Acta Adriat.,32(2):885-898(1991)

ISSN:0001-5113
AADRAY

UDC:597.08(262.3)
Conference paper

FOOD AND FEEDING HABITS OF BLACK SCORPIONFISH (*SCORPAENA PORCUS* L.1758) (PISCES, SCORPAENIDAE) ALONG THE ADRIATIC COAST

ISHRANA ŠKRPUNA (*SCORPAENA PORCUS* L. 1758) U OBALNIM VODAMA JADRANSKOG MORA

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Stomach contents of 298 black scorpionfish (*Scorpaena porcus*) from 13 stations of the eastern Adriatic, sampled in May (spring), June and July (summer), September (autumn), December and March (winter) 1987-1991 were examined. The relative importance of different components of the diet was assessed using three feeding indices (IRI, MFI, Q) which combine in different ways the percentage frequency of occurrence (%F), percentage number (%N) and percentage weight (%W) of prey categories. Decapoda Brachyura were dominant food component independent of the season, followed by fishes and crustaceans Decapoda, Anomura and Natantia. Taking individual species into account, ***Pilumnus hirtellus*** was the most dominant prey, both by number and weight, followed by ***Ilia nucleus, Lissa chiragra*** and ***Xantho*** species. Of the fishes, the species of Gobiidae family were the most numerous, of Anomura the *Galathea* species and of Natantia the species of Alpheiidae and Palaemonidae families. The food changes were recorded with fish length. Seasonal quantitative dietary changes were also recorded. The lowest feeding activity was recorded in summer during the spawning season of this species in the Adriatic Sea.

INTRODUCTION

Scorpaena porcus Linnaeus, 1758 (black scorpionfish) is one of the most numerous species of Scorpaenidae in the Mediterranean and the Adriatic Sea. It inhabits rocky and rocky-sandy infralittoral bottoms overgrown by algae and "meadows" of marine phanerogams (*Cymodocea nodosa, Posidonia oceanica*) between 0.5 and 50 m depth, most numerous between 5 and 15 m (Grubišić, 1982). After some authors (Hureau and Litvinenko, 1986) they may reach as deep as 800 m. They are solitary and sedentary species. They are of a defined commercial importance in the coastal fishing of the Mediterranean and Adriatic where they are caught by trammels and beach seines. Annual mean catch of all commercially interesting scorpaenidae (mainly *Scorpaena scrofa* and *S. porcus*) amounts to 178 t and shows slight increase (Grubišić, 1982). Apart from the Adriatic and the whole Mediterranean, including the Black Sea, this species is distributed along the eastern Atlantic coast, from British Isles to Senegal, around Azores and Canary Islands (Hureau and Litvinenko, 1986). In the Adriatic they attain up to 35 cm length (TL) and 0.80 kg weight. Spawning occurs during the first half of summer (Grubišić, 1982).

After some earlier studies of food and feeding habits of this species (Šoljan and Karlovac, 1932; Valiani, 1935; Dieuzeide *et al.*, 1955; Boutière, 1958; Collignon and Aloncle, 1960; Svetovidov, 1964; Bradai and Bouain, 1990, etc.) black scorpionfish are markedly carnivorous species feeding mainly on decapod crustaceans, small fish (Blenniidae and Gobiidae) and some benthic invertebrates.

This paper presents qualitative-quantitative analysis of food of the species *Scorpaena porcus* with special regard to selectivity, seasonal intensity and differences in feeding habits between individual length groups.

MATERIALS AND METHODS

Stomach contents of 298 specimens of 8.2 to 30.0 cm total length (TL), collected during May (spring), June and July (summer), September (autumn) and December and March (winter) 1987-1991, were analyzed. The samples originated from 13 localities along the eastern Adriatic coast (Fig. 1). Fig. 2 depicts the polygon of length frequency distribution of analyzed specimens. Bottoms at sampling sites were rocky and rocky-sandy, overgrown by algae and isolated meadows of marine phanerogams (*Possidonia oceanica, Cymodocea nodosa*) between 1 and 30 m depths. Most of analyzed material originated from the trammel catches and smaller proportion from

Fig. 1. Map of sampling stations in the eastern Adriatic

beach seine catches. Of all analyzed stomachs, 186 contained food residues and 112 were empty.

