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Length-weight relationships for 11 fish species from the Gulf of Tunis (SW Mediterranean Sea, Tunisia)

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Abstract. In this study, length–weight relationships of 11 commercial fish species from the Gulf of Tunis: *Mullus barbatus*, *Scomber scombrus*, *Sparus aurata*, *Boops boops*, *Spicara maena*, *Diplodus annularis*, *Merluccius merluccius*, *Trachurus trachurus*, *Trachurus mediterranus*, *Pagellus erythrinus* and *Lithognathus mormyrus* were presented. The values of the slope *b* in the length - weight relationship ranged from 2.674 to 3.368 and intercepts between 0.0021 and 0.0515.

Key words: Fishery resourses, fish morphometry, ichthyofauna of the Mediterranean Sea.

Resumo. Relações comprimento-peso para 11 espécies de peixes do Golfo de Tunes (Mar Mediterraneo Sudocidental, Tunisia). No presente estudo, as relações comprimento-peso para 11 espécies comerciais de peixes do Golfo de Tunis: *Mullus barbatus*, *Scomber scombrus*, *Sparus aurata*, *Boops boops*, *Spicara maena*, *Diplodus annularis*, *Merluccius merluccius*, *Trachurus trachurus*, *Trachurus mediterranus*, *Pagellus erythrinus* e *Lithognathus mormyrus* foram apresentadas. O valor do coeficiente angular b nas relações comprimento – peso variou entre 2.674 e 3.368 e o valor de interseção da reta no eixo Y variou entre 0.0021 e 0.0515.

Palavras-chave: Recursos pesqueiros, morfometria de peixes, ictiofauna do mar mediterrânea.

The Gulf of Tunis provides a significant proportion of the overall marine fish production in Tunisia and is considered one of the most important fishery grounds of the Tunisian coast (Azouz 1973, Gharbi 1980, Zarrad *et al.,* 2001). The Gulf of Tunis is also known as an important spawning and nursery ground for several fish species (Hattour 1991, Zarrad *et al.,* 2003).

Length and weight data are a useful and standard result of fish sampling programs. These data are needed to estimate growth rates, length and age structures, and other components of fish population dynamics (Kolher *et al*., 1995). Length-weight relationships allow fisheries scientists to convert growth-in-length equations to growth-in-weight in stock assessment models (Dulčić & Kraljević 1996, Gonçalves *et al*., 1997, Morato *et al*., 2001, Stergiou & Moutopoulos 2001, Özaydin *et al.,* 2007), estimate biomass from length frequency distributions (Anderson & Gutreuter 1983, Petrakis & Stergiou 1995, Dulčić & Kraljević 1996), and calculate fish condition (Petrakis & Stergiou 1995). Length-weight relationships are also useful for comparing life history and morphological aspects of populations inhabiting different regions (Gonçalves *et al*., 1997, Stergiou & Moutopoulos 2001). Despite the utility of length-weight relationship in fisheries science and the importance of the Gulf of Tunis for Tunisian fisheries, information about the length-weight relationships of fish species in Tunis Gulf is scarce and incomplete.

The present study presents estimates of the length weight relationships for 11 species of the families Carangidae, Mullidae, Scombridae, Sparidae and Merlucciidae.

Data were collected during twelve monthly trawl surveys conducted in February 2003 to January 2004 in the gulf of Tunis (Fig 1). Twelve hauls were operated monthly, based on a random sampling method, covering an area of 570 km²

