Food Array Analysis in Turbot *Psetta maeotica* (Pallas, 1811) at the Romanian Black Sea Coast in 2013 *(Aurelia Totoiu, George Tiganov, Madalina Galatchi, Magda Nenciu)*	"Cercetari Marine" Issue no. 44 Pages 164-172	2014

FOOD ARRAY ANALYSIS IN TURBOT *Psetta maeotica* (Pallas, 1811) AT THE ROMANIAN BLACK SEA COAST IN 2013

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ABSTRACT

This paper shows the results of research made on the food array of the stomach content of turbot (*Psetta maeotica*) in Romanian Black Sea waters. The investigations were made during 2013, in fish caught on the Romanian continental shelf.

The main identified component in the analyzed turbot's diet is fish, the most common species found in the stomach content being: anchovy, gobies, sprat, whiting, but also crustaceans and mollusks.

KEY-WORDS: turbot, Black Sea, prey items, feeding coefficient, Index of Relative Importance - IRI, frequencies of occurrence

AIMS AND BACKGROUND

Psetta maeotica (Pallas, 1811) (turbot) is a marine benthic species, typical for soft bottoms; fingerlings are often encountered close to the shore, on sandy bottom and, as they grow, they move to greater depths (Iliescu et al., 1968, Pogarneata, 1959).

Adults are found in winter at depths beyond 60-70 m, in the faseolinoid facies area, and in spring and summer migrate to shallower waters for breeding and feeding. The pelagic turbot larvae feed on nano- and microplankton, juveniles feed on crabs and mollusks, polychaets, shrimps and fish fingerlings, and, starting with the 4^{th} and 5^{th} years of life, fish become the main food of turbots (Radu G. et al., 2008).

The knowledge of the food items included in wild turbot's diet is important for ecological research. The study of the food array is an integration of several significant ecological components: habitat use, energy input use, as well as interaction between existing species (Radu E., et al., 2002).

MATERIAL AND METHOD

The biological material used for analysis was obtained by survey trawling during the research surveys in the Romanian marine area, in 2013, within the National Fisheries Data Collection Program - the National Agency for Fisheries and Aquaculture (NAFA).

In order to determine stomach content of turbot, the stomach of the fresh fish was removed by dissection with scissors and cutting the digestive tube in its extremities. At one end a note was inserted, whose number indicated the meristic features of the fish. The digestive tubes thus collected and tagged were tied at both ends with thread and inserted in formaldehyde solution (4% solution) (FAO, 1974) (Fig.1).

Fig. 1. Turbot stomach collection (original photo)

The study of the food array was performed by analyzing the gastro-intestinal content and determining as accurately as possible the type of food contained in the stomach, followed by determining the species or groups of species.

Two methods were used, namely the qualitative and quantitative methods. The qualitative analysis consisted in the full identification of the food components found in the fish’s stomach. The quantitative method consisted in numerical analysis (frequency of occurrence, dominance) and gravimetrical analysis (feeding coefficient, Index of Relative Importance - IRI).

The **frequencies of occurrence (FO%)**, as numerical percentages of prey items, were calculated to characterize the stomach contents (Hyslop, 1980, Hansson, 1998). The frequency of occurrence calculates the percentage of the total number of stomachs in which the specific prey species occurs:

$$FO\% = FO_i / FO_t \times 100$$

where FO_i is the number of stomachs in which the species ”I” occurs, and FO_t is the total number of full stomachs.

The **dominance** was calculated as the proportion of stomachs dominated by a certain prey type and expressed as a percentage of the total number of stomachs.

The **feeding coefficient** results from multiplying the weight of the stomach content by 10,000 and dividing the result to the full body weight of the fish (Porumb, 1961).

