A REVIEW OF LENGTH-WEIGHT RELATIONSHIPS OF SOME MOST IMPORTANT FISHES FROM THE BULGARIAN BLACK SEA COAST

Maria YANKOVA[1], V. RAYKOV[1], V. MAXIMOV[2], G. RADU[2], Tania ZAHARIA[2]
[1]Institute of Fishing Resources
Varna, Bulgaria,
e-mail: maria_y@abv.bg,vio_raykov@abv.bg
[2]NIMRD "Grigore Antipa," Constanta, Romania
e-mail: maxi@alpha.rmri.ro, gpr@alpha.rmri.ro, zahar@alpha.rmri.ro

ABSTRACT

Length-weight relationships (LWRs) of 12 354 fish samples covering 6 families, 7 genera and 7 species caught in the Bulgarian Black Sea waters were studied. Shark (*Squalus acanthias*), skate (*Raja clavata*), sprat (*Sprattus sprattus*), pontic shad (*Alosa immaculata*), whiting (*Merlangius merlangus euxinus*), horse mackerel (*Trachurus mediterraneus*) and round goby (*Neogobius melanostomus*) were collected from May 2006 to December 2008. The slope or allometric coefficient (*b*) of the functional regression between length and weight values varied between 2.3019 and 3.3467 with the mean *b* = 3.1510. Total length and weight of species (mean, maximum and minimum) were given.

KEY WORDS: Length-weight relationships, fish species, Black Sea waters, Bulgaria

INTRODUCTION

The WLRs have several applications, namely on fish biology, physiology, ecology and fisheries assessment. In a given geographic region, the WLRs are useful for the estimation of weight-at-age from total reported catch weight and length-frequency distributions (PETRAKIS and STERGIOU, 1995). Furthermore, the WLR is useful for estimating condition (SAFRAN, 1992), production and biomass of a population (ANDERSON and GUTREUTER, 1983) or comparisons of populations from different regions (GONCALVES *et al*., 1997). In the present study, the parameters of LWRs are reported for 7 species caught in the Bulgarian Black Sea waters using bottom-trawl and gill netting, trawl net, trap nets of various mesh sizes.

MATERIAL AND METHODS

Samplings took place in the Western Black Sea during 2006-2008 (Fig. 1). A total of 12 354 fish samples (22 *S. acanthias*, 24 *R. clavata*, 3060 *Sprattus sprattus,* 191 *A. immaculata*, 3715 *Merlangius merlangus euxinus*, 1432 *Trachurus mediterraneus* and 3910 *Neogobius melanostomus*, were collected by different fishing techniques (gill netting, trawl net, and trap nets). The samples were transported to the research laboratory in polythene bags containing ice blocks to prevent spoilage and then stored in a deep freezer (-30°C) to avert deterioration. Prior to length and weight measurements the fishes were taken out in batches from the freezer and allowed to thaw. Total length of each fish was taken from the tip of the snout to the extended tip of the caudal fin using a measuring board. Body weight was measured to the nearest gram using a balance. Four species: *Squalus acanthias*, *Raja clavata*, *Sprattus sprattus*, and *Merlangius merlangus euxinus* were collected by the research vessels "Elis" and "RK-3" (boat lengths 13.7 and 17m, engine horsepower 1.7 and 1.8 hp). After hauling, the catch was removed and analyses were carried out on the deck of the research vessel and later in the laboratory. The LWR was estimated by using the equation:

$$W = aL^b \text{ (RICKER, 1975)}$$

where W is total body weight(g), L the total length(cm), a and b are the coefficients of the functional regression between W and L. Allometric coefficient b larger or smaller than 3.0 shows an allometric growth (Bagenal and Tesch, 1978). Value b is>3 and it can be said to have a positive allometric growth. However, b<3 showed a negative allometric growth or isometric growth when equal to 3.0. The values of constant a and b were estimated from the log transformed values of length and weight i.e.

$$\log W = \log a + b \log L$$

via least square linear regression. The degree of association between the variables was computed by the determination coefficient, r^2.

