

## MORPHOMETRIC AND MERISTIC PARAMETERS OF SARDINE (*Sardina pilchardus*, Walbaum, 1792) IN THE ZADAR FISHING AREA

B. Mustać<sup>1</sup>, G. Sinovčić<sup>3</sup>

### Summary

This paper presents the results of some morphometric and meristic parameters of sardine, *Sardina pilchardus* (Walbaum, 1792) from coastal (Virsko more) and open waters (Dugi Otok) of the Zadar area, during the period from March 2004 to February 2005. The total length of all analyzed specimens ranged from 13.0 to 19.0 cm and weights ranged between 16.72 g and 51.45 g, respectively. Body length analyses indicated greater values for sardine females ( $N=541$ ) than males ( $N=668$ ) in all observed lengths ( $LT$ ,  $LF$ ,  $LS$ ,  $LA$ ,  $LH$ ,  $OK$ ,  $LP$  and  $BD$ ), except for the eye diameter ( $ED$ ), where both sexes had equal average value. The length–weight relationship indicated negative allometric growth ( $b=2.5538$ ,  $a=0.0261$ ). In length–length relationships, statistical significance occurred in the following relationships: eye diameter in head length (2.78%) and head length in total length (9.01%). For vertebrae analyses, two groups were compared according to their length: the first one obtained specimens smaller than 16.0 cm in total length ( $LT$ ), whereas samples longer than 16.0 cm belonged to the second group. The number of vertebrae in both groups ranged between 48 and 52 with the most abundant vertebrae class of 50 vertebrae (37.7 %), whereas a minimal number of sardines (4.9 %) had 48 vertebrae. A statistically significant difference between the two analyzed groups was not found ( $t=0.86$ ). The number of rays ( $RD$ ) in the dorsal fin ranged from 17 to 19 and the average value was  $18.11 \pm 0.51$ .

**Key words:** sardine, Zadar area, length–weight relationship, length–length relationship, number of the vertebrae

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## INTRODUCTION

Sardine, *Sardina pilchardus* (Walbaum, 1792) belongs to the Clupeidae family and is the most abundant and most commercially important fish species in the Adriatic Sea (Sinovčić, 2000; Cingolani et al., 2003). It is distributed widely, from 15° to 66°N and from 23° to 42°E (Whitehead, 1985). Sardine is caught in the entire Mediterranean Sea. In the middle eastern Adriatic Sea, sardine takes over 70% of the annual total catch of fish. It is also the most numerous species used in the Croatian fish processing industry (>75 %).

The first data on small pelagic fisheries in the Croatian part of the Adriatic Sea comes from Dugi Otok (the beginning of 10<sup>th</sup> century), which is also the area included in this research. Pelagic fishery which mostly exploited sardine has been the most economically important fishery in the Zadar area, which officially started in 1532 (Basioli, 1962, 1974, 1984).

Sardine biometry was studied mostly in the northern Adriatic and south of the Split area (Mužinić, 1936, 1954; Gamulin, 1953; Hure, 1960; Karlovac, 1967; Alegria, 1985; Alegria et al., 1986; Sinovčić, 1995; Sinovčić and Alegria 1997). In the Zadar area, data on sardine biometry were mostly from the coastal sea, Novigradsko more (Sinovčić, 2000, 2003; Sinovčić et al., 2005, 2008) but rarely from Virsko more and Dugi Otok (Mustać and Sinovčić, 2007; Sinovčić et al., 2009).

The aim of this paper was to present some morphometric and meristic parameters of sardine, *Sardina pilchardus* (Walbaum, 1792) from coastal (Virsko more) and open sea waters (Dugi Otok) of the Zadar area. Based on the differences in gill raker numbers and migratory patterns, it was supposed that two subpopulations of sardine exist in the Adriatic Sea (Alegria et al., 1986). The results of these studies give the basis for comparisons between sardine biometric characteristics from different parts of the Adriatic Sea, as well as from other regions.

## MATERIAL AND METHODS

Sardine specimens were caught by purse seine in coastal (Virsko more) and open sea waters (Dugi Otok) of the Zadar area, during the period from March 2004 to February 2005 (Fig. 1).

