

Biometry and distribution of the black goby *Gobius niger* (Linnaeus, 1758) in the Adriatic Sea

Josip BOBAN, Igor ISAJLOVIĆ, Barbara ZORICA*,
Vanja ČIKEŠ KEČ and Nedo VRGOČ

Institute of Oceanography and Fisheries, P. O. Box 500, 21 000 Split, Croatia

**Corresponding author, e-mail: zorica@izor.hr*

*The results of biometrical analysis of ten morphometric and six meristic characters of *Gobius niger* were presented in this paper. Total of 301 specimen of *G. niger* were collected in Croatian territorial waters. Total length of all analysed specimens ranged from 70 mm to 145 mm, with mean 109.90 ± 15.64 mm. Meristic counts of analyzed black goby were D1: V-VII, D2: I+10-14, A: I+7-12, P: 10-19, C: 14-23, V: 5. Black goby was distributed through the eastern part of Adriatic with three hot spots of population.*

Key words: *Gobius niger*, black goby, biometry, distribution, Adriatic Sea

INTRODUCTION

The black goby *Gobius niger* (Linnaeus, 1758) is widely distributed across Eastern Atlantic and Mediterranean Sea (include Black Sea), throughout North Africa from Cape Blanc, Mauritania north and eastwards to the Suez Canal and along the eastern Atlantic coast northwards to Trondheim (Norway) and Baltic Sea (MILLER, 1986). It can be found on sandy and muddy bottoms, in depth between 2 and 70 m (HUREAU & MONOD, 1973; VESEY & LANGFORD, 1985). Also, it can inhabit brackish waters down to salinity of 6 (VAAS *et al.*, 1975). The size at which 50% of females and males matured was respectively 7.5 cm and 8.5 cm total length (TL). Combined sexes reached sexual maturity in the second year of life (WHITEHEAD *et al.*, 1986). Depending on geographic area they spawn from spring to the end of summer (MILLER, 1986; JARDAS, 1996; MUUS & NIELSEN, 1999). Black goby eggs are small and larvae are pelagic (SVETOVIDOV, 1964).

It feeds mostly on tiny crustaceans, polychaetes and sometimes small fish (JARDAS, 1996). This species morphology and meristics was established through Mediterranean but for Adriatic Sea those studies were scarce. The main goal of this study was to report the data on the black goby morphometric and meristic characteristics with its distribution in the eastern part of the Adriatic Sea.

MATERIAL AND METHODS

Sampling of *G. niger* was conducted during two scientific expeditions: MEDITS (Mediterranean International Bottom trawl Survey) spring-summer period from 1996 to 2008 and FAO AdriaMed Trawl Survey ("Scientific Cooperation To Support Responsible Fisheries in the Adriatic Sea") autumn-winter period from 2002 to 2007 in Croatian territorial waters. Investigated area was divided according to depth (up to 50 m, 50 to 100 m, 100 to 200 m and over 200 m)