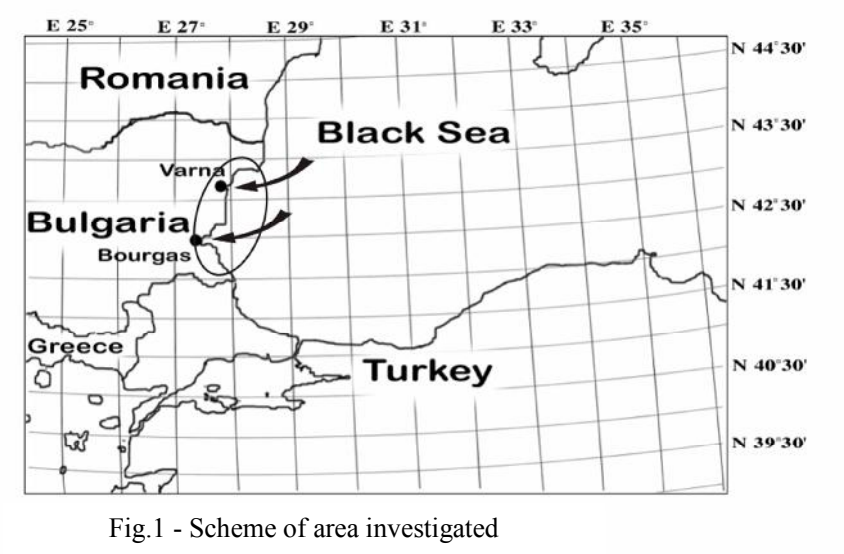

Fig.1 - Scheme of area investigated

RESULTS AND DISCUSSIONS

The sample size, length range, mean length (± SE), weight range and mean weight (±SE) for each species are presented in Table 2. Parameters *a* and *b* of the WLRs, coefficient of correlation r^2 are presented similarly in the Table 2. The sample size ranged from 22 individuals, for *Squalus acanthias*, to 3910, for *Neogobius melanostomus*. The r^2 values ranged from 0.99 for *Merlangius merlangus euxinus* to 0.78 for *Alosa pontica*, and all regressions were highly significant ($p < 0.001$). The *b* value ranged from 2.3019 for *R. clavata* to 3.3467 for *Neogobius melanostomus*, the mean value of coefficient *b* was 3.1510 (Fig. 2). The growth was negative allometric for *Raja clavata, Sprattus sprattus, and Alosa immaculata*, the functional regression *b* values for each species were found to be smaller than 3 ($b<3$). *Squalus acanthias, Merlangius merlangus euxinus, Trachurus mediterraneus* and *Neogobius melanostomus* exhibited positive allometric growth, *b* –values were higher than 3, ($b>3$). Weight-length relationships have been published for the same species in the Mediterranean, Black and Azov Sea (Table 1). The comparison of the *b* values obtained in our study and some of previously reported results in the Black and Azov Seas and the Mediterranean, indicates variation in the

b values. However, WLRs for *Raja clavata* (Aegean Sea), *Sprattus sprattus* (Adriatic and eastern Black Seas), *A. immaculata* (M. Black Sea), differed significantly from our results. The variation in the *b* exponents for a same species could be attributed to differences in sampling, sample size or length ranges. In addition, growth increment, food, environmental conditions, such as temperature, salinity, seasonality, as well as differences in age and stage of maturity can also affect the value of *b* (SHEPHERD and GRIMES, 1983; WEATHERLEY and GILL, 1987).

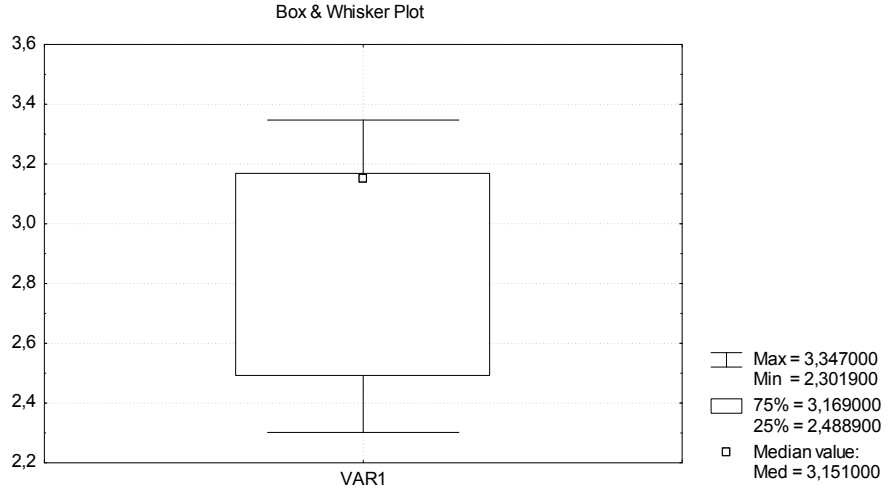

Fig. 2 – Box-Whisker Plot of the exponent *b* of length-weight relationships for seven fish species from the Bulgarian Black Sea waters

