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DIET COMPOSITION OF PAINTED COMBER *Searranus scriba* (LINNAEUS 1758) IN THE EASTERN-CENTRAL ADRIATIC SEA

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ABSTRACT

The diet composition of painted comber *Serranus scriba* was studied in the eastern central Adriatic Sea. The stomach contents of 275 individuals with a total length (TL) between 10.8 and 24.1 cm, collected by a small beach seine from January to December 2017, were analyzed. The food items in stomachs belonged to seven prey groups: Gastropoda, Bivalvia, Polychaeta, Decapoda, Isopoda, Stomatopoda and Teleostei. Overall, decapods were the most important prey group (%IRI = 54.0), followed by teleosts (%IRI = 40.4%). All other prey groups had much lower %IRI values and thus were of less importance. Painted comber had a diverse diet, feeding on a higher number of prey items (H' = 3.11), and can be considered an opportunistic feeder whose diet in the Adriatic Sea consists of different groups of benthic organisms, with a wide range of prey sizes and morphology. For fish of small and medium size (up to 20 cm TL), decapods were the most important prey, whereas large-sized individuals (> 20 cm TL) mainly consumed teleosts. Decapods were the most important prey in spring, summer and autumn, whereas teleosts dominated in winter.

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INTRODUCTION

Serranids are carnivorous fish that live near the bottom in the littoral and sublittoral zones of tropical and temperate seas. They play an important role in coastal marine ecosystems where they are active predators of several benthic organisms (Tuset et al., 1996; Labropoulou and Eleftheriou, 1997). Painted comber *Serranus scriba* (Linnaeus 1758) is a demersal species distributed along the eastern Atlantic coast from the Bay of Biscay to Mauritania, and in the Mediterranean and Black Sea (Bauchot, 1987). In the Adriatic Sea, it is a common serranid species, abundant in the rocky and sandy-muddy bottoms covered with algae or seagrass such as *Posidonia oceanica* and *Cymodocea nodosa* (Dulčić and Kovačić, 2020). Painted comber is a hermaphrodite which matures at about 170 mm total length (TL) and spawns from June to August in the Adriatic Sea (Zorica et al., 2006). It is not commercially exploited in the Adriatic Sea, but it is often caught as by-catch by fishermen (Jardas, 1996).

Despite its abundance in the Adriatic Sea, its biology, particularly feeding ecology, is not well known. Only one study provides information on painted comber feeding habits using a non-destructive method of fecal pellet analysis (Lokovšek et al., 2022). In the northern part of the Adriatic Sea, crustaceans, polychaets, molluscs and teleosts dominate in its stomach contents (Lokovšek et al., 2021). The literature on other areas is not extensive. The diet of painted comber from the Canary Islands (Moreno-Lopez et al., 2002), western Italian coast (Arcuelo et al., 1993; Zupo and Stübing, 2010) and Greek waters (Vasiliki, 2016) consists also of various benthic invertebrates, mainly crustaceans and teleosts. The study of fish diet composition is useful for developing trophic models as a tool for understanding the complexity of coastal ecosystems (Lopez-Peralta and Arcila 2002; Stergiou and Karpouzi, 2002). Also, diet analysis is essential in determining the intensity of the interspecific interactions in marine fish communities (Morte et al., 2001).

The aim of this study was to examine the diet composition of the painted comber in the eastern central Adriatic Sea. The effects of predator size and seasons on stomach contents were assessed to provide a more comprehensive description of the trophic ecology for this species.

MATERIALS AND METHODS

Samples of painted comber were collected from three different locations in the eastern central Adriatic: the coast of Šolta Island (43°23'6'' N – 16°10'40'' E), coast of Hvar Island (43°09'36'' N – 16°41'24'' E) and coast of Brač Island (43°23'43'' N – 16°40'22'' E), on infralittoral bottoms at depths from 2 to 33 m using a small beach seine. The net was 150 m long with a 12 mm stretched mesh cod-end. Fishing was conducted during daylight hours. Sampling sites were placed on soft bottoms mostly covered with meadows of seagrass *Posidonia oceanica*. A total of 275 painted comber were collected seasonally from January to December 2017; 58 specimens sampled during the winter, 62 during the spring, 85 in the summer and 70 during the autumn. Immediately after capture, the total length (TL) of fish was measured to the nearest 1.0 cm and weight to the nearest 1.0 g. In the laboratory, fish were dissected, their stomach removed and preserved in a 4% buffered formaldehyde. Evidence of regurgitation during capture was never observed. Prey was identified at the species level whenever possible. Species abundance and blotted wet mass (±0.001 g) were recorded. In this study, the following indices were used (Hyslop, 1980):

