Feeding characteristics of *Neogobis caspius* in the south west coastline of the Caspian Sea (Gilan Province)

Sarpanah Sarkohi A.[1*]; Ghasemzadeh, G.R.[2]; Nezami, S.A.[1]; Shabani, A.[3]; Christianus, A.[4]; Shabanpour, B.[3] and Chi Roos Bin Saad[4]

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Abstract

Neogobius caspius is an endemic species of the Caspian Sea which plays an important role in food chain as a predatory fish. The main aim of this study was to investigate selected feeding characteristics of *Neogobius caspius* in the south west coasts of the Caspian Sea. Monthly sampling was carried out using a bottom trawler at three stations (Astara, Anzali and Chabuksar) in three depths (0-5, 5-10 and 10-15m) on a monthly basis from October 2004 to September 2005. Relative gut length (RLG) was less than one suggesting that this species is carnivorous. RLG was significantly lower in older fish but gut length was longer ($P<0.05$). Intensity of fullness was below the favorite degree ($IF<400$) from October to March, however, it was higher ($400<IF<900$) from April to October at all stations, indicating that feeding conditions for this species is suitable in the study area.Study showed that *N. caspius* mainly fed on molluscs (Food preference, FP=100%), worms (FP=89%) and crustaceans (FP=74%), hence, this species is considered as euryphagus species.

Keywords: *Neogobius caspius*, Feeding characteristics, Relative gut length, Food preference, Caspian Sea, Iran

1- Institute of Applied Scientific Higher education of Jihad-E-Agriculture : 13145-1783, Tehran, Iran
2-Iranian Fisheries Organization, Gilan Fisheries Department, P.O.Box:15156 Rasht, Iran
3- Faculty of Agricultural and Natural Science, Gorgan University, P.O.Box: 49165-386, Gorgan, Iran
4- Faculty of Agriculture, University of Putra , No. 43400, Serdang, Selangor, Malaysia
*Corresponding author's email: a_sarpanah@yahoo.com

Introduction

Gobies, including *Neogobius caspius*, have lived at least for over 40 million years (Miller, 2001), during which they have established natural populations in different regions of the world (Rahimov, 1991). They are made up of five families and over 212 genera with 1875 species and sub-species living in fresh, brackish and marine waters throughout the world (Gasemov, 1994; Nelson, 1994). It is believed that these fish were originated from the Mediterranean, Ponto Caspian and the Caspian Sea. According to Rahimov (1991), among 18 families in the Caspian Sea, *Gobiidae* comprises the greatest diversity. There are 11 genera, 38 species and sub-species of gobies in the Caspian Sea. Among them, the genus *Neogobius* consists of 12 species and sub species. *N. caspius* is a native species in the Caspian Sea (Kazanchev, 1981; Gasemov, 1994; Coad, 2003, 2006).

Nikolskii (1963) classified the feeding habits of *Gobiidae* according to the degree of food variation consumed by them as (i) monophagic (feeding on only one single type of food), (ii) stenophagic (feeding on few different types of food), and (iii) euryphagic (feeding on a variety of foods). However, Rahimov (1991) categorized *Gobiidae* of the Caspian Sea into 3 groups on the basis of diets including mollusc feeders, crustacean feeders and fish feeders. He stated that crustaceans are the main food source for the Caspian goby (*N. caspius*). They also feed on worms and molluscs in the north Caspian Sea. Their natural food can be broadly classified into four groups, including planktons, nektons, benthoses and detritus. Another classification could as main food or natural food which is the most preferred food and by which the fish will thrive the best; and occasional food which has a relatively high nutritive value and is liked and consumed by the fish whenever there is an opportunity and random food which enters passively into the fish gut (Biswas, 1993). Relative length of the gut (RLG) is a useful index which provides an idea of the nature of food consumed. Biswas (1993) stated that the length of the gut of an animal depends on the nature of food they consume and increases with increasing proportion of vegetable materials. In the diet, Girgis (1952) reported that RLG value was lowest in the fry stage and highest in the older fish. As the fish grows, the alimentary tract lengthens and is coiled in order to digest and absorb the vegetable portion of the food resulting in a progressive increment of RLG. Studying the food indices of fish is of a very complicated nature and needs much field and laboratory work to accomplish. Analysis of the gut contents is a widely used method to ascertain the food and feeding habits of a fish species (Potts & Wootton,1989;Wootton, 1990;Wootton,1992). Investigating food preferences and analysis of gut content, is an important aspect of fish biology (Winfield & Nelson, 1991; Biswas, 1993).