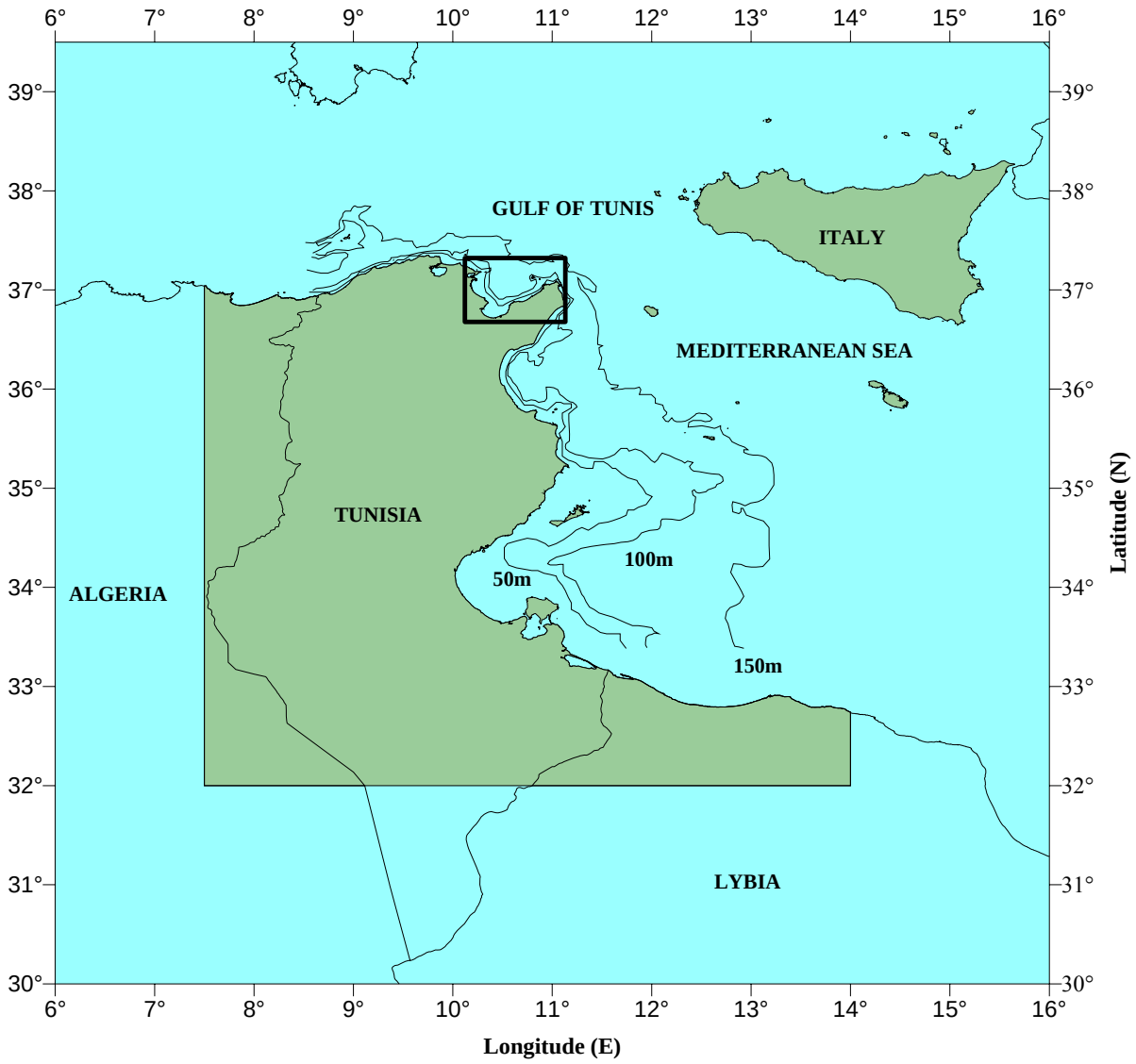

Figure 1. M ap of Gulf of Tunis

between 40 and 100 m of depth, on professional boats. These experimental surveys were operated monthly on professional boats, covering an area of 570 km² between 40 and 100 m of depth. The vessel used was equipped with a Tunisian shrimp's trawl (modified Gulf of Mexico trawl) with 52 mm stretched mesh in the wing and 40 mm in the cod-end. Each haul lasted 120 min at an average speed of 3 knots.

