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Age and growth of sharpsnout seabream *Diplodus puntazzo* (Cetti, 1777) in the eastern Adriatic Sea

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Abstract: The age and growth parameters of *Diplodus puntazzo* from the eastern middle Adriatic Sea were studied. Total lengths (TL) of 630 specimens ranging from 13.3 to 46.7 cm were obtained from commercial fishery catches by "tramata" fishing (2004-2005). All specimens sampled were fully mature above 22 cm TL. The male-female ratio for all fish combined was 0.75:1.00, but the ratio changed according to length classes. The mean lengths, as well as the age frequency distributions of males and females were not significantly different. Scales showed clearly the ring pattern common to teleost fishes. The opaque ring was deposited during the summer months. The length-weight relationship showed an isometric growth ($b = 3.001$; $R^2 = 0.988$). The parameters of the von Bertalanffy growth equation were: $L_\infty = 45.28$ cm; $K = 0.191$ per year; $t_0 = -0.306$ year; $R^2 = 0.953$. This study revealed that *D. puntazzo* is a relatively slow growing and long-lived species with a life span in excess of 18 years.

Résumé : *Age et croissance de* Diplodus puntazzo *(Cetti, 1777) en Mer Adriatique orientale*. Les paramètres d'âge et de croissance de *Diplodus puntazzo* ont été étudiés en Mer Adriatique orientale. Les longueurs totales (LT) de 630 spécimens s'étendant de 13,3 à 46,7 cm ont été obtenues à partir des pêches commerciales au "tramata" (2004-2005). Tous les spécimens prélevés étaient complètement mâtures au-dessus de 22 cm LT. Le ratio mâle-femelle pour l'ensemble des poissons capturés est de 0,75:1,00, mais le rapport varie selon la longueur. La longueur moyenne, aussi bien que les distributions de fréquence d'âge des mâles et les femelles ne sont pas significativement différentes. Les écailles montrent nettement le schéma classique de stries commun aux poissons téléostéens. L'anneau opaque est formé pendant les mois d'été tandis que l'anneau translucide se forme au cours des mois d'hiver. Le rapport taille-poids met en évidence une croissance isométrique ($b = 3{,}001$; $R^2 = 0{,}988$). Les paramètres de l'équation de croissance de Von Bertalanffy sont : $L_\infty = 45{,}28$ cm; $K = 0{,}191$ an^{-1} ; $t_0 = -0{,}306$ ans; $R^2 = 0{,}953$. Cette étude montre que *D. puntazzo* présente une croissance relativement lente et une longévité supérieure à 18 ans.

Keywords: Age • Growth • *Diplodus puntazzo* • Adriatic Sea • Scale readings

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Introduction

The sharpsnout seabream, *Diplodus puntazzo* (Cetti, 1777) is a demersal marine fish found in groups over rocky and sandy bottoms and seagrass meadows, at depths ranging from 0 to 150 m, but mostly from 5 to 20 m. The species is distributed in the eastern Atlantic, from the Gulf of Biscay to Sierra Leone, as well as in the Mediterranean and Adriatic Seas (Bauchot & Hureau, 1986; Jardas, 1996). Although Sparids family and especially *Diplodus* genus are widespread in the Mediterranean Sea and constitute an important fishery resource along its coasts, there is a lack of data on *D. puntazzo* biology and ecology with an exception of recently published paper about age and growth of this species inhabiting the Canarian archipelago (Domínguez-Seoane et al., 2006). Majority of published studies deals with investigation of its potential for introduction in intensive mariculture (e.g. Divanach et al., 1993; Abellan & Garcia-Alcazar, 1995; Gatland, 1995), while its commercial production still remains at an experimental level due to market prices that cannot justify the production costs (Katavić et al., 2000). Settlement and recruitment process (e.g. García-Rubies & Macpherson, 1995; Vigliola et al., 1998; Vigliola & Harmelin-Vivien, 2001) and growth of juvenile sparids (e.g. Planes et al., 1999; Vigliola et al., 2000) have only recently been surveyed in the northwestern Mediterranean Sea. In the Adriatic Sea, Kraljević (1995) and Katavić et al. (2000) investigated feeding and growth performance of *D. puntazzo* in capture, respectively. Recently, the growth of juvenile *D. puntazzo* (0^+) was investigated (Matić-Skoko et al., 2007a, in press). However, nothing is known about the growth of adult wild sharpsnout seabream in the Adriatic and other parts of the Mediterranean Sea.