The aim of the present study was to investigate selected feeding indices, including relative gut length, intensity of fullness and food preference of *N. caspius* in south western

coasts of the Caspian Sea.

Materials and methods

The south western coast of the Caspian Sea was considered as study area. Three sampling stations, including (48º 52´53´´E, 38º 25´40´´N), Anzali (49º 26´46´´E, 37º 28´55´´N´) and Chabuksar (50º 34´41´´E, 36º 58´33´´N) and three depths (0-5m, 5-10m and 10-15m), showed in Figure 1.

The specimens were collected monthly from October 2004 to September 2005 using a standard 2 meters-beam bottom trawl (12.45 meters in length and mouth size of 4.7 meters). The mesh size of the front and the cod end was 8 and 4mm, respectively. Trawling was carried out using a 6 m boat at a speed of 1.5-2 knots along the shore (King, 1995). The geographical location of the sampling stations was recorded by Geografical Positioning System (Majellan 410). A total of 2026 samples of *N. caspius* were collected. Specimens were fixed in 4% formalin solution, kept in plastic containers and transferred to the ichthyology Laboratory, Inland Waters Aquaculture Research Centre, located in Anzali port, Gilan province, Iran. Fish species were identified according to Berg**,** 1949; Svetovidov, 1953; Kazanchev, 1981; Rahimov, 1991; Abdoli, Samples were first placed on a dissection tray and wiped dry using Turnsel paper. They were weighed in full and then were weighedin full using a digital balance (precision 0.001g.). Total length was measured using callipers (precision 0.05mm) (Holcik, 1989; Biswas, 1993). Age was determined using fish scales.

Figure 1: Sampling stations located in the south-west of the Caspian Sea

Digestive tract of the samples was removed, weighed to the nearest 0.001g and fixed in 4% formalin solution in a measuring cylinder (5cc). Benthic organisms found in the fish gut, were identified based on the body parts of crustaceans (legs, claws, telson, rostrum, etc.) and type and form of shell or cuticle in the case of molluscs following Birstein *et al.* (1968). The planktons in the food were counted using an inverted microscope. The feeding indices for *N. caspius* were calculated using the following formulae:
RLG was calculated by the ratio of gut length to total body length (Biswas, 1993):
RLG = Length of the gut (mm) / total body length (mm)
Where fish can be classified as herbivorous (RLG>1), carnivorous (RLG<1) or omnivorous (RLG =, or>, or <1) (Biswas, 1993).

Intensity of fullness (IF) = $(w * 10^4)/ W$, where w is weight of the gut content and W is the weight of the fish (Biswas, 1993). Biswas (1993) described the value of intensity of fullness as favourite if 400<IF<900 and unfavored if 400>IF.

Food preference (FP) = Ni / Ns* 100, where Ni is number of the guts in which a certain food item is observed and Ns is the number of the guts which contain food. According to Euzen (1978) if FP is calculated less than 10 then it is a randome food for the fish, If FP is between 10 and 50 then it is an occasional or secondary food item and if FP is more than 50 then it is the main one.

Due to the rejection of normality assumption in Shapiro-Wilk's W test (Sahai & Ageel, 2000), the effects of difference caused by sampling station, depth, time and sex class on the relative length of gut and intensity of fullness were analyzed by non-parametric analysis of variance (Kruskal–Wallis), followed by comparisons of treatment means with Mann-Whitney U tests at 5% probability level (Pelosi & Sandifer, 2003). All tests were undertaken using SPSS version 11.5 (SPSS Inc).

