Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 5, No. 2, p. 37-43, 2014
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Age and growth of *Mullus surmuletus* (L.) in Mostaganem coast, Northwest Algeria

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Article published on August 02, 2014

Key words: *Mullus surmuletus*, Mostaganem, relationship, Von Bertalanffy.

Abstract

The age, growth, of *Mullus surmuletus*, caught in Mostaganem (Northwest Algerian Sea) between January and December 2009, were investigated. Sex ratio female to male was 1:1.60. The total length of females ranged from 12.5 cm to 23 cm and of males from 12.3 cm to 22.5 cm. The length-mass relationship for all individuals can be described by the parameters a =0.009 and b = 2.934. Fish aged 0-7 years were present in the samples. The parameters of the Von Bertalanffy growth equation obtained for females were L_∞= 24.70 cm, k = 0.37 cm / year, and t_0 = - 0.37 year. For males L_∞= 25.52 cm, k = 0.32 cm / year, t_0 = - 0.71 year. Significant differences were found in the growth parameters between males and females.

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Introduction

Red mullet *Mullus surmuletus* (Linnaeus 1758) is a demersal marine fish that inhabits sandy and rocky substrata, usually at depths <200 m (Hureau, 1986). *M. surmuletus* is a major target species of Mediterranean demersal fisheries (Reňones *et al.,* 1995; Mehanna, 2009) and encountered in shallower soft bottoms, sea grass beds and rocky bottoms (Lombarte *et al.*, 2000; Bautista-Vega, 2008). This species is benthic carnivores and feed on small invertebrates (Gharbi and Ktari, 1981b; Golani and Galil, 1991; Mehanna, 2009; N'Da, 1992; Labropoulou and Eleftheriou, 1997; Vassilopoulou *et al.,* 2001).

In the Mediterranean, most investigators have studied *Mullus surmuletus* jointly with *M. barbatus,* and reports are available comparing chemical composition (Fernández and Val, 1966), age and growth (Bougis, 1952; Gharbi and Ktari, 1981 a; Andaloro and Giarritta, 1985; Morales-Nin, 1986; 1991; Campillo, 1992; Stergiou *et al.,* 1997; Mehanna, 2009), reproduction (Gharbi and Ktari, 1981b), trophic relationships (Gharbi and Ktari, 1979; Golani and Galil, 1991), and biological and fishing aspects (Sánchez *et al.* 1983; Vassilopulou and Papaconstantinou 1992; Renõnes *et al.,* 1995; Pajeulo *et al.,* 1997) of both species. In Algeria, only Djabali *et al.,* 1993 and Derbal *et al.*, 2001 have studied some biological aspects of this specie.

The aim of our study is analysing the age and the growth aspects of *M. surmutetus* in Mostaganem (Northwest Algeria).The result of the present work will contribute to the knowledge about the age composition and growth of *M. surmuletus* and also to better understanding of its role in the ecosystem. Consequently, this study will be a step forward to the improvement of the fisheries assessment and management of *M. surmuletus* in this area.

Materials and methods

A total of 838 *M. surmuletus* specimens were collected between January and December 2009 from monthly samples at depths ranging from 10 to 150 m in Mostaganem coast, Mediterranean Sea, using a commercial bottom trawl net (Fig. 1).

A subsample was taken from monthly samples for the biological examination later in the laboratory, the total lengths (TL) of all fish were measured to the nearest cm and the nearest gram total weight (TW), and the sex of each specimen was determined by examining the gonads macroscopically.

The length-weight relationships were determined according to the allometric equation (Sparre *et al.,* 1989): $W = aL^b$, where W is the total body weight (g), L is the total length (cm), while *a* and *b* are constants. Statistical comparison of length-weight relationships between sexes was performed with t-tests (Zar, 1999).

Growth was expressed in terms of the von Bertalanffy equation (Beverton and Holt, 1957): $L_t = L_\infty (1-e^{-K(t-t_o)})$, where: L_∞: is the asymptotic total length; L_t: the total length at age t; K: the growth curvature parameter and t_o is the theoretical age when fish would have been at zero total length.

Growth parameters were estimated according to the non-linear method by using the software FISAT program package (subroutine ELEFAN). In ELEFAN, data are reconstructed to generate "peaks" and "trought", and the goodness of fit index (Rn) is defined by: $R_n = 10^{ESP/ASP}/10$, where the ASP "Available Sum of Peaks" is computed by adding the "best" value of the available "peaks" and the ESP "Explained Sum of Peaks" is computed by summing all the peaks and troughs "hit" by a growth curve of the form: $L_t = L_\infty (1- EXP(- K(t - t_o) + St_s + St_o)$ where:

$St_s = (CK/2\pi) * \sin (2\pi (t-t_s))$,

$St_o = (CK/2\pi) * \sin (2\pi (t_o-t_s))$, and Lt is the length at time t. (Sparre *et al.*, 1989). Growth parameters obtained for males and females were compared using the multivariate Hotelling's T^2 test (Bernard, 1981). For the sake of comparison, the index of overall

growth performance Φ, proposed by Pauly and Munro,1984 was used. This test provided an indication of the reliability of age estimates since it had been suggested that phi-prime test values were similar for the same species and genera. The test was based on: $\Phi = \log K + 2 \log L_\infty$ (Piñeiro and Saínza, 2003).