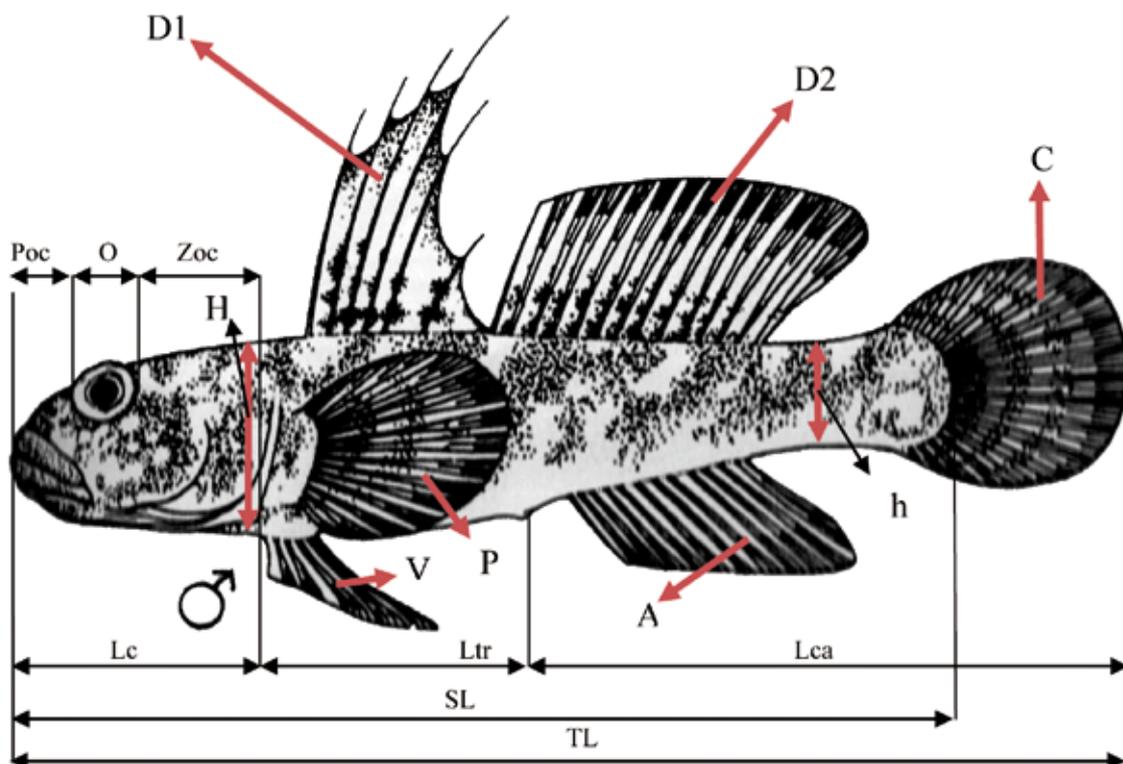


Fig. 1. Stylised drawing of body proportions and meristic counts measured on black goby: TL- total length, SL-standard length, Lc-head length, Ltr-body length, Lca-caudal length, POC - preopercular head length, ZOC - postocular head length, O-eye diameter, H- maximum body height, h- minimum body height, D1-first dorsal fin, D2-second dorsal fin, C-caudal fin, A-anal fin, P-pectoral fin, V-ventral fin

in order to have proportional number of stations by the area of each depth range. Total research area was around 92.261 km² (in Croatian territorial waters research area was around 31.727 km²) (VRGOČ, 2000). Geographic position of each station was randomly chosen. Subsequent area division was made to analyse benthic populations according to type of sediment from sedimentology map of Adriatic Sea.

Sampling was conducted with specially constructed trawl net named GOC 73. This net technically differs from commercial trawl nets as it has eye diameter of 10 mm from knot to knot, while in commercial trawl nets that size is 20 mm. Further, GOC 73 trawl has greater vertical and horizontal opening and as it is differently constructed- has less contact with bottom (FIORENTINI & DREMIERE, 1996). Sweep line was 100 m on depths below 200 m and 150 m on depth over 200 m. Horizontal opening of trawl during sampling ranged from 14.8 m to 18.2 m and vertical opening from 2.2 m to 2.4 m. Dura-

tion of each haul was 30 min, and for stations situated in the area deeper of 200 m was 1 hour. Sampling depth range was from 21 m to 491 m (RELINI *et al.*, 2008; VRGOČ *et al.*, 2004).