In Adriatic Sea, *D. puntazzo* is caught almost only with “tramata” fishing. This fishing technique is not known from anywhere else in the world except in Croatian coastal waters, and undoubtedly, this method is the most efficient method for Sparidae harvesting (Jardas et al., 1998). It is based on the use of ropes, gillnets and beach seines. Depending on the enclosed area, length of the enclosing rope and “decorations” (white plastic lines, wooden plates or some other material of white colour as an additional method for scaring the fish), fishing gear used and fishery tradition of the area, distinction has been made between “ludar”, “zagonica” and “fruzata” (Cetinić et al., 2002). It is a very old method, based on the fish behaviour. More specifically, the vibrations and sounds derived from constant pulling of the ropes affect the sense organs of fish and they swim away from the source of vibrations. This method of fishing has provoked controversy and antagonism, and it was often forbidden or very restricted, but recent investigation (Cetinić & Pallaoro, 1993; Cetinić et al., 2002) shows that tramata fishing was not so harmful to coastal ichthyocommunities.

The present paper deals with the growth and the age data of *D. puntazzo* to obtain growth estimation, which are important input parameters to stock assessment techniques and will provide an insight into the life history of this species.

Material and methods

Samples were collected only in warmer part of the year (June-October) monthly in 2004 and 2005 at 5 locations in the eastern middle Adriatic Sea (Fig. 1). Usually, investigations were carried out during the fishing season (from July 1 to September 1), but sometimes even before and/or after that period in order to determine and regulate, for fishery legislation, proper start of the fishing season, spawning seasons and lengths at first maturity for target seabream species. Specimens were sampled from “ludar”, one of three kinds of tramata fishing. Ropes (up to 4000 m) are used for enclosing a large sea area (up to 4 km^2, but because of coastal and bottom configuration that is mainly up to 1.5 km^2), herding fish by vibrations produced by pulling of ropes, close to the coast; they are then harvested by common gillnet, witch stretched mesh size must not be smaller than 56 mm (Cetinić et al., 2002). A total of 630 specimens, caught through the sampling months were taken for analysis. For each fish, the total length (TL) was measured (0.1 cm), the total body weight (TW) was recorded (0.1g) and the sex was determined macroscopically (male, female or juvenile).

Before grouping the samples per location, the differences between the individuals collected at five different locations were tested using a pair-wise comparison of the mean lengths at age. Because such comparison showed that there were no significant differences in the mean lengths at age for any of the sampling location (t-test: $t_{0.05} = 0.241$, $p < 0.05$), data of *D. puntazzo* were combined. Unfortunately, due to previously mentioned specific fishing season of “ludar” and the fact that there is no other fishing gear which allow catch of *D. puntazzo* in larger quantities (only sporadic catch), age analysis could not be provided through the year but only at five months sampling basis (June-October).

The sample available for age and growth studies consisted of scales of 598 individuals (94.9% readible scales). Among them 577 specimens (96.5%) were mature (they have gonads with previous spent event). Scales from the back of the pectoral fin were removed for determining age by interpreting growth rings. Each scale was read three times by three different readers using a compound microscope (magnification 1.6 x 11.2) with a black background

