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Feeding Habits of Black Scorpionfish *Scorpaena porcus*, in the South-Eastern Black Sea

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Abstract

This study was carried out to describe the feeding habits of *Scorpaena porcus* and to investigate the effect of sex, size and season on their diet. Within the framework of this study, food preferences of 262 *Scorpaena porcus* (13±0.26 cm; 67±3.46 g) (±SE of means) which were taken from the stomach contents of fish caught at Trabzon coast (located at the South – Eastern Black Sea coast, between November 2003 and January 2004) were investigated. *Scorpaena porcus* fed mainly upon red mullet (*Mullus barbatus*) (IRI%=34.67) and mud shrimp (*Upogebia pusilla*) (IRI%=28.10), but also upon harbour crab, brown shrimp, sea horse, and others. It was found that there were significant differences between its dietary habits in summer and winter times (χ^2=38.10, P<0.01). *Scorpaena porcus*, fed mainly upon harbour crab (IRI%=63.43) in summer and red mullet (IRI%=57.46) in winter. As a result of statistical evaluation, red mullet, harbour crab and sea horse were found statistically significant in their seasonal diet (P<0.05).

Keywords: black scorpionfish, *Scorpaena porcus*, feeding habit, seasonal changes, Black Sea.

Introduction

The study of the feeding behaviour of marine fish is necessary for fish stock assessment and ecosystem modelling. Some major models and methods like methods of multi-species virtual population analysis (Sparre, 1991; Bulgakova *et al*., 2001) and the ECOPATH II ecosystem model (Christensen and Pauly, 1992) use the information on the dietary composition of fish. Information on the feeding habits of marine fish, such as the predatory-prey relationships is useful in order to assess the role of marine fish in the ecosystem (Bachok *et al*., 2004). Moreover, data on the diet composition are useful in the creation of trophic models as a tool to understand complex coastal ecosystems (Lopez-Peralta and Arcila, 2002). Diet analysis is also necessary to demonstrate the trophic overlap among species within a community. This parameter is essential in determining the intensity of the interspecific interactions in marine fish communities as well (Morte *et al*., 2001).

Scorpaenid fish are mainly distributed in the Eastern Atlantic: British Isles to the Azores, and the Canary Islands, including Morocco, the Mediterranean Sea and the Black Sea and *Scorpaena porcus* is a dangerous animal that is frequently found in the areas mentioned above (Hureau and Lituinenko, 1986). Members of this group of fish have venomous spines on their dorsal, ventral and anal fins. Each spine has a separate venom gland at the base. This is a shallow water species, which is believed to lie motionless during the day among rocks on the seabed and feed mainly at night. Scorpionfish feeds on small fish (gobies, blennies), crustaceans and other invertebrates and found common among rocks and algae (Hureau and Lituinenko, 1986).

The analysis of stomach contents of fish provides information about particular fish in the ecosystem. The stomach content of the organisms is a valuable source in order to obtain data about the animal and plant population in a certain area as well as to determine the population parameters of species that can not be determined by other methods (İbrahim *et al*., 2003).

There were no studies carried out in order to determine their feeding habits in the Black Sea coast until that time. Several researches carried out on the feeding habits of scorpaenid fish in the Mediterranean Sea. Harmelin-Vivien *et al*. (1989) studied food partitioning among scorpaenid fish in Mediterranean seagrass beds. Arculeo *et al*. (1993) studied food partitioning between *Serranus scriba* and *Scorpaena porcus* (Perciformes) on the infralittoral ground of the south Tyrrhenian Sea. Morte *et al*. (2001) studied diet of *Scorpaena porcus* and *Scorpaena notata* in the Western Mediterranean. La Mesa *et al*. (2007) studied feeding habits of the madeira rockfish, *Scorpaena maderensis*, from central Mediterranean Sea. Bradai and Bouain (1990) studied feeding pattern of *Scorpaena porcus* and *S. scrofa* from gulf of gabes.

The aim of the study was to examine the diet composition of *Scorpaena porcus*, to describe their feeding patterns and the effect of season, size and sex on their diet.

