SOME BIOLOGICAL PARAMETERS OF SHORTFIN SQUID, *ILLEX COINDETII* (VÉRANY, 1839), IN TRAWL FISHERIES ON THE MONTENEGRIN COAST

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NEKI BIOLOŠKI PARAMETRI VRSTE LIGNJUN MALI ILI TOTANJ (*ILLEX COINDETII* VÉRANY, 1839) UHVAĆENIH POVLAČNOM MREŽOM-KOČOM NA CRNOGORSKOM PRIMORJU

Abstract

U razdoblju od septembra 2009. do septembra 2010. obrađeno je 299 primjeraka vrste lignjun mali ili totanj (*Illex coindetii* Vérany, 1839) uhvaćenih pridnenom povlačnom mrežom-kočom na području Crnogorskog primorja. Uzorci su otkupljivani od ribara po dolasku na mjesto iskrcaja, i potom prenošeni u laboratorij Instituta za biologiju mora u Kotoru.

U laboratoriju je svakom primjerku određena dorzalna dužina plašta pomoću ihtiometra s preciznošću od 1 mm, izmjerena ukupna masa i masa gonada na elektroničkoj vagi (preciznost 0,01 g). Stadiji zrelosti određeni su prema MEDITS–ovoj skali (MEDITS Instruction manual V.5, 1997).

Dužinsko–težinski odnos izražen je preko formule $W = a \cdot L^b$, a parametri a i b određeni su metodom linearne regresije i pretvorbom u prirodne logaritme ($\ln W = \ln a + b \cdot \ln L$) (Huxley, 1924; Jensen, 1976).

Gonadosomatski indeks izražen je preko formule:

$$GSI = \frac{W_{gonad}}{W}$$

Odnos spolova izražen je kao odnos broja ženki u ukupnom broju spolno određenih primjeraka:

$$SR = \frac{N_f}{N_f + N_m} \cdot 100$$

U ukupnom uzorku bilo je 68 (23%) ženki, 143 (48%) mužjaka i 88 (29%) jedinki neodređena spola. Odnos spolova bio je 32,27 u korist mužjaka. Prosječna dužina plašta

iznosila je 11,04 cm sa mužjacima u rasponu od 7,4 do 15,9 cm, a ženke od 7,5 do 20,7 cm. Najviše jedinki pripadalo je II. stupnju zrelosti.

Dužina prve spolne zrelosti ($DML_{50\%}$) izračunata je za ženke (150 mm), mužjake (133 mm) i oba spola zajedno (90 mm). Također su izračunate dužine pri kojima 25%, odnosno 75% populacije dostiže spolnu zrelost.

Gonadosomatski indeks izračunat je za mužjake i ženke. Kod mužjaka vrhunac dostiže u junu i poslije toga je u stalnome padu, dok kod ženki vrhunac dostiže u julu.

Dužinsko–težinski odnos pokazao je alometrijski negativan rast na cijelom uzorku, ali i odvojeno za mužjake i ženke. Kako je *I. coindetii* brzorastuća, kratkoživuća vrsta, izračunati su i sezonski parametri za jesen, zimu i ljeto (u proljeće 2010. nije bilo uzorkovanja) kako bi se dobio točniji uvid u rast lignjuna. Ipak, i zimski i ljetni period pokazuju negativan alometrijski rast (s iznimkom ženki u ljetnom razdoblju), dok je rast alometrijski pozitivan za oba spola i ukupni uzorak u jesenjem periodu.

Usporedba sa ranijim istraživanjima vrste *I. coindetii* u Jadranu pokazuje nešto drugačije rezultate od onih dobivenih u ovome istraživanju, što se djelomice može objasniti relativno malim brojem uzoraka, nedostatkom uzoraka iz proljetnog razdoblja i neravnomjernog odnosa spolova.

Ključne reči: *Lignjun, Crnogorsko primorje, dužinsko–težinski odnos, GSI*

INTRODUCTION

Shortfin squid, *Illex coindetii* Vérany, 1839 is one of the economically most important species of cephalopods in the Atlantic, Mediterranean and Adriatic Sea. In the Adriatic it constituted about 95% of the total cephalopod catch until 2003 (FAO, 2006; Ceriola, 2006).

Despite its importance for fisheries purpose, the current information on the *I. coindetii* biology in the Southern Adriatic (especially its eastern part) is rather poor and published data focus mainly on the distribution of the species. This paper aims to provide information on some important biological parameters (length–weight relationship, size at first maturity, gonadosomatic index) of *I. coindetii* from the eastern part of South Adriatic, which can complement information on this species available from other sources.

MATERIALS AND METHODS

The samples were taken in period from September 2009 to August 2010, obtained from fishermen upon landing, and further processed in laboratory. The length was measured to the nearest mm, and the total body weight and weight of gonads (using a precise electronic balance) to the nearest 0.01 g.

