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BIOMETRIC PROPERTIES OF AXILLARY SEA BREAM, *PAGELLUS ACARNE* (OSTEICHTHYES: SPARIDAE), FROM THE EASTERN ADRIATIC SEA

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ABSTRACT

*A sample of 266 specimens of the axillary seabream *Pagellus acarne* (Risso, 1826) from the eastern Adriatic Sea was biometrically analysed. Total length of all specimens ranged from 9.3-9.5 cm. Eighteen morphometric and seven meristic characteristics were obtained. Changes in morphological relations with growth of the fish were studied in order to describe relative growth of the axillary seabream. Data from this study indicate that certain differences between populations of *P. acarne* from the Adriatic Sea and the eastern Atlantic might exist.*

Keywords: *Pagellus acarne*, Sparidae, biometry, morphology, meristics, Adriatic Sea

PROPRIETÀ BIOMETRICHE DI PAGELLO BASTARDO, *PAGELLUS ACARNE* (OSTEICHTHYES: SPARIDAE), DELL'ADRIATICO ORIENTALE

SINTESI

*Gli autori riportano i risultati dell'analisi biometrica di un campione di 266 esemplari di pagello bastardo, *Pagellus acarne* (Risso, 1826), pescato nell'Adriatico orientale. La lunghezza totale degli individui è risultata fra 9,3 e 9,5 cm. Nell'articolo vengono evidenziate 18 caratteristiche morfometriche e sette meristiche. Al fine di descrivere la crescita relativa del pagello bastardo, sono state inoltre studiate le variazioni morfologiche in relazione alla crescita. I risultati dello studio indicano possibili differenze fra le popolazioni di *P. acarne* dell'Adriatico e dell'Atlantico orientale.*

Parole chiave: *Pagellus acarne*, Sparidae, biometria, morfologia, meristica, mare Adriatico

INTRODUCTION

Axillary seabream, *Pagellus acarne* (Risso 1826) is a sparid fish distributed throughout the eastern Atlantic (from the North Sea to Senegal) and in the entire Mediterranean Sea. It is a demersal species, inhabiting various types of sea bottoms, but is more common on soft bottoms and seagrass beds (Bauchot & Hureau, 1986). It is distributed throughout the Adriatic Sea, but is considered relatively rare (Jardas, 1996). According to Jardas *et al.* (2008) the status of the species was evaluated as of Least Concern (LC). The axillary seabream is a protoandric hermaphroditic species (Bauchot & Hureau, 1986) and aspects of its biology are still poorly known for the Adriatic Sea. Although a considerable amount of information about its biology is present in the literature, there is a scarcity of information on its morphological properties *i.e.* morphometry and meristics.

Reproduction, age and growth of *P. acarne* from the Canarian archipelago were studied by Pajuelo & Lorenzo (1999), from the Spanish waters by Velasco *et al.* (2011) and from the Portuguese waters by Coelho *et al.* (2005) and Santos *et al.* (1995). A diet of axillary seabream from Tunisian waters was studied by Fehri-Bedoui *et al.* (2009), from central eastern Atlantic by Domanevskaya & Patokina (1984) and from the Azorean archipelago by Morato *et al.* (2001). Le-Trong & Kompowski (1972) provided, among various other aspects of biology of *P. acarne*, a brief overview of its morphological characteristics for the north-west African region.

Knowledge of the biometry of the species is essential for providing a more accurate description of the species, while differences in morphological parameters in different regions might indicate distinctiveness of populations of the same species.

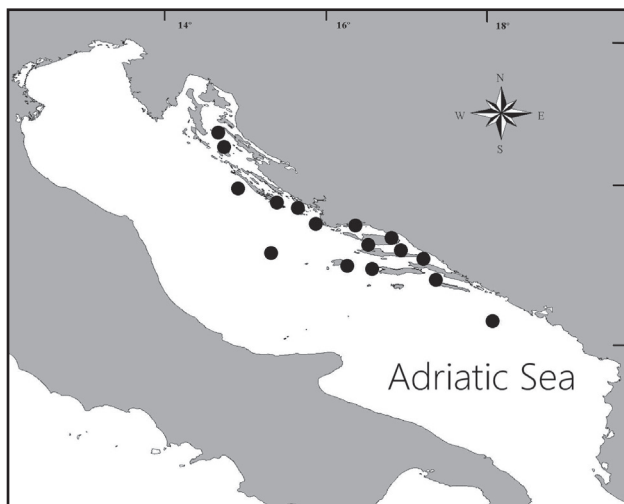


Fig. 1: Sampling locations of *P. acarne* in the eastern Adriatic Sea.