Vacuity index (VI) = number of empty stomachs divided by total number of stomachs multiplied by 100;

Percentage frequency of occurrence (%F) = number of stomachs in which a food item was found divided by the total number of non-empty stomachs multiplied by 100;

Percentage numerical abundance (%N) = total number of a particular prey item in all non-empty stomachs divided by the total number of food items in all stomachs multiplied by 100;

Percentage gravimetric composition (%W) = total wet mass of a particular prey item in all non-empty stomachs divided by the total mass of stomach contents multiplied by 100.

The main food items were identified using the index of relative importance (IRI) (Hacunda, 1981):

$$IRI = \%F \times (\%N + \%W)$$

The index was expressed as:

$$\%IRI = (IRI / \sum IRI) \times 100$$

Prey species were sorted in decreasing order according to IRI and then the cumulative %IRI was calculated.

Species diversity in prey number was calculated using the Shannon-Wiener index (Colwell and Futuyma, 1971):

$$H'^{S}_{i=1} = -\sum pi \times \ln pi$$

where *pi* is the proportion of individuals belonging to the i^{th} species. The value of *H'* increases with species diversity and a high value indicates a generalist predator.

The sample size of the examined fish ranged from 10.8 to 24.1 cm in total length (TL) (Fig. 1). To evaluate variation in feeding habits as a function of size, the individuals were separated into three length classes: 10 -15 cm TL (n = 73), 15 – 20 cm TL (n = 135) and > 20 cm TL (n = 67). The sample size of each size class was large enough to evaluate seasonal size differences using cumulative prey curves and *a priori* power analysis (Ferry and Cailliet, 1996).

Proportional food overlap between fish size classes and seasons was calculated using Schoener's (1970) dietary overlap index: $C_{xy} = 1 - 0.5 \sum |P_{xi} - P_{yi}|$, where P_{xi} and P_{yi} are the proportion of prey *i* (based on %IRI) found in

the diet of groups *x* and *y*. This index ranges from 0 (no prey overlap) to 1 (all food items in equal proportions). Schoener's index values above 0.6 are usually considered to indicate significant overlap (Wallace, 1981).

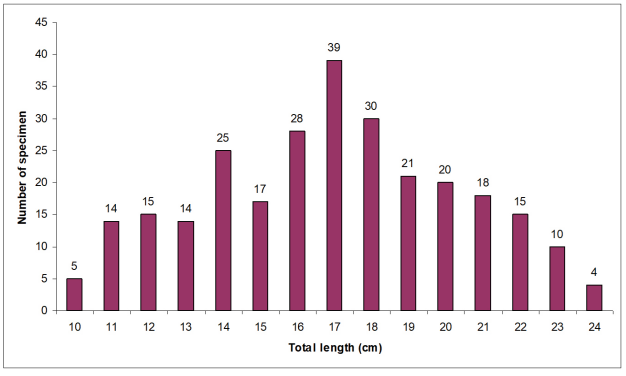

Fig 1. Length - frequency distribution of *S. scriba* caught in the eastern central Adriatic Sea by a small beach seine

RESULTS

Diet composition

Frequency of occurrence, abundance, gravimetric composition and IRI values of prey organisms found in the stomachs are shown in Table 1 and Figure 2. Food items identified in the stomachs belonged to seven different prey groups: Gastropoda, Bivalvia, Polychaeta, Decapoda, Isopoda, Stomatopoda and Teleostei. The group Spermatophyta is included as a finding of fragments of *Posidonia oceanica*. It is assumed that these fragments were incidentally swallowed and would therefore be irrelevant to separate them into one prey group. However, ingested plants had no nutritional value. The most common prey species were decapods *Alpheus glaber* and *Liocarcinus depurator* (Table 1). Decapod crustaceans occurred in 42.1% of stomachs that contained food and represented 45.0% of the total prey number and 25.1% of the total prey weight. Teleosts occurred in 30.0% of stomachs examined and represented 26.5% by number and 47.3% by weight of total prey. Decapod crustaceans were the most important prey group ingested, constituting 54.0% of the total IRI, followed by teleosts (%IRI = 40.4). Other prey groups had a much lower %IRI (< 2%) and were thus of less importance (Fig. 2). Of the total number of stomachs examined (n = 275), 28 were empty (VI = 10.1%). Overall, painted comber had a diverse diet, feeding on higher number of prey items (H' = 3.11).