Length–weight relationship was determined for the entire sample and seasonally, according to the formula $W = a \cdot L^b$. Parameters a i b were estimated using ordinary least–square regression after transforming the data in natural logarithms ($\ln W = \ln a + b \cdot \ln L$) (Huxley, 1924; Jensen, 1976).

The gonadosomatic index was calculated as a proportion of the gonad mass to the total body mass (Barber & Blake, 2006):

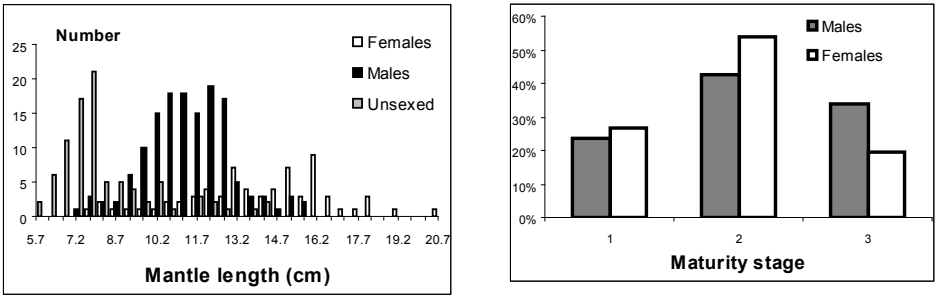
$$GSI = \frac{W_{gonad}}{W}$$

Maturity stages were determined according to the MEDITS Instruction manual V.5 (1997). Sex ratio was given as a proportion of females in the sample, according to the formula:

$$SR = \frac{N_f}{N_f + N_m} \cdot 100$$

RESULTS AND DISCUSSION

During the sampling period, a total of 299 *Illex coindetii* specimens were sampled in 7 samplings. The dorsal mantle length (DML) for the sampled specimens ranged from 5.5 to 20.7 cm, with an average length of 11.04 cm. Length frequency distribution (LFD) of males ranged from 7.4 to 15.9 cm, while that of females was from 7.5 to 20.7 cm. The majority of the sample consisted of individuals with DML in the 10.0 to 12.5 cm range (Figure 1.A).



A B

Figure 1. Length frequency distribution by sex of *Illex coindetii* (A) and Gonad maturity stages proportion by sex of *Illex coindetii* (B)

Of the 299 specimens, 88 (29%) were unsexed or immature, 143 (48%) were males, and only 68 (23%) were females (Table 1). Sex ratio for the whole sample, expressed as the proportion of females in the subsample composed of sexed individuals was determined at 32,38 in favour of males. The vast majority of males were between 9.0 and 13, while females were mostly between 13 and 16.5 cm DML (Figure 1.A). The samplings had individuals of maturity stage 2 as the most abundant (Figures 1.B).

Table 1. Gonad maturity stages by sex of *Illex coindetii*

Maturity stage	M				F			
	No	%	DML min	DML max	No	%	DML min	DML max
1	38	26.57	7.4	12.6	16	23.53	7.5	15.2
2	77	53.85	9.6	15.9	29	42.65	9.0	20.7
3	28	19.58	11.1	15.2	23	33.82	11.6	18.2
Total	143	100.00			68	100.00		

Table 2. Length at first maturity and logistic curve parameters

Sex	Logistic curve parameters		Length at maturity (mm)		
	a	*b*	$ML_{25\%}$	$ML_{50\%}$	$ML_{75\%}$
♂	7.768003	0.580994	115	133	153
♀	5.158364	0.343528	118	150	182
♂+♀	5.331835	0.591038	72	90	110

The size at first maturity ($ML_{50\%}$) for the entire sample (males and females) was estimated at 90 mm (2.C), or at 134 for males and 159 mm for females (Table 2) The estimated values of $ML_{25\%}$ and $ML_{75\%}$ are given in Table 2.

Gonadosomatic index (GSI) for males ranged from 2 to 5.5, with a peak in June and a steady drop afterwards. The female GSI was in the 5.4 to 6.7 range, with a peak in July (2.A.).