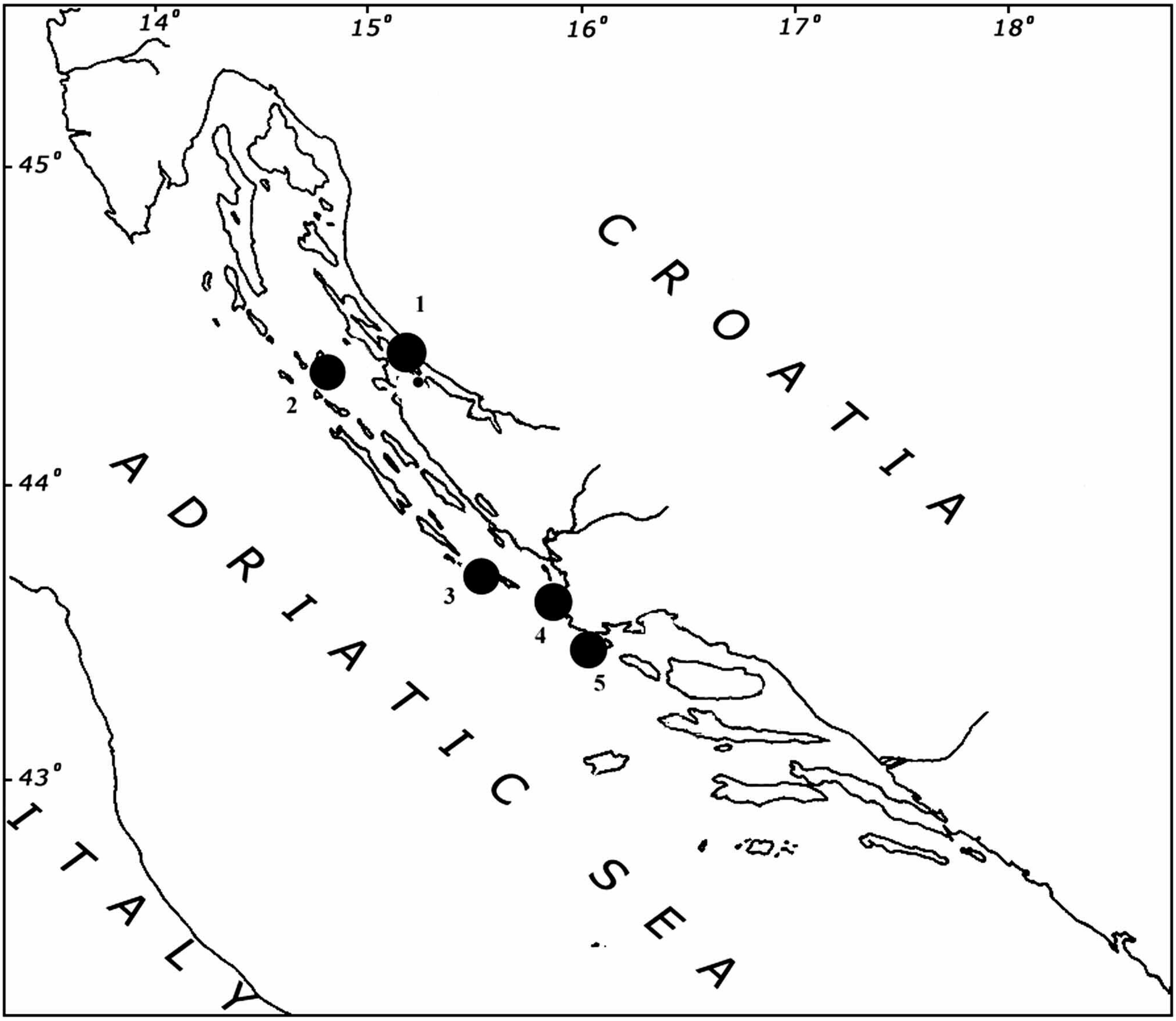

Figure 1. *Diplodus puntazzo*. Investigation areas with 5 sampling locations in middle Adriatic Sea: (1) Vir (2) Silba (3) Žirje (4) Šibenik-Primošten (5) Drvenik.

Figure 1. *Diplodus puntazzo*. Localisation des 5 sites d'échantillonnage en Mer Adriatique moyenne : (1) Vir (2) Silba (3) Žirje (4) Šibenik-Primošten (5) Drvenik.

and under reflected light. Only coincident readings of 598 individuals (21 juveniles, 246 males and 331 females) were accepted. The index of average percent error (IAPE) (Beamish & Fournier, 1981) as well as the mean coefficient of variation (CV) (Chang, 1982) was calculated to estimate the relative precision between readings. Low values of the indices indicated a good precision of age estimation.

Disturbance ring on the scales were distinguished from annual rings based on their irregularity; disturbance rings were not continuous across whole scales and had thickening. For validating the periodicity of increments formation, the marginal increment was measured (Jearld, 1983). The edge of the scale was treated as the last ring, and the area between the previous ring and edge of the scale was treated as the annual growth increment. Measurements were always made along the longest axis of the scale. Once the ring was considered to be annual, each specimen was assigned to a year class taking into account the data of capture, the annuli counts and their formation period. So, due to the period of the ring formation (July-August) and considering September 1st as the peak of spawning (unpublished data), each fish was assigned to an age class.

A pair-wise comparison of the mean lengths at age was used to test differences between males and females in same age classes. Kolmogorov-Smirnov two-sample test was used to age frequency distribution analysis.

The non-linear least squares regression procedure was used to estimate the growth parameters of the von Bertalanffy growth function (VBGF):

$$TL = L_{\infty} (1- e^{-k (t-t0)}) \quad (1)$$

where TL is the total length at age t, L_{∞} is the asymptotic length, k is the body growth coefficient and t_0 is the theoretical age at zero length (Beverton & Holt, 1957). Maximum likelihood test (Kimura, 1980) was used for comparison of growth parameters for males and females. In addition, the weight-length relationship was described by the equation:

$$TW = aTL^{b} \quad (2)$$

where TW is total fresh weight (g) and TL is total length (cm).