Total length (TL) in mm and weight (W) in g (fresh) were measured in all the collected specimens. Thereupon fish were dissected and stomach contents taken out and preserved in 5% formalin solution for laboratory analyses.

Found prey was identified, whenever possible, to the level of lowest taxonomic categories (genus and species) and in cases of tiny (Isopoda, Amphipoda) or semidigested organisms (particularly Natantia and Paguridae) only to the level of genus or suborder. Specimens of identified organisms were wet weighed to the nearest 0.01 g.

To make the analysis easier, found prey was classified to higher taxonomic categories (Pisces, Decapoda Brachyura, Anomura, Natantia etc.) for which the following percentages were calculated (R o s e c c h i and N o u a z e , 1987):

%F = *percentage of the frequency of occurrence*: the number of stomachs containing one or more individuals of each prey category expressed as a percentage of total number of stomachs with food;

%N = *percentage number*: the total number of individuals of each food category expressed as the percentage of the total number of individuals of all food categories;

%W = *percentage weight*: the total weight of each food category expressed as the percentage of the total weight of all stomach contents.

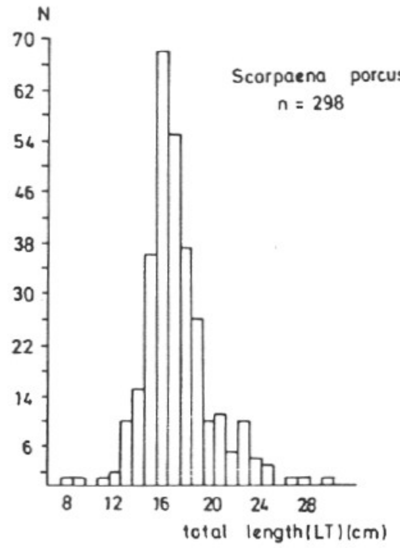

Fig. 2. *Scorpaena porcus.* Frequency polygon of examined specimens size

To get better insight into the food selectivity and make the comparison of the differences in feeding habits between different length classes and in different seasons, the following three nutrition indexes were calculated from these percentages:

IRI = *index of relative importance* (P i n k a s *et al.*, 1971):

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

MFI = *main food item* (Z a n d e r , 1982):

$$(\%N + \%F)/2 \times \%W$$

where obtained values MFI > 75 mean the essential food, 51 < MFI < 75 principal food, 26 < MFI < 50 secondary and MFI < 26 occasional food;

Q = *feeding coefficient* (H u r e a u , 1970):

$$\%N \times W$$

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where obtained values $Q > 200$ refer to preferred food, $20 < Q < 200$ secondary and $Q < 20$ occasional food.

The analysis of changes in feeding habits in different seasons and in different length classes was performed by the use of the following indexes:

$$\%Jr = \text{fullness index} : \frac{\text{weight of diggested food}}{\text{fish weight}} \times 100$$

(H u r e a u , 1970).

$$\%V = \text{vacuity coefficient} : \frac{\text{Er (number of empty stomachs)} \times 100}{\text{N (total number of analyzed guts)}}$$

(H u r e a u , 1970).

RESULTS

Faunal list and total group selectivity

The list of found prey organisms is presented in Table 1. As shown by the table Decapoda Brachyura (IRI = 6561.06;MFI = 50.80; Q = 2009.75) and Pisces (IRI = 1037.44; MFI = 25.08; Q = 465.90), were followed by Decapoda Anomura and Natantia. The rest of organisms (the rest of Crustacea, Mollusca, Polychaeta, Spermatophyta and Phycophyta) were more rarely present in the food. As shown by obtained values of MFI and Q coefficients, Decapoda Brachyura and Pisces are principal or preferred food of this species, Decapoda Anomura and Natantia are secondary food whereas all the other organisms are only occasional prey (Fig. 3A).

The analysis of the presence of individual species showed that *Pilumnus hirtellus* was the most numerous species of Decapoda Brachyura (30% of the total numbers and 39.9% of the total weight of Brachyura crustaceans). The species *Ilia nucleus, Lissa chirarga* and the species of genus *Xantho* were far less represented. Of Decapoda Anomura the species of genus *Galathea* were best represented, and of Natantia the species of families Alpheiidae and Palaemonidae. Of fish the species of family Gobiidae were best represented.