Table 1 - Some results of length-weight relationship for fish species in different localities

	Authors	**Areas**	**Range (cm)**	***a***	***b***
M. merlangus	Samsun and Erkoyuncu, 1998	M. Black Sea	9-24	0.0039	3.24
M. merlangus	Genç et al., 1999	E. Black Sea	5-40	0.0052	3.14
M.merlangus	İşmen, 2002	Black Sea	5-32.5	0.0042	3.24
M. merlangus	Maximov et al.,2009	Black Sea		0.0048	3.11
A. immaculata	Kolarov, 1991	Bulgaria	9-36	0.0629	2.55
A. pontica	Samsun, 1995	M. Black Sea	11.6-31.6	0.0021	3.39

S. sprattus	Sinovčić, et al., 2004	Adriatic	9-17.4	0.0039	3.16
S. sprattus	Sinovčić, et al., 2004	Adriatic Sea	8.6-11.9	0.0226	2.51
S. sprattus	Şahin, 1999	E. Black Sea	7.2-13.2	0.0021	3.46
T. mediterraneus	Yankova et al., 2009	Bulgaria	10.5-17.0	0.0350	3.30
T. mediterraneus	Genç et al., 1999	E. Black Sea		0.0051	3.17
S. acanthias	Filiz and Mater, 2002	Aegean Sea	27.00-70.50	0.0031	3.10
R. clavata	Filiz and Mater, 2002	Aegean Sea	20.50-99.0	0.0016	3.29
N. melanostomus	Froese and Pauly, 2009	Sea of Azov		0.0972	2.431

Table 2 – Mean total length, weight and parameters of the length-weight relationship for
seven species caught from the Bulgarian Black Sea Coast

	Length characteristics				**Weight characteristics**			**Parameters of relationship**		
	N	**MTL**	**± SE**	**TL_{min} - TL_{max}**	**MW**	**±SE**	**W_{min} - W_{max}**	***a***	***b***	***r^2***
Squalidae										
Squalus acanthias	22	125	0.02	112-144	10.35	0.68	6.2-14.2	2E-06	3.1531	0.81
Rajidae										
Raja clavata	24	68.81	1.38	56-79	2.89	0.24	1.2-5.5	0.0002	2.3019	0.86

Clupeidae										
Sprattus sprattus	3060	9.59	0.03	6-11.5	5.25	0.04	1.32-7.99	0.0103	2.7335	0.95
Alosa immaculata	191	29.11	0.14	24.2-37.7	318.66	4.34	175- 515	0.0715	2.4889	0.78
Gadidae										
Merlangius merlangus euxinus	3715	15.23	0.05	5.5-22.5	29.02	0.29	1.05- 80.9	0.0046	3.1514	0.99
Carangidae										
Trachurus mediterraneus	1432	13.38	0.04	7-18.4	20.19	0.21	4.5-55	0.0051	3.1685	0.92
Gobiidae										
Neogobius melanostomus	3910	15.45	0.01	13.6-19.2	58.11	0.16	37.5- 113	0.006	3.3467	0.98

N – Number of fishes; MTL-Mean total length; ±SE – Standard error; MW – Mean Weight; *a* and *b* are the coefficients of the functional regression between W and L; r^2 - coefficient of determination.

CONCLUSIONS

This article contributes with length-weight relationships data of some fishes from the Bulgarian Black Sea waters. These values can be used in fishery or biomass assessment and in trophic studies in this area of the Black Sea basin. This is the first attempt to determine the relationships between length and weight of two elasmobranches species (*R. clavata* and S. *acanthias*) in the Bulgarian Black Sea Coast. All allometric coefficients (*b*) estimated in this study varied between 2.3019 and 3.3467. As a result of the study, some species (shark, whiting, horse mackerel and round goby) exhibited positive allometric growth, while others (skate, sprat and pontic shad) had negative allometric growth.

