



## MAIN CHARACTERISTIC OF POPULATION DYNAMIC OF HAKE (*MERLUCCIUS MERLUCCIUS*, LINNAEUS 1758) IN THE OPEN SEA OF THE MONTENEGRIN COASTAL WATERS

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### SYNOPSIS

European hake (*Merluccius merluccius*, Linnaeus 1758) is, next to Red Mullet (*Mullus barbatus*), economically most important species and most exploited species in trawl fisheries in Montenegrin shelf.

Data that are presented in this paper are results of annual research of this species of trawl catches in Montenegrin open sea. Individuals are collected by month dynamics during 2007 and 2008 in all tree fish ports in Montenegrin coast (Bar, Budva and Herceg Novi) from almost all trawlers of Montenegrin fleet.

Distribution, length-weight relation, length frequency structure, sex ratio and maturity stages are described.

### SINOPSIS

#### OSNOVNE KARAKTERISTIKE POPULACIONE DINAMIKE OSLIĆA (*MERLUCCIUS MERLUCCIUS*, LINNAEUS 1758) U OTVORENIM VODAMA CRNOGORSKOG PRIMORJA

Oslić (*Merluccius merluccius*, Linnaeus 1758) uz barbuna (*Mullus barbatus*), predstavlja ekonomski najvažniju vrstu, i najviše eksploatisanu vrstu u kočarskom ribolovu na crnogorskom primorju.

U radu su predstavljeni rezultati jednogodišnjeg istraživanja ove vrste u kočarskom ulovu i osnovne karakteristike njene populacione dinamike. Uzorci su prikupljeni mjesečnom dinamikom tokom 2007 i 2008 godine iz sve tri ribarske luke na crnogorskom primorju (Bar, Budva i Herceg Novi) sa gotovo svih kočarskih brodova crnogorske flote.

Predstavljeni su podaci distribucije, dužinsko-težinskog odnosa, dužinskih frekvenci, odnosa polova i polne zrelosti.

## INTRODUCTION

This article is based on the research done in the frame of AdriaMed Trawl survey Project 2007/08. It was predicted annual research of several target species in trawl fisheries of Montenegrin waters.

European hake (*Merluccius merluccius*, Linnaeus, 1758) represents an important component of the demersal ecosystem and a resource of great economic value. It's widely distributed in all Mediterranean, and it is one of the most valuable and heavily exploited demersal species in European fisheries.

## MATERIALS AND METHODS

Specimens of hake were collected from commercial trawlers carried out from September 2007 to September 2008 by monthly dynamics on the Montenegrin shelf area. Ten trawl hauls were analysed in total. There were no samples in three months (November, February and March) because of very bad weather conditions.

Most of the trawl activity takes place in the area from Budva to Bar where the seabed is sandy to a depth of between 80 m to 200 m.

Investigated area including open sea of Montenegrin coast (Figure 1) in all three fish ports (Herceg Novi, Budva, Bar). Specimens were taken from commercial trawlers and duration of hauls was 3 to 4 hours. Collected material were processed immediate after catch in fresh condition.

Hauls were performed at depths ranging from 80 to 200 m. Total length (TL) was measured to the nearest 1 mm precision, weight (W) was measured with precision of 0.01 gram and maturity stages of the gonads were determined by a macroscopic observation of the gonads on 450 specimens in total. (MEDITS protocol)

The sex ratio, as the function of males over the total of males and females combined was computed for each survey.

Length-weight relationship was approximated with power function of the form:

$$W = a L^b \quad (1)$$

Where W is the weight in grams, L is total length in centimeters, while **a** and **b** are constants.

The function (1) was linearized taking the logarithms W and L:

$$\text{Log } W = \text{Log } a + b \text{ Log } L \quad (2)$$

Equation (2) was fitted to the data, and constant a and b were estimated with method of linear regression, where logL was independent and logW dependent variable.

Linear regression was estimated from logarithms of average values of the length classes with intervals of 0.5 cm.