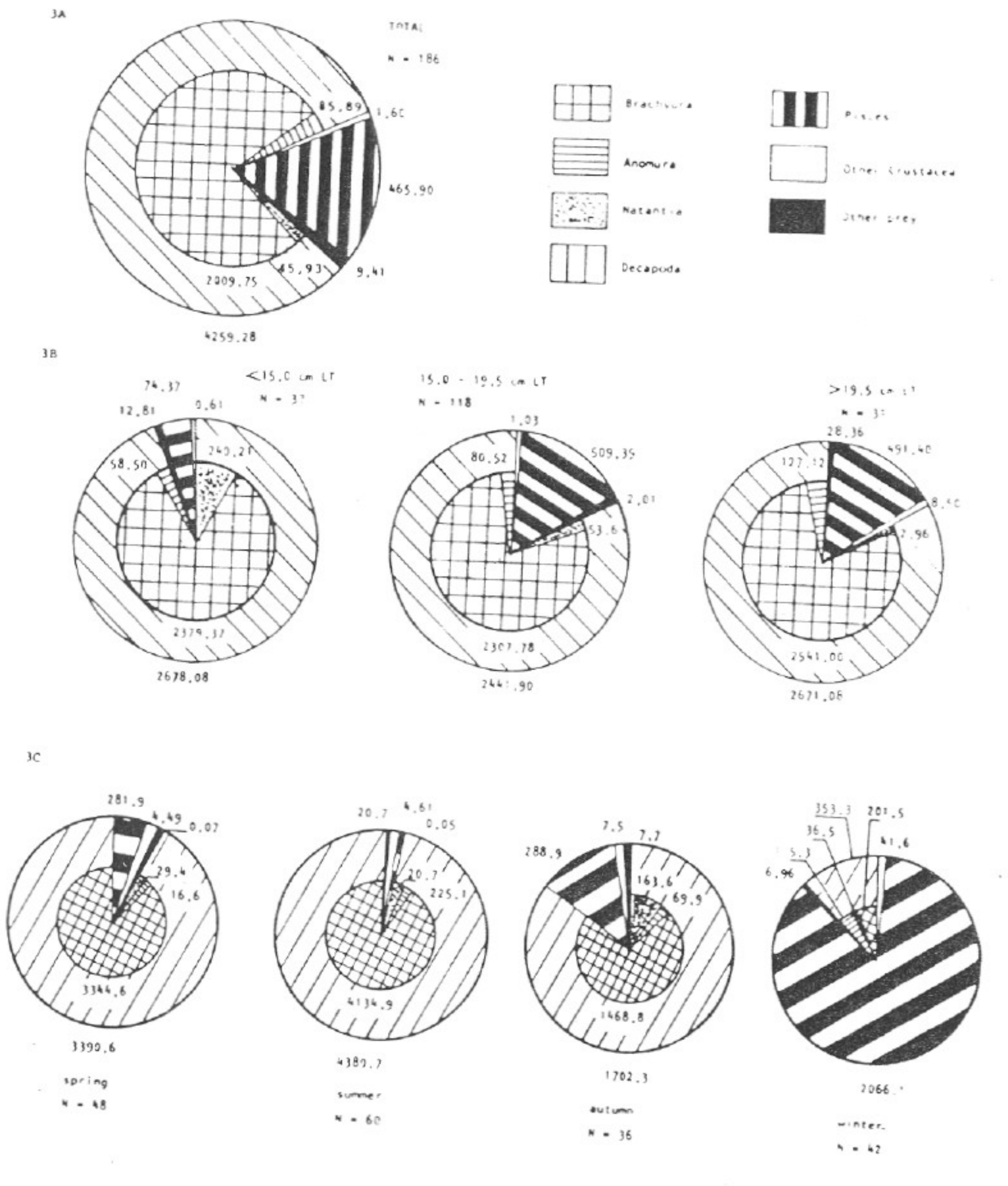
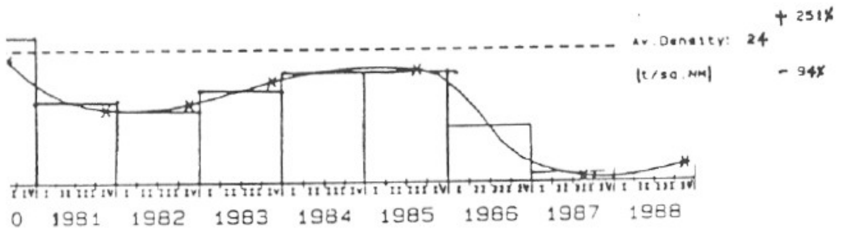