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Material and Methods

Scorpaena porcus were collected in November 2003 and February 2004 by using bottom trawls at Trabzon coast (South – Eastern Black Sea). Black scorpionfish were caught at depths (sandy bottom) ranging from 20 to 40 m. at 10:00-11:00 a.m. every month. Temperature of depths where samples were collected was recorded using CTD System (conductivity- temperature-depth). Temperature was found 9.0-15.4°C (summer), 8.7-8.8°C (winter). The fish samples were taken to the laboratory for stomach analysis. Total length (nearest 1mm) and fresh weight (nearest 0.001 g) of the individual sampled specimens were measured and their sex (only summer) were determined. Stomachs were fixed in formalin in plastic jars for subsequent analysis. Next, fish were gutted and cut open. Prey items in the stomachs were identified down to the most precise taxonomic level. The total number, wet weight and frequency of occurrence of each prey item in the stomach of the fish were recorded.

The percentage of empty stomach (vacuity index, V%) and stomach content weight were used to evaluate the feeding activity of fish. For diet analysis, the percentages of frequency of occurrence (O%), number (N%) and weight (W%) for each prey type were used to describe the diet of this species (Hyslop, 1980). The index of relative importance

$[IRI_i = (N\% + W\%) * O\%]$ and the

$$IRI\% \ (IRI_i\% = 100 * IRI_i / \sum_{i=1}^{n} IRIi)$$

were calculated for each prey category and used in diet comparisons (Pinkas *et al*., 1971; Cortes, 1997; Morato *et al*., 2003).

To asses changes in diet with size, black scorpionfish were divided into three size classes (6-12 (n= 143), 12-18 (n=101), 18-24 (n= 18) cm). The diet of black scorpionfish was also analyzed by sex and season.

Statistical differences in diet composition in relation to size, season and sex were assessed using χ^2 - test (Sokal and Rohlf, 1981). This was applied over the number of stomachs in which a prey occurs. Different prey items were pooled into six categories using contingency tables. These categories were: Red mullet, sea horse, mud shrimp, brown shrimp, harbour crab and others (*Bittium reticulatum*, hermit crab, shrimp larvae, algae and tissue unidentified). All graphs were developed by using Microsoft Excel 7.0® software.

Results

General diet Composition

Out of 262 stomachs of *S. porcus*, mean length 13±0.26 cm (±SE of means) (range 6.3-23.5 cm) and mean weight 67±3.46 g (range 5.6-257.2 g) examined, 86 were found to be empty (V% = 32.83). Ten prey species (two fish, six crustaceans, one mollusc and one algae) were identified in the stomach of *S. pocus*.

The red mullet (*Mullus barbatus* [IRI%=34.67]) was found as the main diet component of black scorpionfish and the mud shrimp, *Upogebia pusilla* [IRI%= 28.10] was identified as the most important crustacean decapod prey item. Other important crustaceans included harbour crab, *Liocarcinus depurator* [IRI%=27.32] and brown shrimp (*Crangon crangon* [IRI%=3.17]), seahorse *Hippocampus sp.* [IRI%=5.02] and others (*Ulva lactuca*, Shrimp larvae, *Isopoda*, Hermit crab, *Bittium reticulatum* and tissues unidentified [IRI%=1.72]) (Table 1).

Size-related Changes in the Diet

The diet of the small black scorpionfish (6-12 cm) was composed mainly of the red mullet, *Mullus barbatus* [IRI%=62.24]. Also for medium size black scorpionfish, (12-18 cm) the red mullet, *Mullus barbatus* [IRI%=16.76] was the dominant species. However, for the larger size black scorpionfish (18-24 cm size calss), sea horse, *Hippocampus* sp. [IRI%= 32.18] was found as the main prey species (Table 2).

A chi-square test based on the relationship between the size classes of scorpionfish and the change in the stomach contents, revealed significant differences among black scorpionfish size classes (χ^2= 42.96 P<0.01), red mullet (χ^2=31.06, P<0.05), mud shrimp (χ^2=12.29, P<0.05), brown shrimp (χ^2=14.00, P<0.05), harbour crab (χ^2=28.50, P<0.05) and sea horse (χ^2=11.47, P<0.05).

