

BIOLOGICAL CHARACTERISTICS OF ANCHOVY (*ENGRAULIS ENCRASICOLUS*) IN BOKAKOTORSKA BAY (MONTENEGRO)

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BIOLOŠKE KARAKTERISTIKE INĆUNA (*ENGRAULIS ENCRASICOLUS*) U BOKOKOTORSKOM ZALIVU (CRNA GORA)

Apstrakt

Inćun, *Engraulis encrasicolus*, je jedna od najrasprostranjenijih i komercijalno najvažnijih vrsta riba u Jadranskom moru (FishStat Plus, FAO). Industrijski ribolov srdele i inćuna u Crnoj Gori je još uvek nerazvijen, pa se ove vrste uglavnom love alatima malog obalnog ribolova, tj. mrežama potegačama male veličine okaca (5-6 mm) u Bokokotorskom zalivu kao i malim mrežama plivaricama na ulazu u zaliv. Podaci predstavljeni u ovom radu rezultat su istraživanja sprovedenog u okviru Pilot studije AdriaMed projekta u periodu septembar 2007. – avgust 2011. godine. Tokom Pilot studije putem intervjuja sa ribarima prikupljane su informacije o ulovu i ribolovnom naporu svih aktivnih tipova brodova, a takođe su uzimani i biološki uzorci komercijalno važnih vrsta kako bi se proučavale njihove biološke karakteristike. Uzorci inćuna prikupljeni su u području Bokokotorskog zaliva (Sl. 1) koji predstavlja jedno od najproduktivnijih područja na crnogorskom primorju, pa je mrestilište i hranilište mnogih ribljih vrsta. Uzorci su prikupljeni mesečnom dinamikom. Prikupljeni su sledeći podaci: totalna dužina tela sa preciznošću 0.1 cm, totalna težina sa preciznošću 0.01 g, pol i stadijum zrelosti gonada (upotrebljena je skala sa četiri stadijuma zrelosti, 1 – nezrele, 2 – sazrevanje, 3 – zrele i 4 – izmrešćene jedinke). Na osnovu ovih podataka određen je dužinski raspon, distribucija dužinskih frekvenci, odnos polova, GSI, dužina dostizanja polne zrelosti ($L_{50\%}$, dužina pri kojoj je 50% populacije polno zrelo, kao i $L_{25\%}$, $L_{75\%}$), kao i dužinsko-težinski odnos prema formuli $\log W = \log a + b \log L_T$. Inćun je bio najzastupljeniji u ulovu u septembru i aprilu. Dužinski raspon iznosio je od 7.5 do 14.4 cm, sa srednjom vrednošću od 10.13 cm, dok je težinski raspon bio od 0.9 do 21 gram, sa srednjom vrednošću 6.4 g. Od ukupnog broja jedinki (2000) ženke čine 61%, mužjaci 33%, a 6% su jedinke kojima nije

bilo moguće odrediti pol. Ženke su zastupljenije od mužjaka u svim dužinskim klasama, osim na 8 cm dužine gde je odnos polova 1:1. Najveći broj uzorkovanih jedinki bio je u drugom stadijumu zrelosti. Procenjeno je da je dužina pri kojoj 50% populacije inćuna dostigne polnu zrelost 9.1 cm, dok su $L_{25\%}$ i $L_{75\%}$ procenjeni na 8.6 i 9.7 cm. Koeficijent b dužinsko-težinskog odnosa kod mužjaka iznosio je 3.212, a kod ženki 3.437.