Fig. 3. *Scorpaena porcus.* Total prey composition (A), by size classes (B) and seasonal (C) in specimens analyzed: the angle is proportional to Q (alimentary coefficient)



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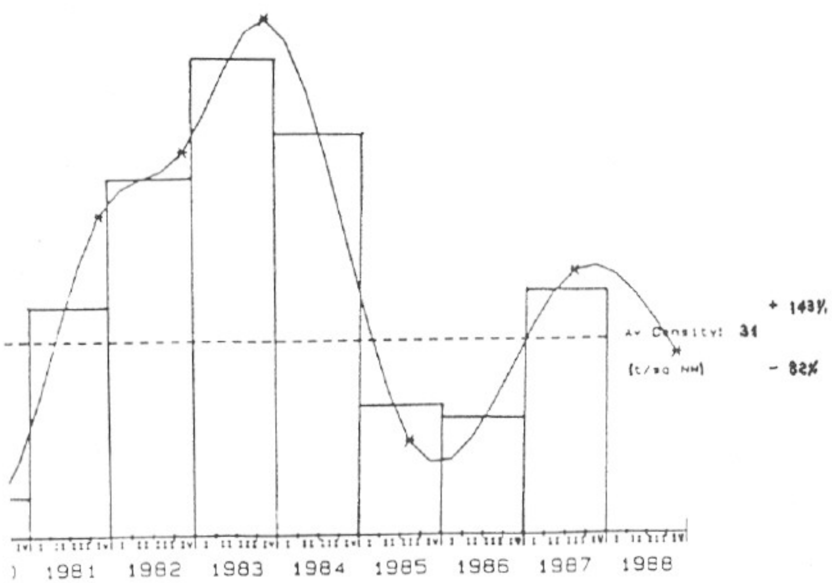


