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NOTES ON BIOLOGICAL AND BIOMETRIC DATA OF THE SWORDFISH (*XIPHIAS GLADIUS* L.) IN AREAS OFF MADEIRA

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SUMMARY

This paper offers biological and biometric information on swordfish caught in waters off the island of Madeira.

Since there was very little activity carried out by the fleet, it was only possible to obtain data on a limited number of fish. Nonetheless, we were able to develop biometric relationships between the gutted weight (GW) and round weight (RW) between EOFL and JLFL that will be of great interest in the preparation of future ICCAT work.

Sex was determined and a quantitative index of sexual maturity in females (gonadal index) was calculated, which allowed comparisons to be made with other authors' indices for different areas of the Atlantic.

The pattern of sex ratio by size class was found to be similar to those described in other areas of the Atlantic having similar latitudes.

The gonadal indices obtained indicate that the females analyzed showed primordial stages of maturity. No cases were detected where females were close to spawning. However, we must remember the limitation in the number of samples as well as their spatial and temporal concentration which leads us to refrain from making any definite conclusions at the present time.

RESUME

Le présent document présente une information biologique et biométrique sur l'espadon capturé dans les eaux au large de l'île de Madère.

Etant donné que la flottille a été très peu active, il n'a été possible d'obtenir des données que sur un nombre limité de poissons. Toutefois, nous avons pu élaborer des rapports biométriques entre le poids éviscéré (GW) et le poids vif (RW) et la EOFL et la LJFL, qui seront très utiles pour la préparation de travaux futurs pour l'ICCAT.

Le sexe a été déterminé, et un indice quantitatif de la maturité sexuelle des femelles (indice gonado-somatique) a été calculé; cet indice a permis d'effectuer des comparaisons avec les indices d'autres auteurs pour diverses zones de l'Atlantique.

Le schéma du sex ratio par classe de taille observé a été jugé semblable à ceux qui sont décrits pour d'autres régions de l'Atlantique aux mêmes latitudes.

Les indices gonado-somatiques obtenus indiquent que les femelles analysées montraient les premiers signes de maturité. On n'a observé aucun cas de femelle sur le point de frayer. Nous devons cependant rappeler que le nombre limité des échantillons, ainsi que leur concentration spatiale et temporelle, nous empêche de formuler à l'heure actuelle des conclusions définitives.

RESUMEN

En el presente documento se ofrece información biológica y biométrica del pez espada capturado en las proximidades de la isla de Madeira.

Debido a que la actividad de la flota es escasa solo ha sido posible obtener datos de un limitado número de peces. Pese a ello, se han desarrollado relaciones biométricas entre el peso eviscerado (GW) y el peso vivo (RW), entre EOFL y LJFL, que serán de gran utilidad para la preparación de las futuras tareas de ICCAT.

Se ha procedido al sexado de los peces y al cálculo de un índice cuantitativo de madurez de las hembras (Indice gonadal) que permite comparaciones con los índices aportados por otros autores para otras áreas del Atlántico.

El patrón de sex ratio por clase de talla obtenido es similar al descrito para otras zonas del Atlántico de similares latitudes.

Los índices gonadales obtenidos indican que las hembras analizadas presentaban estados primordiales de madurez. En ningún caso fueron detectadas hembras próximas a la puesta, si bien ha de considerarse la limitación en el número de muestras y la concentración espacio temporal de las mismas, lo que no permite sacar conclusiones definitivas por el momento.

INTRODUCTION

Swordfish has been caught incidentally in Madeira, by the local deep fishing fleet targeting the black scabbard fish (Aphanopus carbo) and sport fishing gears for a long time. The Japanese tuna longliners operating in the area also record significant amounts of this species, as a tuna fishing by-catch.

In 1989 a fishing experiment was carried out by the Local Fishery Directorate, for the purpose of evaluating the resource and studying the viability of exploitation by local fishermen, as a new alternative fishery (GOUVEIA, 1992) . Since then, several boats have started with this activity, operating throughout the winter season. This fleet is made up of six small boats, whose length varies between 6 and 8 meters and 3-6 gross tonnage. They use a drifting surface longline with 450-500 hooks per set operation.