The average depth in Virsko more is 45 m and most of the seabed is covered by sand (Magaš, 1977). Waters around Dugi Otok are deeper with an average depth of ca. 70 m where influence of winds, especially the southern one, is much greater. However, open waters are characterized by much lower



Figure 1. Study area

Slika 1. Područje istraživanja

- Coastal waters (obalno more)
- Open waters (otvoreno more)

variations of hydrographic characteristics in comparison to the coastal sea. The salinity in this area ranged from 37.0 to 38.67 (Zore–Armanda et al., 1999). The average sea surface temperature varied from 11.1°C (March 2004) to 24.2°C (July 2004).

Monthly sardine samples containing ca. 100 specimens were collected from purse seine caches. A total of 12 month samples, with 1.219 specimens (668 male, 541 female and 10 unsexed specimens) were analyzed for the

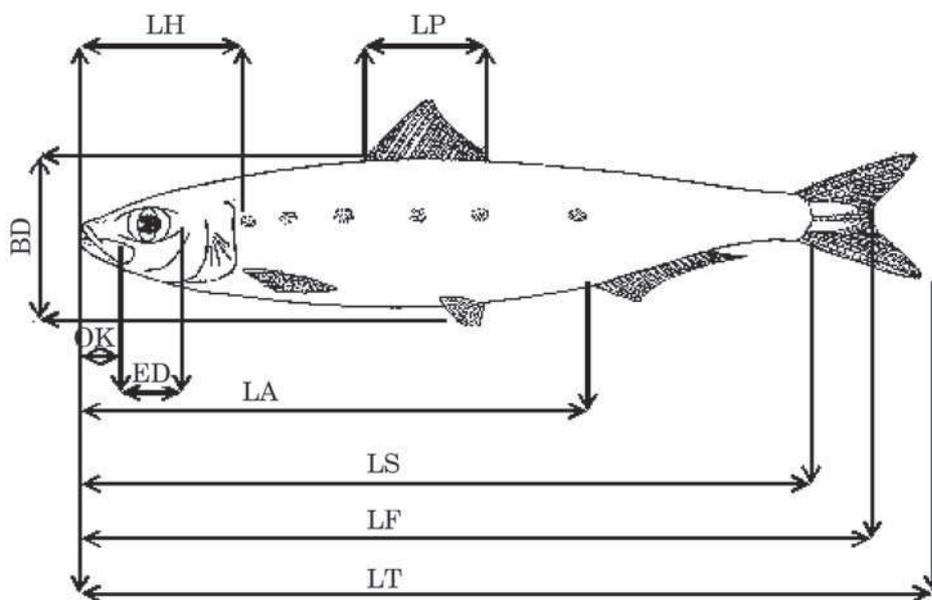


Figure 2. Analyzed morfometric parametres of sardine  
Slika 2. Analizirana morfometrijska obilježja srdele

morphometric characteristics ( $LT$ ,  $LS$ ,  $LF$ ,  $LA$ ,  $LH$ ,  $LP$ ,  $BD$ ,  $OK$  and  $ED$ ) (Fig. 2). All lengths were measured to the nearest mm and weighted to the nearest g in wet mass. Sex was determined macroscopically on the basis of the shape, appearance and structure of gonads (Sinovčić, 1978; Sinovčić et al., 2008). Almost all measured lengths: standard length ( $LS$ ), fork length ( $LF$ ), anal length ( $LA$ ), head length ( $LH$ ), length of dorsal fin base ( $LP$ ), maximum body height ( $BD$ ), except for the eye diameter ( $ED$ ) and preorbital length ( $OK$ ), were compared to the total length ( $LT$ ) and their relative relations were given as a percentage. The eye diameter ( $ED$ ) and preorbital length ( $OK$ ) were analyzed in relation to the head length ( $LH$ ). Student's  $t$ -test was used to examine possible significant differences between these relations in males and females. The length ( $LT$ )–weight ( $W$ ) relationship was determined according to the equation:  $\log W = \log a + b \log LT$ .

