

PRELIMINARY OBSERVATIONS ON FEEDING HABITS OF GARFISH *Belone belone* (L., 1761) IN THE ADRIATIC SEA

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Summary

The objective of this study was to present feeding habits of garfish population inhabiting Adriatic Sea. Gut contents of 211 *Belone belone* specimens caught with seine net in the Adriatic Sea (Croatian fishing ground) were analysed. Although animal and plant prey items were present in analysed guts, the preferred prey group was animal one (94%). The most frequent prey items were copepods (56.9 %) and decapods (44.4 %), while the most abundant were euphausiids (59.9 %) and copepods (20.7 %).

Key words: diet, pelagic fish, *B. belone*, Adriatic Sea

INTRODUCTION

Garfish, *Belone belone* (Linnaeus, 1761), is a pelagic, oceanodromous fish species wide spread in brackish and marine waters of the north-eastern Atlantic, Mediterranean and the Black Sea (Colette and Parin, 1986). Similarly to other pelagic fish species garfish has migratory pattern; generally it is found in offshore areas, except during the spawning period (January – May) when its specimens migrate into coastal regions (Zorica et al., 2010). Despite its wide distribution in the Adriatic Sea, garfish is considered as a minor commercially important fish species (National fishery statistics), whose catches are mainly realised with seine nets (stretched mesh size 10-30 mm) that are used only along the middle eastern Adriatic Sea (around the islands Vis, Korčula, Iž and Susak). Biological knowledge of garfish population, that inhabiting Adriatic Sea, is partial and refers only to its reproduction traits (Zorica et al., 2010), while there are no data concerning its diet.

It is well known that abundance of pelagic fish species exhibits drastic fluctuations over time in marine ecosystem. The causes of these shifts in abundance are not well understood but they could probably be associated with natural environmental effects like food availability or fishing activity (Beverton, 1990). Therefore, knowledge of fish troph-

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ic ecology should provide a better comprehension of the species and its functioning in an ecosystem. The aim of this study was to describe and give an insight in garfish feeding habits by describing its prey as well as by observations of its size-related changes in diet.

MATERIALS AND METHODS

Garfish specimens (N=211) were collected in the eastern part of the middle Adriatic Sea from February 2008 to February 2009 (Fig. 1).