Interval midpoint (cm)	log Lt	log W	Interval midpoint (cm)	log Lt	log W
7.245	0.8600384	0.409933123	23.245	1.3663296	1.941490136
7.745	0.8890214	0.440909082	23.745	1.3755722	1.958751276
8.245	0.9161907	0.494154594	24.245	1.3846222	1.97735773
9.245	0.9659069	0.7084209	24.745	1.3934875	1.989282064
9.745	0.9887818	0.849419414	25.245	1.4021754	2.039204429
10.245	1.010512	0.841046465	25.745	1.4106929	2.06642377
10.745	1.0312064	0.902184263	26.245	1.4190466	2.065274643
11.245	1.0509595	0.905256049	26.745	1.4272426	2.128964388
11.745	1.069853	0.989894564	27.245	1.4352868	2.168968647
13.245	1.122052	1.194514342	27.745	1.4431847	2.180333793
14.245	1.1536625	1.262830635	28.245	1.4509416	2.18093241
14.745	1.1686448	1.261527199	28.745	1.4585623	2.249687428
15.245	1.1831274	1.297954946	29.245	1.4660516	2.216358209
15.745	1.1971427	1.369637462	29.745	1.473414	2.26146906
16.245	1.2107197	1.413194951	30.245	1.4806536	2.261306494
16.745	1.2238852	1.458249238	30.745	1.4877745	2.255272505
17.245	1.2366632	1.504752339	31.245	1.4947805	2.301503119
17.745	1.249076	1.545495146	31.745	1.5016753	2.380211242
18.245	1.2611439	1.592438237	32.245	1.5084624	2.375370938
18.745	1.2728854	1.621169788	32.745	1.515145	2.414973348
19.245	1.2843179	1.658081142	33.245	1.5217263	2.425169982
19.745	1.2954571	1.732106433	33.745	1.5282094	2.505149978
20.245	1.3063178	1.784611807	35.245	1.5470975	2.477121255
20.745	1.3169134	1.793487716	35.745	1.5532153	2.505149978
21.245	1.3272567	1.825654975	36.245	1.5592481	2.579783597
21.745	1.3373594	1.881792101	36.745	1.5651983	2.603425869
22.245	1.3472324	1.897335208	37.245	1.571068	2.556302501
22.745	1.3568859	1.919753427	37.745	1.5768594	2.531478917

Table 1: Logarithmic averages of the length and weight trough lenth intervals in the open part of Montenegrin sea

## RESULTS AND DISCUSSION

### DISTRIBUTION

*Merluccius merluccius* inhabits a wide range of bottom depth, from 10-800 (1000) m, and it's most concentrated between 100 to 200m. European hake inhabit the north-eastern Atlantic from Norway to Mauritania and the entire Mediterranean; in the Black Sea the species lives only along the southern coasts (Jardas, 1996, Relini et al., 1999). There are only limited areas to the north of the Po delta in which it is not caught (Jukić and Arneri, 1984; Frattini and Paolini, 1995; Frattini and Casali, 1998).

### LENGTH-WEIGHT RELATIONSHIP

During investigations 10 trawl catches were performed. Total number of specimens was 450, and total weight was 34.887 kg, minimum length was 7.2 cm, and maximal 39.6 cm.

The following results for the length - weight relationship were obtained:

**a** = -2.318  
**b** = 3.1095

Antilogarithm of the coefficient **a** is:

a = 0.0048

Standard error of the constant b is  $S_b = 0.032458$ , and the confidence limits for 95% probability levels are from -2.37758 to -2.25848, coefficients of determination and correlation are  $r^2 = 0.997209$  and  $r = 0.998603$ .

So, the length-weight relationship of *Merluccius merluccius* in the open part of Montenegrin sea is:

$$W = 0.0048 L^{3.1095}$$

The logarithmic length-weight relationship is shown in Figure 3.:

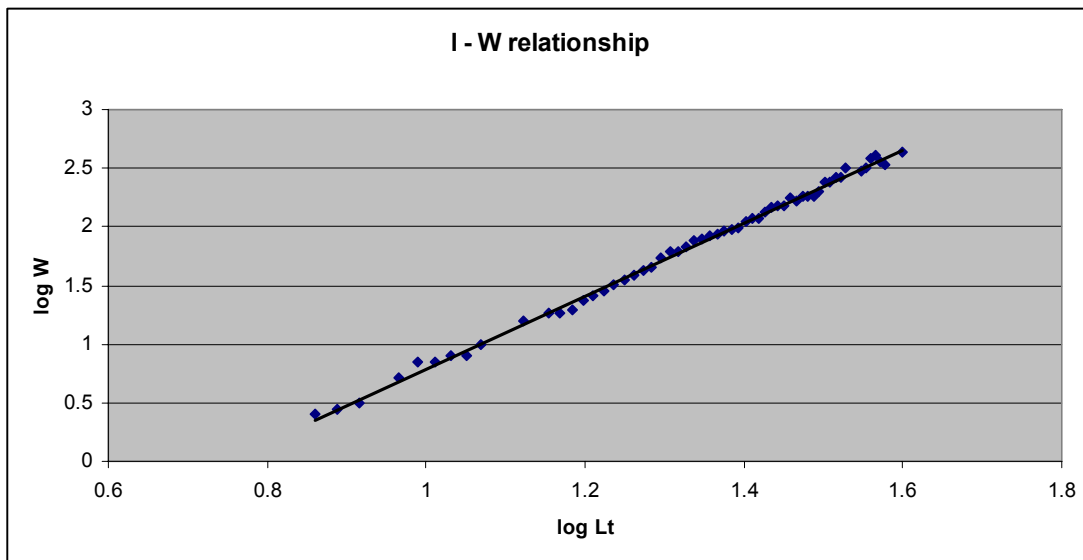


Figure 3: – Length-weight relationship of *Merluccius merluccius* in the open sea of Montenegrin coastal waters (full line)

### SEX RATIO

On the whole catch (450 specimens), the largest fraction (56.67 %) was males, 40.44% were females and 2.89% were unsexed.

Sex ratio is presented in Figure 4.

More females than males in the TL classes from 18 cm to 22 cm are recorded. Likewise, there were more males than females within the higher TL classes (22.5 cm to 30 cm). (Figure 5)

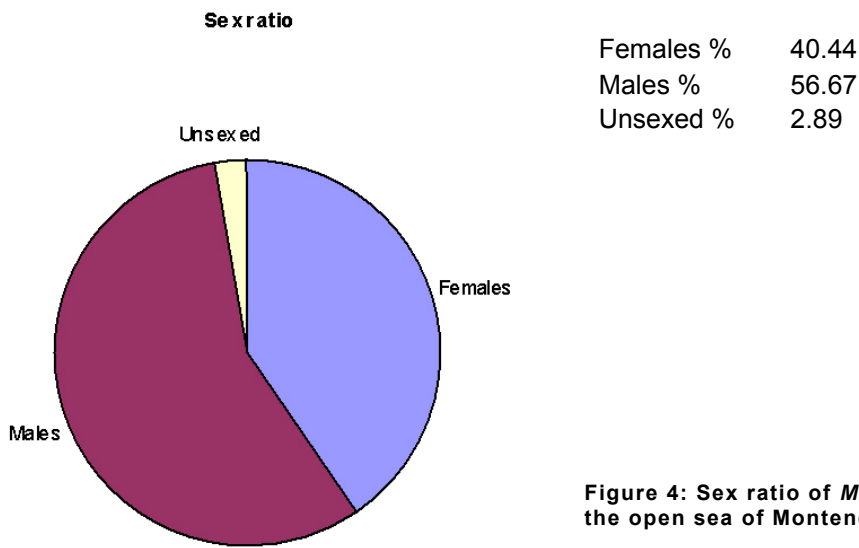


Figure 4: Sex ratio of *Merluccius merluccius* in the open sea of Montenegrin coastal waters