Two meristic parameters: number of vertebrae ( $V$ ) and number of rays in the dorsal fin ( $RD$ ) were analyzed. A total of 122 sardine specimens were randomly taken and used to determine the number of vertebrae from the January — March 2005 period. Only the vertebrae obtained from specimens during the peak of the spawning period were measured to examine whether they belonged to the same population (Sinovčić, 1992). For easier count-

ing, sardine tissue was removed from the vertebrae and left to dry for 2 to 3 days. The vertebrae were counted using monocular lens from the occipital condyle (not counted) to the urostyle, included, as recommended by FAO Fisheries Division. Samples were divided in two groups. The first one obtained sardine specimens smaller than 16.0 cm in total length (*LT*), and all samples longer than 16.0 cm belonged to the second group. The number of rays (*RD*) in the dorsal fin was analyzed in 52 randomly taken sardine specimens.

The samples were also analyzed statistically. Means were presented with standard deviations (s.d.).

## RESULTS AND DISCUSSION

### MORPHOMETRIC CHARACTERISTICS

Analyzed specimens ( $N=1, 219$ ) ranged from 13.0 to 19.0 cm in total lengths and their weights were between 16.72 g and 51.45 g. The modal value was at the length of 15.5 cm; the mean was  $16.35 \pm 0.91$ . In general, dominant modal lengths were between 14.5 and 16.0 cm, and as a total at 16.0 cm. Only one sardine specimen was 19 cm long, while 3 were in 13.0 cm length class (Table 1).

From the total of 1, 219 sardine specimens, 702 were the samples from open waters (Dugi Otok), while 517 were caught in coastal waters (Virsko more). The total length of sardines from Virsko more ranged from 13.0 to 18.2 cm ( $\bar{x}=15.8 \pm 0.87$ ), and for sardines from Dugi Otok, it ranged between 14.0 and 19.0 cm ( $\bar{x}=16.3 \pm 0.66$ ). In general, greater sardine total lengths (*LT* 15.5) were more frequent in open sea waters than in coastal waters (Fig. 3).

The regression coefficient indicated a negative allometric growth ( $b=2.5538$ ,  $a=0.0261$ ) of sardine in the Zadar area (Fig. 4).

The results regarding body length analyses indicated greater values of female than male sardine in all observed lengths (*LT*, *LF*, *LS*, *LA*, *LH*, *OK*, *LP* and *BD*), except for the eye diameter (*ED*) for which both sexes had equal average value (Table 2 and 3). Statistically significant differences between almost all, male and female lengths were observed, except between the head length ( $t=0.65$ ) and eye diameter ( $t=0.48$ ).

In length-length relationships, statistical differences between sexes occurred in the following ratios: eye diameter in head length ( $t=2.78$ ) and head length in total length ( $t=9.01$ ) (Table 3).

The greatest variability coefficient was noticed in the ratio between the dorsal fin base length and total length (10.35%). The least variability coefficient was noted in the relationship of standard length in total length (1.35%).

Table 1. Total length distribution (N, %) of sardine, *Sardina pilchardus*, Zadar area, March 2004 — February 2005.  
 Tablica 1. Dužinska raspodjela srdele (N, %) na zadarskom području, ožujak 2004. — veljača 2005.

Date Datum	N	Length class, cm (N, %) Dužinski razred, cm (N, %)												
		13.0	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0	17.5	18.0	18.5	19.0
15.3.2004.	102			2 (2.0)	3 (3.1)	24 (24.5)	13 (13.3)	24 (24.5)	16 (16.3)	11(11.2)	3 (3.1)	4 (4.1)		2 (2.0)
14.4.2004.	98					2 (2.0)	13 (12.7)	21 (20.6)	16 (15.7)	25 (24.5)	8 (7.8)	12 (11.8)	1 (1.0)	
18.5.2004.	100					10 (10.0)	19 (19.0)	21 (21.0)	22 (22.0)	13 (13.0)	10 (10.0)	4 (4.0)	1 (1.0)	
16.6.2004.	100	2 (2.0)	11 (11)	13 (13.0)	18 (18.0)	12 (12.0)	12 (12.0)	15 (15.0)	9 (9.0)	5 (5.0)	2 (5.0)	1 (1.0)		
13.7.2004.	96				1 (1.0)	2 (1.9)	9 (8.6)	25 (24.0)	23 (22.1)	18 (17.3)	13 (12.5)	5 (4.8)		
17.8.2004.	100	1 (1.0)			5 (5.0)	17 (17.0)	40 (40.0)	28 (28.0)	6 (6.0)	3 (3.0)				
14.9.2004.	97			1 (1.0)		10 (9.7)	30 (29.1)	38 (36.9)	9 (8.7)	5 (4.9)	4 (3.9)			
19.10.2004.	124			1 (1.2)	6 (7.4)	32 (39.7)	41 (50.8)	25 (31.0)	15 (18.6)	3 (3.7)		1 (1.2)		
18.11.2004.	100			2 (2.0)	5 (5.0)	10 (10.0)	24 (24.0)	17 (17.0)	19 (19.0)	15 (15.0)	5 (5.0)	3 (3.0)		
8.12.2004.	100					17 (17.0)	24 (24.0)	36 (36.0)	18 (18.0)	3 (3.0)			2 (2.0)	
11.1.2005.	102			1 (1.0)		4 (4.1)	24 (24.5)	29 (29.6)	22 (22.4)	10 (10.2)	7 (7.1)	3 (3.1)	2 (2.0)	
7.2.2005.	100					7 (7.0)	27 (27.0)	34 (34.0)	23 (26.0)	7 (7.0)	2 (2.0)			
Total Ukupno	1219	3 (0.3)	11(1)	20 (1.6)	38 (3.9)	147(13.7)	277 (25.3)	313 (23.4)	198 (15.9)	118 (9.6)	54 (4.1)	33 (2.7)	6 (0.4)	2 (0.2)