Collected samples of black goby were frozen on board and processed later in a laboratory. Total of 301 specimen of *G. niger* were analysed. Ten morphometric variables: total length (TL), standard length (SL), head length (LC), preocular head length (POC), eye diameter (O), postocular head length (ZOC), predorsal (PD) and preanal (PA) distance, maximum (H) and minimum (h) body height (Fig. 1) were determined to the nearest 1 mm. Morphometric characters were expressed as % of TL, with the exception of preocular head length (POC), eye diameter (O), and postocular head length (ZOC), which were expressed as % of head length (LC), and also minimum body height (h), which was expressed as a % of maximum body height (H). Also, six meristic characteristics were counted: number of rays in first dorsal fin (D1), second

dorsal fin (*D2*), pectoral fin (*P*), ventral fin (*V*), anal fin (*A*) and in caudal fin (*C*).

Length-length relationships were determined by the method of least squares to fit a simple linear regression model. Length conversion equations were derived for total length (*TL*), head length (*LC*) and the maximum body height (*H*).

Total body weight (*W*) was measured on electronic scale with accuracy of 0.01 g. The length-weight relationship was calculated by applying exponential regression $W=aL^b$, where *W* is the fish weight (g), *L* the total length (*TL*) (cm), *a* and *b* are constants. Growth type was determined by the Student's *t*-test ($P < 0.05$).

Arithmetic means, standard deviations and variability coefficients were used to process the numerical data.

RESULTS AND DISCUSSION

Overall collected black goby specimens throughout two expeditions pointed out that main patterns of distribution for this species

was in channels of middle Adriatic, along western coastline of Istra and in the Zadar channel. Furthermore, it was obvious that black goby preferred silty and fine sands (Fig. 2). This was in accordance with previous studies obtained on the same species that inhabit Mediterranean (BAUCHOT, 1987). Namely, black goby in general prefers sandy and muddy bottoms (BAUCHOT, 1987). Biomass index and distribution density for research area was in range 0.08–1.40 kg/km² and 4.65–15.54 N/km² (VRGOČ, 2000). In total commercially important demersal fish species biomass, biomass of black goby made a small portion. On the other hand, distribution analysis by depth stratum indicated that black goby was most abundant on the depths up to 50 m (0.24 kg/km²–5.96 kg/km² and 15.69 N/km²–648.05 N/km²), while decrease of its abundance was noticed forward to greater depths.

Total length of all analysed specimens (N=301) ranged from 70 mm to 145 mm, with mean of 109.90 ± 15.64 mm. Length range obtained in this study was somewhat different