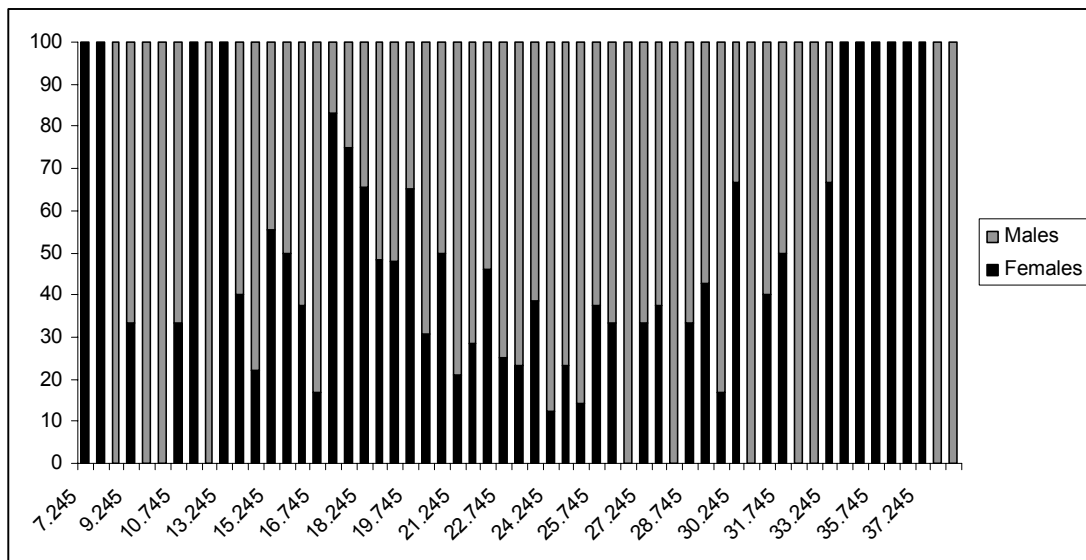


Figure 5: Sex ratio variations according to the size, computed on the whole catch

### LENGTH FREQUENCY STRUCTURE

The catches of *M. Merluccius* were characterised by a very broad size range, from 7.2 to 39.6 cm, but quite rarely TL exceeded 31 cm. The males mean size (21.71 cm) were greater than females (20.76 cm). The LFSs for total and by sex are presented in Figures 6., 7 and 8.

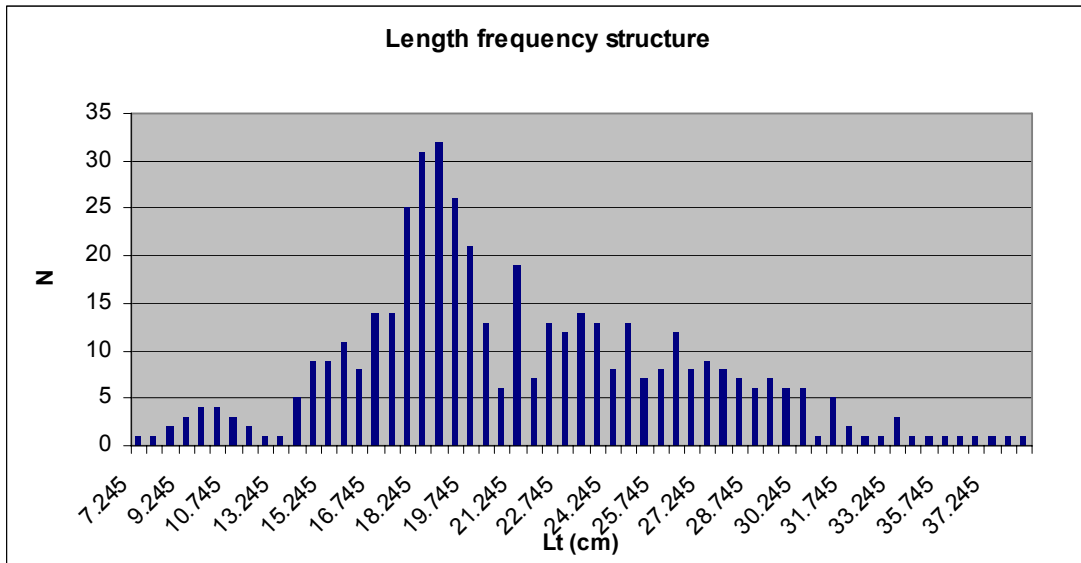


Figure 6: Length frequency structure by middle length intervals in total sampling