Results

The length and weight of the *M. surmuletus* ranged from 12 cm to 23 cm in total length (TL) and from 16 g to 120 g in weight, respectively. Most fish were 14 - 16 cm TL, accounting for 64 % and 42 % of females and males, respectively (Fig. 2).

Of 838 specimens captured, 516 were female and 322 were male. Females measured 12 to 24 cm *TL* ($\bar{X}$=*18.21* cm), males 12.5 to 23.5 cm *TL* ($\bar{X}$ =*17.69* cm). The length-weight relationship of *Mullus surmuletus* indicated a positive allometry for female and a negative allometry for male by the following equation: ($W_T = a\ L_T{}^b$).

Females: $W = 0.009 * L_T{}^{3.02}$, $r^2 = 0.935$, n = 516

Males: $W = 0.010 * L_T{}^{2.98}$, $r^2 = 0.977$, n = 322

The analysis by sex showed a significant difference in the *b* coefficient (Table 1).

Table 1. Biometric Relations *M.surmuletus* (Linne, 1758).

	$W_T = a\ L_T{}^b$	
Females	$W_\infty = 0{,}009 L_T{}^{3,02}$	$r^2 = 0.935$
Males	$W_\infty = 0{,}010 L_T{}^{2,98}$	$r^2 = 0.977$

The Von Bertalanffy growth parameters for *M. surmuletus* were estimated as L_∞= 24.70 cm, K = 0.37 cm/year and t_o = - 0.37 year for females, and L_∞ = 25.52 cm, K = 0.32 cm/year and t_o = - 0.71 year for males (Table 2). Significant differences were found between the growth of males and females.

Table 2. Growth parameters for *M.surmuletus* females and males.

	Females				Males			
Parameters	k (cm/yr)	L_∞ (cm)	t_o (yr)	Φ	k (cm/yr)	L_∞ (cm)	t_o (yr)	Φ
Results	0,37	24,70	- 0,37	2.35	0,32	25,52	- 0,71	2.32

Table 3. Von Bertalanffy Equation.

	Von Bertalanffy Equation
Females	$L_t = 24{,}70(1\text{-}e^{-0,37\,(t\,+\,0,37)})$
Males	$L_t = 25{,}52(1\text{-}e^{-0,32\,(t\,+\,0,71)})$

Discussion

The calculated growth performance index (Φ) in Mostaganem waters was 2.35 for females and 2.32 for males. This finding is in agreement with the considerable similarity between the growth performance indice (Φ) calculated for each sex. In order to compare the growth of the *M. surmuletus* population with others, all available literature data of von Bertalanffy growth parameters and Φ values, including results from the present study are compiled (Table 4).

The positive allometry of the length weight relationship for the whole population agrees with results of other studies (Table 4 and 5). The differences between females and males, with a small difference in allometric coefficient in females than males, are probably due to the different length distributions of the two sexes. In the size weight relationship, this difference between females and males as a whole means that the portion of the population > 21 cm in length has a very low proportion of males (Fig.2).

Table 4. *Mullus surmuletus* length weight and growth parameters in different areas of Mediterranean Sea (F females; M males; F + M females and males; further abbreviations as in Tables 1 and 2).

	L_∞ (cm)	k(cm/year)	t_0 (year)	Φ	a	b	Area	Source
F+M	32.52	0.1097	-3.64	2.06	0.0073	3.10	Catalonia	Sáncez *et al* (1983)
F	29.75	0.49	-0.31				Sicilian	Andaloro and
M	26.25	0.41	-0.23				Channel	Giarritta (1985)
F	21.82	0.51	-0.112	2.38	0.1403	3.351	Tunisia	Gharbi and Ktari
M	19.87	0.49	-0.025	2.28	0.1443	3.28		(1981a)
F+M	21.51	0.50	-0.116	2.36				
F	31.90	0.20	-2.60	2.32	0.0095	3.1090	Majorca	Renones (1995)
M	25.54	0.27	-2.45	2.25	0.0104	3.0672		
F+M	31.28	0.21	-2.34	2.31	0.0091	3.1203		
-	31.74	0.47	-0.30	2.67			Egypt	Mehanna (2009)
F	24.70	0.37	-0.37	2.35	0.009	3.02	Algeria	Kherraz *et al* (2014)
M	25.52	0.32	-0.71	2.32	0.010	2.98		

Table 5. Total length-total weight relationships of *M. surmuletus* reported by various studies.