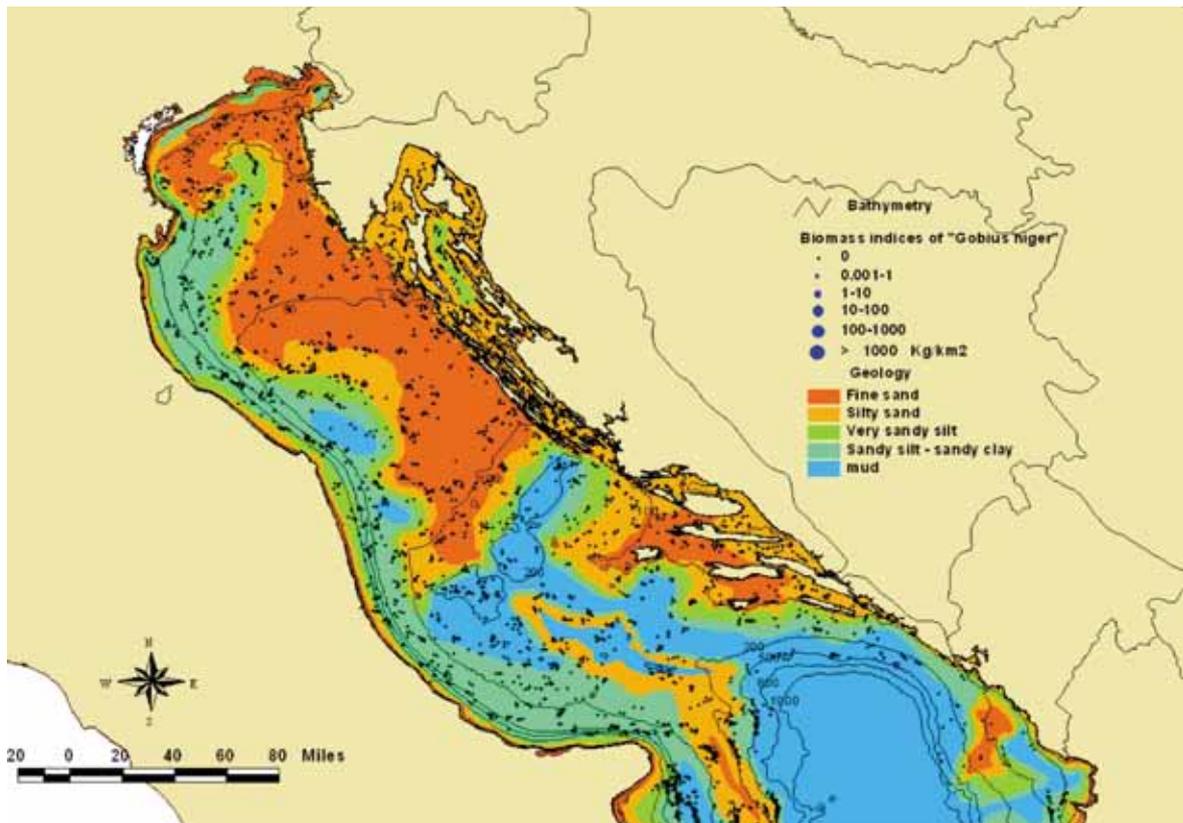


Fig. 2. Geological map of Adriatic Sea and sampling stations

from results given for North-east Mediterranean population of black goby. Namely, average total length for North-east Mediterranean population was determined to be 58.4 ± 24 mm (range from 21 mm to 122 mm) (ÇIÇEK *et al.*, 2006). Difference was even greater in comparison with results reported for western Mediterranean population which total length ranged between 36 mm to 92 mm (VERDIELLI-CUBEDO *et al.*, 2006). Observed difference in this case was expected as noted investigations aims was to sample juveniles. The maximum total lengths of black goby inhabiting different geographical area are given in Table 1. According to data given in Table 1, the greatest maximal total length was reported for Baltic Sea (MUUS & NIELSEN, 1999), while the smallest one was observed in Mar Menor Lagoon (Mediterranean, VERDIELLI-CUBEDO *et al.*, 2006) due to previously mentioned sampling methodology. In general, the maximal total length given in this study was more or less in accordance with the earlier findings and slight deviations could probably be attributed to different sampling methodology like different time of sampling or fishing technique.

The results of relative morphometric relationships of measured body proportions expressed in percentages are presented in Table 2. Ranges of all observed morphometric relationships were within medium limits and the variability coefficients (*CV*) were quite low for all analyzed morphometric relationships except for *POC/LC* proportion ($CV=25.23$) (Table 2). Only data available in the literature concerning relative morphometric relationships were found on www.fishbase.org. In relation to those data, our relative morphometric relationship slightly varied. Namely, portion of standard length ($SL/LT=80.3\%$) and head length ($LC/TL=24.2\%$) in total body length noted on FishBase were lower and higher, respectively, to values given within this study. Also, slightly lower portion values of eye diameter in head length ($O/LC=21.3\%$) on FishBase were noticed in correlation to data given in this study ($O/LC=26.8\%$).