Table 1. N%, W%, O% and IRI% of the main prey categories for *Scorpaena porcus*

General	N	N%	W%	O%	IRI%
Fish					
Mullus barbatus ponticus	64	25.10	30.75	26.09	34.67
Hippocampus sp.	24	9.41	11.68	10.00	5.02
Crustaceans					
Upogebia pusilla	56	21.96	31.28	22.17	28.10
Liocarcinus depurator	67	26.27	18.47	25.65	27.32
Crangon crangon	22	8.24	7.09	8.70	3.17
Others*	23	9.02	0.73	7.39	1.72

* (*Ulva lactuca,* Shrimp larvae, *Isopoda,* Hermit crab, *Bittium reticulatum* and tissues unidentified)

Table 2. Main prey categories (IRI%) for *S. porcus* size classes (N: number of prey, n=number of fish)

Prey	N	6-12 cm (n=143)	N	12-18 cm (n=101)	N	18-24 cm (n=18)	χ^2	P
Mullus barbatus ponticus	36	62.24	21	16.76	7	15.42	31.06	P<0.05
Upogebia pusilla	18	10.07	30	42.75	8	22.65	12.29	P<0.05
Crangon crangon	7	1.48	15	8.14	0	0	14.00	P<0.05
Liocarcinus depurator	32	25.52	26	19.77	9	29.50	28.50	P<0.05
Hippocampus sp.	0	0	15	9.13	9	32.18	11.47	P<0.05
Others*	6	0.68	16	3.45	1	0.26		

* (*Ulva lactuca*, Shrimp larvae, *Isopoda*, Hermit crab, *Bittium reticulatum* and tissues unidentified)

Changes in Feeding Habits Depending on Season

Stomachs of *S. porcus* were found to be empty (V% = 28.33) in summer samples. It was found that the black scorpionfish fed on harbour crab most frequently in summer (IRI%=63.43), and on red mullet (IRI%=57.46) in winter. Since there were significant differences between summer and winter (χ^2=38.10, P<0.001) it was concluded that the red mullet (χ^2= 31.23, P<0.05), harbour crab (χ^2=5.39, P<0.05) and sea horse (χ^2=13.76, P<0.05) were statistically significant in seasonally diet. Significant differences in summer were detected (χ^2=24.32, P<0.01), (Figure 1, Table 3).

The small size black scorpionfish feed mainly on the harbor crab [IRI%=82.23]) in summer. For the medium size black scorpionfish, mud shrimp (*Upogebia pusilla* [IRI%=58.53]) was the dominant species. It was found that the harbour crab (*Liocarcinus depurator* [IRI%=65.39]) became the main prey species in summer for larger size black scorpionfish. As for winter, it was found that the small and medium size black scorpionfish fed mainly on red mullet ([IRI%=71.41], [IRI%=41.34]) while the large size black scorpionfish fed mainly on sea horse [IRI%= 63.17] in winter.

Changes/ Preferences in Diet Depending on Sex

Differences (P<0.01) in dietary preferences were observed between male and female black scorpionfish in summer. The main diet components of black scorpionfish (both sexes) in summer were mud shrimp and harbour carb. However, female preference was mostly mud shrimp (IRI%=57.65), and male preference was mud shrimp (*Upogebia pusilla* [IRI%=33.06]) and harbour crab (IRI %=32.31).