In the laboratory specimens were sorted by sex, measured to the nearest 1 mm (total length, TL) and weighed to the nearest 0.1 g (weight, W). The relationship between the length and weight of a fish is usually expressed by the equation $W=aL^b$ (Ricker 1973) where W is body weight (g), L is total length (cm), *a* is the intercept and *b* is the slope (fish growth rate) (Beverton & Holt 1996). The parameters *a* and *b* of the length-weight relationships were estimated by the least-square method based on the predictive or Type I linear regression model (Sokal & Rohlf 1981), using W as the dependent variable and L as the independent variable, the data analysis has given that for each specie, the number of outliers is far less than 10% of total data and thus the least square model is satisfactory for each set of data (Chen & Jackson 2000). The degree of adjustment of the model studied was assessed by the correlation coefficient (r). Student's t-test was applied to verify whether the declivity of regression (constant "b") presented a significant difference of 3.0, indicating the type of growth: isometric (b=3.0), positive allometric (b>3.0) or negative allometric (b<3.0) (Spiegel 1991). In all cases a statistic significance of 5% was adopted.

A total of 5533 individual fish length and weight observations were recorded for the 11 fish species analyzed in this study. The estimated parameters and length characteristics of the length-weight relationship are given in Table I.

Table I. Descriptive statistics and estimated parameters of the length-weight relationship for 11 fish species from the Gulf of Tunis. min, minimum; max, maximum; S.E, standard error; n, the sample size; *a*, the intercept of the relationship; *b*, the slope of the relationship; *r*, coefficient of correlation.

		Length characteristics (cm)					Parameters				
Species	**Sex**	**n**	**mean**	**SE**	**min**	**max**	***a***	***b***	**SE (*b*)**	***r***	**t-test**
Mullus barbatus (Linnaeus, 1758)	males	664	12,8	0,12	6,3	21	0,004	3,28	0.0314	0,99	4,237*
	females	1099	16,4	0,07	9,7	25	0,007	3,12	0.0521	0,97	5,073*
	both	1763	14,9	0,07	6,3	25	0,005	3,23	0.0072	0,99	3,291*
Sparus aurata (Linnaeus, 1758)	males	124	19	0,1	16	22	0,052	2,8	0.0651	0,92	3,096*
	females	271	17	0,06	17	23	0,014	2,72	0.0398	0,93	3,566*
	both	395	19,2	0,05	16	23	0,03	2,67	0.0152	0,91	4,381*
Diplodus annularis (Linnaeus, 1758)	males	183	13,2	0,09	9,6	17	0,033	2,72	0.0557	0,92	3,022*
	females	287	13,1	0,07	10	17	0,01	2,86	0.0723	0,92	2,873*
	both	470	13	0,52	9,6	17	0,012	2,9	0.0752	0,93	2,895*
Pagellus erythrinus (Linnaeus, 1758)	males	285	19,1	0,16	11	29	0,01	2,84	0.0358	0,97	2,012*
	females	613	16,8	0,08	11	25	0,018	2,84	0.0637	0,97	2,395*
	both	898	17,2	0,84	7,4	29	0,017	2,85	0.0239	0,98	2,208*
Spicara maena (Linnaeus, 1758)	males	121	16	0,17	9,9	19	0,03	2,82	0.0448	0,97	1,708*ns*
	females	209	14,9	0,11	11	19	0,012	2,94	0.0333	0,96	1,695*ns*
	both	330	15,4	0,09	9,5	20	0,014	2,87	0.0328	0,96	1,493*ns*
Merluccius merluccius (Linnaeus, 1758)	males	187	22,4	0,35	16	43	0,004	3,17	0.0354	0,98	3,511*
	females	340	26,1	0,24	17	41	0,005	3,11	0.0284	0,98	2,996*
	both	527	24,8	0,21	16	43	0,004	3,13	0.0232	0,98	4,147*
Boops boops (Linnaeus, 1758)	males	71	18,2	0,24	15	23	0,003	3,01	0.0827	0,97	0,245*ns*
	females	172	19,5	0,19	12	26	0,009	2,98	0.0458	0,97	0,232*ns*
	both	243	18,5	0,14	12	26	0,007	3,06	0.0278	0,98	0,255*ns*
Trachurus trachurus (Linnaeus, 1758)	males	85	19,3	0,32	13	32	0,007	3,00	0.0242	0,98	0,553*ns*
	females	144	19,1	0,17	15	25	0,007	2,98	0.0168	0,97	0,287*ns*
	both	229	17,5	0,17	9	32	0,007	2,98	0.0279	0,99	0,749*ns*
Trachurus mediterranus (Steindachner, 1863)	males	182	18,9	0,28	8,8	30	0,007	2,99	0.0206	0,98	0,201*ns*
	females	280	19,6	0,18	12	28	0,009	2,9	0.0135	0,96	0,231*ns*
	both	462	17,9	0,2	8,8	30	0,007	3,01	0.0236	0,99	0,166*ns*
Lithognatus mormyrus (Linnaeus, 1758)	males	28	18,5	0,28	15	21	0,005	2,92	0.0457	0,96	0.854*ns*
	females	89	18,8	0,15	15	22	0,01	2,98	0.0398	0,98	0.778*ns*
	both	117	18,7	0,13	15	22	0,009	2,84	0.0291	0,98	0.852*ns*
Scomber scombrus (Linnaeus, 1758)	males	44	24,4	0,49	17	32	0,002	3,35	0.0385	0,98	3,177*
	females	55	26,1	0,31	18	32	0,006	3,18	0.0429	0,99	2,386*
	both	99	25,2	0,21	17	32	0,002	3,37	0.1658	0,99	3,557*

