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Feeding ecology of black scorpionfish (*Scorpaena porcus* Linnaeus, 1758) from the Romanian Black Sea (Agigea – Eforie Nord area)

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Abstract. The present study investigates the variations in the feeding ecology of the black scorpionfish (*Scorpaena porcus*). The index of relative importance indicated opportunistic feeding on macrobenthic fauna. The fish fed mainly on bivalves, fishes, amphipods and isopods. There were differences in diet composition during the years, seasons and sexes. *Scorpaena porcus* exhibited a generalistic feeding strategy with a relative broad niche width.
Key words: black scorpionfish, feeding ecology, benthos, Black Sea.

Résumé. Le régime alimentaire de *Scorpaena porcus* et ces variations ont été étudié dans le secteur Agigea-Eforie Nord de la Mer Noire. Le index de importance relative a indiquée une spectre généraliste de alimentation. Cette espèce se nourrit principalement de poissons, amphipodes et isopodes. Des variations dans le régime alimentaire ont été observées et sont liées au les années d'etude, saisons et au sexe des individus. *Scorpaena porcus* a presenté une large niche trophique.
Mots clés: rascasse brune, ecologie alimentaire, benthos, Mer Noire.

Introduction. Studies of feeding habits and diet are the key to understanding many aspects of the biology, ecology, physiology and behaviour of fish (Rosecchi & Nouazi 1987; Goncalves & Erzini 1998). Given the inherent difficulties of *in situ* observation of feeding habits of particular species, the analyses of stomach contents has become the most widely used method for studying the diet of fish. Fishes have the potential for integrating different aspects of their habitat(s) at spatial/or temporal scales because of their mobility and longevity. Thus, fish diet reflects the available prey and a fish can be considered a sampling tool whereby the stomach content represents a sample of the prey items available in the aquatic environment (Wootton 1990).

Feeding ecology research is a fundamental tool for understanding fish roles within their ecosystems since they indicate relationships based on feeding resources and indirectly indicate community energy flux (Hajisamaea et al 2003) which allows inferring competition and predation effects on community structure. In general habitat and diet are the most important niche dimensions separating coexisting fish species (Ross 1986); both high and low overlap in these dimensions could be indicative of competition (Hansson 1995; Raborn et al 2004).

Material and Method. The present study was carried out in the Agigea-Eforie Nord area of the Black Sea. Fish were sampled with a trap net placed at a depth of 9 m (Agigea) and 12 m (Eforie Nord) during the seasons of 2008 and 2009. There were sampled 133 individuals of *Scorpaena porcus*. In the laboratory the sampled fishes were identified, counted, measured and weighed. Sex was determined from external examination and confirmed by

gonadal examination. For dietary analysis fishes were dissected and the gastrointestinal tracks were drawn out and imediately preserved in absolute ethyl alcohol in order to prevent tissues damages. Then the gastrointestinal tracks were longitudinally sectioned, the gastrointestinal content of each individual was weighted using the analytical balance and the prey items were identified to the lowest taxonomic level possible using the stereomicroscope. A high level of prey identification (LPI) was reached for most of the items (up to family); niche breadth value could be influenced by such LPI. The use of LPI could underestimate species dietary breadth in the same way those values of dietary overlap could have been overestimated by the LPI (Hansson 1998).

The dietary components were wet-weighed and preserved in 70% ethyl alcohol. The empty gastrointestinal tracks were also counted. In order to determine the importance of each food category to the diet of the black scorpionfish weight percent (%*W*), frequency of occurence (%*F*), number percent (%N) (Hyslop 1980) were calculated. Frequency of occurrence: $F = (f_x/f)*100$, where f_x = number of fish with component *x* in food; *f* = number of all studied fish. Weight contribution: $W = (w_x/w)* 100$, where w_x = weight of component *x* of the food; *w* = total food weight. Number percent: $N = (n_x/n)*100$, where $n_{x=}$ number of the individuals of the prey x in food; n= total number of analyzed fishes. An index of relative importance (IRI) for all prey items was calculated with the formula: IRI = (%N+%V)*%F (Pinkas et al 1971, Cortés 1997). The IRI of each food item was standardized to %IRI: %IRI = (IRI/ΣIRI)*100. The prey items were separated in three categories: main prey (%IRI>50%), accessory prey (25%<%IRI>50%) and infrequently prey (%IRI<25%) (Rosecchi & Nouaze 1987).