Results

Statistical descriptive analyses of Absolute and Relative gut length of *N. caspius* in different age classes is shown in Table 1.

The results of Kruskal-Wallis analysis of absolute and relative gut length of *N. caspius* at different ages in south west coastline of the Caspian Sea (Table 2) showed that age class has age class effect significant (P<0.001) on both absolute and relative gut length of *N. caspius*.

In addition, Mann Whitney U tests (Figs. 2 & 3) indicated that absolute gut length increases with age increase, while relative gut length in 5 year was significantly higher than that in other age classes. This ratio in 1 year was higher than that in 2, 3 and 4 year groups. There was not significant difference (P>0.001) between relative gut length among 2, 3 and 4 year classes.

Table 1: Statistical descriptive analyses of absolute and relative gut length of *N. caspius* in different ages in the present study

variable	Age (year)	No.	Mean	Min.	Max.	S.D.	S.E.
Absolute gut length	1	582	33.58	26	40	3.911	0.162
	2	527	48.41	38	57	5.174	0.225
	3	394	65.95	51	80	7.337	0.370
	4	302	84.86	73	96	5.570	0.321
	5	221	96.07	88	106	4.145	0.279
Relative gut length	1	582	0.662	0.650	0.670	0.009	0.000
	2	527	0.630	0.620	0.640	0.008	0.000
	3	394	0.630	0.630	0.640	0.002	0.000
	4	302	0.630	0.630	0.640	0.002	0.000
	5	221	0.667	0.660	0.670	0.005	0.000

Table 2: Kruskal-Wallis analysis of Absolute and relative gut length of *N. caspius* in terms of age

Parameter	Chi-Square	Degree of Freedom	P-Value
Absolute gut length	1890.771***	4	0.000
Relative gut length	1596.278***	4	0.000

***** indicates significant difference at 0.001% probability level.**

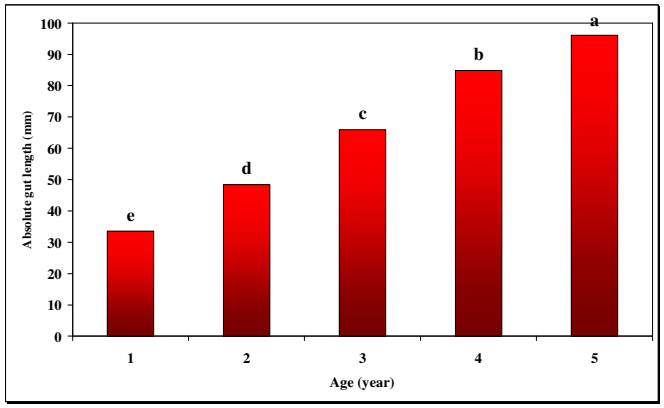

Figure 2: AGL in *N. caspius* in terms of age (Mean ±Standard error) based on Mann Whitney U analysis. Bars marked by different letters are significantly different at 5% probability level (a>b>c>d).

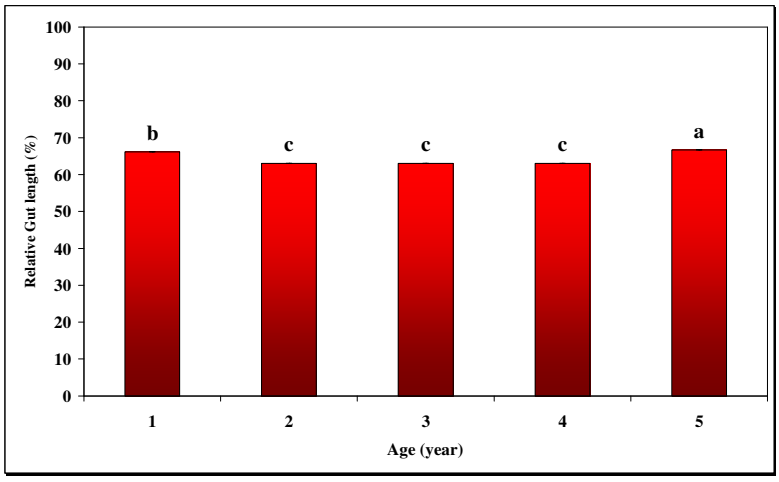

Figure 3: RLG in *N. caspius* in terms of age (Mean ±Standard error) based on Mann Whitney U analysis. Bars marked by same letters are not significantly different at 5% probability level (a>b>c).