The activity carried out by this fleet has allowed us access to limited information on several biological and biometric parameters. The small number of samples obtained all pertain to very specific time periods and fishing areas, which makes it impossible to carry out a spatial-temporal analysis. However, we did feel that it would be of interest to mention them in order to broaden our general knowledge of the biological and biometric characteristics of this species, which have been described for other areas of the Atlantic.

The equations permitting biometric transformations are a necessary tool that must be specifically crafted for each fleet, since every fleet has its own particular habits. However, some of these biometric transformations may be applied to other fleets in cases where transformation criteria and the treatment of the fish coincide.

MATERIAL AND METHODS

Most of the samples came from the experimental fishing carried out from January to May 1990. A few samples from the commercial fleet taken in January and September 1991 were also included. The fishing operations took place in areas close to the island, usually 3 to 6 nautical miles offshore.

The length measurements LJFL and EOFL (MIYAKE 1990) were taken on board with a tape measure and individual weight was checked during landings at the fishing port. Gutted weight was recorded in the majority of the samples and corresponded to gutted and gillnet fish.

Sex determination was carried out by examining internal organs on board, before the fish were eviscerated. The gonads were weighed in the Laboratory using a digital scale with an accuracy of 0.01

Gonadal Index.

The use of weighted criteria to estimate the maturity level of the swordfish has proved to be useful in earlier studies. The KUME & JOSEPH (1969) Gonadal index has been the standard traditionally used for the species as a quantitative indicator of the degree of maturity of the females (GARCIA & MEJUTO 1988, DE LA SERNA et al. 1992).

$$GI = (Wg/LJFL^{**}3) * 10 ** 4$$

GI= gonadal index, Wg=weight of gonads (gr.), LJFL= size in cm.

The relation between gutted weight (GW) and round weight (RW) was constructed by using two simple linear models of the following type :

(1) $RW = a + b*GW$, (2) $RW = b*GW$

The biometric relation between LJFL and EOFL was similarly established using a simple linear model.

In order to compare this study with other research done on immature individuals, the relation between size (LJFL) and gonad weight (female) was established according to the multiplicative model $Wgon. = a * LJFL ** b$.

RESULTS AND DISCUSSION

Due to the limited availability of swordfish, only 211 specimens were sampled. However, not all the variables analyzed were available in all the records.

Figure (1a) shows the size distribution by sex corresponding to the individuals analyzed. The distribution of both sexes is similar for fish smaller than 130 cm. However, starting from this size on, females become progressively more dominant, as has been found in studies in other areas. Thus, figure 1b shows the sex ratio according to size class. The pattern is similar to the one that was reported in other Atlantic zones (HOEY 1986, 1990 GARCIA & MEJUTO 1988, DE LA SERNA et al. 1992, LEE 1992, MEJUTO et al. 1991).

Table 1 presents the relation obtained for only 17 pairs of values, gutted weight (GW) - Total weight (RW) available, for both types of fit. The results are summarized as follows :

(1) $RW = 0.18234 + 1.1028*GW$
(2) $RW = 1.107735*GW$ UL95%= 1.12482
LL95%= 1.09065

The transformation value obtained in model (2) differs from the transformation factor 1.14 traditionally used by ICCAT (MIYAKE, 1990). However, these differences could be attributed to the particular way the fleets themselves are accustomed to gutting the fish and/or to the limited size of the sampling and its restricted spatial-temporal coverage.

The relation that exists between the EOFL and LJFL size for 163 pairs analyzed is shown in table 2 and figures 2a and 2b and may be summarized as follows :

$$LJFL = 7.26354 + 1.07623 * EOFL$$
$$EOFL = -5.86537 + 0.9224 * LJFL$$

The relation that exists between female gonad weight and fish size (LJFL) for 82 pairs of values available is shown in table 3 (figures 3a, 3b). These values were compared to data provided by other authors for similar stages of maturity (GARCIA & MEJUTO, 1988), (figure 3c).