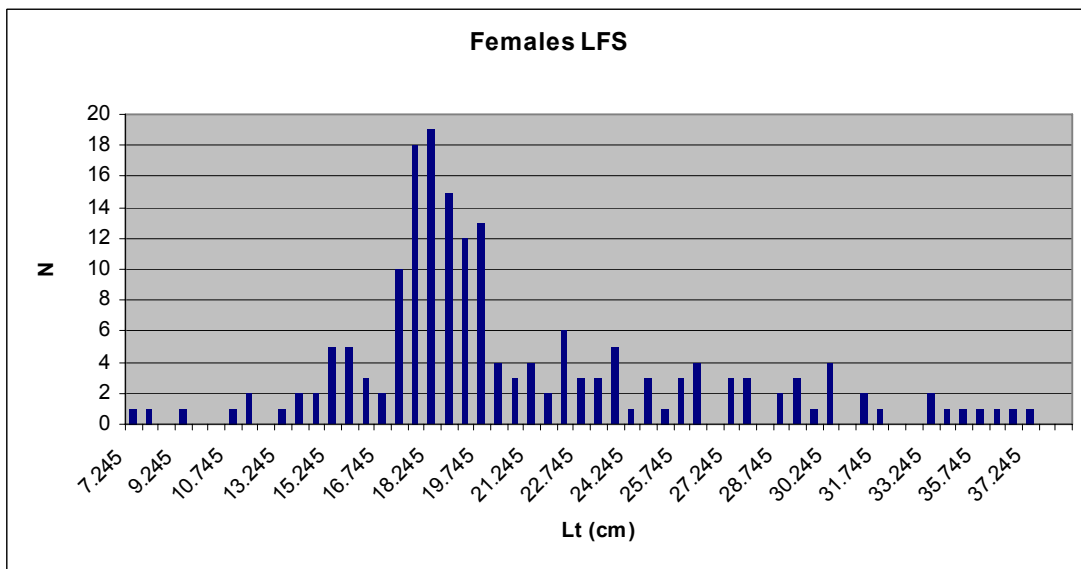


Figure 7: Length frequency structure by sex (females and males)

**MATURITY**

European hake spawn during whole year, most intensive in the winter and spring in 100-300 m of depth. Females reach mature between 23-33 cm (mostly 29-32) and males between 20-28 cm (23-25).

Females attain larger size than males, who grow more slowly after maturation at the age of three or four years. Consequently, the proportion of males in the population is higher in lower length classes and proportion of females is higher at greater lengths. In the central and northern Adriatic, females already start dominating the population at lengths of about 30 to 33 cm. (Vrgoč, 2000).

Mature specimens of *M. Merluccius* were found at wide size range, TL varying between 13 and 37 cm in females and 14 and 39.6 cm at males. Only one post-spawning female and one post-spawning male were caught during the whole sampling activity. Percentage of immature (stage 1), maturing (stage 2), mature (stage 3) and post-spawning (stage 4) specimens are presented in table 2.