Sl. 1: Vzorčevalne lokalitete divjega ribona *P. acarne* v vzhodnem Jadranskem morju.

The aim of this study was to investigate morphological properties of the axillary seabream from the eastern Adriatic by analysing its morphometric and meristic characters and variations of these parameters in relation to its growth.

MATERIALS AND METHODS

A total of 266 specimens of axillary seabream were collected for this study in the period from July 2007 to July 2008. Specimens were collected using various fishing gear *i.e.*, trammel nets, beach seines and trawlers at various locations in the eastern Adriatic Sea (Fig 1).

All body lengths were measured with dial calipers to the nearest 1 mm. Sex of the fish was determined macroscopically according to the appearance and shape of gonads and specimens were classified as male, female, hermaphrodite or immature. In all, 18 morphometric and 7 meristic characters were analysed.

Morphometric characters were as follows: total length (TL), standard length (SL), length of dorsal (LD) and anal fin base (LA), length of pectoral (LP), ventral (LV) and caudal fins (LC), pre dorsal (PD), preanal (PA), preventral (PV) and prepectoral (PP) distance, maximum (H) and minimum (h) body height, head length (CL), eye diameter (O) and preocular (PO), interocular (IO) and postocular distance (OLO). Meristic characters were as follows: number of rays in dorsal (D), pectoral (P), ventral (V), anal (A) and caudal (C) fins, number of gillrakers (Brsp) and number of scales in linea lateralis (L. Lat) (Fig. 2).

Analysis of biometry data was carried using arithmetic means, standard deviations and variability coefficients. Differences between mean values of morphometric characters of males and females were determined by Student's *t* test ($p < 0.05$).

Relative growth was analysed using linear regression between the morphometric relations and the total length of the fish. Statistical analysis was performed using the Statistica 7 software package and only regressions that

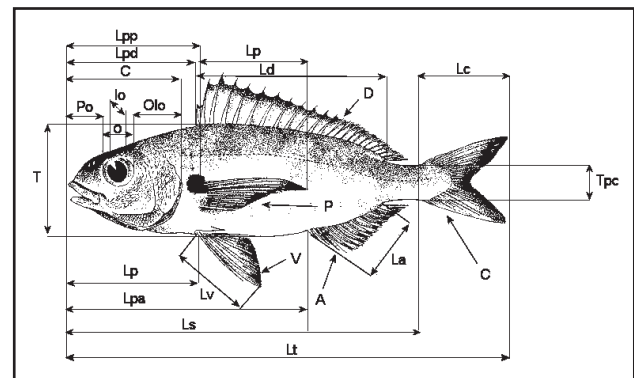


Fig. 2: Visual representation of morphometric characters examined in *P. acarne*.

Sl. 2: Preiskani morfometrični znaki pri divjem ribonu *P. acarne*.

Tab. 1: Relationships of morphometric characters (%) for males ($n = 76$), females ($n = 99$) and total sample ($n = 266$) of the axillary seabream, *Pagellus acarne* from the eastern Adriatic Sea. SD = standard deviation; V = variability coefficient.

Tab. 1: Odnos med morfometričnimi znaki (%) za samce ($n = 76$), samice ($n = 99$) in celotni vzorec ($n = 266$) divjih ribonov *Pagellus acarne* iz vzhodnega Jadranskega morja. SD = standardna deviacija, V = koeficient variacije.