The gonadal indices found for the 81 females analyzed were low, in all cases under 0.9, with a mean value of 0.33, (Conf. Interval for Mean 95%: 0.298-0.380) (table 4). The frequency histogram of the gonadal indices is shown in figure 4a.

The values from the gonadal indices and sight observations indicate that the females analyzed present primordial stages of maturity, and are a long way from maturation.

In the area studied the surface temperature values of the sea throughout the year, and specifically during the months when most of the samples were taken (winter) appear to be out of the range of temperatures defined as optimum for gonad development and spawning (REY 1988).

In the case of identical stages of maturity, the gonadal index value shows a positive relation as size increases, for sizes ranging from 75 to 150 cm (figures 4a, 4b) which confirms the findings of earlier research (GARCIA & MEJUTO 1988).

Based on these preliminary results, this area would be rejected is as a possible spawning or pre-spawning area for this species. Nonetheless, the fact that most of the samples come from the first quarter of the year (for the most part in January), and that the number of observations is limited, it is not possible to confirm this as yet. Additional biological information must be obtained to give us a wider temporal vision at the very least.

Therefore, previous studies referring to samplings in latitudes similar to those in the Northeast Atlantic, near the Mediterranean Sea (DE LA SERNA et al. 1992) suggest that there may be a seasonal variation in the GI values, which is probably related to the migratory movements of the species.

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Regression Analysis - Linear model: RW = a + b*GW

Dependent variable: RNGH.PESO_VIVO Independent variable: RNGH.PESO_EVISC

Parameter	Estimate	Standard Error	T Value	Prob. Level
Intercept	0.10234	0.367352	0.496364	.62734
Slope	1.1028	0.0129039	85.4622	.00000

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	Prob. Level
Model	6405.4719	1	6405.4719	7303.784	.00000
Error	12.278163	14	.877007		
Total (Corr.)	6417.7500	15			

Correlation Coefficient = 0.999043 R-squared = 99.81 percent
Stnd. Error of Est. = 0.936487

Model fitting results for: RW = b*GW

Independent variable	coefficient	std. error	t-value	sig.level
RNGH.PESO_EVISC	1.107735	0.008815	138.2125	0.0000

R-SQ. (Adj.) = 0.9991 SE= 0.912658 MAE= 0.751899 DurbWat= 2.080
Previously: 0.0000 0.000000 0.000000 0.000
16 observations fitted, forecast(s) computed for 0 missing val. of dep. var.

Analysis of Variance for the Full Regression

Source	Sum of Squares	DF	Mean Square	F-Ratio	P-value
Model	15911.5	1	15911.5	19102.7	.0000
Error	12.4942	15	0.832945		
Total	15924.0	16			

R-squared = 0.999215 Stnd. error of est. = 0.912658
R-squared (Adj. for d.f.) = 0.999215 Durbin-Watson statistic = 2.08037

Fri Feb 26 1993 08:20:46 PM Page 1

95 percent confidence intervals for coefficient estimates

	Estimate	Standard error	Lower Limit	Upper Limit
RNGH.PESO_EVISC	1.10774	0.00801	1.09065	1.12482

Table 1.- Results of the regression analyses between round weight (RW) and gutted weight (GW) using two fitting models.

Regression Analysis - Linear model: LJFL= a+b*EOFL

Dependent variable: FLLD1.FL Independent variable: FLLD1.LD1

Parameter	Estimate	Standard Error	T Value	Prob. Level
Intercept	7.26354	0.855518	8.49023	.00000
Slope	1.07623	7.2668E-3	148.102	.00000

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	Prob. Level
Model	140406.08	1	140406.08	21934.2	.00000
Error	1030.5976	161	6.4012		
Total (Corr.)	141436.67	162			

Correlation Coefficient = 0.99635 R-squared = 99.27 percent
Stnd. Error of Est. = 2.53006

Regression Analysis - Linear model: EOFL= a+bLJFL

Dependent variable: FLLD1.LD1 Independent variable: FLLD1.FL

Parameter	Estimate	Standard Error	T Value	Prob. Level
Intercept	-5.86537	0.83335	-7.0383	.00000
Slope	0.9224	6.22813E-3	148.102	.00000

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	Prob. Level
Model	120337.34	1	120337.34	21934.2	.00000
Error	883.29064	161	5.48628		
Total (Corr.)	121220.63	162			

Correlation Coefficient = 0.99635 R-squared = 99.27 percent
Stnd. Error of Est. = 2.34228

Table 2.- Results of the regression analyses between variables of LJFL and EOFL size.