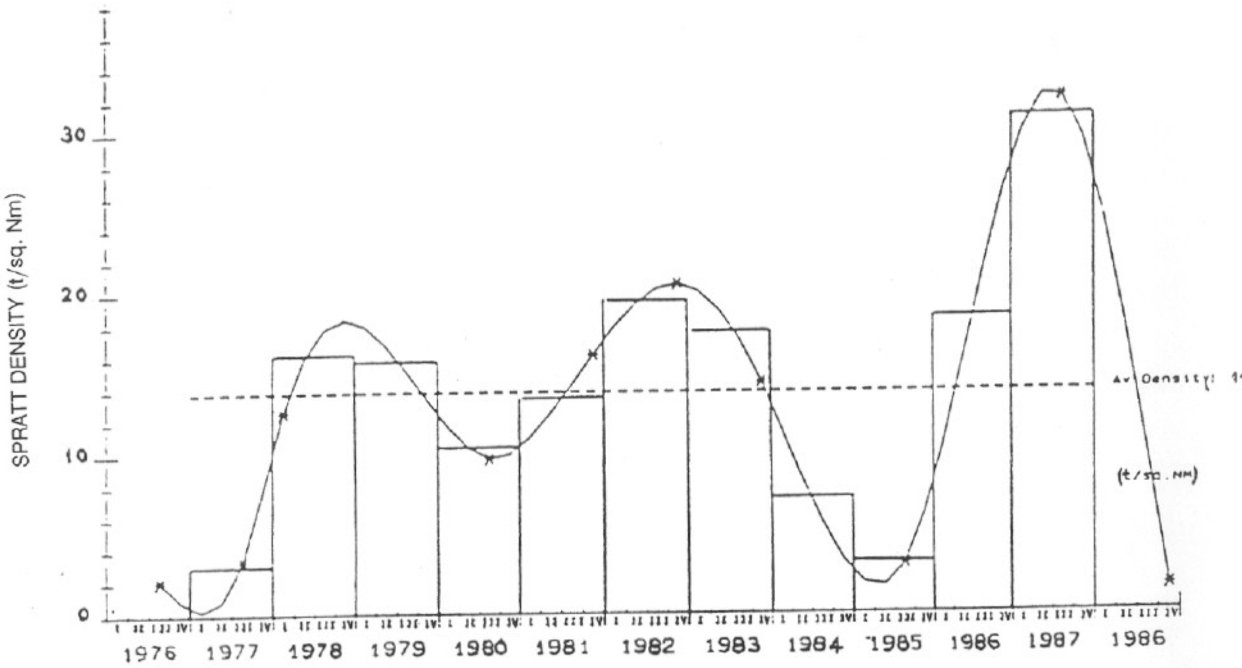
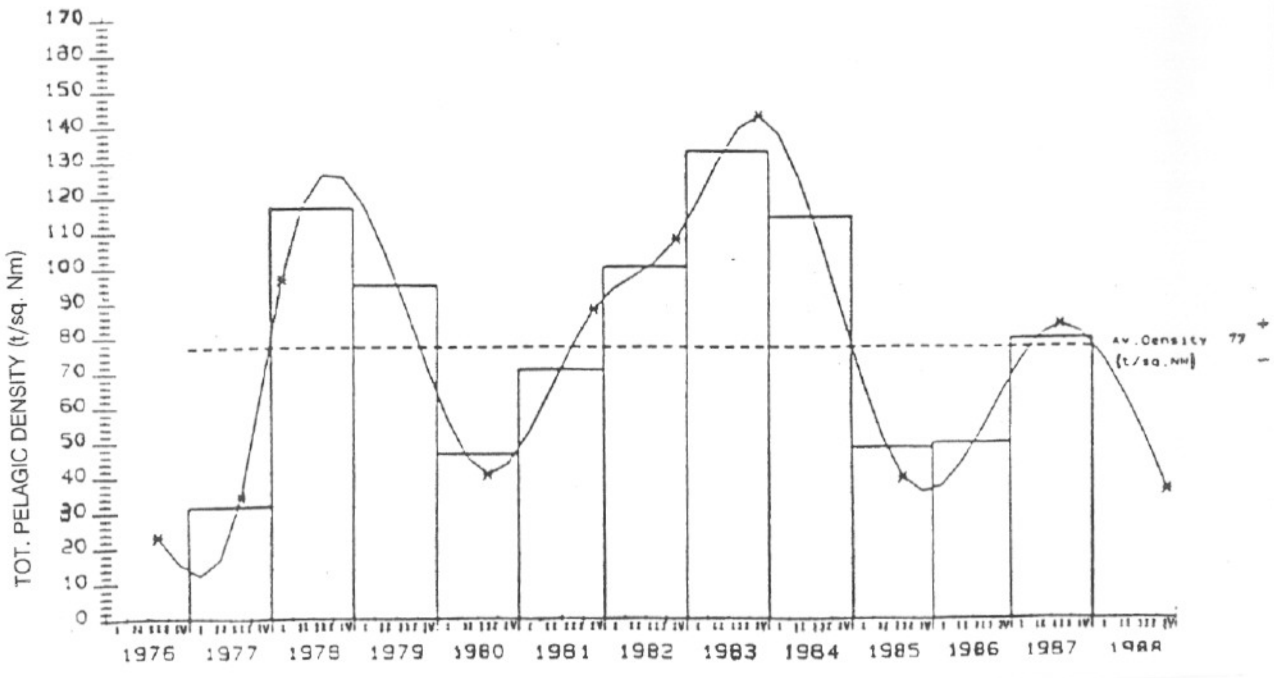


Fig. 20. Trend of sprat biomass (Azzali, Cosini, Luna, 1989)



Changes with fish length

An increase in fish length was also followed by defined changes in feeding habits (Table 2, Fig. 3B). Comparing the values of all three nutrition indexes in defined length groups (specimens smaller than 15.0 cm TL, from 15.1-19.5 cm TL and bigger than 19.5 cm TL) it is obvious that Decapoda Brachyura are present in almost equally high numbers in all the length groups, even though they were slightly better represented in specimens smaller than 15.0t cm TL. The presence of Anomura increased with length increase. On the contrary, the presence of Natantia was reduced with the body length increase being particularly high in specimens smaller than 15.0 cm LT to be almost completely absent from gut contents of the biggest individuals. The presence of fish was markedly increased in the food of individuals of greater body lengths. Isopoda, Mollusca and Polychaeta were best represented in the smallest individuals and not at all present in the biggest individuals. The largest number of different groups (10) was recorded from stomach contents of the smallest and medium length class, and only 8 in the biggest specimens.