Discussion

There were no studies carried out in order to determine their feeding habits of scorpionfish (*Scorpaena porcus*) in the Black Sea coast until that time. Several studies were performed on the feeding habits of scorpaenid fish in the Mediterranean Sea (Harmelin-Vivien *et al*., 1989; Pallaoro and Jardas, 1991; Morte *et al*., 2001; La Mesa *et al*., 2007). Among coastal species, *Scorpaena porcus*, *S. notata* and *S. scrofa* are described as macrophagic carnivores, due to the large size of preferred prey compared to their body (La Mesa *et al*., 2007). All of them are ambush predators, which have developed a hunting technique typically based on capture of moving prey, such as crustaceans and teleosts size (Harmelin-Vivien *et al*., 1989; Morte *et al*., 2001)

Pallaoro and Jardas (1991) demonstrated that *Scorpaena porcus* (n=298) fed mainly on Crustacean such as decapods, brachyuran and fish rocky and rocky-sandy, overgrown by algea and marine phanerogams between 1 and 30 m along the Adriatic coast. Feeding habits of *Scorpaena pocus* have been studied also in the Western Mediterranean Sea. Crustacea Decapoda constituted the preferential prey of both fish species, whereas Amphipoda were found as the secondary prey. In Spanish Mediterranean waters, at the Tyrrhenian Sea *Scorpaena porcus* appears to feed mainly on decapods. Similar results have been reported for other Mediterranean areas. However, the stomach contents of black scorpionfish from French and Tunisian Mediterranean waters and Adriatic coast more frequently revealed the existence of teleost (Morte *et al*., 2001). Taking this data into account, it could be concluded that *S. porcus* and *S. notata* diet also changes according to the abundance of different prey in the environment, provided that these prey are within the selected size range and similar ecological characteristics (Morte *et al*., 2001).

Feeding regime of *S. maderensis* has been very poorly investigated notwithstanding it is common in many areas of the Mediterranean basin. A recent study described decapods (mostly brachyarans) as preferred prey of *S. maderensis*, whereas fish and other crustaceans, such as amphipods are eaten occasionally (La Mesa *et al*., 2007). The number of prey taxa recorded in *S. porcus* in the present study. These categories were: Red mullet, sea horse, mud shrimp, brown shrimp, harbour crab and others (*Bittium reticulatum*, hermit crab, shrimp larvae, algae and tissue unidentified). The red mullet (*Mullus barbatus*) was found as the main diet component of black scorpionfish and the mud shrimp, *Upogebia pusilla* was identified as the most important crustacean decapod prey item in this study.