Food in relation to fish size

The % IRI changed depending on the size of individuals (Fig. 3). In the first and second length classes, decapods markedly dominated the diet (I length class %IRI = 60.7; II length class %IRI = 67.8), followed by teleosts (I length class %IRI = 36.2; II length class %IRI = 24.7).

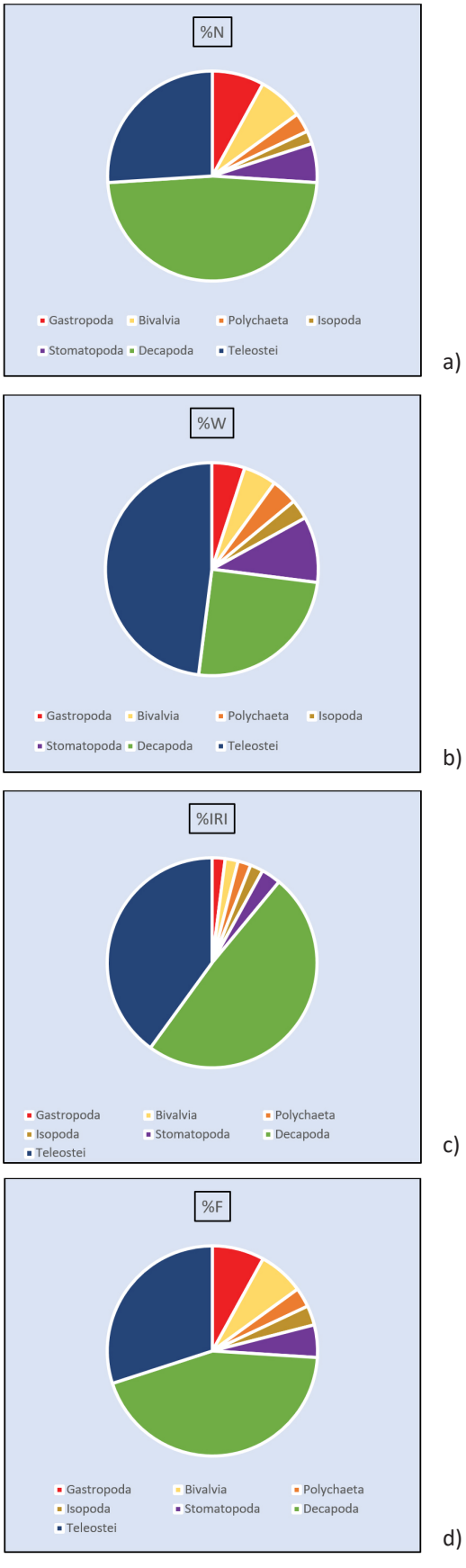

Fig 2. a) Percentage of numbers (%N), b) Percentage of weight (%W), c) Percentage of IRI (%IRI) and d) Frequency of occurrence (%F) of seven prey groups identified in stomachs of *S. scriba*

Table 1. Diet composition from 247 non-empty stomachs of *Serranus scriba* (%F, frequency of occurrence; %N, numerical composition; %W, gravimetric composition; IRI, index of relative importance)