Table 3: Statistical descriptive analyses of IF in the present study

Variable		No.	Mean	Min.	Max.	S.D.	S.E.
Station	Astara	409	593.05	181	832	191.411	9.465
	Anzali	512	604.79	194	854	190.577	8.422
	Chabuksar	753	613.20	190	850	189.022	6.888
Depth (m)	0-5	728	590.14	203	854	190.847	7.073
	5-10	545	608.90	195	854	192.256	8.235
	10-15	401	612.34	181	853	185.296	9.253
Month	October	110	398.44	390	415	8.102	0.772
	November	85	377.53	370	390	6.484	0.703
	December	68	297.79	290	310	6.371	0.773
	January	45	249.00	240	260	6.792	1.013
	February	26	199.04	190	210	6.636	1.301
	March	46	319.80	310	330	7.104	1.047
	April	90	449.06	440	460	6.906	0.728
	May	160	497.94	490	510	6.785	0.536
	June	267	648.19	640	664	7.081	0.433
	July	392	778.43	770	794	7.057	0.356
	August	256	838.15	830	854	6.911	0.432
	September	129	518.55	510	530	6.470	0.570
Age (year)	1	433	598.68	190	830	186.904	8.982
	2	428	599.53	195	838	190.764	9.221
	3	337	601.58	200	844	192.569	10.490
	4	274	600.79	205	847	193.049	11.662
	5	202	613.07	210	854	189.200	13.312

The results of Kruskal-Wallis analysis for IF in *N. caspius* at different stations, depths, time and age classes in south western coast of the Caspian Sea (Table 4) showed that sampling depth, time and age have significant effect (P<0.001) on *N. caspius* intensity of fullness. There was no significant differences were observed in intensity of fullness of *N. caspius* between different sampling stations (P>0.05).

Additionally, Mann Whitney U tests (Figs. 4, 5, 6 & 7) indicated that there was no significant difference at 5% probability level between stations and there was significant difference (P<0.005) between depths. Also, based on the Mann Whitney U tests the IF in *N. caspius* populations in different months was significantly differed (P<0.005). The minimum and maximum intensity of fullness were recorded in February and August, respectively. Based on Mann Whitney U test, there was significant difference (P<0.005) between different months. Intensity of fullness in different age classes significantly differed (P<0.005) and increased with age increase. However, results showed that intensity of fullness in 4 year class was lower than that in 3 year class.

Table 4: Kruskal-Wallis analysis of IF of *N. caspius* in the present study

Parameter	Chi-Square	Degree of Freedom	P-Value
Station	3.886^{ns}	2	0.143
Depth	13.779^{***}	2	0.001
Time	1635.954^{***}	11	0.000
Age	21.805^{***}	4	0.000

^{ns} and *** indicate non-significant difference at 5% probability level and significant difference at 5% probability level, respectively.

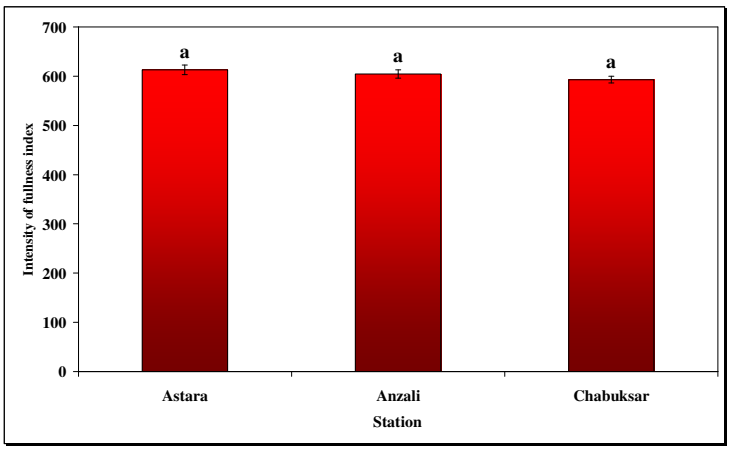

Figure 4: IF in *N. caspius* in terms of station based on Mann Whitney U analysis. Bars marked by same letters are not significantly different at 5% probability level.