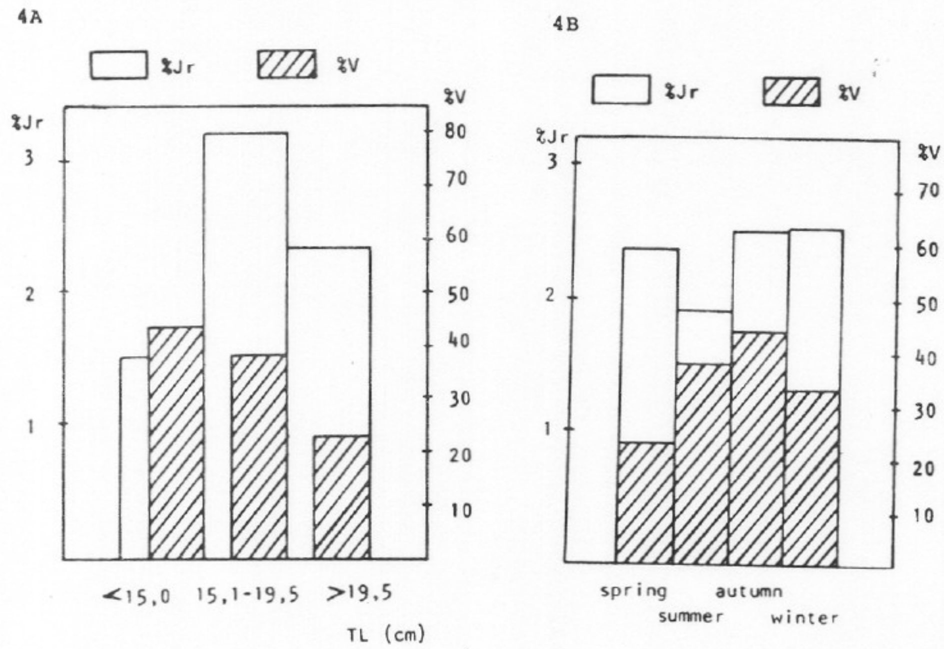


Fig. 4. *Scorpaena porcus*. Fullnes index (Jr) and vacuity coefficient (V) in specimens analyzed by particular size classes (A) and sampling seasons (B)

Table 2. *Scorpaena porcus*. Values of feeding indices IRI, MFI and Q of major prey categories by size classes

	IRI			MFI			Q		
Prey categories/TL(cm)	<15.0	15.1-19.5	>19.5	<15.0	15.1-19.5	>19.5	<15.0	15.1-19.5	>19.5
Brachyura	7311.6	6351.6	6179.3	58.61	52.13	53.18	2379.4	2307.8	2541.0
Anomura	166.9	198.5	380.5	8.75	9.26	13.67	58.5	80.5	127.1
Natantia	1419.8	499.6	13.6	16.58	7.50	1.71	240.2	53.6	3.0
Pisces	240.8	1055.4	1293.9	10.61	26.04	24.54	74.4	509.4	491.4
Stomatopoda	-	2.0	21.8	-	1.10	3.53	-	0.9	8.5
Amphipoda	1.7	-	-	0.23	-	-	0.1	-	-
Isopoda	15.6	3.9	-	0.92	0.37	-	0.6	0.1	-
Euphausiacea	0.4	-	-	0.08	-	-	0.1	-	-
Mollusca	48.8	8.9	-	2.15	0.74	-	3.7	0.5	-
Polychaeta	5.4	0.5	-	1.15	0.26	-	0.9		
Spermatophyta	74.4	9.0	316.1	3.54	1.38	6.32	8.3	1.4	27.2
Phycophyta	-	1.8	23.7	-	0.17	1.31	-	0.1	1.2

The analysis of feeding intensity expressed by the index of stomach fullness (Jr) and vacuity coefficient (V) in individual length groups, points to the fact the feeding intensity was highest in medium length class (15.0-19.5 cm LT and lowest in the smallest individuals (smaller than 15.0 cm LT). All this is shown in Fig. 4A. In medium length class the index of gut fullness was 3.19 and in the smallest length group 1.49. The highest values of vacuity coefficient was, normally, obtained in the smallest specimens (%V = 43.9) and the lowest (%V = 22.5) in the biggest specimens (exceeding 19.5 cm LT).