Food items	%F	%N	%W	IRI	%IRI
Spermatophyta					
Posidonia oceanica remains	4.8	4.2	0.4	22.0	0.4
Gastropoda					
Gibulla sp.	1.6	1.6	1.1	4.3	< 0.1
Cerithium sp.	1.6	1.3	0.9	3.5	< 0.1
Murex sp.	1.2	1.3	0.7	2.4	< 0.1
Rissoa sp.	1.2	1.0	0.6	1.9	< 0.1
Non-identified Gastropoda	2.8	2.3	1.5	10.6	0.2
Total Gastropoda	7.6	7.5	4.8	93.4	1.8
Bivalvia					
Modiolus barbatus	2.4	1.8	1.5	7.9	< 0.1
Mytilus galoprovincialis	1.2	1.0	1.2	2.6	< 0.1
Non-identified Bivalvia	4.0	3.9	1.9	23.2	0.4
Total Bivalvia	6.8	6.7	4.6	76.8	1.5
Polychaeta					
Non-identified Polychaeta	3.2	2.3	4.4	21.4	0.4
Isopoda					
Idotea sp.	2.8	1.8	2.8	12.8	0.2
Stomatopoda					
Rissoides desmarseti	4.0	3.5	5.1	34.4	0.6
Non-identified Stomatopoda	2.0	1.8	4.1	11.8	0.2
Total Stomatopoda	4.8	5.3	9.2	69.6	1.3
Decapoda					
Alpheus glaber	11.3	10.4	3.7	159.3	3.0
Liocarnicus sp.	10.9	7.2	4.6	128.6	2.4
Liocarnicus depurator	8.0	5.3	3.9	73.6	1.4
Parthenope sp.	5.6	3.7	3.5	40.3	0.7
Pilumnus hirtellus	4.0	2.9	2.6	22.0	0.4
Processa sp.	3.6	2.9	0.9	13.6	0.2
Palaemon sp.	3.2	2.1	0.8	9.2	0.1
Pisidia sp.	2.8	1.8	0.8	7.2	0.1
Processa canaliculata	2.4	1.8	0.5	5.5	0.1
Non-identified Decapoda	5.6	6.9	3.8	59.9	1.1
Total Decapoda	42.1	45.0	25.1	2951.2	54.0
Teleostei					
Gobius sp.	9.7	6.7	8.3	145.5	2.8
Parablenius sp.	8.0	5.8	7.6	107.2	2.0
Chromis chromis	5.2	3.5	6.2	50.4	1.0
Symphodus sp.	4.0	2.9	5.2	32.4	0.6
Atherina sp.	2.0	1.3	4.5	11.6	0.2
Spicara flexuosa	2.0	1.3	4.0	10.6	0.2
Non-identified Teleostei	6.4	5.0	11.5	105.6	2.0
Total Teleostei	30.0	26.5	47.3	2214.0	40.4

In the third length class, with the largest individuals analyzed, the importance of decapods decreased (%IRI = 10.7). In the stomachs of these specimens (over 20 cm TL), teleosts markedly dominated (%IRI = 86.3). Other prey groups were present in small quantities and were of minor importance in the stomachs of painted comber of all length classes. Schoener's overlap index indicated differences in diets between the largest fish (> 20 cm TL) and both smaller length classes of up to 20 cm in TL. On the contrary, high values of overlapping were found between the length classes 10–15 and 15–20 cm TL, where the diet was dominated by decapod crustaceans (Table 2).

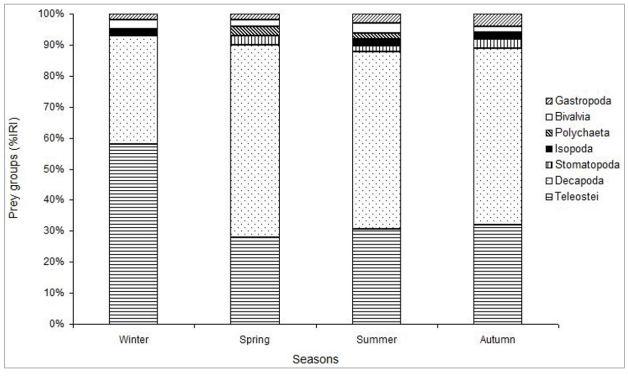

Fig 3. Food in relation to fish size

Table 2. Proportional food overlap coefficients (Schoener's index) of the diet between total length (TL) classes of *Serranus scriba*

TL class (cm)	10 - 15	15 - 20
15 - 20	0.87	-
> 20	0.49	0.38

Seasonal variation in diet composition

Food habits of painted comber varied over the season. Decapods were the dominant prey in spring, summer and autumn, followed by teleosts (Fig. 4). However, teleosts were the most abundant food in stomachs during the winter (%IRI = 55.1). Gastropods and bivalves were also present in stomachs throughout the year but were minor prey items (Fig 4). A particularly high degree of food overlap was observed between spring, summer and autumn. Schoener's overlap index indicated differences in diets between winter and other seasons (Table 3).