Results

The 598 individuals of *D. puntazzo* used for age study consisted of 246 (41.1%) males, 331 (55.4%) females and 21 (3.5%) immature individuals. All specimens sampled were fully mature above 22 cm TL. The male-female ratio for all fish combined was 0.75:1.00, but the ratio changed according to length classes. The fish sampled ranged from 13.3 to 46.7 cm TL (mean 28.7 ± SD 6.77 cm) and from 41.2 to 1545.0 g TW (mean 387.71 ± SD 255.291 g). Males ranged from 13.3 to 45.0 cm with a mean TL of 28.0 ± SD 6.31 cm and females ranged from 13.7 to 46.7 cm with a mean TL of 29.3 ± SD 7.05 cm. The mean lengths of males and females were not significantly different (Mann-Whitney test: U = 65742; p = 0.358). The length frequency distribution exhibited a mode at 23 cm. The weight-length relationship for whole sample was:

$$W = 0.139 \times TL^{3.001} \ (R^2 = 0.988) \quad (3)$$

indicating an isometric growth.

The age was determined by interpreting growth rings on the scales (Fig 2). The index of average percent error (IAPE) of ring counts for each reader did not differ greatly, and was slighly lower for the first author (2.47) than for the second (2.69) and third (2.73). The precision of the age estimates (CV) was 1.3. In general, scales were easy to read, with clearly identifiable increments, although the phenomenon of stacking of growth zone towards the scale edge, especially in fish older than 10 years, was evident. Scales showed clearly the ring pattern common to teleost fishes. The opaque ring was deposited during the summer months. Marginal increment analysis showed that single annuli formed each year during autumn-winter. *D. puntazzo* ages ranged from 2 to 18 years, with a predominance of age classes 2 to 6 in the catch (74.2% individuals). The oldest female was estimated to be 18 yr old *vs* 16 yr old for male. 5-yr old individuals, ranging in lengths from 21.7 to 33.7 cm TL (30.6%) dominated in the sample. There was some overlapping of individuals with same lengths, especially for the ages from 3 to 6.

A pair-wise comparison of the mean lengths at age of

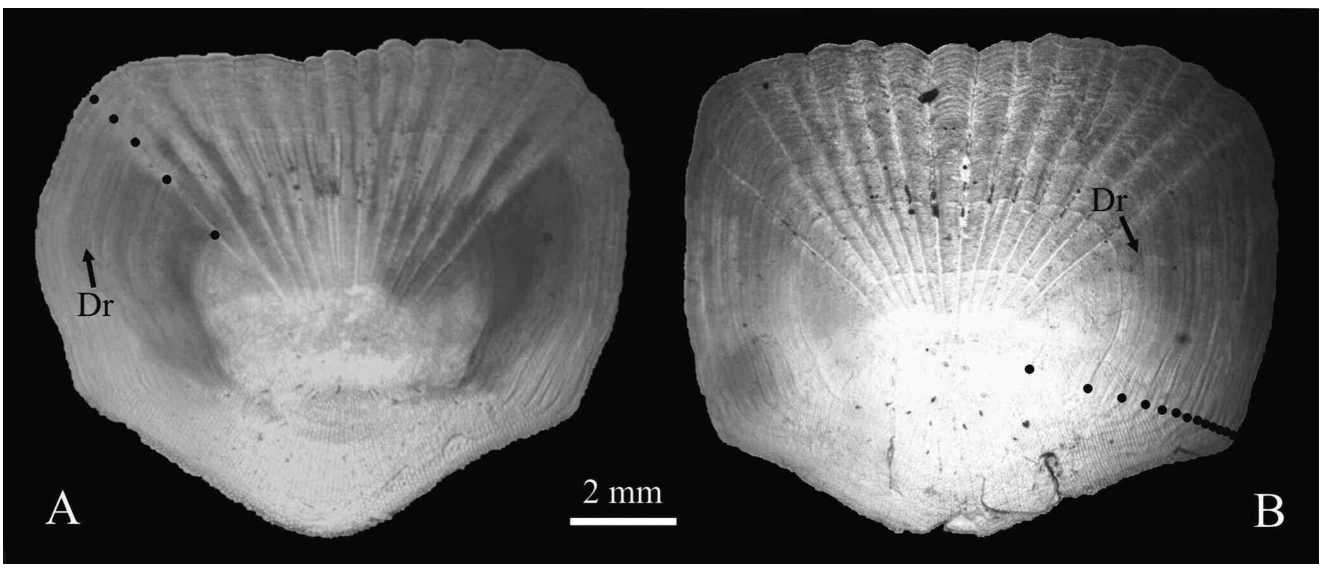

Figure 2. *Diplodus puntazzo*. Scales of *D. puntazzo* from the Adriatic Sea. **A.** A 5 year old (31.5 cm). **B.** A 13 old (40.1 cm). Dr is the disturbance ring (magnification 1.6 x 11.2).