Regression Analysis - Multiplicative model: Y = aX^b

Dependent variable: IGMADE.PESO_GONAD Independent variable: IGMADE.FL

Parameter	Estimate	Standard Error	T Value	Prob. Level
Intercept*	-20.6475	0.724541	-28.4973	.00000
Slope	5.08763	0.148147	34.3418	.00000

* NOTE: The Intercept is equal to Log a.

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	Prob. Level
Model	118.1635	1	118.1635	1179.361	.00000
Error	8.015427	80	.100193		
Total (Corr.)	126.17898	81			

Correlation Coefficient = 0.967717 R-squared = 93.65 percent
Stnd. Error of Est. = 0.316533

Table 3.- Results of the regression analyses between gonad weight and size (LJFL).

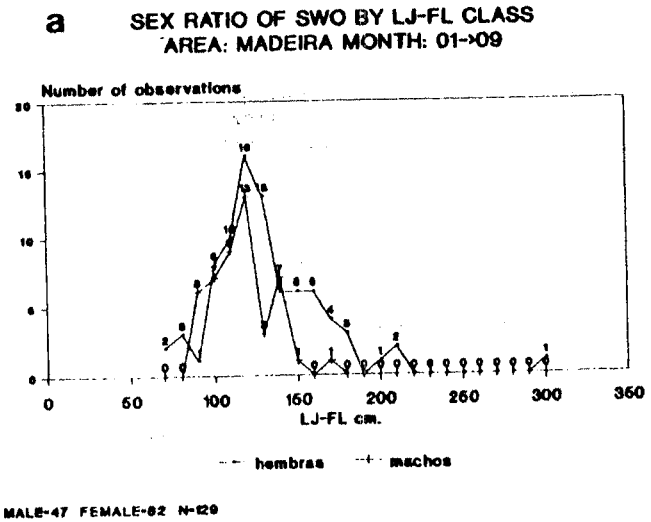
Variable: IG

Sample size	81
Average	0.339136
Median	0.29
Mode	0.24
Geometric mean	0.290318
Variance	0.033633
Standard deviation	0.183393
Standard error	0.020377
Minimum	0.07
Maximum	0.84
Range	0.77
Lower quartile	0.21
Upper quartile	0.47
Interquartile range	0.26
Skewness	0.773437
Standardized skewness	2.84179
Kurtosis	-0.113847
Standardized kurtosis	-0.20915

One-Sample Analysis Results

		IG	
Sample Statistics:	Number of Obs.	81	
	Average	0.339136	
	Variance	0.033633	
	Std. Deviation	0.183393	
	Median	0.29	
Confidence Interval for Mean:		95 Percent	
	Sample 1	0.298575 0.379696	80 D.F.
Confidence Interval for Variance:		0 Percent	
	Sample 1		
Hypothesis Test for HO: Mean = 0		Computed t statistic = 16.6431	
vs Alt: NE		Sig. Level = 0	
at Alpha = 0.05		so reject HO.	

Table 4.- Exploratory analysis of the gonadal index values obtained (GI).