Table 3. Seasonal proportional food overlap coefficients (Schoener's index) of *Serranus scriba* diet

Season	Winter	Spring	Summer
Spring	0.51	-	-
Summer	0.56	0.93	-
Autumn	0.59	0.90	0.95

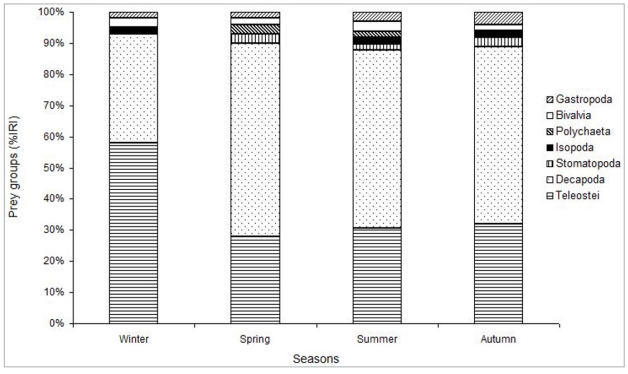

Fig 4. Seasonal variation in diet composition

DISCUSSION

The composition of food suggests that painted comber inhabiting the eastern part of the central Adriatic Sea is a carnivorous species with a preference for crustaceans. Decapod crustaceans were the most abundant prey constituting 54.0% of the total IRI. The prey group accounted for more than 50% of the total IRI can be considered as the primary food source (Rosecchi and Nouaze, 1987). Based on the total IRI, teleosts were the second most important prey (%IRI = 40.4), while other prey groups were of less importance. Like the results of the present study, Lokovšek et al. (2022) reported that decapod crustaceans were dominant in the stomach contents of painted comber sampled in the northern Adriatic. Reports from the eastern Atlantic (Moreno-Lopez et al., 2002) and the Mediterranean Sea (Arcuelo et al., 1993; Zupo and Stübing, 2010; Vasiliki, 2016) list decapods as the major food components in the *S. scriba* diet. Taken together, the results of these studies confirm the importance of decapods in the painted comber diet. Possibly, decapod crustaceans are the main prey items of *S. scriba* irrespective of biotope or geographical zone. Even though teleosts are not as primary food as regards to IRI, their mass is larger than other prey and they are therefore a very important part of the diet. The structure of jaw and type of teeth indicate that this species is a carnivorous hunter fish. Painted comber have a homodont jaw with numerous small canine teeth set in several rows at maxillary, vomer, and palatine bones (Šantić, 1987). In the Adriatic Sea, generally, it feeds on epibenthic prey with relatively hard structures including slow movers (brachyura decapods, such as species of *Liocarnicus*, *Pilminus* or *Parthenope genus*), swimmers (natantia decapods such as *Alpheus glaber*, *Processa canaliculata*) and very quick swimmers (teleosts). Most prey in stomach contents are abundant on littoral bottoms of soft sediments. Decapods (*Alpheus glaber*, *Liocarcinus depurator*, *Palaemon* sp.), stomatopods (*Rissoides desmaresti*), gastropods (*Rissoa* sp.), polychaets and teleosts (*Gobius* sp., *Parablenius* sp.) are common on Adriatic littoral substrates covered by seagrass *Posidonia oceanica* (Milišić, 2007, 2008).