The **Index of Relative Importance (IRI)** is an integration of measurements of number, volume and frequency of occurrence to assist in evaluating the relationship of the various food items found in the stomach. It is calculated by summing the numerical and volumetric percentage values and multiplying with frequency of occurrence percentage value (Pinkas et al., 1971, Ahlbeck et al., 2012):

$$IRI_i = (\%N_i + \%V_i) * \%FO_i$$

where, N_i, V_i and FO_i represent percentages of number, volume and frequency of occurrence of prey **i**, respectively.

To estimate the importance of diet comparisons among species, IRI was standardized to % IRI (Cortés, 1997).

RESULTS AND DISCUSSION

Research on fish stomach content have always been an important concern in fishery biology. There is a strong correlation between the marine environment overall and fish, which are a significant link in the food chain.

Prey items identified in the stomach content very much depend on the period when the analyzed individuals were collected, on the biodiversity occurring in the respective habitat, on the health state of the fish. There is a very tight connection between the food chain components, depth, temperature, salinity.

For stomach content determination in 2013, 15 turbot individuals were analyzed. The fish were collected during the trawling surveys within the national fisheries data collection program (Fig. 2).

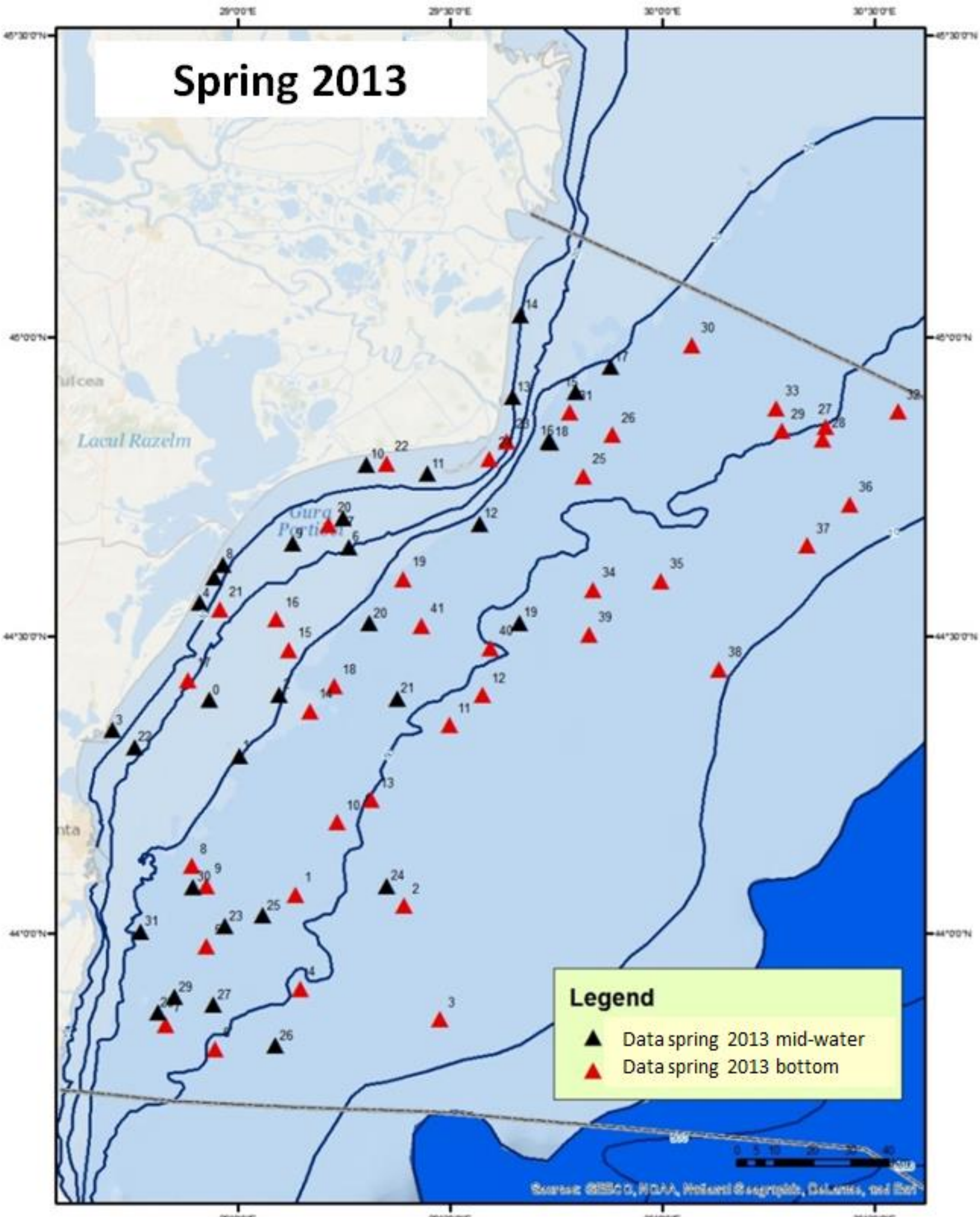

Fig. 2. Turbot sample collecting sites

In the Black Sea ecosystem, fish are the main consumers and the analysis of the prey items in the stomach can help assessing the ecosystem status from the ecological point of view.

The turbot individuals analyzed were collected in May 2013, during the breeding period (when feeding becomes less intensive).