Meristic counts of analysed black goby specimens are given in Table 3. For all meristic characteristics coefficients of variation (*CV*) generally varied within very low limits with its maximal value of 9.89% obtained for caudal fin

Table 1. Comparison of the maximum lengths obtained from different areas according to several authors

Area	Study	Locality	TLmax (mm)
Adriatic	This study	Adriatic Sea	145
	TORTONESE (1975)	Adriatic Sea	150
	FABI & FROGLIA (1983)	Adriatic Sea	165
	FABI & FROGLIA (1984)	Adriatic Sea	160
	FABI & GIANNETTI (1985)	Adriatic Sea	165
	JARDAS (1996)	Adriatic Sea	160
	LOCATELLO ET AL. (2002)	Venetian Lagoon	149
	RASOTTO & MAZZOLDI (2002)	Venetian Lagoon	139
	MAZZOLDI & RASOTTO (2002)	Venetian Lagoon	135
Mediterranean	POMPOULIE ET AL. (1999)	Vaccares Lagoon	139
	JOYEUX ET AL. (1991a)	Mauguio Lagoon	136
	ABDALLAH (2002)	Off Alexandria	133
	ÇIÇEK ET AL. (2006)	Babadilliman Bight	122
	VERDIELLI-CUBEDO ET AL. (2006)	Mar Menor Lagoon	92
	FILIZ & TOĞULGA (2009)	Izmir Bay	152
	DEMIRHAN ET CAN (2007)	Black Sea	132
Atlantic	VAAS ET AL. (1975)	Verse Meer Lake	130
	VESEY & LANGFORD (1985)	England	126
	ARRUDA ET AL. (1993)	Rio de Aveiro Lag.	144
	SILVA & GORDO (1997)	Obidos Lagoon	150
	MUUS & NIELSEN (1999)	Baltic Sea	180

Table 2. Relative relationships of measured body proportions of *Gobius niger* (N=113) from Adriatic Sea, 1996 – 2008 period

Body proportion	Range (%)		SD	CV
SL/TL	76.47 – 89.17	81.98	1.86	2.27
Lc/TL	19.66 – 26.96	23.65	1.44	6.11
Ltr/TL	30.36 – 48.25	41.11	2.94	7.15
Lca/TL	30.49 – 43.75	35.23	2.42	6.87
H/TL	10.34 – 19.40	15.01	1.68	11.19
h/H	38.10 – 77.78	55.58	6.69	12.04
POC/Lc	4.35 – 37.29	21.55	5.43	25.23
O/Lc	17.86 – 35.29	26.80	2.88	10.77
ZOC/Lc	35.71 – 64.00	51.64	4.86	9.42

rays (C) and minimal value of 2.21% gained for first dorsal fin spines (D1), while no variation was observed in pectoral fin rays (P). Obtained meristic characters of black goby collected in the Adriatic Sea for this study showed very low variability within data previously reported for this species from Adriatic (JARDAS, 1996) and Black (DIEUZEIDE, 1952) Seas. Adversely, to JARDAS (1996) and DIEUZEIDE (1952) range of rays in second dorsal, anal and pectoral fins obtained throughout this study was slightly wider.

All length-length relationships were linear. The estimated parameters of the length-length relationships as well as the coefficients of determination (r^2) are presented in Table 4. The best fit was recorded between total length (TL) and standard length (SL) ($r^2=0.957$), while the lowest value of coefficient of determination was

established between head length (LC) and pre-ocular length (POC) ($r^2=0.263$) (Table 4).

Average total weight of all processed specimens in this study was 15.21 ± 6.33 g and it varied between 2.98 and 37.53 g. Length-weight relationship of black goby point out that this species had negative allometric growth (Fig. 3; $W=10^{-5} L^{2.966}$, $r^2=0.8729$, $t=4.073$, $p<0.05$). Over viewing the literature isometrical growth of black goby was established in Mediterranean ($b=2.971$; VERDIELL-CUBEDO *et al.*, 2006) and Black Sea ($b=3.0$; DEMIRHAN & CAN, 2007), while positive allometry was reported for the population of the same species that inhabited North-east Mediterranean ($b=3.394$; ÇIÇEK *et al.*, 2006). Slight allometric coefficient deviations between different geographical areas could be due to sampling strategy, degree of stomach

Table 3. Meristic characters of *Gobius niger* (N=113) from Adriatic Sea, 1996 – 2008 period