Figure 2. *Diplodus puntazzo*. Ecailles de *D. puntazzo* de Mer Adriatique. **A.** Individu âgé de 5 ans (31,5 cm). **B.** Individu âgé de 13 ans (40,1 cm). Dr est l'anneau de perturbation.

Table 1. *Diplodus puntazzo*. Length-at-age data from Adriatic Sea, individuals aged using scales readings.

Tableau 1. *Diplodus puntazzo*. Données de longueur en fonction de l'âge en Mer Adriatique, individus âgés grâce à la lecture des écailles.

Length	Age																	Total
intervals (cm)	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
13	1																	1
14	4																	4
15	4																	4
16	7	1																8
17	9	1																10
18	8	9																17
19	5	6																11
20		20																20
21		24																24
22		20	1	1														22
23		23	5	1														29
24		1	18	4														23
25		3	10	9														22
26			3	15														18
27			3	22		1												26
28			6	27	1													34
29			2	40	1													43
30				36	6													42
31				18	10	2	3											33
32				8	12	1												21
33				1	17	3	1	3										25
34				1	17	3	5	6	2									34
35						16	4	1	3									24
36					1	9	8	2										20
37					1	7	4	8										20
38					1	1	9	3			2							16
39							1	6		1		3						11
40								8	1	1	1	1	1					13
41							1	2	3			2	2					10
42									2					1				3
43									2				1		1			4
44										2			1					3
45															1			1
46																	1	1
47																	1	1
Total	38	108	48	183	67	43	36	39	13	4	3	6	5	1	2	0	2	598
%	6.35	18.06	8.03	30.60	11.20	7.19	6.02	6.52	2.17	0.67	0.50	1.00	0.84	0.17	0.33	0.00	0.33	100
mean TL (cm)	16.6	21.0	25.0	28.5	32.5	34.9	35.8	37.3	38.8	41.7	38.7	39.9	41.6	41.6	44.1	0.0	46.5	
SD TL	1.58	1.73	1.83	2.03	1.72	2.04	2.26	2.54	3.68	2.71	0.87	0.97	1.70	0.00	1.34	0.00	0.35	
mean TW (g)	70.5	141.7	227.7	325.7	477.9	590.4	648.3	742.8	813.0	1061.5	695.3	924.5	1052.4	888.0	1092.5	0.0	1525.0	
SD TW	16.59	33.10	60.12	70.63	84.98	113.78	126.83	149.68	233.65	238.50	189.47	62.81	197.97	0.00	31.82	0.00	28.28	

males and females showed that there were no significant differences for any of the age classes except for age class 6 (t-test: $t_{0.05} = 2.865$, $p < 0.05$). Overall, the age frequency distributions of males and females were not significantly different (Kolmogorov-Smirnov two sample test: $n_f = 331$, $n_m = 246$; $D = 0.667$, $p < 0.05$). The pooled length-at-age data for *D. puntazzo* is given in Table 1.

We estimated the von Bertalanffy growth parameters for the combined sample: $L_\infty = 45.28$ cm (SE = 0.273), K = 0.191 yr^{-1} (SE = 0.014) and $t_0 = -0.306$ yr (SE = 0.199) ($R^2 = 0.953$; Fig. 3). The non-linear least squares estimated parameters are given in Table 2. Growth parameters for males and females are not significantly different (Max. likelihood test: L = 2.68, $C^2_{0.05,3} = 7.81$, $p > 0.05$). The calculated asymptotic length values agree well with the maximum observed length. The VBGF's curve fitted the data reasonably well, considering that individual observations of length-at-age were used instead of the mean

Table 2. *Diplodus puntazzo*. Growth parameters from Adriatic Sea estimated by non-linear regression from scale readings, for all data, males and females.

Table 2. *Diplodus puntazzo*. Paramètres de croissance en Mer Adriatique estimés par régression non linéaire des données de lecture d'écailles, pour l'ensemble des mâles et des femelles.

Parameters	All data	Males	Females
L_∞	45.28 ± 0.483	44.72 ± 0.522	45.76 ± 0.264
K (per year)	0.191 ± 0.023	0.185 ± 0.095	0.191 ± 0.011
t_0 (cm)	-0.306 ± 0.235	-0.534 ± 0.199	-0.294 ± 0.157

* All lengths are TL in cm ± S.E.

length-at-age (Fig. 3). According to obtained von Bertalanffy growth equation, *D. puntazzo* growth is intensive during first four years of its life and growth rate slows down considerably after fish reaches five years of age (Fig. 3). Fish reaches the legal catch length set up by the EU (Petrakis & Stergiou, 1997) of over 15 cm after age 3.