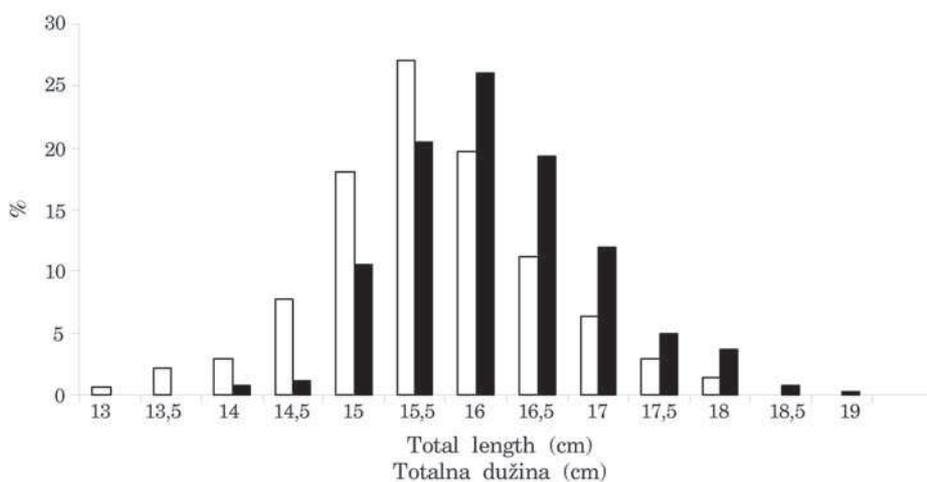


Figure 3. Length distribution of sardine from coastal waters (Virsko more; □) and open waters (Dugi otok; ■), Zadar area, March 2004 — February 2005.  
 Slika 3. Dužinska raspodjela srdele iz uzoraka lovina obalnog (Virsko more; □) i otvorenog mora (Dugi otok; ■), zadarsko područje, ožujak 2004. — veljača 2005.