Seasonal changes in feeding habits

It was observed that Scorpaena porcus change their feeding habits with seasons (Table 3, Fig. 3c). So, the analysis of nutrition indexes show that Decapoda Brachyura prevailed in food during spring and especially summer, whereas their quantities were considerably smaller in autumn and particularly in winter. On the contrary, Decapoda Natantia were most poorly represented in stomach contents in spring and summer and highly present in autumn and winter. Decapoda Anomura were better represented in summer and winter and poorer in spring and autumn. Fish, however, occurred in far greater quantities than any other food component in winter whereas their summer quantities were extremely low. In summer stomachs contained the largest number of different components (10) and the lowest number was recorded in winter (only 6).

Food quantity in analyzed guts, expressed as the index of fullness (Jr), showed some oscillations in all seasons. Feeding intensity is more or less the same all year round with the exception for summer when a significant drop was recorded (Fig.4B). Presumably, this is due to spawning, since these fish spawn in the Adriatic in summer (June and July). On the contrary, the highest values of vacuity coefficient were obtained for autumn (%V=42.9) and the lowest ones for spring (%V=22.6).

Table 3. Scorpaena porcus. Values of feeding indices IRI, MFI and Q of major prey categories by seasons

	I R I				M F I			
Prey categories/Seasons:	spring	summer	autumn	winter	spring	summer	autumn	winter
Brachyura	8983.7	10074.0	4483.8	1033.6	64.8	67.9	44.0	16.0
Anomura	71.1	553.8	206.0	313.5	4.5	17.6	10.4	10.9
Natantia	327.2	230.0	1556.8	557.6	5.7	4.7	14.8	6.9
Pisces	759.9	52.9	676.5	4535.8	20.1	5.5	20.1	51.4
Amphipoda	9.4	-	-	-	0.3	-	-	-
Isopoda	-	1.6	-	-	-	0.2	-	-
Euphausiacea	-	1.6	-	-	-	0.2	-	-
Stomatopoda	-	-	19.5	14.9	-	-	3.4	3.0
Mollusca	48.7	18.9	-	-	1.4	1.2	-	-
Polychaeta	-	18.7	-	-	-	2.1	-	-
Spermatophyta	26.3	1.8	49.2	237.4	2.1	0.5	3.5	7.4
Phycophyta	-	6.5	36.7	-	-	0.8	1.7	-

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Table 3. continued

Table 3. continued

	Q			
Prey categories/Seasons	spring	summer	autumn	winter
Brachyura	3344.6	4134.9	1468.8	201.5
Anomura	16.6	255.1	69.9	115.3
Natantia	29.4	20.7	163.6	36.5
Pisces	281.9	20.7	288.9	2066.1
Amphipoda	0.1	-	-	-
Isopoda	-	0.1	-	-
Euphasiacea	-	0.1	-	-
Stomatopoda	-	-	7.5	7.0
Polychaeta	-	3.0	-	-
Spermatophyta	2.9	0.2	5.9	41.6
Phycophyta	-	0.4	1.8	-

DISCUSSION

Feeding of the species Scorpaena porcus has been relatively well studied in the Mediterranean and Adriatic. The feeding of these fish was studied by Šoljan and Karlovac (1932) (eastern Adriatic coast) and by Valiani (1935) (Italian coast), Svetovidov (1964) (Black Sea), Dieuzeide (1955) (Mediterranean coast) and Siblot-Butaflika (1976) (Algerian area) as well as Bradai Bouain (1990) (Tunisian waters), whereas Boutière (1958) and Collignon and Aloncle (1960) studied the feeding of this species along the Atlantic coast of Morocco. All the authors came to the same results; all of them recorded the dominance of Crustacea Decapoda in relation to other food components (fish and other benthic invertebrates). So Šoljan and Karlovac (1932) reported an absolute dominance of Crustacea Decapoda (85.6%) (44.2% Brachyura, 19.9% Anomura and 17.1% Natantia) in relation to other crustaceans (Isopoda, Amphipoda, Stomatopoda) (6.6%), fish (2.2%) and other food components (Cephalopoda, the rest of Mollusca, Polychaeta, residues of algae and Spermatophyta) (5.5%). Bradai and Bouain (1990) found the following: all Crustacea (82.11%) (43.3% Macroura, 18.7%, Brachyura Isopoda 18.9%, Notopoda O.2%), fish 16.26% and other groups (Mollusca, Annelida, Echinodermata) (3.42%). These authors reported Decapoda Brachyura and Macroura as the preferred food of the species *Scorpaena porcus* followed by fish, Isopoda as secondary food and all the other recorded groups of prey as occasional food. This broadly agrees with our results.