Table 1 comprises the data for each analyzed individual and the food components found in each turbot stomach.

Table 1. Food array analysis of turbot

N.	Station	Depth (m)	Length (cm)	Total fish weight (g)	Stomach weight (g)	Food array analyzed
1.	Haul 1	50	44/35/38	1360	16.2	- fish (anchovy) - 2.0 g
2.	Haul 1	50	65/50/57	4460	129.1	- fish (anchovy) - 3.0 g
3.	Haul 1	38	43/34/46	1380	13.7	- fish (anchovy) - 0.4 g - Semidigested decapods - 0.3 g - Semidigested bivalves - 0.2 g
4.	Haul 2	39.6	43/33/38	1390	31.8	- Fish (goby) - 4.3 g - Semidigested fish - 0.3 g
5.	Haul 3	47.3	35/28/35	1020	91.0	- Fish (anchovy) - 3.5 g - Semidigested fish - 2.4 g
6.	Haul 3	47.3	51/42,5/45	2890	111.9	- Fish (goby) - 58.8 g - Semidigested fish - 4.4g
7.	Haul a 6	53	43/35/46	1430	47.6	- Fish (anchovy) - 4.4 g
8.	Haul 11	50	36/27/30	1750	93.2	- *No food*
9.	Haul 11	50	55/45/48	2900	85.3	- Fish (whiting) - 10.5 g - Semidigested fish - 0.7 g
10.	Haul 12	45.5	51/40/43	2100	60.3	- *No food*
11.	Haul 22		20/15/16	540	4.6	- Semidigested fish - 2.0 g
12.	Haul 22		48/36/38	1540	38.4	- Fish (goby) - 17.2 g - Semidigested bivalves - 0.4 g - Semidigested fish – 0.2g
13.	Haul 31	49	39/30/32	1040	35.6	- *No food*
14.	Haul 31	49	39/30/31	1870	58.0	- Fish (whiting) - 25.5 g - Semidigested decapods - 0.7 g - Semidigested fish - 0.9 g
15.	Haul 31	49	50/38/41	1900	47.8	- Fish (whiting) - 15.5 g - Semidigested decapods - 0.2 g - Semidigested fish - 0.3 g

As a follow-up of analyzing the food array of turbot described in Table 1, in some stomachs undigested (whole) fish individuals were found, which could be easily identified (Fig. 3). Semidigested fish was recorded in almost all analyzed samples. Semidigested decapods and mollusks were also determined in small amounts.