Relationship	Sex	Range (% , mm)	Mean \pm SD (mm)	t-value	V (%)
SL/TL	\rightarrow	76.47-87.95	81.35 \pm 1.67	1.64	2.05
	\rightarrow	76.85-85.7	81.77 \pm 1.37		1.68
	Total	76.47-87.95	81.34 \pm 1.51		1.86
CL/SL	\rightarrow	26.02-31.38	29.35 \pm 1.11	1.06	3.81
	\rightarrow	27.23-32.66	29.54 \pm 1.20		4.06
	Total	25.86-32.66	29.38 \pm 1.18		4.03
LD/SL	\rightarrow	43.15-53.19	48.57 \pm 1.88	1.24	3.87
	\rightarrow	44.72-52.41	48.25 \pm 1.49		3.10
	Total	43.11-53.19	48.23 \pm 1.74		3.60
LA/SL	\rightarrow	13.70-18.24	16.19 \pm 1.00	0.53	6.20
	\rightarrow	13.48-17.68	16.11 \pm 0.82		5.09
	Total	12.94-19.27	16.14 \pm 1.03		6.38
LP/SL	\rightarrow	22-27.08	27.80 \pm 1.62	1.09	5.83
	\rightarrow	24.69-30.24	27.90 \pm 1.14		4.11
	Total	22-32.27	27.66 \pm 1.49		5.42
LV/SL	\rightarrow	13.33-19.39	16.97 \pm 1.13	0.20	6.67
	\rightarrow	14.01-18.66	16.94 \pm 0.91		5.39
	Total	13.33-19.51	16.89 \pm 1.11		6.61
LC/SL	\rightarrow	23.12-30.49	27.67 \pm 1.37	0.22	4.96
	\rightarrow	23.03-31.03	27.62 \pm 1.34		4.88
	Total	20.86-31.03	27.69 \pm 1.46		5.27
PD/SL	\rightarrow	29.45-37.03	33.52 \pm 1.49	1.40	4.44
	\rightarrow	30.62-38.18	33.83 \pm 3.82		3.82
	Total	29.45-39.47	33.85 \pm 1.38		4.08
PA/SL	\rightarrow	58.21-70.92	65.39 \pm 1.92	0.53	2.94
	\rightarrow	60.57-70.98	65.59 \pm 1.71		2.61
	Total	58.21-70.98	65.34 \pm 1.75		2.68
PP/SL	\rightarrow	28-36.29	32.02 \pm 1.41	1.50	4.41
	\rightarrow	29.06-34.50	32.32 \pm 1.14		3.53
	Total	27.70-36.29	32.15 \pm 1.32		4.11
PV/SL	\rightarrow	29.45-38.54	34.25 \pm 1.65	0.69	4.83
	\rightarrow	30.81-37.70	34.41 \pm 1.41		4.10
	Total	29.05-38.54	34.23 \pm 1.50		4.39
H/SL	\rightarrow	26.53-35.29	30.14 \pm 2.00	1.49	6.65
	\rightarrow	23.83-35	29.70 \pm 1.87		6.30
	Total	22.78-35.29	29.41 \pm 2.14		7.29
h/SL	\rightarrow	7.46-9.71	8.50 \pm 0.57	1.16	6.81
	\rightarrow	7.33-9.70	8.40 \pm 0.53		6.38
	Total	7.07-10.12	8.45 \pm 0.63		7.48
O/CL	\rightarrow	29.41-39.58	34.73 \pm 2.70	0.54	7.78
	\rightarrow	26.66-39.53	34.52 \pm 2.1		6.08
	Total	26.66-53.84	34.62 \pm 2.60		7.51
IO/CL	\rightarrow	16.27-30	23.93 \pm 2.05	1.23	8.59
	\rightarrow	20.40-28	24.36 \pm 1.80		7.40
	Total	16.27-30	24.22 \pm 2.20		9.11
PO/CL	\rightarrow	16.27-33.33	25.57 \pm 3.41	0.76	13.34
	\rightarrow	18.36-34.37	25.97 \pm 3.42		13.18
	Total	16.27-39.13	25.88 \pm 3.49		13.49
OLO/CL	\rightarrow	35-47.91	42.40 \pm 2.60	0.21	6.14
	\rightarrow	37.03-48.27	42.32 \pm 2.37		5.61
	Total	32.25-50	42.14 \pm 2.82		6.71
h/H	\rightarrow	24.39-32.55	28.26 \pm 1.83	0.25	6.50
	\rightarrow	25-32.55	28.33 \pm 1.39		4.92
	Total	24.39-40	28.88 \pm 2.33		8.08

were statistically significant ($p < 0.05$) were accepted as indicators of decreasing ($b < 0$) or increasing ($b > 0$) relation.