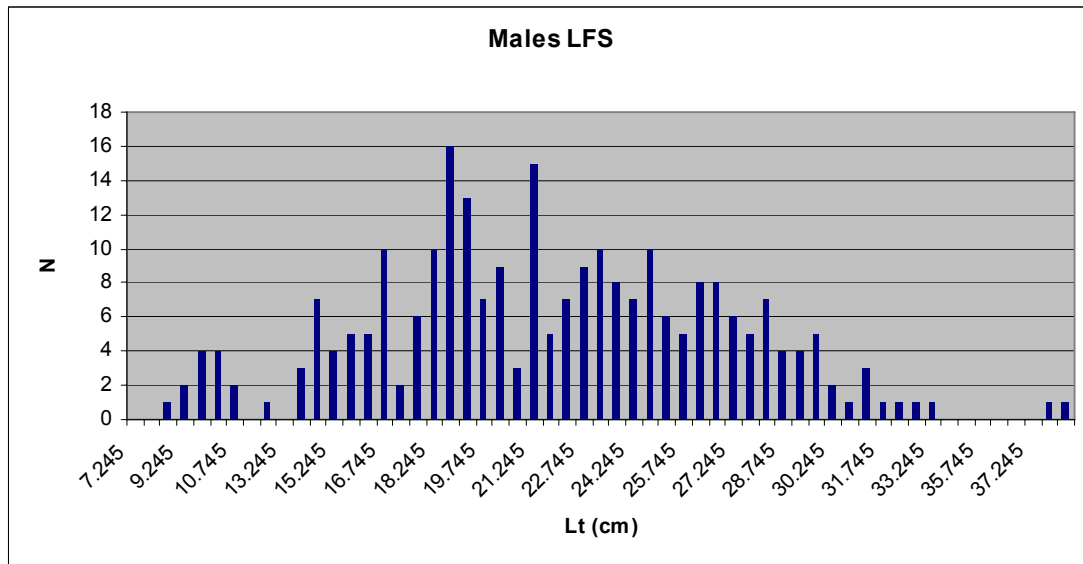


Figure 8: Length frequency structure by sex (females and males)

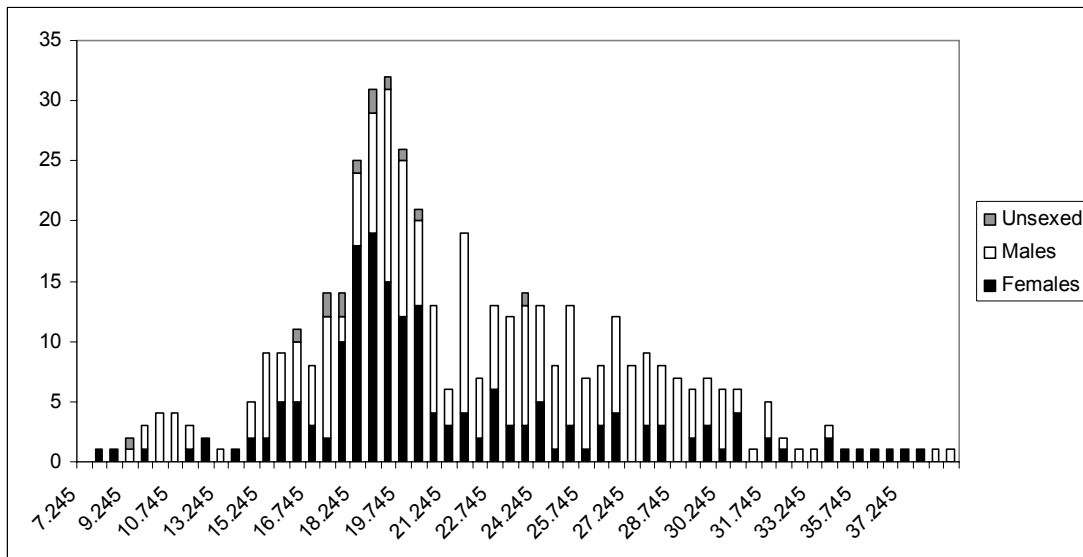


Figure 9: Length frequency distribution by sex, whole specimens pooled

**Table 2 : Percentage of immature(stage 1), maturing ( stage 2), mature (stage 3) and resting (4) *M. Merluccius* specimens per sex**

Maturity stage				
	1 (%)	2 (%)	3 (%)	4 (%)
<b>Females</b>	29.66	67.04	2.75	0.55
<b>Males</b>	32.55	59.22	7.84	0.39

### CONCLUSIONS

Research showed that length of the largest number of specimens was between 15 and 22 cm which are still juveniles and their catch is forbidden. Ministry for agriculture, forestry and water management bring Regulation which ban catching and putting on sale fries, juvenile fishes and other sea organisms (on the basis of Low of marine fisheries, Official paper RCG, No 55/03). This Regulation ban catching hake smaller then 22 cm.

Earlier investigation of hake in south Adriatic Sea were related on nutrition of the hake (Radujković, 1980) and composition and density of benthic ichtio communities in the southern Adriatic basin (Merker *et al.*, 1973). So, there are no data for comparing our results, except the fact that the hake is most numerous species in trawl catches, and present in all depth levels from 20 to 500 m.

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