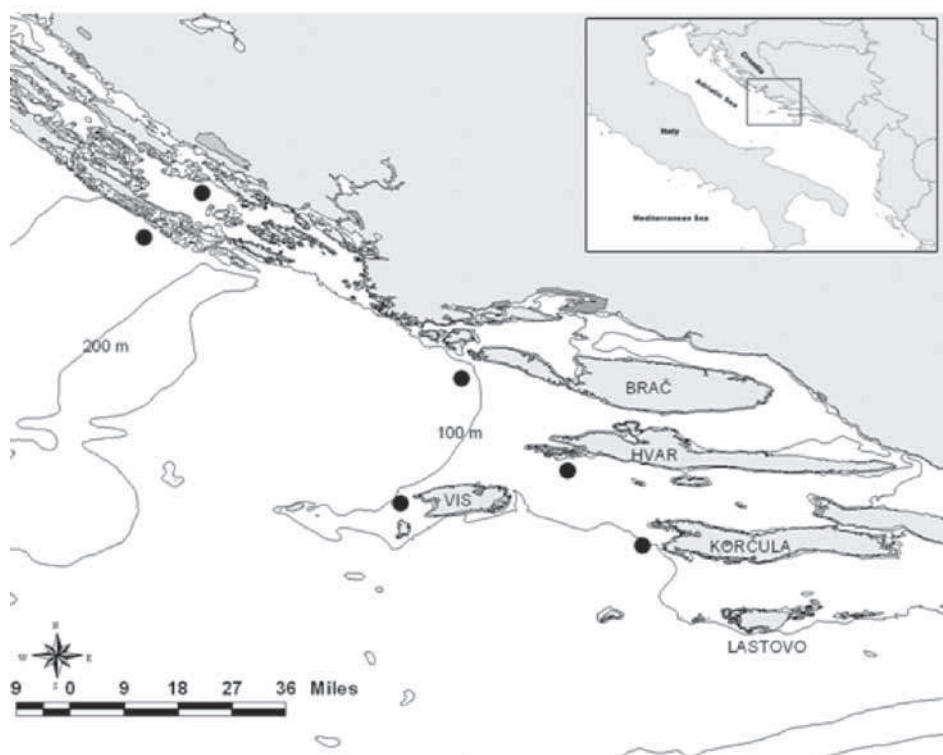


Figure 1. Study area, middle eastern Adriatic Sea with marked sampling sites (●).
Slika 1. Područje istraživanja – šire ribolovno područje istočnog dijela srednjeg Jadrana s označenim mjestima uzorkovanja (●).

Samples of *B. belone* were collected during the night using seine net with stretched mesh size of 10 mm (the main net) to 34 mm (the net cod end). Immediately after landing on board garfish specimens were preserved in 10% buffered-formalin. Later in the laboratory all specimens were measured (total length TL, mm) to the nearest 1 mm and weighed (total body weight W, g) with a precision of 0.01 g. Before and after the prey

items were carefully separated, gut weights were noted (total weight of full (W_{gt}) and empty gut (W_{ge}), g) with accuracy of 0.01 g. Prey items were identified under a binocular microscope (magnification from 1.6 X) to the lowest possible taxonomic level, which in this study was class or family. Individuals of each identified taxon were counted. In order to describe a diet composition the following indexes were calculated:

- frequency of occurrence (%F) (Hureau, 1970):
 $\%F = n/N \times 100$, where n is the number of guts containing certain prey and N is the total number of analysed guts containing any kind of prey.
- abundance (%N) (Berg, 1979):
 $\%N = np/N_p \times 100$, where np is the number of prey specimens in a specific group and N_p is the number of all determined prey groups.
- fullness index (%Jr) (Hureau, 1970.):
 $\%Jr = (W_p/W) \times 100$, where W_p was a weight of prey items calculated as discrepancy between weights of full and empty gut ($W_{gt} - W_{ge}$), while W referred to a total body weight.
- vacuity index (%V) was calculated as:
 $\%V = E/N \times 100$, where E was the number of empty guts and N the total number of guts analysed.

RESULTS

During one year period 211 garfish specimens were collected in the middle eastern Adriatic Sea and used for diet analysis. Collected garfish specimens ranged from 23.1 to 72.0 cm (mean \pm SD: 40.49 \pm 7.83 cm) in total length and 24.59 and 453.55 g (mean \pm SD: 90.89 \pm 66.21 g) in total body weight (Fig. 2).

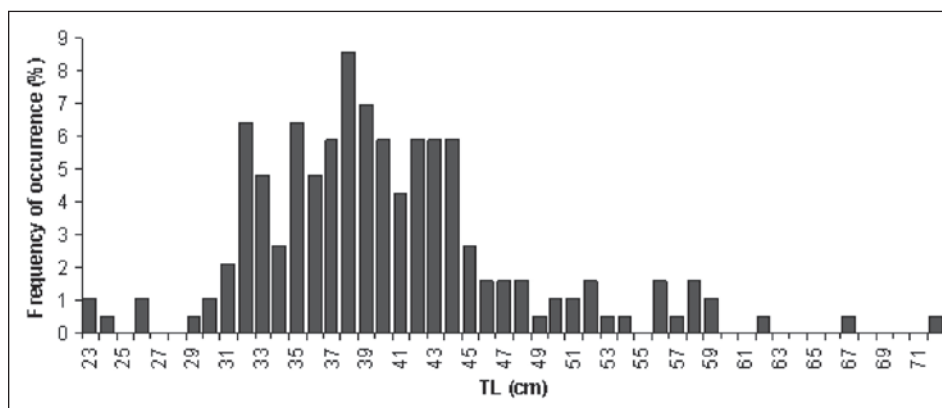


Figure 2. Length frequency distribution of garfish specimens, middle eastern Adriatic Sea, 2008 – 2009.

Slika 2. Učestalost totalnih tjelesnih dužina (TL) analiziranih jedinki iglice u lovinama ostvarenim u istočnom dijelu srednjeg Jadrana, 2008.– 2009. god.