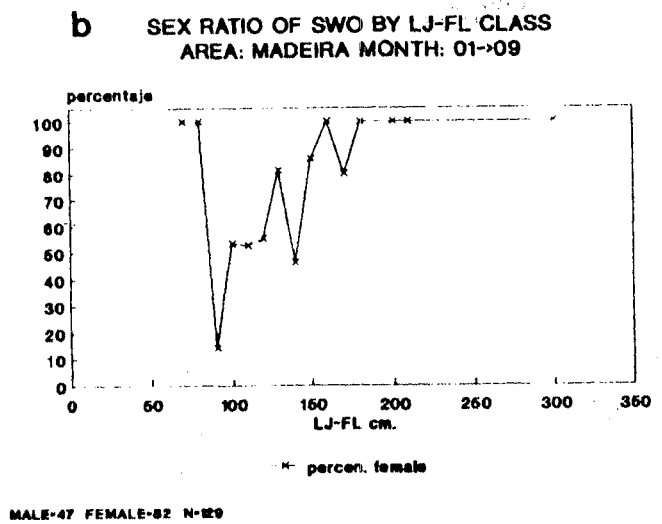
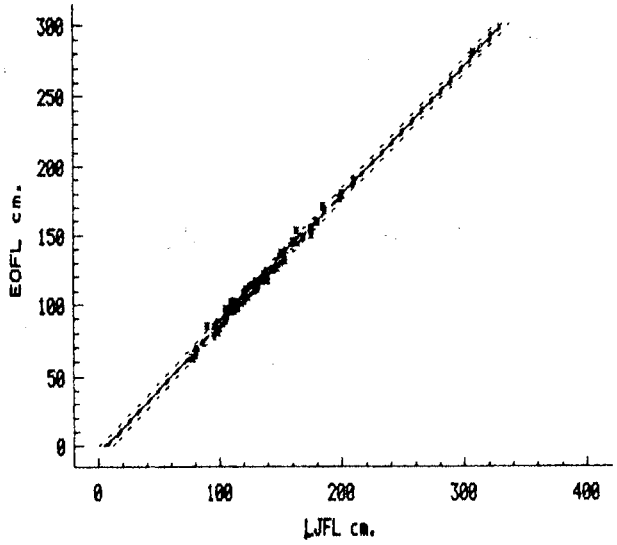


Figure 1.-
(a) Number of individuals sampled by size and sex.
(b) Sex-ratio by size class. Percentage of females.



Regression of LJFL on EOFL

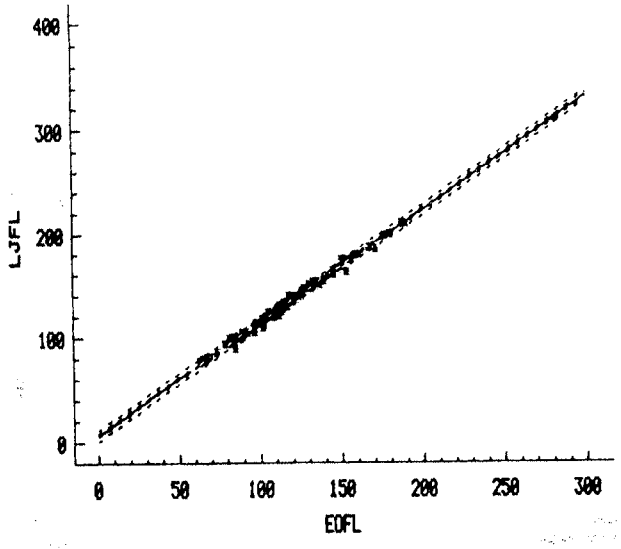
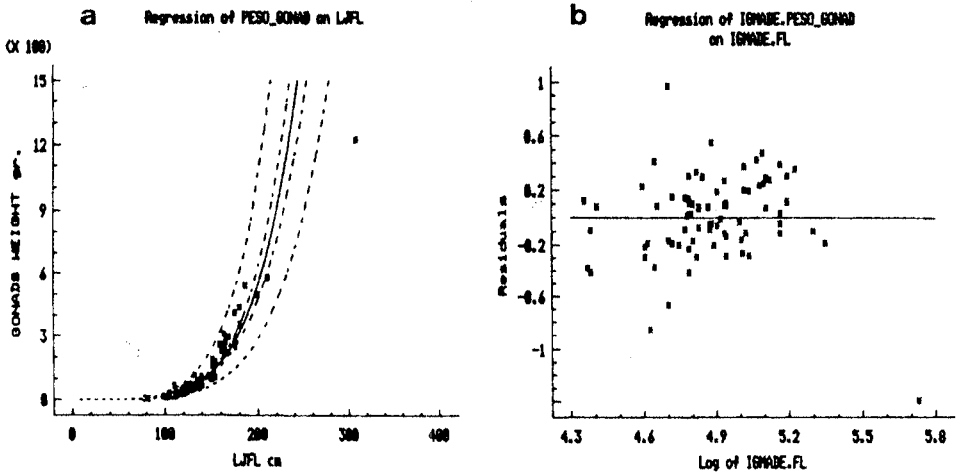


Figure 2.- Regression analysis between variables of LJFL and EOFL size.