Peculiarity	Range		SD	CV
Dorsal fin rays (D1)	V-VI	5,98	0,13	2,21
Dorsal fin rays (D2)	I+10 - I+14	12,75	0,77	6,07
Pectoral fin rays (P)	10-19	16,08	1,26	7,85
Pelvic fin rays (V)	5	5,00	0,00	0,00
Anal fin rays (A)	I+7 – I+12	11,58	0,96	8,30
Caudal fin rays (C)	14-23	17,52	1,73	9,89

\bar{x} - mean value; SD – standard deviation; CV – variability coefficient

Table 4. Length-length regression parameters (a,b) and determination coefficient (r^2) *Gobius niger* ($N = 301$) from Adriatic Sea, 1996 – 2008 period

Equation	a	b	r^2
LS=a+b*LT	3,953	0.785	0.957
Ltr=a+b*LT	0.420	0.407	0.745
Lca=a+b*LT	3,422	0.382	0.795
LC=a+b*LT	3,001	0.21	0.765
POC=a+b*LC	-1,290	0.263	0.263
O=a+b*LC	1,876	0.197	0.454
ZOC=a+b*LC	-0.586	0.538	0.643
H=a+b*LT	-1,052	0.159	0.576
h=a+b*H	2.681	0.395	0.559

fullness, gonad maturity, sex, size range, health and general fish condition and preservation techniques (TESCH, 1971).

ACKNOWLEDGEMENTS

This study was supported by the Ministry of Science, Education and Sports of the Republic of Croatia, as a part of the research project

Variability of various morphological and meristic characters in different geographic regions and different distribution patterns concerning type of sediment shows that further investigations, especially in genetic structure, should be carried out.

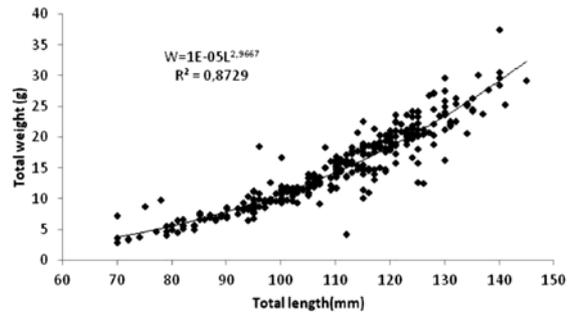


Fig. 3. Length-weight relationship of *Gobius niger*, Adriatic Sea, 1996 – 2008 period

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Received: 17 May 2012

Accepted: 21 September 2013

Biometrijske karakteristike i rasprostranjenost glavoča blatara *Gobius niger* (Linnaeus, 1758) u Jadranskom moru

Josip BOBAN, Igor ISAJLOVIĆ, Barbara ZORICA*, Vanja ČIKEŠ KEČ i Nedo VRGOČ

Institut za oceanografiju i ribarstvo, P.P. 500, 21 000 Split, Hrvatska

**Kontakt adresa, e-mail: zorica@izor.hr*

SAŽETAK

U radu su prikazani rezultati biometrijske analize – deset morfometrijskih i šest merističkih značajki, glavoča blatara *Gobius niger*. Ukupno je analizirana 301 jedinka glavoča blatara koji su prikupljeni u hrvatskim teritorijalnim vodama. Ukupna dužina tijela svih analiziranih jedinki se kretala u rasponu od 70 mm do 145 mm, sa srednjom vrijednošću od 109.90 ± 15.64 mm. Merističke značajke analiziranih jedinki glavoča blatara iznosile su D1: V-VII, D2: I + 10-14, A: I + 7-12, P: 10-19, C: 14-23, V: 5. Na temelju učestalosti pojavljivanja u analiziranim lovinama uočena su tri područja rasprostranjenja glavoča blatara na području istočnog dijela Jadranskog mora.

Ključne riječi: *Gobius niger*, glavoč blatar, biometrija, raspostranjenost, Jadransko more