RESULTS

Overall, 266 specimens of *P. acarne* were examined for morphometric and meristic characters. Of these, 99 were females, 76 were males, 77 were immature specimens and 14 specimens had equally developed male and female gonads and were considered hermaphrodites. Total length of all specimens ranged from 9.3 to 29.5 cm (18.62 ± 3.74), with females ranging from 16.2 to 29.5 cm (20.93 ± 2.79) and males from 15.5 to 25.7 cm (19.44 ± 2.13). Immature specimens ranged from 9.3 to 18.6 cm (14.3 ± 2.65) and hermaphrodite specimens from 16.5 to 25.5 cm (20.6 ± 2.95). There were no statistically significant differences in any of 18 morphometric characters between the sexes.

Range of morphometric characters, arithmetic mean, standard deviation, *t*-value and variability coefficient are presented in Table 1. Variability coefficients were in the range from 1.68 (SL/TL) to 13.49 (PO/CL).

Meristic data are shown in Table 2. In all specimens ventral fin was composed of six rays while other meristic properties showed slight variations among specimens.

The coefficients of linear regression showed that bigger *P. acarne* have relatively shorter predorsal distance ($b = -0.026$) and smaller eye diameter ($b = -0.0948$) while standard length ($b = 0.112$), dorsal fin base length ($b = 0.083$), pectoral fin length ($b = 0.118$), preanal fin distance ($b = 0.106$), preventral fin distance ($b = 0.080$), maximum body height ($b = 0.363$), preocular distance ($b = 0.192$) and postocular distance ($b = 0.062$) are relatively larger in bigger specimens.

DISCUSSION

This study presents first data on the morphometric and meristic properties of *P. acarne* from the Adriatic Sea. Moreover, only a few publications report on the biometric properties of this species and they do so in more general terms (Le-Trong & Kompowski, 1972; Bauchot & Hureau, 1986).

Morphometric differences between sexes were not found which might be due to protandric hermaphroditism of this species. Namely, due to sequential hermaphroditism, the same individuals appear first as males and later as females. However, it is not uncommon to encounter some differences between sexes in hermaphroditic fishes. According to Smith & Heemstra (1986), dichromatism seems to be most highly developed in hermaphroditic fishes. Moreover, according to Pajuelo & Lorenzo (2000), a protogynic sparid species, *Spondyliosoma cantharus*, exhibits sexual dichromatism during the spawning season. It would be interesting to investigate whether some less obvious morphological or chromatic differences exist between males and females of axillary seabream.

It seems that with the exception for the number of rays in the ventral fin, which was the same as the number reported by Perez (1820), all other characters showed some differences at least in the range of encountered characters (Tab. 3). Additionally, the number of pectoral fin rays reported by Perez (1820) is higher than the number from this study. However, it is unclear as to what area Perez (1820) is referring, but beside the description of the species, it is stated that it is abundant mainly off Cadiz, Spain (Eastern Atlantic). Le-Trong & Kompowski (1972) reports that diameter of eye of *P. acarne* from the north-west African region can be accommodated 3-4 times in length of head, while the range of the same

Tab. 2: Meristic characters of *P. acarne* from the eastern Adriatic Sea ($n = 266$). SD = standard deviation; V = variability coefficient.

Tab. 2: Meristični znaki divjega ribona *P. acarne* iz vzhodnega Jadranskega morja ($n = 266$). SD = standardna deviacija, V = koeficient variacije.