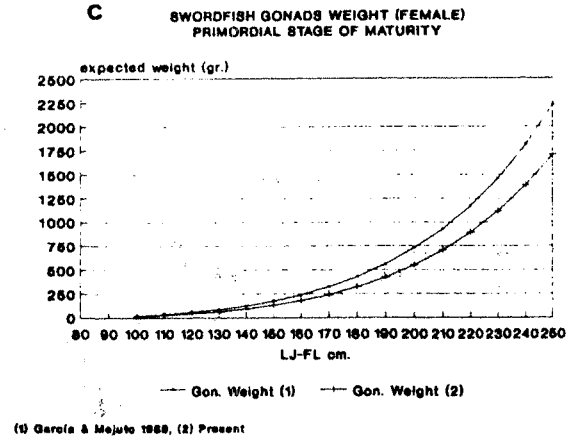
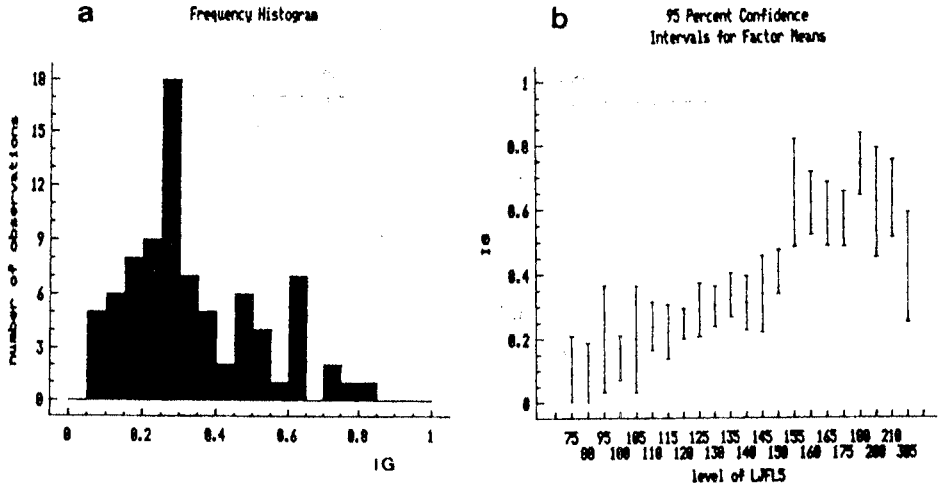


Figure 3.-
(a) Relation between LJFL size and gonad weight.
(b) Residual analysis.
(c) Comparison with results from other research.



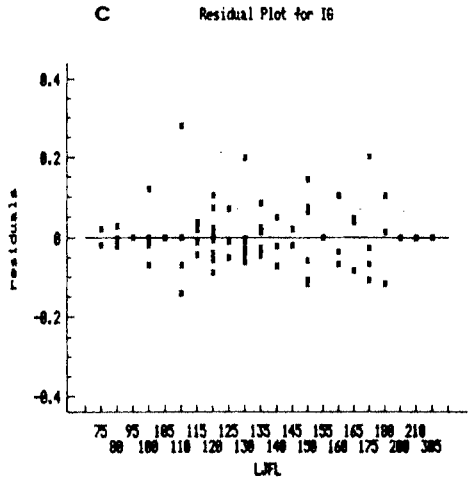


Figure 4.-
(a) Histogram of the GI values obtained.
(b) Effect of size on mean GI and 95% confidence intervals.
(c) Residual analysis.