Levins index was calculated for niche breadth: $B = 1/\Sigma p_i^2$, where *B* = Levins measure for niche breadth; p_i = proportion of individuals that use the resource *i* or the proportion of diet of each individual composed of *i*) and then standardized on a scale from 0 to 1 using Hulbert index: $B_A = (B-1)/(n-1)$, where B_A= Levins standardized index, *B* = Levins index for niche breadth and *n* = number of possible resources (Gomoiu & Skolka 2001).

Results and Discussion. *Scorpaena porcus* Linnaeus, 1758 is a sedentary and solitary species inhabiting littoral waters amongst rocks and seaweeds. It is common in the Mediterranean Sea, the eastern Atlantic from the British Isles to the Canary Islands, Black Sea, Mediterranean Sea (Ben-Tuvia 1990) and Sea of Azov (Quéro et al 1990). It is found all along the Black Sea romanian shore (Oţel 2007). Presents a large head, armed with numerous spines and crests and strong venomous spines in the anterior portion of the dorsal fin (Bănărescu 1964). It doesn't have an economical importance. IUCN Red List Status: not evaluated (IUCN 2010) Threat to humans: traumatogenic.

The individuals had between 13.4 and 14.5 cm in length and between 45 and 53g in weight. All the individuals had the same age (1+ year old) and all of them were female maybe because the females where approaching the littoral in order to reproduce, especially during the summer. This specie reproduces during the summer near the shore (Bănărescu 1964).

There are only a few studies related to the feeding ecology of the black scorionfish of the Black Sea. Several studies were made in the Mediterranean Sea. *Scorpaena porcus* is considered to be an oportunistic predator. Harmelin-Vivien et al (1989) studied food spectrum of the scorpaenids of the Mediterranean Sea (Stergoiu & Karpouzi 2002). Arculeo et al (1993) studied food partitioning between *Serranus scriba* and *Scorpaena porcus* on the south of Tyrrenian Sea (Stergoiu & Karpouzi 2002). The fishes feed on a large spectrum of prey items like: fishes, decapods, amphipods, gastropods (Bănărescu 1964; Stergiou & Karpouzi 2002; Bascinar & Saglam 2009; Demirhan & Can 2009) (Table 1).

Table 1

Diet of *Scorpaena porcus* according to scientific literature

Food items	Area	Year	Reference
Fish, decapodes	Black Sea		Bănărescu 1964
Brachyurans (*Xantho* sp., *Portunus* sp.), decapods, fish	Cyclades Islands		Kyrtatos 1982
Fish, appendicularians, copepods, other	G.Lions	1981	Khoury 1984
Fish, brachiurans, decapods, other	G.Gabes		Bradai & Bouain 1990
Brachyurnas, fish, decapods, other	G.Lions	1980-1986	Harmelin-Vivien et al 1989
Fish, crustaceans, other	G.Mareseille	1980	Bell & Harmelin-Vivien 1983
Brachyurans, fish, decapods, other	G.Palermo	1981-1983	Arculeo et al 1993
Brachyurans, fish, decapods, stomatopods, other	Adriatic Sea	1987-1991	Pallaoro & Jardas 1990
Decapods, crustaceans, brachyurans	G S Evvoikos	1992-1993	Petrakis et al 1993
Fish, crustaceans, molluscs, algae	Black Sea	2003-2004	Bascinar & Saglam 2009
Crustacea, fish, Gastropoda	*Black Sea*	*2002-2003*	Demirhan & Can 2009

Table 2

Seasonal variations of *Scorpaena porcus* trophic spectrum during 2008

2008		Spring				Summer				Autumn			
Food items	**Species**	**%W**	**%F**	**%N**	**%IRI**	**%W**	**%F**	**%N**	**%IRI**	**%W**	**%F**	**%N**	**%IRI**
Bivalves	*Mytilus* sp.	11.31	47.05	82.35	35.53	41.23	94.73	89.47	73.44	33.45	95.45	90.9	67.01
	Mytilaster sp.	5.12	23.52	47	9.88	0	0	0	0	0	0	0	0
	sp.	2.23	11.76	11.7	1.32	0	0	0	0	0	0	0	0
Gastropods	sp.	1.11	5.88	17.64	0.88	0	0	0	0	0	0	0	0
Amphipods	sp.	31.45	41.17	64.7	31.92	0	0	0	0	0	0	0	0
Isopods	*Idotea* sp.	20.78	29.41	23.52	10.5	0	0	0	0	0	0	0	0
Decapodes	*Xantho* sp.	25.67	11.76	11.76	3.54	32.45	26.31	42.1	11.63	35.67	40.9	18.1	12.41
	sp.	2.34	5.88	5.88	0.38	0	0	0	0	3.78	13.63	13.6	1.33
Fishes	sp.	2.22	23.52	29.41	5.99	16.22	47.36	36.8	14.92	35.1	36.36	31.8	13.73
Algae	sp.	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified fragments		0	0	0	0	10	0	0	0	2	22.72	40.9	5.5
Nsa		19				21				23			
Nsp		17				19				22			