Ključne reči: inćun, biološke karakteristike, Bokotorski zaliv

Keywords: anchovy, biological characteristics, Boka Kotorska Bay

INTRODUCTION

The FAO Project AdriaMed provides support to the Adriatic countries in developing the necessary expertise and tools for the appraisal of the fisheries resources and of the main socio economic aspects related to the fisheries, so as to provide the basis for implementing an Ecosystem Approach to Fisheries. The Montenegro joined AdriaMed in 2004 and since then the Project assisted the country in the establishment of a system for the fisheries resources evaluation and management. A Pilot study on biological and socio-economic fishery data collection was scheduled and implemented in Montenegro by the Institute of Marine Biology of Kotor with the support of the AdriaMed Project in the period September 2007. to August 2011., with small interruption and on 12-monthly basis. The information on catch and effort of all the active fleet segments in the sampling ports were gathered by interviewing fishermen, also the biological samples of the main target species were taken to study their biological characteristics. The pilot study was developed on the basis of the existing monitoring practice and requirements in Mediterranean and European countries, in view of the membership of Montenegro in the FAO General fisheries Commission for the Mediterranean Sea (GFCM) and of the future entering of the Country in the European Union (EU).

MATERIAL AND METHODS

Since the industrial fishing at open sea is undeveloped in Montenegro, anchovy samples were collected from beach seine and small purse seine catches in the Boka Kotorska Bay (Fig. 1) on monthly base. This is one of the most productive areas of the Montenegrin coast and it seems to be a nursery ground for anchovy, sardine and other small pelagic fish species.



Figure 1. Map of the study area.

The following data were recorded for each specimen: total length (TL) with precision 0.1 cm, total body weight (TW) to nearest 0.01 g, sex, sexual maturity (according to MEDITS maturity scales - immature, maturing, mature and spent/resting, in stages 1, 2, 3, and 4, respectively), gonad weight (W_G) to nearest 0.01 g. This data collection scheme allowed for an estimation of size range and length frequency distribution of landings raised to the trimester of each sampling period, where possible. Sex ratio is given as a number of males, females or unsexed individuals over the total number expressed as percentage. Sex ratio by length is given as the number of males or females over a combined sum of the number of males and females, expressed as a proportion, for any given length category with a significant number of individuals (usually more than 10). Length at first maturity was calculated using the linear regression on a ratio of mature individuals (MEDITS subcategories 2b and above) over the total number of sexed individuals for a given length category, transformed using the

$$\ln\left(\frac{1}{P} - 1\right)$$

expression (where P is the proportion of mature individuals over the total number of sexed individuals for any given length class). The regression gives the parameters α (intercept) and β (slope) of the maturity ogive. These parameters are then used to calculate lengths at which 25, 50 and 75% of the population reaches sexual maturity ($L_{25\%}$, $L_{50\%}$, and $L_{75\%}$, respectively). Maturity ogive is then estimated using the formula:

$$\frac{1}{1 + e^{\alpha - \beta \cdot TL}}$$

The gonadosomatic index is calculated according to the formula:

$$GSI = \frac{W_G}{W} \cdot 100,$$

where W_G is gonad weight (g), and TW stands for total weight (g). The index is calculated for each mature individual (MEDITS sub-stage 2b and above) separately, and then averaged by sex and month. The relation between the length, TL and total weight (TW) of the specimens was determined according to the formula $TW = a \cdot L^b$.

RESULTS AND DISSCUSSION

A total of 2000 specimens of anchovy were sampled. The greatest abundance of anchovy in the landings was in September during the 2007/08, and in April during the 2009/10 and 2010/11 sampling periods. Length of the sampled individuals ranged from 5.0 to 14.4 cm TL (average of 10.13 ± 1.33 cm TL), while the weight was in the 0.9–21.0 g range, with an average of 6.4 ± 2.9 g. Minimum and maximum length of females was 6.5 and 14.4 cm TL, respectively, and averaged at 10.2 ± 1.3 cm TL. Weight was in the 1.8–21.0 g range (average of 6.5 ± 2.9 g). Males were, on average, slightly longer at 10.3 ± 1.2 cm TL (7.5–13.1 cm TL) and somewhat heavier at 6.7 ± 2.6 g (from 2.64–14.69 cm). Length frequency distributions were predominantly unimodal, with modes at 8–9 and 9–10 cm TL for the 1st and 2nd trimester of 2007/08, respectively. In 2009/10, the modes were at 10–11 cm TL (1st trimester), 7–9 cm TL and 9–11 cm TL (2nd trimester), and at 7–9 and 10–12 cm TL (3rd trimester). In 2010/11, modes were between 7 and 9 cm TL in 1st trimester, between 9 and 11 cm TL in 2nd trimester, and between 10 and 12 cm TL in 3rd.