Author	Region	Sex	Size range (cm)	a	b	effective
Morales-Nin (1991)	Majorca	-	-	0.016	2.91	1092
Campillo (1992)	Gulf of Lion	-	-	0.082	3.00	-
Sanche *et al* (1995)	Spain	-	-			
Gonçalves *et al* (1996)	Portugal	-	21.5-38	0.029	3.08	299
Abdallah (2002)	Egypt	-	5.4-20.8	0.011	3.03	122
Valle *et al* (2003)	West Mediterranean	-	7.7-25.4	0.0097	3.07	146
Mendes *et al* (2004)	Portugal	-	17-38.2	0.039	3.36	108
Ilhan *et al* (2009)	Izmir Bay	-	6.6-22.6	0.0083	3.12	192
Mukadder *et al* (2013)	Saros Bay	♀	11-26.8	0.0075	3.16	184
		♂	11.8-19.8	0.0114	3.01	118
Kherraz *et al* (2014)	Mostaganem	♀	12-24	0.009	3.02	516
		♂	12.5-23.5	0.010	2.98	322

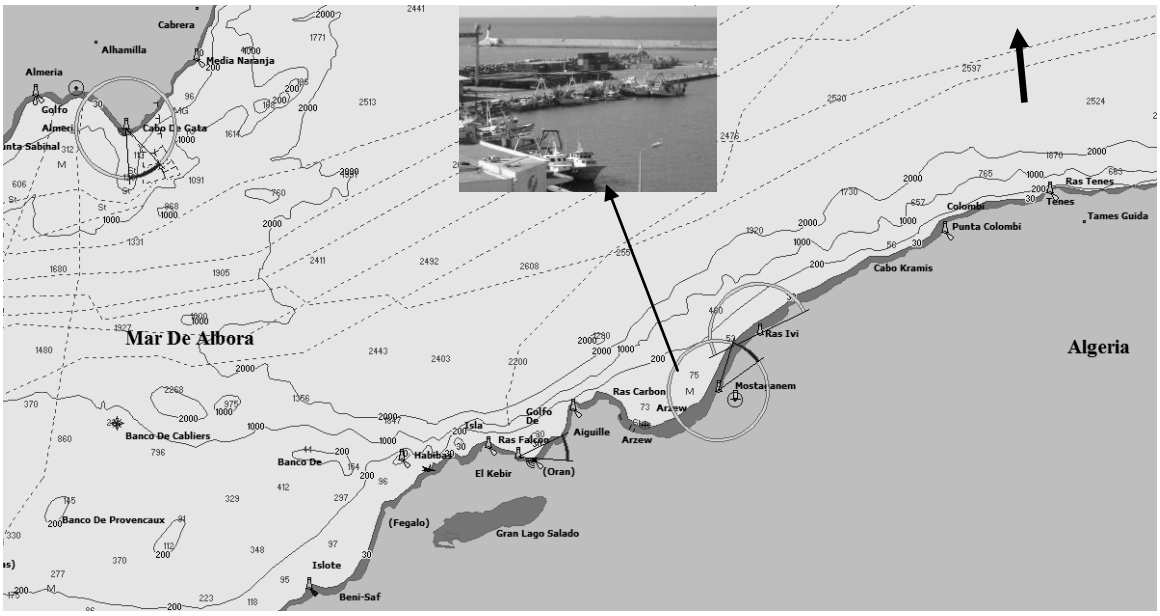

Fig. 1. Study area (Max Sea-marine software V.10).

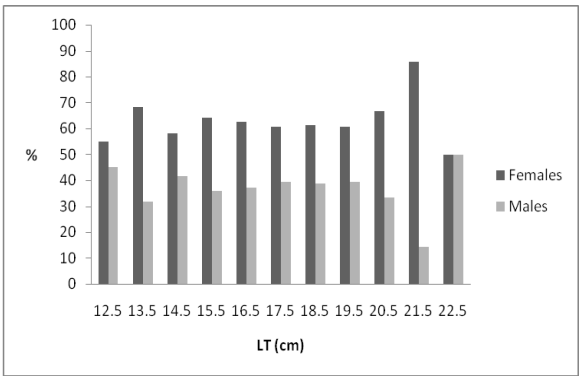

Fig. 2. Length-frequency distribution by sex of *M. surmuletus*.

As a whole, growth of *Mullus surmuletus* is fast, with females growing at a slightly slower rate than males. There is no apparent difference in the maximum age between sexes, but females are predominant in Age Classes IV and V. The growth of *Mullus surmuletus* recorded in our study is very similar to that reported for this species in other areas, except in Catalonia where it is lower (Table 4). However, the calculated growth parameters describe the exploited population for the trawl fishery, where the oldest fish were 7 yr of age.

The results of the present work will contribute to the knowledge on age composition, growth of *M. surmuletus* in Mostaganem and also to better understanding of its role in marine ecosystem. This information will help fisheries scientists for future studies on *M. surmuletus* populations and may also help to enforce regulations on commercial fisheries with regard to minimum landing size restrictions for this species.

Acknowledgements

We thank the Algerian Ministry of Higher Education and Scientific Research (MESRS) which funded this experimental study within the framework of CNEPRU project No F01820090008. We are grateful to anonymous reviewers for the constructive critisms of an earlier draft.

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