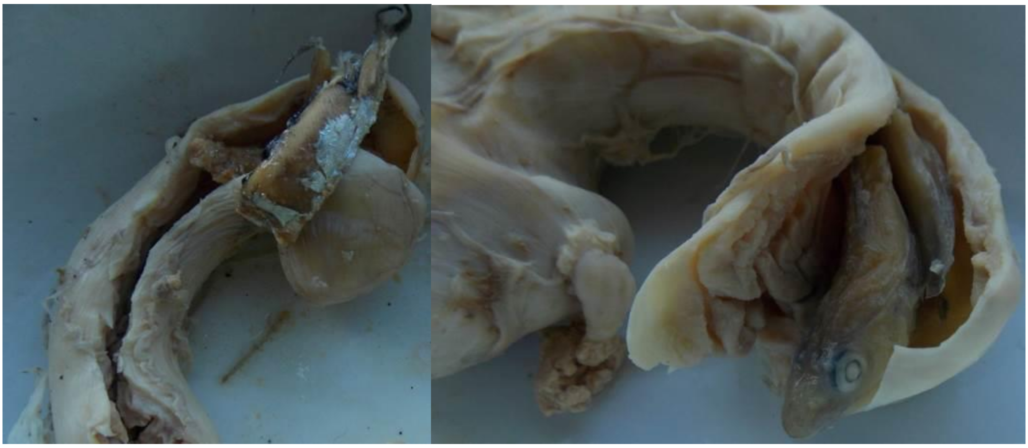

Fig. 3. Fish species determined in the analyzed stomach content (original photos)

In 10 of the 15 analyzed turbot stomachs, the flat worm *Bothriocephalus scorpii* (Muller, 1779) and nematode worms were identified. Whenever the number of parasites is so large that they fill the entire digestive duct of fish, as reported in almost all analyzed fish, severe nutritional disturbances occur, along bleeding lesions of the intestine wall, intoxication and sometimes death of the fish. Actually, this parasite was reported in almost 35-50% of the analyzed turbot individuals from the Romanian Black Sea coast (Maximov, 2012) (Fig. 4).

Fig. 4. Occurrence of the flat worm *Bothriocephalus scorpii* and nematodes in turbot stomachs (original photos)

The most important food item determined in turbot stomachs was fish. Three fish species were identified, the dominant fish being whiting (*Merlangius merlangus euxinus* Nordmann, 1840), with 50.66% of the total food weight, followed by Gobiidae, with a share of 34.49%, and anchovy (*Engraulis encrasicoulus* Linnaeus, 1758), with 8.39%. Semidigested bivalves and decapods were identified in very small shares (Fig. 5)

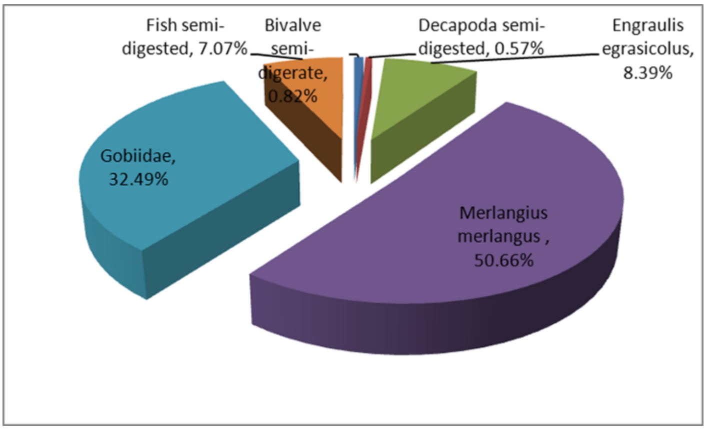

Fig. 5. The dominant food items in the stomachs of analyzed turbot

The feeding coefficient ranged between 0% and 218.68%. This coefficient varied in relation to fish length and weight, as well as the feeding conditions of the living environment of the respective fish.

Three of the 15 analyzed stomachs were completely lacking food, as the flat worm *Bothriocephalus scorpii* was present in extremely high effectives.