*: $p<0.05$; *ns*: $p>0.05$

The sample size ranged from 99 individuals for *Scomber scombrus* to 1763 for *Mullus barbatus*. The *r* values ranged from 0.82 for *Sparus aurata* to 0.99 for *Trachurus trachurus*, and all regressions were highly significant. Values of *b* ranged from 2.674 for *Sparus aurata* to 3.368 for *Scomber scombrus*. A high degree of positive correlation between total length and total weight of all 11 fish species is indicated by high values of correlation coefficient *r*. The estimated values of *b* were close to 3.0 ($p>0.05$) showing isometric growth for *Lithognathus mormyrus*, *Boops boops*, *Spicara maena, Trachurus trachurus* and *Trachurus mediterranus*.

The values of the exponent *b* for males, females and combined sexes were significantly ($p<0.05$) higher than 3.0 exhibited a positive allometric growth for *Mullus barbatus*, *Merluccius merluccius,* and *Scomber scombrus*. The slopes for male, female and both sexes for *Sparus aurata*, *Diplodus annularis* and *Pagellus erythrinus* showed a significant difference ($p<0.05$) lower than 3.0 reflecting a negative allometric growth.

Even though the change of *b* values depends primarily on the shape and fatness of the species, various factors may be responsible for the differences in parameters of the length/weight relationships among seasons and years, such as temperature, salinity, food (quantity, quality and size), sex, time of year and stage of maturity (Pauly 1984, Sparre 1992). According to Bagenal & Tesch (1978), Gonçalves *et al.,* (1997), Taskavak & Bilecenoglu (2001) and Özaydin *et al*., (2007), the parameter *b*, unlike the parameter *a*, may vary seasonally, and even daily, and between habitats. Thus, the length-weight relationship in fish is affected by a number of factors including gonad maturity, sex, diet, stomach fullness, health, and preservation techniques as well as season and habitat, none of which were taken into consideration in the present study.

The information gained in the present survey can enable fish biologists to derive weight estimates for the Gulf of Tunis fishes that are measured but not weighed. The length-weight parameters hereby reported may be of considerable use in ongoing studies of catches in Tunisian commercial fisheries.

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