Analysis of gut content indicated that garfish preferred feeding on animal food (94%) but the plant food component was also present. From 211 specimens examined, 160 (75.8%) had food in their guts. Plant component found inside of garfish guts referred to pieces of brown algae (Phaeophyta) and wads of *Posidonia oceanica*. A total of 24,992 animal preys belonging to ten taxonomic groups were identified (Table 1). Abundance and frequency of occurrence of all the categories of prey are reported in Table 1. According to presented data, copepods (56.9 %) and decapods (44.4 %) were the most frequent, while the most abundant prey items were euphausiids (59.9 %) and copepods (20.7 %) (Table 1).

Table 1. Frequency of occurrence (% F) and abundance (% N) of prey items found in garfish guts collected in the middle eastern Adriatic Sea, February 2008-February 2009.

Tablica 1. Vrijednosti postotaka učestalosti pojavljivanja (% F) kao i postotaka brojnosti (% N) plijena u probavilima iglice prikupljene tijekom razdoblja 2008. – 2009. god. sa šireg ribolovnog područja istočnog dijela srednjeg Jadrana.

Prey item/Svojta	% F	% N
Amphipoda	22.5	3.90
Euphausiacea	31.3	59.5
Mysidacea	6.30	0.50
Decapoda	44.4	5.50
Copepoda	56.9	20.7
Cirripedia	2.50	0.10
Larva decapoda	19.4	2.40
Ostracoda	2.50	0.10
Gastropoda	3.10	0.00
Polychaeta	2.50	0.10
Pisces	31.9	6.70
Fish eggs	8.80	0.40
Plant component	8.10	0.10
Unidentified	5.00	0.20

With respect to observed garfish length sizes, prey abundance did not significantly differ ($0.007 < r^2 < 0.417$; $P < 0.05$). Namely, diet composition of garfish specimens was not size related as all examined garfish preyed mainly upon euphausiids, decapods and copepods. The proportion of empty guts varied from 0.23 % (TL=37.0 cm, W=52.78 g) to 10.25 % (TL=37.5 cm, W=66.83 g). Although, decrease of fullness index with garfish size was observed (% Jr= 4.022 – 0.032TL) it was not statistically significant ($r=0.382$, $p=0.075$) (Fig. 3). Conversely to a low value of fullness index (mean±SD: 2.70±1.84 %) quite high vacuity index was obtained (% V=31.88 %).

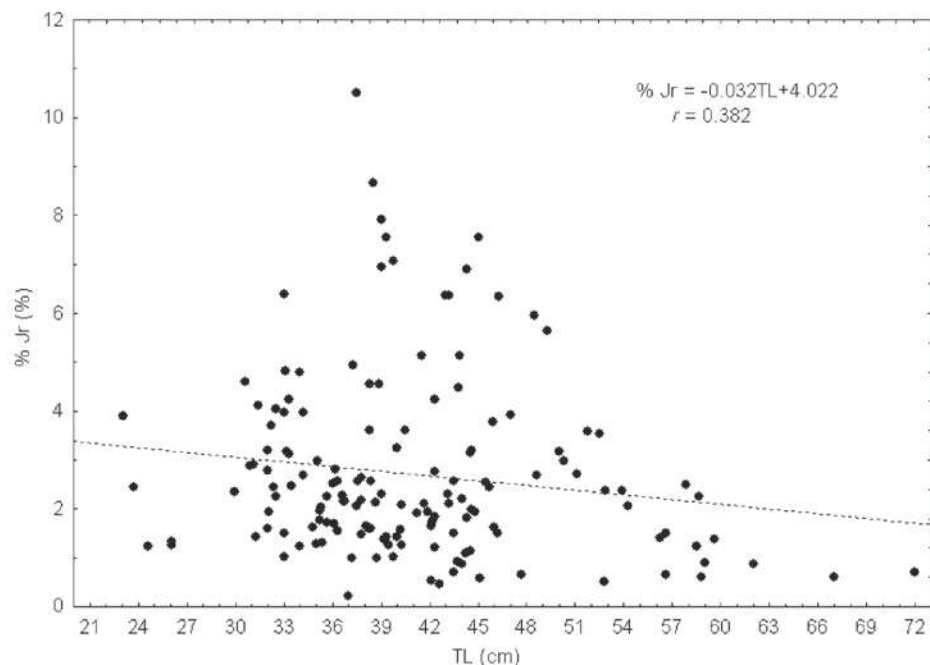


Figure 3. Oscillations of fullness index (% Jr, %) with size (TL, cm) of garfish specimens, middle eastern Adriatic Sea, 2008 – 2009.

