai'S Traces and Lawley-Hotelling. However, all these tests are asymptotically of equal power and no test can be recommended in a systematic way, preferably with the others (Dagnelli, 2000). According to Huberty (1994) the test of Wilk's is most popular.

The order MANOVA of MINITAB, applied to the data of the two sites to carry out the multivariate analysis of variance with two fixes criteria of classification and the factor sex is hierarchically arranged with the factor site, gives the results of the two following Table (3 and 4).

The examination of Table 3 shows that there are significant differences between the two sites, the Gulf of Stora and the Gulf of Lions, for the whole of the morphometric and meristic characters observed on the species of *Engraulis*.

Whereas, the examination of Table 4; does not give any significant differences, between the two sexes for each site and for the whole studied variables.

The results of MANOVA confirm the results of the univariate analyses of variance obtained previously encrasicolus.

This research treats morphometric variability of a pelagic fish the European anchovy *Engraulis encrasicolus*.

The compared morphometric study, between two sites (the gulf of Stora and the Gulf of Lions) shows that: All the univariate statistical analyses carried out let predict significant differences between the two sites, as well as a possible sexual dimorphism. The analysis of the univariate variance with two criteria of classifications ANOVA, for the factor site, gives significant differences for all variables except the variables (Pror, Lain, Hpv, Hdo and Han). Whereas, ANOVA shows that it is possible to deduce significant differences between sexes for all two sites for 8 variables (Lppc, Lcep, doan, Lpop, Hpc, Baan, Mist and brin).

The multivariate statistical tests confirm the preceding univariate results and show, that there are significant differences between sites, whereas for all two sites, there are not significant differences between the two sexes.

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