Discussion

Previous research has shown that fish species in temperate waters form annual surface rings as a result of reduced growth in winter caused by declining seawater temperatures and decreased food availability (Morales-Nin, 1989). The seasonal deposition of alternative rings has also been demonstrated for other *Diplodus* species in the Mediterranean (Vigliola, 1997). Scales of *D. puntazzo* also showed clearly the ring pattern confirming such theory common to teleost fishes with annuli ring formation during the summer months. *D. puntazzo* off the Adriatic Sea has a relatively long life span of 18 years. Taking into account the lack of age and growth data for *D. puntazzo*, except for those inhabiting the Canarian archipelago (Domínguez-Seoane et al., 2006), we compared the results of this study with results previously published for some sparids in Adriatic (Table 3) and Mediterranean Sea and North-eastern Atlantic (Table 4). Our results differed from those from the Canary Islands (Domínguez-Seoane et al., 2006) due to faster growth and shorter life cycle of *D. puntazzo* in that area. They obtained maximum age of 10 yr, L_∞ = 54.1

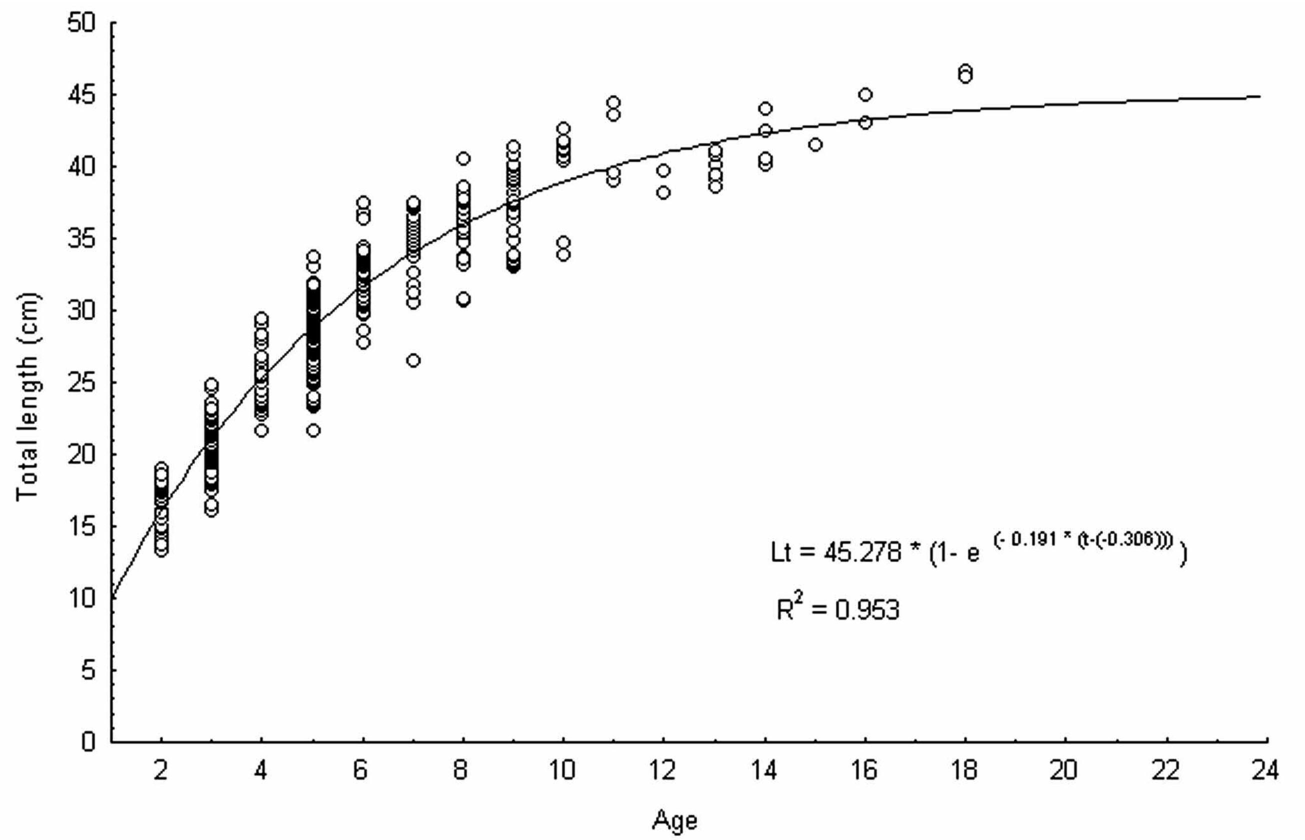

Figure 3. *Diplodus puntazzo*. Length at age data with the fitted VBGF curve: $L_t = 45.28\ (1\text{-}e^{-0.191\ (t+0.306)})$.