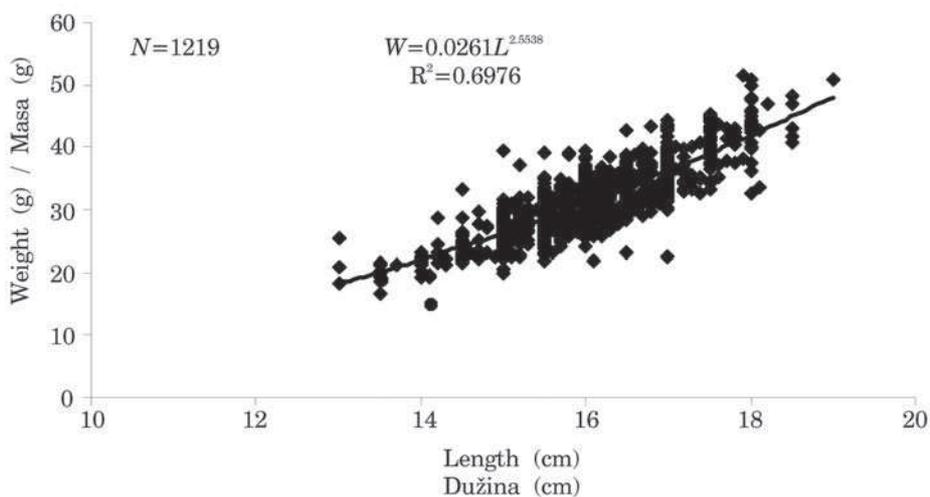


Figure 4. Length-weight relationship of sardine from the Zadar area, March 2004 — February 2005  
 Slika 4. Dužinsko-maseni odnos srdele, zadarsko područje, ožujak 2004. — veljača 2005.

Table 2. Morphometric characteristics of sardine male (♂) and female (♀), Zadar area, March 2004 — February 2005

Tablica 2. Morfometrijske značajke mužjaka (♂) i ženki (♀) srdele, zadarsko područje, ožujak 2004. — veljača 2005.

Body length Tjelesna dužina	♂ $\bar{x} \pm s.d.$ (cm)	♀	<i>t</i>
Total length ( <i>LT</i> ) Totalna dužina ( <i>LT</i> )	15.79±0.75	16.35±0.91	11.49
Standard length ( <i>LS</i> ) Standardna dužina ( <i>LS</i> )	14.13±0.65	14.63±0.79	9.71
Fork length ( <i>LF</i> ) Vilična dužina ( <i>LF</i> )	13.43±0.63	13.93±0.77	12.50
Anal length ( <i>LA</i> ) Analna dužina ( <i>LA</i> )	9.74±0.52	10.19±0.64	13.20
Head length ( <i>LH</i> ) Dužina glave ( <i>LH</i> )	3.04±0.18	3.11±0.19	0.65
Eye diameter ( <i>ED</i> ) Promjer oka ( <i>ED</i> )	0.82±0.06	0.82±0.08	0.48
Preorbital length ( <i>OK</i> ) Preorbitalna dužina ( <i>OK</i> )	0.97±0.07	0.98±0.07	3.33
Length of dorsal fin base ( <i>LP</i> ) Dužina osnovice leđne peraje ( <i>LP</i> )	1.76±0.16	1.83±0.15	3.53
Maximum body height ( <i>BD</i> ) Najveća visina tijela ( <i>BD</i> )	2.65 ± 0.21	2.75 ± 0.25	10.01

The smallest difference of the average length–length relationship value between sexes was in relation of fork length in total length (0.03%), while the greatest difference was found in the relationship of head length in total length (0.40%).

In this study, sardine length range varied according to the catch area, with greater lengths of specimens from Dugi Otok ( $\bar{x}=16.3 \pm 0.66$ ) in regard to the ones from Virsko more ( $\bar{x}=15.8 \pm 0.87$ ). In the Adriatic Sea, as well as in the south Mediterranean Sea, earlier investigations also showed greater sardine lengths in samples from the open sea, whereas fishes from the coastal sea had smaller lengths (Sinovčić, 2003; Muino et al., 2003). Sinovčić et al. (2004) found that in the Adriatic Sea sardine length ranged between 5.5 and 19.3 cm (coastal waters), whereas sardine total lengths of the catch samples from Dugi otok (open sea waters) varied from 11.5 to 19.5 cm (Sinovčić et al., 2009).

Table 3. Length–length relationships of sardine male (♂) and female (♀), Zadar area, March 2004 — February, 2005

Tablica 3. Dužinsko–dužinski odnosi mužjaka (♂) i ženki (♀) srdele, zadarsko područje, ožujak 2004. — veljača 2005.