There were 1217 females in the sample (61%), 667 males (33%), and 116 unsexed individuals (6%). Females strongly outnumbered the males in each of the sampling periods (Table 1).

Table 1. Sex ratio by sampling period

Sampling period	Females	Males	Unsexed
2007/08	58%	38%	3%
2009/10	62%	31%	7%
2010/11	62%	31%	7%

Generally, females were more numerous at each length class, except at 8 cm TL, where the male–female ratio was close to 1:1 (Fig. 2). Similar results are reported for the same area in period 2006–2007 (Djurovic, 2012), as well as in central Adriatic (Sinovčić, 2000; Sinovčić & Zorica, 2006).

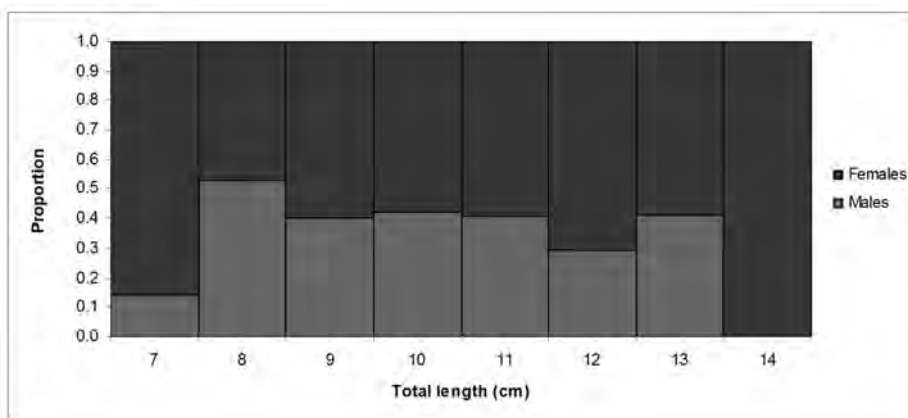


Figure 2. Sex ratio by length for the Montenegrin catch of *E. encrasicolus*

The majority of individuals were of gonad maturity stage 2 (66% of males and 61% of females), with a significant number in stage 1 (21% of males and 25% of females) which can be explained by the fact that younger individuals of anchovy inhabits coastal areas and bays and after the first spawning goes to deeper waters (Regner, 1973; Sinovčić, 1978; Sinovčić, 2000).

Length at first maturity was estimated at 9.1 cm TL for the total sample, or at 9.3 cm TL for females and 8.9 cm TL for males (Table 2., Fig. 3). Authors from Adriatic reported different results on length of first maturity for anchovy: 8.1 cm in north Adriatic (Rampa *et al.*, 2005), 10.9 cm for females in central Adriatic (Muzinic, 1956), 9.7 cm and 7.1 cm in central Adriatic (Sinovcic, 1978; Sinovcic and Zorica, 2006), and 10 cm in Albanian waters, south Adriatic (Kolitari, 2006).

Table 2. Length at first maturity and maturity ogive parameters by sex

Species <i>Engraulis encrasicolus</i>	Maturity ogive parameters		Length at maturity (cm) *(mm)		
	α	β	$L_{25\%}$	$L_{50\%}$	$L_{75\%}$
Total	18.8814	2.0684	8.6	9.1	9.7
Females	20.7300	2.2105	8.9	9.3	9.9
Males	15.6011	1.7377	8.3	8.9	9.6