Detected prey groups reflect painted comber preferences in habitat where this species occupies a high trophic position (Moreno-Lopez et al., 2002). The fragments of *Posidonia oceanica* in painted comber stomachs are probably the consequence of accidental ingestion resulting from the biting behaviour. Generally, prey groups identified in stomachs indicate that painted comber is an opportunistic carnivorous hunter that feeds on a diverse type of benthic organisms with a wide range of sizes and morphology that confirm the values of the Shannon-Wiener index (H' = 3.11). Also, in the northern Adriatic Sea, painted comber consumed different prey (bivalves, gastropods, polychaetes, mysids, amphipods, isopods, ostracods, decapods, and teleosts), supporting an opportunistic behaviour for this species (Lokovšek et al., 2022). Painted comber is an important opportunistic mesopredator of the Adriatic bottom fish communities (Lokovšek et al., 2022), helping to maintain the stability of the ecosystem due to its generalist foraging strategy (Sergio et al., 2006). Also, the wide dietary spectrum of this species was observed in Italian waters (Zupo and Stübing, 2010). In our study, a high percentage of non-empty stomachs (89.9 %) indicated an abundance of prey. The studied area belongs to the oligotrophic part of the Adriatic Sea, and the abundance of prey is related to upwelling events in Palagruža (Regner et al., 1987), located in the vicinity of this area. Similarly, high degrees of stomach fullness were reported for some other demersal fish in the eastern central Adriatic, such as *Scorpaena porcus* (Jardas and Pallaoro, 1991), *Diplodus annularis* (Matić-Skoko et al., 2004), *Salaria pavo* (Šantić et al., 2007) and *Trachinus draco* (Šantić et al., 2016). Fish size was an important factor affecting the diet of painted comber. Size-related diet changes were observed during stomach content analyses and were therefore presented in three separate length classes. The stomach content analyses clearly indicated changes in prey selection with increasing body length. A prominent shift in the feeding habits was recorded from the second to third length class (> 20 cm TL, Schoener's overlap index = 0.38), with a decrease in predation on decapod crustaceans and an increase of larger-sized prey such as teleosts. This suggests that larger individuals consumed very quick and heavier prey, thus maximizing the energetic gain relative to capture effort. Furthermore, dif¬ferences in prey selectivity between smaller and larger painted comber could be related to the higher metabolic demands of larger specimens, their better ability to catch teleosts, as well as their lower prey handling. Similar findings for painted comber and some other serranid fish were reported by several authors (Tuset et al., 1996; Morato et al., 2000; Moreno-Lopez et al., 2002; Lokovšek et al., 2022). The trophic shift of painted comber can also be explained in terms of fish morphology. The width and height of the mouth are linearly related to fish size, and increased body and mouth enable the capture of a broader range of prey sizes and prey types (Ross, 1978). Moreover, the separation of feeding niches with body size certainly helps juveniles to coexist with adults (Langton, 1982). Some seasonal variation was found in the diet of painted comber. Decapods dominated the diet composition throughout the year, except in the winter season. Values of Schoener's index (> 0.60) indicated high dietary overlap between spring, summer and autumn. Increased decapod consumption during spring and summer coincides with the period of the recruits of many decapod species, which may be present in high densities (Milišić, 2008). Observed variations in prey composition between winter and other seasons could possibly be related to the prey densities/availability (Costa et al., 1992), and could reflect the adaptive flexibility in the feeding habits of painted comber (King 1993). In conclusion, painted comber can be considered an opportunistic feeder whose diet in the Adriatic and Mediterranean Sea consists of a different group of benthic organisms, with a wide range of prey sizes and morphology. Decapods were the most important prey in fishes of smaller and medium sizes (up to 20 cm TL), whereas large-sized individuals (> 20 cm TL) mainly consumed teleosts. Decapods were the most important prey in spring, summer and autumn, whereas teleosts dominated in winter.

SASTAV PREHRANE PIRKE *Serranus scriba* (LINNAEUS, 1758.) U ISTOČNOM SREDNJEM JADRANU

SAŽETAK

Istražen je sastav prehrane pirke, *Serranus scriba*, u istočnom dijelu srednjeg Jadrana. Analiziran je sadržaj želuca 275 jedinki ukupne duljine (TL) između 10,8 i 24,1 cm, prikupljenih malom obalnom potegačom u razdoblju od siječnja do prosinca 2017. Hrana u želucima obuhvaćala je sedam skupina plijena: Gastropoda, Bivalvia, Polychaeta, Decapoda, Isopoda, Stomatopoda i Teleostei. Rakovi desetonošci prestavljali su najvažniju skupinu plijena (%IRI = 54,0%), a slijede ih ribe koštunjače (%IRI = 40,4%). Ostale skupine plijena imale su puno niže vrijednosti %IRI i stoga su imale manju važnost u prehrani. Zbog raznolikog sastava hrane (H' = 3,11) pirka se može smatrati oportunističkom vrstom čija se prehrana u Jadranskom moru sastoji od različitih bentoskih organizama. Rakovi desetonošci su najvažniji plijen kod jedinki manjih i srednjih veličina (do 20 cm TL), dok su se velike jedinke (> 20 cm TL) uglavnom hranile ribama koštunjačama. Rakovi desetonošci najvažniji su plijen u proljeće, ljeto i jesen, dok su zimi u ishrani dominirale ribe koštunjače.

Ključne riječi: pirka, prehrana, Jadransko more, Serranidae

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