It was found that the diet of *Scorpaena porcus*

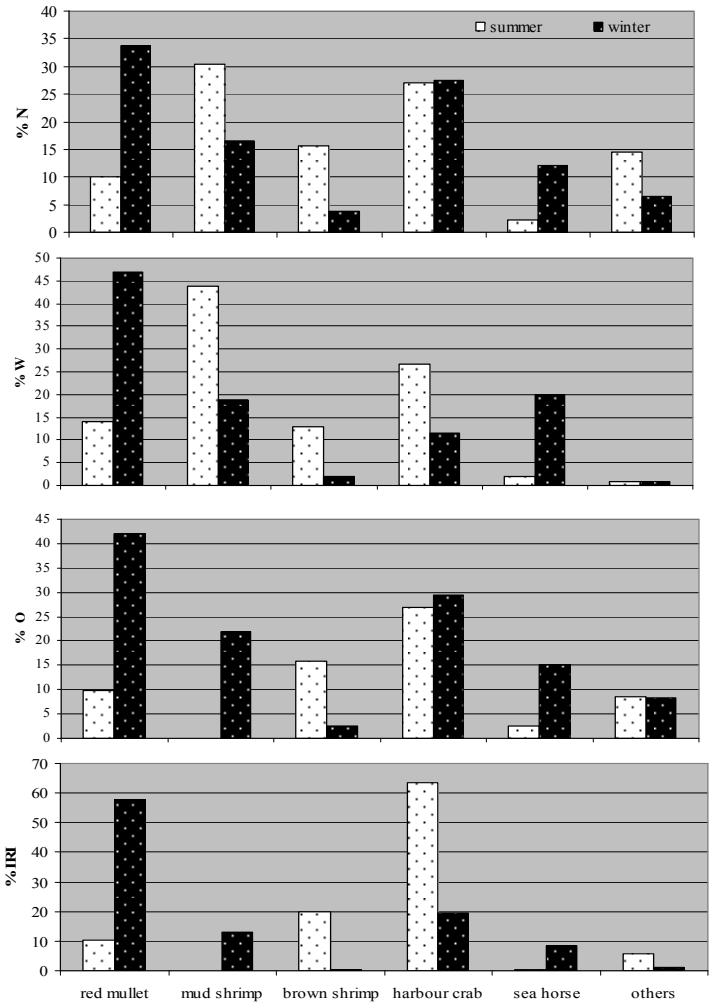

Figure 1. N%, W%, O%, IRI% of the main prey catogories for *S. Porcus.*

Table 3. Main prey categories (IRI%) for *S. porcus* size classes, general, in summer and winter and female (F), male (M) in summer

Prey	Length (cm)									
	6-12		12-18		18-24		Season		Sex (summer)	
	summer	winter	summer	winter	summer	winter	summer	winter	F	M
Red mullet	3.59	71.41	2.46	41.34	21.06	3.25	10.41	57.46	7.04	4.12
Mud shrimp	10.35	10.17	58.53	6.92	13.55	27.36	0.00	13.11	57.65	33.06
Brown shrimp	2.38	1.24	19.95	0	0	0	19.94	0.49	2.75	26.00
Harbour crab	82.23	16.62	14.08	22.34	65.39	5.34	63.43	20.01	29.72	32.31
Sea horse	0	0	0.45	29.00	0	63.17	0.45	8.21	0	1.36
Others*	1.45	0.56	4.53	0.40	0	0.88	5.77	0.72	2.84	3.15
Stomachs (n)	143		101		18		262		35	47

* (*Ulva lactuca,* Shrimp larvae, *Isopoda,* Hermit crab, *Bittium reticulatum* and tissues unidentified)

changed depending on size classes. The small and large sized black scorpionfish in this study fed mainly on harbour crab whereas the medium size black scorpionfish fed mainly on mud shrimp in summer. It has been found that in winter both small and medium size black scorpionfish fed mainly on red mullet while the larger size ones fed upon sea horse. Similar results were reported by other studies (Harmelin-Vivien *et al*., 1989; Bradai and Bouain, 1990; Arculeo *et al*., 1993; Morte *et al*., 2001). This change was due to the decrease of frequency of occurrence of amphipods and other crustaceans with increasing predator size, whereas the frequency of occurrence of reptantia, brachyra and other group increased. A positive correlation between the individual size of predator and of prey ingested has been frequently observed in different species of scorpaenids. *Scorpean. porcus* and *Scorpaena notata,* amphipods and isopods were

almost exclusively consumed by the small sized fish, whereas decapods (brachyuran and carids) were the most abundant prey of larger individuals (Harmelin-Vivien *et al*., 1989; Bradai and Bouain, 1990; Arculeo *et al*., 1993; Morte *et al*., 2001).

Feeding habit of *Scorpaena porcus* changed seasonally in this research. It was found that the black scorpionfish fed on harbour crab most frequently in summer and on red mullet in winter. The main diet components of black scorpionfish (both sexes) in summer were mud shrimp and harbour crab. However, females' preference was mostly mud shrimp and male preference was mud shrimp. Seasonal variation of the diet seems to be associated with the availability of the prey, whose distribution and abundance are related to the dynamics of the water masses of region (Muto *et al.*, 2001). In other scorpaenids, the feeding intensity followed roughly a seasonal trend (La Mesa *et al*., 2007). Several studies revealed that the highest percentage of empty stomachs occurs during reproduction, owing to a significant decrease in food intake in such a period for scorpaenids (Morte *et al*., 2001). Similar result were found in this study. Stomachs of *S. porcus* were found to be empty (V% = 28.33) in summer samples.

In the end of the study, it was found that the feeding habits changed seasonally according to two variables, namely, fish size and sex. This research is important for further studies as to create a reference point to make any possible comparison.

The study of natural diets of fish species is very useful approach for understanding aspect of the species biology and ecology, towards a more sustainable management of their stocks and the development of conservation measures (La Mesa *et al*., 2007; Kitsos *et al*., 2008).

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