Meristic character	Range	Mean \pm SD	V (%)
No. rays in dorsal fin	XII 10-11	22.93 \pm 0.23	1.00
No. rays in anal fin	III 9-11	12.95 \pm 0.27	2.08
No. rays in pectoral fin	15-17	15.96 \pm 0.24	1.50
No. rays in ventral fin	I 5	6.00 \pm 0.00	0
No. rays in caudal fin	21-24	21.88 \pm 0.54	2.46
No. branchiospines	23-29	25.62 \pm 1.22	4.76
No. scales in linea lateralis	66-73	69.70 \pm 1.60	2.29

Tab. 3: Overview of meristic characters reported for *P. acarne* from this study and from other sources.
Tab. 3: Pregled merističnih znakov, objavljenih za divjega ribona *P. acarne* iz te raziskave in drugih virov.

Meristic character / author, area	This study, Adriatic Sea	Le-Trong & Kompowski (1972), north-west African region, eastern Atlantic	Perez (1820), probably eastern Atlantic, Spanish coast	Bauchot & Hureau (1986), general description, area not indicated
No. rays in dorsal fin	XII 10-11	XII 9-11	11-12	XII-XIII 10-12
No. rays in anal fin	III 9-11	III 9-11	III 10	III 9-10
No. rays in pectoral fin	15-17	-	19	-
No. rays in ventral fin	1 5	-	1 5	-
No. rays in caudal fin	21-24	-	22	-
No. branchiospines	23-29	-	-	21-28
No. scales in linea lateralis	66-73	68-72	-	65-72

relation from our study is 1.85-3.75. Furthermore, Le-Trong & Kompowski (1972) reported ranges of IO/LT (6.35-9.10 vs. 2.84-7.05 from our study), O/LT (6.55-9.50 vs. 6.46-9.75) and PO/LT (3.30-5.10 vs. 4.09-9.6). As can be seen, ranges of IO/LT and PO/LT differed from those from this study, whereas O/LT was quite similar.

It is interesting to note that Le-Trong & Kompowski (1972) investigated the morphological properties of *P. acarne* from two adjacent areas – the Cap Blanc region and the Rio de Oro region (western African coast) and found that some morphological differences exist in the previously mentioned characters. Due to observed differences in morphology, rate of growth, condition and period of sex change, they concluded that within the investigated region, at least two separate stocks of this species exist. Differences between our study and that of Le-Trong & Kompowski (1972) might be due to the differing length range of fish subjected to investigation (17-35 cm vs. 9.3-29.5 cm) or due to some other reasons *i.e.*, imperfection of measurements or real morphological differences between adjacent populations.

Higher variability coefficients were found for morphometric characters related to head length. This is especially the case with PO/CL relation (> 13 %). Ferri *et al.* (2010) also encountered higher variability coefficients related to head length in *Scorpaena porcus*. All other coefficients were lower than 10 %. According to Carvalho (1993), values of this coefficient within populations are usually far greater than 10 %. Lower coefficients reported in this study might indicate low intra-population variation, but this should be confirmed with further studies.

This study may indicate that some morphological differences exist between populations of *P. acarne* from the Adriatic Sea and those from the north-west African region, but more elaborate research should be undertaken to conclude that such differences really do exist. Although no evidence of morphological differences between males and females were found in this study, it is possible that such differences exist in some other aspects such as coloration.

BIOMETRIČNE ZNAČILNOSTI DIVJEGA RIBONA, *PAGELLUS ACARNE* (OSTEICHTHYES: SPARIDAE), IZ VZHODNEGA JADRANSKEGA MORJA

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POVZETEK

Avtorji so analizirali biometrične značilnosti 266 primerkov divjega ribona *Pagellus acarne* (Risso, 1826) iz vzhodnega Jadranskega morja. Celotna dolžina vseh primerkov je bila 9,3–29,5 cm. Izmerili so 18 morfometričnih in 7 merističnih značilnosti. Raziskali so spremembe morfoloških odnosov z rastjo rib z namenom, da bi opisali relativno rast divjega ribona. Podatki te raziskave kažejo na možne določene razlike med populacijami divjih ribonov iz Jadranskega morja in vzhodnega Atlantika.

Ključne besede: *Pagellus acarne*, Sparidae, biometrija, morfologija, meristika, Jadransko morje

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