Relationship Odnos	Sex Spol	N	Range (%) Raspon (%)	$\bar{x} \pm s.d.$	$\Delta\bar{x}$	$\Delta V$	V	t
	♂	668	84.6–95.5	89.49±1.30			1.46	
LF/LT	♀	541	85.3–95.7	89.52±1.23	0.03	0.09	1.37	0.36
	♂	668	81.3–92.6	85.07±1.25			1.47	
LS/LT	♀	541	80.0–90.3	85.20±1.15	0.13	0.12	1.35	1.90
	♂	668	54.3–69.7	61.68±1.70			2.73	
LA/LT	♀	541	52.6–68.8	61.70±1.68	0.02	0.03	2.76	0.20
	♂	668	17.0–21.9	19.41±0.75			3.86	
LH/LT	♀	541	15.7–22.3	19.01±0.79	0.40	0.29	4.15	9.01
	♂	668	25.0–40.7	31.85±2.01			6.30	
OK/LH	♀	541	24.2–39.3	31.81±2.11	0.04	0.34	6.64	0.36
	♂	668	21.0–33.0	26.68±1.85			6.85	
ED/LH	♀	541	21.2–32.8	26.35±2.09	0.33	1.07	7.92	2.78
	♂	654	7.9–16.7	11.18±1.01			9.02	
LP/LT	♀	530	8.1–18.4	11.25±1.17	0.07	1.33	10.35	1.14
	♂	668	11.9–20.6	16.79±1.13			6.72	
BD/LT	♀	541	13.5–20.6	16.83±1.16	0.04	0.22	6.90	0.65

In general, these study results showed that sardines from coastal waters of the Adriatic (13.0 to 18.2 cm) were larger than the ones from the estuaries of the eastern part of the Adriatic Sea. Namely, in the Krka River estuary, juvenile sardine length ranged from 4.9 to 12.5 cm (Sinovčić et al., 2007), and in the Neretva River estuary, authors found juvenile sardines from 5.6 to 15.0 cm in total length, while in the Cetina River estuary their length ranged from 5.5 to 13.5 cm (Dulčić and Glamuzina, 2006). Sardine from the north-west Mediterranean Sea (Spain) had a slightly greater range, from 6.75 to 20.25 cm (Morales–Nin and Pertierra, 1990). In Greece, sardine total length ranged between 10.0 — 18.4 cm (Koutrakis and Tsikliras, 2003), while in the Bay of Biscay their total length was greater — ranged from 12.0 to 26.0 cm (Dorel, 1986). A wide range of sardine total lengths was obtained in sardines from the African coast (Morocco) — between 9.0 and 27.0 cm (Delgado and Fernandez, 1985).

The results of this research indicated a proportionally higher length increase relative to weight ( $b=2.5538$ ). Sardine from the northern ( $b=2.757$ ) and middle ( $b=2.851$ ) eastern Adriatic Sea also showed negative allometric growth (Alegria, 1983), whereas Sinovčić (2000) found isometric growth ( $b=3.01$ ) in juvenile sardine from the Novigradsko more and positive allometric growth in the samples from the Karinsko more ( $b=3.26$ ). In other parts of the Mediterranean, negative allometry in sardine was also found. Namely, Stergiou and Moutopoulos (2001) noted  $b=2.754$  for sardine from Greek sea waters, while Mendes et al. (2004) indicated  $b=2.772$  for sardine from the Portuguese west coast.

#### MERISTIC CHARACTERISTICS

A total of 122 sardine specimens were collected to determine the number of vertebrae (Fig. 5). Two length groups were compared. The first one ( $N=66$ ) included specimens smaller than 16.0 cm in total length ( $LT$ ) and the second one ( $N=56$ ), consisted of sardine specimens longer than 16.0 cm.

In both groups, the vertebral number ranged from 48 to 52, but with different portions (Fig. 5).