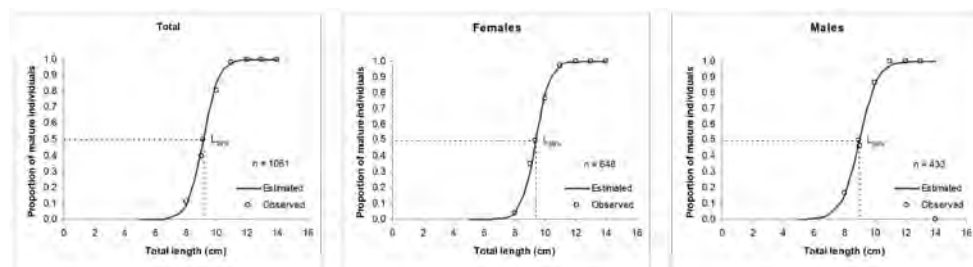


Figure 3. Maturity ogives for the total sample, females and males

The gonadosomatic index of both sexes peaked in May. For females range of GSI was from 0.3 in November to 4.74 in May, and for males from 0.18 in November to 4.97 in May. There were no individuals sampled in July–September period (Fig. 4). Those values are consistent with the results of other authors in Adriatic area; Djurovic (2012) reported 0.83–4.85 for females and 0.7–4.35 for males with the lowest values in winter months and highest in April–June period.

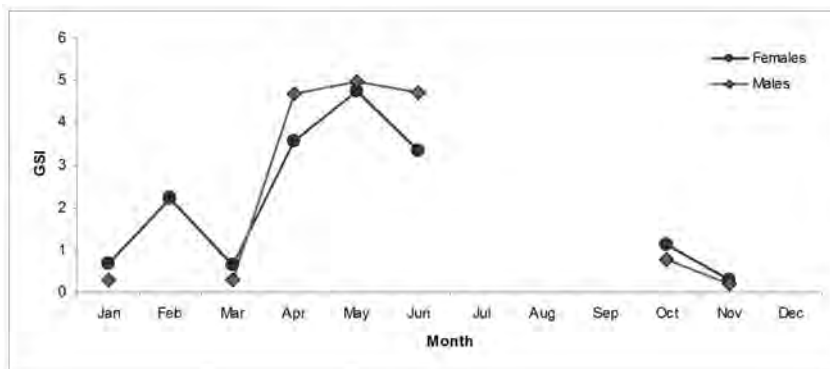


Figure 4. Gonadosomatic index of anchovy, by month

In length–weight relationship, the parameter b was consistently higher than 3 for males ($b_{\text{♂}} = 3.2118$), females ($b_{\text{♀}} = 3.4365$), and total sample ($b_{\text{TOT}} = 3.3604$) (Fig. 5). For the same area Djurovic (2012) reported $b_{\text{TOT}} = 3.167$ and $b_{\text{TOT}} = 3.106$, for period 2004-2005 and 2006-2007 respectively. Similar values are reported for Novigrad Sea, central Adriatic, $b_{\text{TOT}} = 3.19$ (Sinovcic, 1998) and $b_{\text{TOT}} = 3.211$ (Sinovčić and Zorica, 2006). Similar values of parameter b could be explained by similar conditions in these areas, especially in terms of eutrophication, since the amounts of nutrients are higher than in the open sea due to anthropogenic influence.

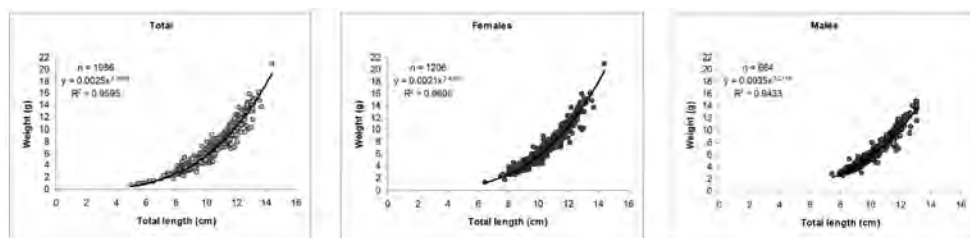


Figure 5. Length–weight ratio of anchovy, total sample, females and males

CONCLUSIONS

Fishery of anchovy and sardine with beach seines has several centuries of tradition in Boka Kotorska Bay. Since this type of fishery targets in certain amount juvenile individuals of those species, therefore it is necessary to introduce measures for conservation of juvenile sardines and anchovies, in order to enable as many immature specimens as possible to reach sexual maturity.

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