N- number percent; F- frequency of occurance; W- weight percent; IRI- Index of relative importance; nsa– number of gastrointestinal tracks analyzed; nsp– number of gastrointestinal tracks analyzed which contained prey items.

From all the 133 of gastrointestinal tracks sampled 13.53% of the gastrointestinal tracks were empty. The gastrointestinal content of the fishes was represented by: bivalves (*Mytilus galloprovincialis*, *Mytilaster lineatus*), gastropods (*Setia valvatoides*, *Bittium* sp.), amphipods, isopods (*Idotea balthica*), decapods (*Xantho poressa*), fishes (*Mullus barbatus*

ponticus, gobiids), algae and there were also some identified fragments due to the advanced degradation level.

All the individuals of *Scorpaena porcus* were one year old and it seems that for this age their favourite type of prey it was *Mytilus galloprovincialis* (%IRI = 39.24); all the other prey categories from the fish diet may be considered as infrequently prey.

Table 3

Seasonal variations of *Scorpaena porcus* trophic spectrum during 2009

2009		Spring				Summer				Autumn			
Spectru trofic	**Specii**	**%W**	**%F**	**%N**	**%IRI**	**%W**	**%F**	**%N**	**%IRI**	**%W**	**%F**	**%N**	**%IRI**
Bivalves	*Mytilus* sp.	8.4	26.31	21.05	5,39	15	40	45	25.03	12.84	38.88	44.4	12.6
	Mytilaster sp.	4.5	15.78	21.05	2.8	0	0	0	0	6.92	44.44	50	14.33
	sp.	1.56	5.26	10.52	0.44	0	0	0	0	6.92	27.77	44.4	8.07
Gastropods	sp.	0.45	21.06	31.57	4.69	8.81	15	25	5.29	2.32	38.88	27.7	6.61
Amphipods	sp.	22.45	47.36	94.73	38.64	0	0	0	0	0	0	0	0
Isopods	*Idotea* sp.	18.21	63.15	36.84	24.2	17.42	40	25	7.26	5.72	44.44	61.1	16.82
Decapodes	*Xantho* sp.	15.12	10.52	15.78	2.26	0	0	0	0	0	0	0	0
	sp.	0	0	0	0	34.2	40	35	28.87	35.4	66.66	38.8	28.02
Fishes	sp.	22.1	15.78	21.05	4.74	30.35	40	50	33.52	26	44.44	27.7	13.52
Algae	sp.	1	21.05	26.31	4	0	0	0	0	0	0	0	0
Unidentified fragments			36.84	42.1	12.79	0	0	0	0	0	0	0	0
Nsa		22				25				23			
Nsp		19				20				18			

N- number percent; F- frequency of occurance; W- weight percent; IRI- Index of relative importance; nsa– number of gastrointestinal tracks analyzed; nsp– number of gastrointestinal tracks analyzed which contained prey items.

Mytilus galloprovincialis represents the main prey category for *Scorpaena porcus* during the summer and autumn of 2008 (%IRI > 65) (Table 2) and it is an accesory prey during the spring of the same year (%IRI = 35.53). Also during the spring an accesory prey is represented by amphipods (%IRI = 31.92). These amphipods are missing from the fish diet during the other two seasons. It can be noticed also the absence during the summer and autumn of other prey items as gastropods and *Mytilaster lineatus*.

Scorpaena porcus feed mostly on amphipods during the spring of 2009 (%IRI = 38.64), but didn't feed on the same prey during the next two seasons (Table 3). During the summer the accessory prey categories were represented mostly by fish (%IRI = 33.52) and decapods (%IRI = 28). Decapods represented also an accessory prey during the autumn of the same year (%IRI = 28).