Figure 3. *Diplodus puntazzo*. Longueur en fonction de l'âge et courbe d'ajustement VBGF : $L_t = 45.28\ (1\text{-}e^{-0.191\ (t+0.306)})$.

Table 3. *Diplodus puntazzo*. Biogeographic comparison of VBGF parameters for *D. puntazzo* and other Adriatic sparids.
Table 3. *Diplodus puntazzo*. Comparaison biogéographique des paramètres de VBGF pour *D.* puntazzo et d'autres sparidés de Mer Adriatique.

Authors	Species	L_∞ (cm)	K (year^{-1})	t_0	b	Max age
Pallaoro et al. (1998)	*Oblada melanura* (N=1729)	34.13	0.208	-0.750	3.017 (m) 3.123 (f)	11
Kraljević et al. (1996)	*Lithognathus mormyrus* (N=202)	40.05	0.196	-0.945	3.023 (m) 3.063 (f)	12
Kraljević et al. (1998)	*Sparus aurata* (N=462)	84.98	0.073	-2.823	3.087	22
Dulcić and Kraljević (1996)	*Spondyliosoma cantharus* (N=745)	47.7	0.178	-0.27	3.14	14
Matić-Skoko et al. (2007b)	*Diplodus annularis* (N=768)	23.95	0.126	-1.664	3.073	13
Pallaoro et al. (unpublished data)	*Sarpa salpa* (N=756)	36.62	0.221	-0.920	3.106	15
Present paper	*Diplodus puntazzo* (N=598)	45.28	0.191	-0.306	3.001	18

Table 4. *Diplodus puntazzo*. Biogeographic comparison of VBGF parameters for some Sparidae species in Atlantic Ocean and Mediterranean Sea.
Tableau 4. *Diplodus puntazzo*. Comparaison biogéographique des paramètres de VBGF pour quelques espèces de Sparidés en Océan Atlantique et Mer Méditerranée.

Authors	Area (sample)	Species	L_∞ (cm)	K (year^{-1})	t_0 (year)	Max age (year)
Pajuelo & Lorenzo (1999)	Canarian waters (N=1276)	*S. cantharus*	43.35	0.240	-0.11	10
Kallianioitis et al. (2005)	Thracian Sea	*L. mormyrus*	30.94	0.200	-0.996	
Mendez-Villamil et al. (2001)	Canary Islands (N=1125)	*S. salpa*	47.9	0.212	-1.08	11
Lorenzo et al. (2002)	Canary Islands (N=687)	*L. mormyrus*	42.90	0.188	-1.370	10
Pajuelo & Lorenzo (2003)	Canarian waters (N=624)	*D. vulgaris*	39.70	0.231	-0.908	9
Gonçalves et al. (2003)	South coast of Portugal (N=1086)	*D. vulgaris*	27.73	0.400	-0.380	14
Pajuelo & Lorenzo (2002a)	Canary Islands (N=604)	*D. sargus cadenati*	47.30	0.142	-1.968	12
Gordoa & Moli (1997)	Catalan coast, Spain (N=184)	*D. annularis*	20.37	0.544	-0.033	6-7
Pajuelo & Lorenzo (2002b)	Canary Islands (N=419)	*D. annularis*	24.85	0.259	-0.871	6
Matić-Skoko et al. (2007b)	Adriatic Sea (N=768)	*D. annularis*	23.95	0.126	-1.664	13
Domínguez-Seoane et al. (2006)	Canary Islands (N=698)	*D. puntazzo*	54.10	0.182	-2.531	10
Present paper	Adriatic Sea (N=598)	*D. puntazzo*	45.28	0.191	-0.306	18

cm, K = 0.182 yr^{-1} and t_0 = -2.531 yr. That is not unexpected because Adriatic Sea, as the northern most part of Mediterranean, is specific oceanographic area where influence of geografical, geomorphological, climatic and other different environmental factors, mostly of a hydrographic nature is crucial for its characteristics (Jardas, 1996). Moreover, the peculiarities of the Adriatic ichthyofauna depend on these factors which probably also affect growth characteristics of marine organisms. Kraljević et al. (1996) found that *Lithognathus mormyrus* (Linnaeus, 1758) from the eastern Adriatic Sea lived twice as long (12 years), had a 17% higher value of L_∞ (40.1 cm), and a growth rate K (0.196) that was 29% lower than *L. mormyrus* from eastern Spain coastal waters (age of 6 yr, L_∞ = 33.3 cm, K = 0.275 yr^{-1} and t_0 = 0.06 yr) (Suau, 1970). Therefore, there was a visible similarity in growth characteristics between *D. puntazzo* and *L. mormyrus* in eastern Adriatic Sea, but also almost equal difference between populations of these two species in Adriatic Sea and western Mediterranean. Differences between estimates were probably the result of differences in region sampled and methodology (otoliths or scales, direct or indirect methods) (Pajuelo & Lorenzo, 2002a). Therefore, any method, which can increase confidence in the correctness of the age structure, is welcome.