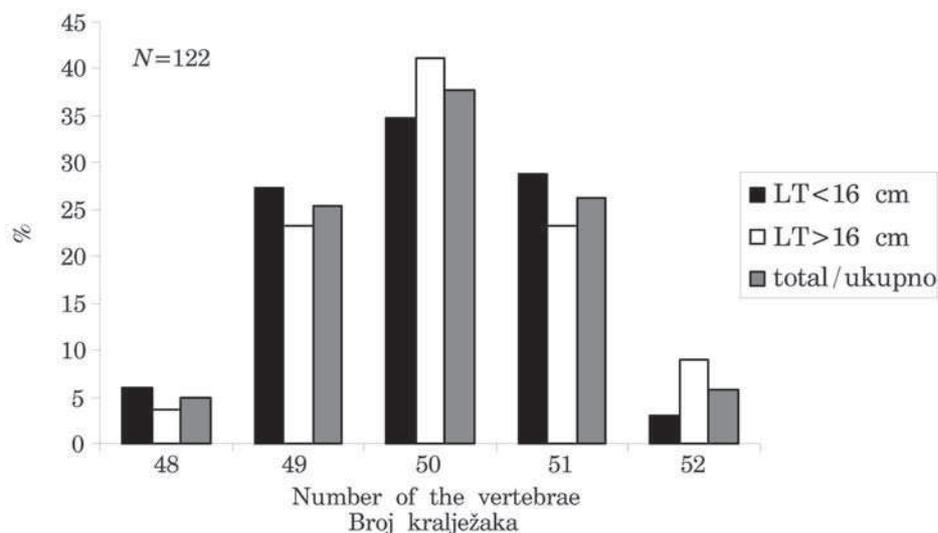


Figure 5. The number of vertebrae frequency distribution in sardine, Zadar area, March 2004 and January — February 2005

Slika 5. Raspodjela broja kralježaka, zadarsko područje, ožujak 2004. i siječanj — veljača 2005.

The smaller length group of sardine ( $LT < 16.0$  cm) had less individuals with 50 vertebrae (34.9 %) than the larger length group ( $LT > 16.0$  cm) (41.1%). The class of 48 vertebrae was more present in the smaller length group (6.1%) than in the larger one (3.6%), while the greatest number of vertebrae, which was 52, was more common in the larger group (8.9%) than in the smaller one (3.0%). Even the differences between the two analyzed groups were not statistically significant ( $t=0.86$ ). Classes with greater number of vertebrae were more frequent in the second analyzed group ( $LT > 16.0$  cm) than in the first one ( $LT < 16.0$  cm). The variability coefficient was only 0.02% greater in the second length group ( $LT > 16.0$  cm).

In both analyzed groups, the number of vertebrae ranged between 48 and 52. The modal value of 50 vertebrae (37.7 %) was observed in all sardine samples. Apart from the modal class, the class of 49 and 51 vertebrae showed the highest frequency. The minimal number of sardines belonged to the class of 48 (4.9 %) and 52 vertebrae (5.7 %)(Fig. 5). The overall mean of vertebral number of sardine from the Zadar area was  $50.02 \pm 0.97$ .

In the group of sardine which were smaller than 16.0 cm in total length, the average vertebral number was  $49.95 \pm 0.97$ , while in the second group ( $LT > 16.0$  cm), the average vertebral number was slightly higher:  $50.11 \pm 0.98$ .

Results of this study and from the papers of other authors (Mužinić, 1954; Sinovčić, 2000) showed that sardine from the eastern part of the Adriatic Sea has a number of vertebrae ranging between 49 and 54 vertebrae. The modal value in both areas was 51 vertebrae.

It seems that the modal value and mean number of vertebrae, which are relatively constant, might be applied at the population differentiation method. Namely, the average number of vertebrae  $50.02 \pm 0.97$  in this research was very similar to that of sardine from the west Mediterranean and Atlantic along the western African coast. Namely, Krzeptowski (1975) found the average number of vertebrae  $50.67 \pm 0.06$  in sardine ( $N=300$ ) from Spanish waters. Bravo de Laguna et al. (1975) reported mean number of vertebrae  $50.65 \pm 0.03$  in sardine from West Africa ( $N=1173$ ), which is very similar to those of Bèlveze and Rami (1978) who found average number of vertebrae  $50.86 \pm 0.05$  in sardine ( $N=633$ ) from the Moroccan fishing grounds.

The number of rays ( $RD$ ) in the dorsal fin was analyzed in 52 sardine specimens with a range from 17 to 19, and the average value was  $18.11 \pm 0.51$ . In this research, 73.1% of analyzed sardines had 18 rays, 19.2% had 19 rays and 7.7% had 17 rays in the dorsal fin (Fig. 6).