Slika 3. Kolebanje vrijednosti koeficijenta punoće probavila (% Jr, %) u odnosu na totalnu dužinu tijela (TL, cm) iglice iz uzoraka lovina ostvarenih na širem ribolovnom području istočnog dijela srednjeg Jadrana tijekom 2008. i 2009. god.

DISCUSSION

Analysis of gut content confirmed garfish as omnivore fish species but with a pronounced preference for animal food. In a garfish diet the most present were copepods and decapods, while the most abundant food items were euphausiids and copepods (Table 1). This was in accordance with previous studies of garfish dietary regime. Dorman (1989, 1991) and Sever et al. (2009) revealed that garfish feeds particularly on crustaceans in Swedish waters and eastern Aegean Sea, respectively. Difference in crustacean composition between garfish population inhabiting Atlantic and Mediterranean (including Adriatic) was observed. Namely, according to Dorman (1988, 1991) in the garfish guts the most abundant crustaceans were brachyuran zoea and megalopa stages, while copepods appeared only occasionally. Adversely to that, Sever et al. (2009) defined copepods as the most important prey item in a garfish diet as it was also acknowledged through this study. Aforementioned discrepancy in crustacean composition was expected as due to zooplankton studies in Adriatic Sea (Gamulin and Hure, 1983) and Aegean Sea (Pavlova, 1966; Moraitou-Apostolopoulou, 1972; Pancucci-Papadopoulou et al., 1992) the most available

zooplankton group were copepods. Nevertheless, zooplankton composition in Atlantic (Swedish waters) and in Mediterranean (Aegean and Adriatic Sea) is for sure different as those geographical areas have different salinity and temperature conditions. Fish prey determined in guts of garfish caught in Adriatic referred to a smaller fish - juvenile stages of anchovy *Engraulis encrasicolus*, sardine *Sardina pilchardus* and sand smelt *Atherina boyeri*. Those fish species were earlier reported as desirable garfish prey item, especially clupeids (Yüce, 1970; Collete and Parin, 1986; Dorman, 1989, 1991; Sever et al., 2009).

No significant correlation between sampled fish length size and prey abundance was observed, although Dorman (1991) indicated that larger garfish specimens might have somewhat different diet. Garfish diet analysis pointed out a prominent number of empty guts, which could be explained by the fact that pelagic fish, in general, have a rapid metabolism. Furthermore, often high percentages of empty stomachs address well known methodology disadvantages (stomach contents are based on prey consumed shortly before capture, taxonomic identification is difficult because of the digestive process, some components in the diets are difficult to quantify) (Iken et al., 1999; Pinnegar et al., 2002).

Data generated from this study on garfish diet proposed *B. belone* as an opportunistic feeder but future diet studies should be done.

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Sažetak

PRELIMINARNA ISTRAŽIVANJA O ISHRANI IGLICE *Belone belone* (L., 1761) U JADRANSKOM MORU

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Cilj ovog rada je prikazati preliminarne rezultate istraživanja vezanih uz ishranu iglice *Belone belone* ulovljene u Jadranskom moru, točnije na širem ribolovnom području Hrvatske. Sveukupno je analiziran želučani sadržaj 211 jedinki iglice. Analizom je utvrđeno da iglica konzumira hranu biljnog i životinjskog podrijetla, s tim što je hrana životinjskog podrijetla ipak značajnije zastupljena (94%). Najučestaliji plijen iglice su bili kopepodni (56,9 %) i dekapodni rakovi (44,4 %), dok su najbrojniji plijen činili eufauzidi (59,9 %) i kopepodni (20,7 %) rakovi.

Ključne riječi: ishrana, pelagična riba, *B. belone*, Jadransko more

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