It seems that inside *Diplodus* genus in the Adriatic Sea there is a great difference between comprising four species, particularly between *D. annularis* (Linnaeus, 1758) (Matić-Skoko et al., 2007b, in press) and *D. puntazzo* (Table 4). *D. vulgaris* (E. Geoffroy Saint-Hilaire, 1817) and *D. sargus* (Linnaeus, 1758) will probably have similar growth pattern, but unfortunately, such studies in this area are still not finished. Although, our growth coefficient value indicated relatively low attainment of maximal size, it is not the slowest slope between sparids (Tables 3 & 4).

In all of the published papers (Tables 3 & 4) the estimations of t_0 tend to be negative and different from zero suggesting that the VBGF model does not accurately describe growth in the early stages. But, obtained value of t_0 in our work and those of Pajuelo & Lorenzo (1999) for *Spondyliosoma cantharus* (Linnaeus, 1758) was not so different from zero, although early stages were missing or insufficient in total sample. Except the phylogenetic relationship between those *D. puntazzo* and *S. cantharus*, such similarity may indicate their similar ecological preferences. Particularly, both species, after recruitment, almost all life live at similar rocky habitats without greater migrations or other high-energy requested physiological processes undertaken.

In Adriatic Sea, *D. puntazzo* grows relatively fast during the first years of life, attaining approximately 50% of its maximum length between third and fourth year. Because the individuals are mature by the third year of life (Cetinić et al., 2002), the annual growth rate drops rapidly in that period. The percentage of sexes in age groups as well as difference in growth between sexes was not significant indicating the normally separated sexes without sexual dimorphism.

Most specimens aged in this study were aged 10 or less; however, only 23 (3.85%) specimens ranged from 11 to 18. We suspect that fish older than age 10 are uncommon in the population and are rarely caught by fisherman. Nevertheless, the species is longer lived than previously known for *Diplodus* species in Adriatic Sea. Such high longevity (> 20 years) is not uncommon for Sparidae family since only *Sparus aurata* (Linnaeus, 1758) in Adriatic Sea, for example, can have a life span of 22 years or maybe even more (Kraljević et al., 1998).

In recent investigations, Cetinić et al. (2002) recorded that *Diplodus puntazzo* represent only 0.40% (1.16% of total weight) of catches in tramata fishing, ranged from 12.3 to 34.5 cm (mean value 21.1 ± 0.19 cm) with a mode of 18 cm. Moreover, the spawning period of sharpsnout seabream is in period from August to October and length at first maturity according to the previously mentioned study is 22.6 cm for females and 21.8 cm for males (Cetinić et al., 2002). In our investigation, the mode of total sample was at 23 cm, and therefore up then length of first maturity for males and females. This fact, confirmed in some manner non-damaging effect of tramata fishing on *D. puntazzo,* but non-harmuful effect of this gear is still has to be analysed. Also, according to our results, 3.5% individuals were immature while 24.1% were in potentially immature age classes, showing that "ludar"could be in or little out of border to be considered as non harmful fishing gear for. *D. puntazzo*. Moreover, tramata is operating during the spawning season and the most fecund and larger females are removed, and they have to be protected as well.

As catches from commercial "tramata" fishing not include a significant part of undersized *D. puntazzo*, analysis of size selectivity and mortality rates should be taken with caution, because without taking into account the catches of this species for all gears presently in use, results may be biased. Particularly, the low values of fishing mortality may give a wrong interpretation about "healthy stock". It is more realistically that due its relatively high commercial value, *D. puntazzo* appears to be under some fishing pressure, not yet sufficiently quantified.

The protection of juveniles and their habitats is probably a key factor for the sustainability of these resources. Juveniles of *D. puntazzo* settled from ichthyoplankton at the end of November to shallow coves and stay there until the end of next summer (Vigliola & Harmelin-Vivien, 2001; Matić-Skoko et al., 2007a, in press). Moreover, *D. puntazzo* have displayed the most intensive growth in that period (Matić-Skoko et al., 2007a, in press). Thus, control of fish landings and continued monitoring in the temperate coastal environments are very important and necessary for sustainable fisheries of *D. puntazzo*.

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