REFERENCES

ANDERSON R., GUTREUTER S., 1983 - Length, weight and associated structural indices. In: *Fisheries Techniques* (Nielsen L. and D. Johnson, Eds), pp. 283-300. American Fisheries Society.

FILIZ H., MATER S., 2002 - A preliminary study on length-weight relationships for seven elasmobranch species from North Aegean Sea, Turkey. *Journal of Fisheries and Aquatic Sciences*, Issue (3-4): 401-409.

FROESE R. PAULY D. Editors. 2009 - FishBase.World *Wide Web electronic publication*. www. fishbase.org, version (02/2009).

GENÇ Y., ZENGIN M., BAŞAR S., TABAK İ., CEYLAN N., ÇIFTCI Y., USTÜNDAĞ C., AKBULUT B., ŞAHIN T., 1999 - The Research Project of economical Marine Products. TKB, Central Fisheries Research institute, Trabzon, 157pp. (in Turkish).

GONCALVES J.M.S., BENTES L., LINO P.G., RIBEIRO J., CANARIO A.V.M., ERZINI K., 1997 - Weight-length relationship for selected fish species of the small-scale demersal fisheries of the south and south-west coast of Portugal. *Fish.Res*., 30: 253-256.

İŞMEN A., 2002 - A preliminary study on the population dynamics parameters of whiting, (*Merlangus merlangus euxinus*) in the Turkish Black Sea coastal waters. *Turkish Journal of Zoology*, 26: 157-166.

KOLAROV P., 1991 - *Alosa pontica pontica* (Eichwald, 1938) In: H. Hoestlandt (Ed.), the freshwater fishes of Europe. Vol. 2. Clupeidae, Anguillidae, *http://www.fishbase.org/*, last accessed: 28 March 2006). AULA- Verlag Wiesbaden: 337-368.

MAXIMOV V., RAYKOV V., YANKOVA M., ZAHARIA T., 2009 - Whiting (*Merlangius merlangus euxinus*) population parameters in the Romanian and Bulgarian Black Sea Coast during 2000 – 2007. 4th International Environmental Conference of Katerini-Pieria: "Life Quality and Capacity Building in the frame of a Safe Environment". Abstracts, 61pp.

PETRAKIS G., STERGIOU K.I., 1995 - Weight-length relationship for 33 species in Greek waters. *Fish. Res*., 21(3-4): 465-469.

RICKER W.E., 1975 - Computation and interpretation of biological statistics of fish populations. Bull. *Fish Res.* Board Can., 191:382.

SAFRAN P., 1992 - Theoretical analysis of the weight-length relationships in the juveniles. *Mar. Biol*., 112: 545-551.

ŞAHIN T., 1999 - The Research Project of economical Marine Products. TKB, Central Fisheries Research institute, Trabzon, 157pp. (in Turkish).

SAMSUN O., 1995 - The weight-length relationship of the shads (*Alosa pontica* Eichw., 1938) in the mid of the Turkish Black Sea. E. Ű. Su. Űrűnleri Dergisi, 12(1-2): 15-21(in Turkish).

SAMSUN N., ERKOYUNCU İ., 1998 - The research on the estimation of some parameters of whiting (*Gadus merlangus euxinus* Nordmann, 1840) caught by the bottom trawlers from the viewpoint of fishery biology E. Ű.Su. Űrűnleri Dergisi, 15(1-2): 19-31(in Turkish).

SHEPHERD G., GRIMES C., 1983 - Geographic and historic variations in growth of weakfish, *Cynoscion regalis*, in the middle Atlantic Bight. *Fish. Bull*. U.S., 81: 803-813.

SINOVČIĆ G., FRANICEVIC M., ZORICA B., CILES-KEC V., 2004 - Length-weight and length-length relationships for 10 pelagic fish species from the Adriatic Sea (Croatia). *Journal of Applied Ichthyology*, 20: 156-158.

WEATHERLEY A.H., GILL H.S., 1987 - *The Biology of Fish Growth*. 443 p. London: Academic Press.

YANKOVA M., RAYKOV V., GERDZHIKOV D., BOGOMILOVA P., 2010 - Growth and Length-Weight Relationships of the Horse Mackerel, *Trachurus mediterraneus* (Aleev, 1956), in the Bulgarian Black Sea Coast. *Turkish Journal of Zoology*, Volume 34, Issue 4, 85-92.