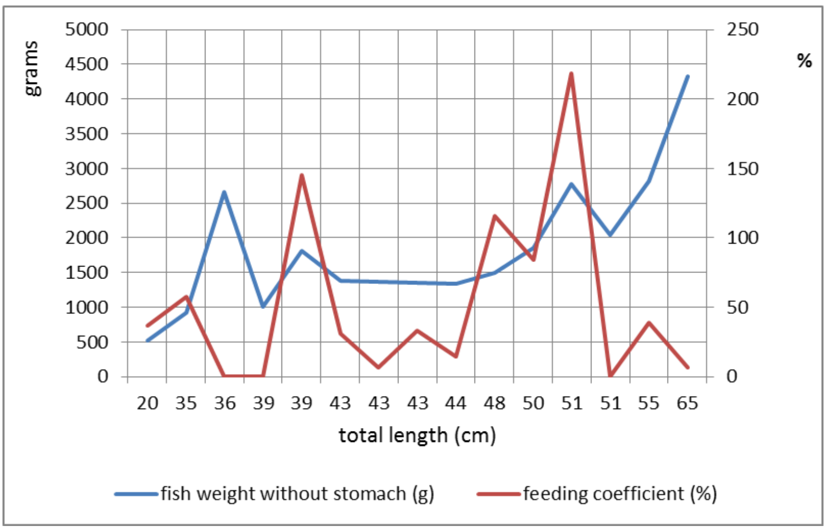

Fig. 6. Feeding coefficient in relation to total length (cm) and fish weight with no stomach

Table 2. Index of relative importance(IRI)

Identified species	% of organisms (N)	% of weight (G)	Frequency of occurrence %	Index of relative importance (IRI)	IRI %
Mollusks	**7.42**	**0.57**	**20.00**	**159.80**	**1.09**
Semidigested bivalves	7.42	0.57	20.00	159.80	
Crustacean	**12.96**	**0.76**	**20.00**	**274.40**	**1.87**
Semidigested decapods	12.96	0.76	20.00	274.40	
Fish	**79.62**	**98.67**	**80.00**	**14263.20**	**97.04**
Engraulis egrasicolus	12.96	8.51	41.66	894.44	
Merlangius Merlangus euxinus	31.48	32.95	25.00	1610.75	
Gobiidae	16.66	51.37	25.00	1700.75	
Semidigested fish	18.52	5.84	8.34	203.16	

Table 2 clearly proves that fish is the most important food ietm, the frequency of occurrence in the analyzed samples being 80%, bivalves and crustaceans recording a frequency of occurrence of 20%.

According to the data obtained, gobies and whiting are the main prey items of turbot, with IRI= 1700.75 and IRI = 1610.75, respectively.

The three food items identified in turbot stomachs recorded IRI% = 97.04 fish, IRI%= 1.87 crustaceans, IRI% = 1.09 mollusks.

To sum-up, the main prey items for adult turbots in Romanian Black Sea waters are fish, followed by crustaceans and mollusks.

CONCLUSIONS

The food array items found in the stomach content of turbots largely depend on the period when fish individuals were collected, the biodiversity of the respective habitat and the health state of the fish.

The most significant prey item determined was fish. Three fish species were identified, the dominant fish being whiting, with 50.66% of the total food weight, followed by Gobiidae, with a share of 34.49%, and anchovy, with 8.39%. Semidigested bivalves and decapods were identified in very small shares.

The highest value of the feeding coefficient was 218.68%, the analyzed specimen having undigested fish in its stomach. The minimum value was 0%, as these individuals had their stomachs infested by parasites.

As a follow-up of calculating the Index of relative importance, it resulted that gobies and whiting are the main prey items of turbot, with IRI= 1700.75 and IRI =

1610.75, respectively. The three food items identified in turbot stomachs recorded IRI% = 97.04 fish, IRI%= 1.87 crustaceans, IRI% = 1.09 mollusks.

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