Feeding behaviour of this species, like that of most of fish species, considerably oscillates during the year affected by physiological processes, particularly during reproduction. It was found that feeding intensity, expressed by the index of gut fullness (Jr) showed markedly lower values during spawning (the beginning of summer), whereas it was at almost the same level during the rest of the year, with slight intensity increase in postspawning period (autumn and winter). The same was reported by Bradai and Bouain (1990). Obtained values of gut vacuity coefficient (V) does not, however, follow this regular pattern, probably due to inadequate sampling method. *Scorpaena porcus* is a nocturnal species, the feeding activity of which begins during early evening hours and extends to the morning, whereas the light period of the day is the period of resting and complete digestion of the prey caught the preceding night (Šoljan and Karlovac, 1932). The specimens caught during early evening hours when trammels, by which most of analyzed material was caught, were set into the sea, could not fill up their stomach like the fish caught during the night or early morning when nets were dragged out. The departures from Jr and V values were probably due to this inappropriate sampling.

Feeding habits do not change qualitatively in function of seasons, but they change quantitatively, that is the percentages of individual prey groups are changed. These changes may be related to seasonal habitat changes, and therefore directly to the relative numbers of different food components in different seasons.

The differences in feeding behaviour as a function of predator size are quite obvious. Bigger predator specimens normally catch larger prey. It was recorded that medium and largest length classes feed more intensively than the smallest specimens, which was confirmed by Bradai and Bouain (1990) for the Bay de Gabes in Tunisia.

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Received : November 9, 1990

ISHRANA ŠKRPUNA (*SCORPAENA PORCUS* L. 1758)(PISCES, SCORPAENIDAE) U OBALNIM VODAMA JADRANSKOG MORA

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KRATKI SADRŽAJ

Analizirani su želučani sadržaji 298 primjeraka škrpuna (Scorpaena porcus) raspona totalnih dužina tijela (Lt) od 8,2-30,0 cm (Slika 2), sakupljenih duž istočne obale Jadrana tijekom mjeseca svibnja (proljeće), lipnja i srpnja (ljeto), rujna (jesen), prosinca i ožujka (zima) 1987-1991 godine. Uspoređujući dobivene vrijednosti triju hranidbenih indeksa (IRI, MFI, Q) koji na različite načine u sebi uključuju postotak frekvencije pojavljivanja (%F), postotak brojnosti (%N) i postotak težine (%W) pojedinih kategorija plijena, dobiveno je da su preferentna hrana ove vrste rakovi Decapoda Brachyura i ribe, sekundarna rakovi Decapoda Natantia i Anomura, a slučajna, odnosno dodatna, sve ostale pronadjene skupine (Tablica 1; Slika 3A). Od pojedinačnih vrsta najbrojniji su medju plijenom od brahiurnih rakova bili *Pilumnus hirtellus, Lissa chiragra, Ilia nucleus* i vrste roda *Xantho*, od riba vrste porodice Gobiidae, anomurnih rakova vrste roda *Galathea*, a natancija vrste porodica Alpheiidae i Palaemonidae.

Utvrđene su određene promjene u kvantitativnom sastavu hrane kod primjeraka različitih dužinskih klasa (Tablica 2, Slika 3B). Manji primjerci (<15,0 cm Lt) najčešće gutaju manje rakove (Natantia, Isopoda, Brachyura) ali i polihete i mekušce, dok veliki primjerci (19,5 cm Lt) uzimaju uglavnom velike rakove (Stomatopoda, Anomura, Brachyura) i ribe. Utvrđene su također promjene u prehrani i u različitim sezonama (Tablica 3, Slika 3C). U pogledu intenziteta ishrane dobiveno je da je on više-manje identičan tijekom cijele godine osim ljetnog perioda kad je znatno niži {to se može protumačiti odvijanjem reprodukcije u toj sezoni.