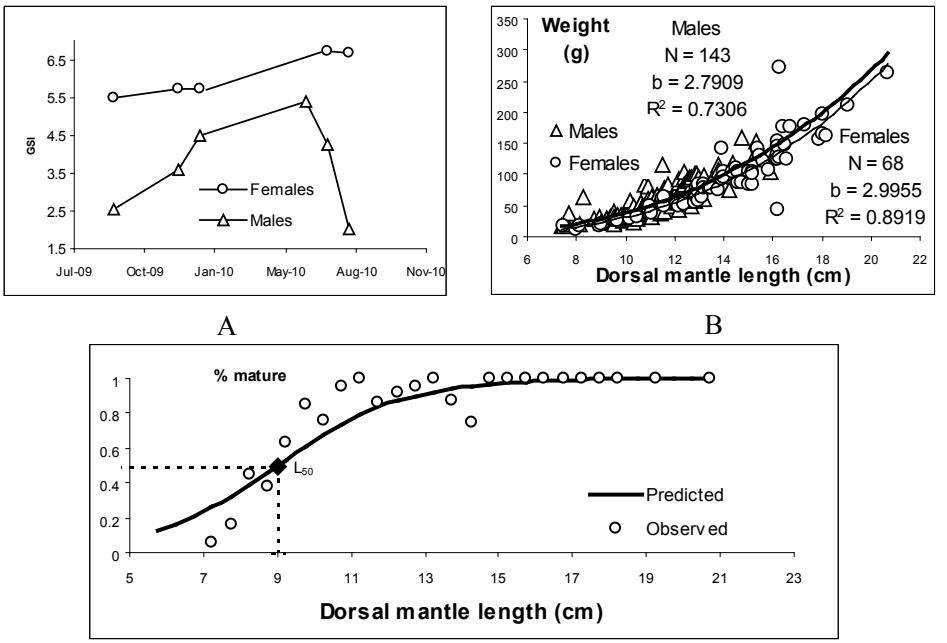


Figure 2. Mean monthly gonadosomatic index for males and females of *Illex coindetii* (A), length–weight relationship for males and females (B) and length at first maturity (50%) for both sexes (C)

The power coefficient of the LW relationship for the total sample was an allometric negative for both sexes ($b_{♂}$ = 2.7909, $b_{♀}$ = 2.9955) (Table 3, Figure 2.B). Due to short life–span and fast growth of the species in question, seasonal power coefficients for autumn, winter and summer were also calculated (there were no sampled specimens in the spring period). The autumn sample showed a positive allometric growth for males ($b_{♂}$ = 3.7970), females ($b_{♀}$ = 3.0691), and the total sample (b_{AUT} = 3.0369). The winter and summer samples showed negative allometry, with the exception of females in summer sampling ($b_{♀}$ = 3.34909) (Table 4).

Table 3. Length–weight relationship parameters

	Mantle length			LWR parameters		
Sex	Min.	Max.	n	*a*	*b*	r^2
♂	7.4	15.9	143	0.0626	2.7909	0.7306
♀	7.5	20.7	68	0.0318	2.9955	0.8919
♂+♀+0	5.5	20.7	298	0.0709	2.7160	0.8661

Table 4. Length –weight relationship parameters by season

		Mantle length			LWR parameters		
Season	Sex	Min.	Max.	n	*a*	*b*	r^2
Autumn	♂	9.0	12.5	23	0.0049	3.7970	0.9650
	♀	8.0	15.8	11	0.0250	3.0691	0.7040
	♂+♀+0	6.0	15.8	17	0.0288	3.0369	0.9405
Winter	♂	7.4	15.9	34	0.0940	2.6482	0.8578
	♀	7.5	20.7	28	0.0810	2.6358	0.8147
	♂+♀+0	6.7	20.7	6	0.1255	2.5084	0.8869
Summer	♂	8.3	15.2	85	0.0734	2.7324	0.6563
	♀	8.9	18.0	31	0.0133	3.3490	0.9284
	♂+♀+0	5.5	18.0	64	0.0847	2.6549	0.8352

CONCLUSION

The data presented in this paper differs somewhat from the data reported in previous research in the Adriatic Sea (Ceriola *et al.*, 2006, Petrić *et al.*, 2010) (Tables 5–6). While the general lack of data regarding *I. coindetii* (and practically all other cephalopod species) in Montenegrin waters since the 1980s (Mandić, 1984.) makes any kind of new information valuable, it is still necessary to further research biological parameters of this species due to its significant economical value and its abundance in the catch.

Table 5. Comparison of data from previous research on *I. coindetii* in the Adriatic

			LWR parameters		
Author	Sex	n	*a*	*b*	r^2
Petrić *et al.*	♂	265	0.000040	3.4496	0.92
	♀	249	0.000200	3.0181	0.97
Ceriola *et al.*	♂	139	0.000003	3.5800	0.94
	♀	148	0.000030	3.0000	0.98
	♂+♀+0	492	0.000041	2.9500	0.97

Table 6. Length at maturity and the logistic curve parameters as per Ceriola *et al.*, 2006.

	Logistic curve parameters		Length at maturity (mm)		
Sex	*a*	*b*	$ML_{25\%}$	$ML_{50\%}$	$ML_{75\%}$
♂	12.690	0.9300	125	137	149
♀	15.147	0.1040	135	146	156

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