In 2008, during the summer season the black scorpionfish feed mostly on *Mytilus galloprovincialis* (%IRI = 73.44) which was by far the main category of prey (Table 2). The same species become an accessory prey for the summer of 2009 (%IRI = 25.03) (Table 3). It can be observed that fishes represented an infrequently prey for the summer of 2008

(%IRI = 14.92) and an accessory prey for the next summer (%IRI = 33.52). Also during the same season black scorpionfish didn't feed on *Xantho poressa* in 2009 and on decapods and gastropods in 2008.

Table 4

Food spectrum of *Scorpaena porcus* during the reproductive season (in summer)

Reproductive season		**Summer**							
		Females				**Males**			
Food items	**Species**	**%W**	**%F**	**%N**	**%IRI**	**%W**	**%F**	**%N**	**%IRI**
Bivalves	*Mytilus* sp.	19.37	83.3	88.88	32.01	41.23	90.9	81.81	69.8
	Mytilaster sp.	3.75	55.5	61.1	12.77	0	0	0	0
	sp.	1.78	27.7	11.1	1.26	0	0	0	0
Gastropods	sp.	2.11	50	33.3	6.28	0	0	0	0
Amphipods	sp.	7.98	66.6	27.7	8.43	0	0	0	0
Isopods	*Idotea* sp.	11.35	50	27.7	0.06	0	0	0	0
Decapodes	*Xantho* sp.	14.15	33.33	33.3	5.61	31.45	15	31.81	5.92
	sp.	12.62	16.66	38.8	3.04	0	0	0	0
Fishes	sp.	22.01	74.4	44.4	17.54	17.32	50	22.72	12.49
Alge	sp.	0.16	33.3	33.3	3.95	0	0	0	0
Unidentified fragments		5.08	27.7	16.6	2.13	10.1	45	31.81	11.7
nsa		23				22			
nsp		18				22			

N- number percent, F- frequency of occurance, W- weight percent, IRI- Index of relative importance, nsa – number of gastrointestinal tracks analyzed, nsp – number of gastrointestinal tracks analyzed which contained prey items.

Scorpaena porcus feed mosty on *Mytilus galloprovincialis* during the autumn of 2008 (%IRI = 67.01), but this prey become accessory in 2009 (%IRI = 12.6). Decapods were an infrequently prey in 2008 (%IRI = 1.33) but they become an accesory prey during the next autumn (%IRI = 28.02).

The reproductive season of the black scorpionfish is during the summer (Bănărescu 1964). There were found 21.74% of empty stomachs for females. During this period the females feed on all prey categories, but males seemed to preffer as the main category of prey *Mytilus galloprovincialis* (%IRI = 69.8) (see Table 4).

Table 5

Niche breadth of *Scorpaena porcus* during the seasons of 2008 and 2009

	2008			**2009**		
Species	**Spring**	**Summer**	**Autumn**	**Spring**	**Summer**	**Autumn**
Scorpaena porcus	0.509	0.693	0.668	0.673	0.51	0.286

* the marked values proves a specialization of the black scorpionfish.

Prey availability is the main factor for *Scorpaena porcus* feeding strategy in the Black Sea. Availability of prey affects the diet composition and values of the diet breadth (Table 5). A small value (<0.5) for the niche breadth shows a specialization of the species for a small number of prey items. Niche breadth values vary between seasons and years of sampling between B = 0.286 during the autumn of 2009 and B= 0.693 during the summer of 2008.

We can relate the food spectrum with the biology and the number of prey items offered by the rocky mussel beds of the sea. Also *Scorpaena porcus* diet changes according to the abundance of different preys whose distribution is related to the dynamics of the water masses. As other studies revealed (Demirhan & Can 2009) the number of prey species identified in the gastrointestinal tracks of black scorpionfish was smaller than the number of prey items consumed by the same species in other seas as Mediterranean (Harmelin-Vivien et al 1989, in Stergiou & Karpouzi 2002). This reduced number of prey items seems to be related to the fact that the biodiversity of the Black Sea is smaller than the Mediterranean one (Zaitsev et al 2002).

Conclusions. The gastrointestinal content of the blackscorpionfish was represented by: bivalves, gastropods, amphipods, isopods, decapods, fishes and algae. Feeding habits of the black scorionfish changed seasonally and annualy. Food spectrum varies between males and females during the reproductive season. *Scorpaena porcus* exhibited a generalistic feeding strategy with a relative broad niche width.

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