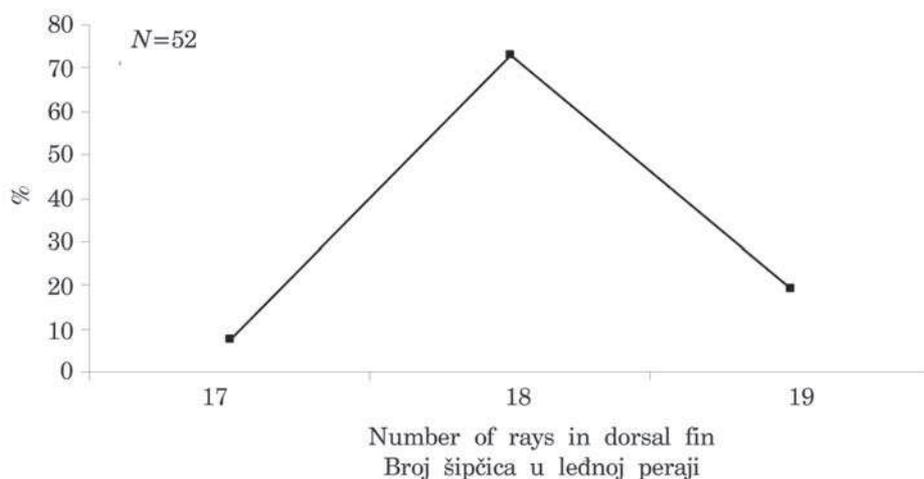


Figure 6. The number of rays frequency distribution in the dorsal fin of sardine, Zadar area, March 2004 and January–February 2005

Slika 6. Raspodjela šipčica u leđnoj peraji srdele, zadarsko područje, ožujak 2004. i siječanj — veljača 2005.

## CONCLUSIONS

The total length of all analyzed specimens ( $N=1\ 219$ ) ranged from 13.0 to 19.0 cm (mean= $16.03 \pm 0.88$ ) and weights ranged between 16.72 g and 51.45 g (mean= $31.46 \pm 1.09$ ). The modal lengths were between 14.5 and 16.0 cm, respectively. In general, females ( $N=541$ ) had greater values of analyzed body lengths than males ( $N=668$ ).

The length–weight relationship indicated negative allometric growth ( $b=2.5538$ ).

The number of vertebrae ranged between 48 and 52, with the modal class of 50 vertebrae. The number of rays ( $RD$ ) in the dorsal fin ranged from 17 to 19 with the average value being  $18.11 \pm 0.51$ .

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All analyzed parameters could point to the homogeneity of sardine population in this part of the Adriatic Sea. Besides, modal values and vertebral number means might be applied at the population differentiation method.

### Sažetak

## MORFOMETRIJSKA I MERISTIČKA OBILJEŽJA SRDELE (*Sardina pilchardus*, Walbaum, 1792.) IZ ZADARSKOGA RIBOLOVNOG PODRUČJA

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U ovom su radu prikazane neke morfometrijske i merističke značajke srdele *Sardina pilchardus* (Walbaum, 1792.) iz obalnog (Virsko more) i otvorenog (Dugi otok) mora zadarskog područja tijekom razdoblja od ožujka 2004. do veljače 2005. Totalna dužina (*LT*) svih analiziranih jedinki varirala je od 13,0 do 19,0 cm, a težine su bile u rasponu od 16,72 do 51,45 g. Ženke ( $N=541$ ) su pokazale veće dužine od mužjaka ( $N=668$ ) u svim analiziranim tjelesnim dimenzijama (*LT*, *LF*, *LS*, *LA*, *LH*, *OK*, *LP* i *BD*), osim kod promjera oka (*ED*), gdje su vrijednosti u oba spola bile izjednačene. Utvrđen je negativan alometrijski rast srdele ( $b = 2,5538$ ,  $a = 0,0261$ ). U dužinsko–dužinskim odnosima zabilježena je statistički značajna razlika između spolova pri odnosu promjera oka i dužine glave ( $t = 2,78$ ), te dužine glave u totalnoj dužini tijela ( $t = 9,01$ ). Za analizu broja kralježaka ribe su podijeljene u dvije grupe: prva je sadržavala jedinke totalnih dužina manjih od 16,0 cm, a u drugoj su grupi bile ribe veće od 16,0 cm. Broj je kralježaka u obje skupine varirao od 48 do 52, s modalnim razredom od 50 kralježaka (37,7%), dok je samo 4,9% jedinki srdele imalo 48 kralježaka. Nije utvrđena statistički značajna razlika između dviju promatranih skupina ( $t = 0,86$ ). Broj šipčica na leđnoj peraji kolebao je od 17 do 19, sa srednjom vrijednošću od  $18,11 \pm 0,51$ .

**Ključne riječi:** srdela, zadarsko područje, dužinsko–maseni odnos, dužinsko–dužinski odnos, broj kralježaka

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