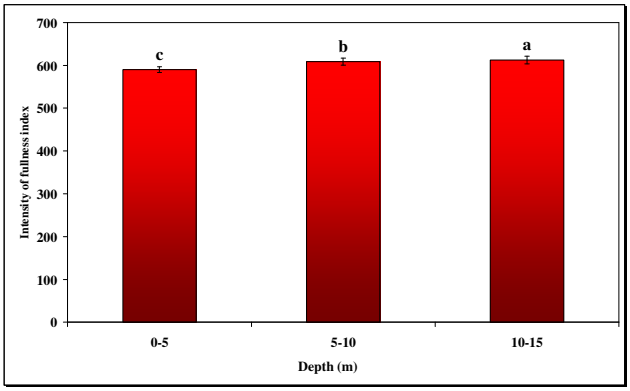

Figure 5: IF in *N. caspius* in terms of depth based on Mann Whitney U analysis. Bars marked by different letters are significantly different at 5% probability level.

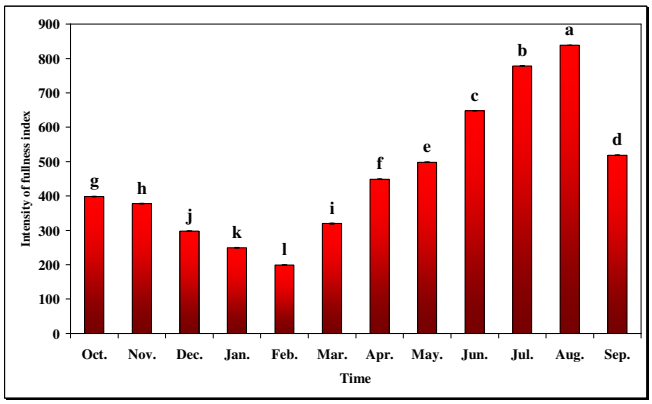

Figure 6: IF in *N. caspius* in different months based on Mann Whitney U analysis. Bars marked by different letters are significantly different at 5% probability level.

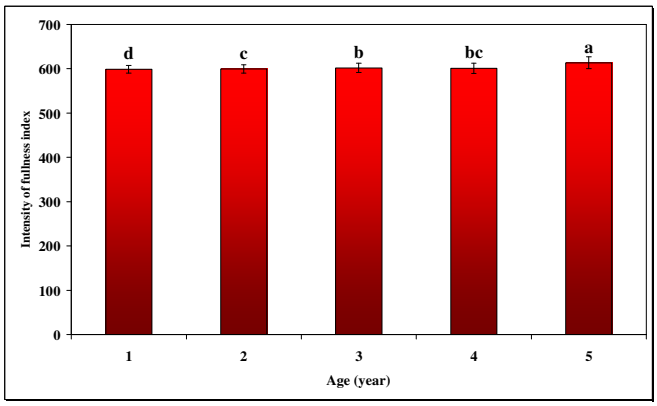

Figure 7: IF in *N. caspius* in different ages based on Mann Whitney U analysis. Bars marked by different letters are significantly different at 5% probability level.

Food preferences of *N. caspius* population in the study area were counted and recorded by systematic classification except planktons. Because of very low frequency of planktonic community (zooplankton and phytoplankton) in gut content of *N. caspius*, this food item was only expressed as plankton. Different types of food items were recognized in gut content, including crustaceans (Balanidae, Cyprididae, Mysidae, Pseudocomidae, Gammaridae, Xantidae,Palamonidae),insects(Chronomidae), molluscs (Bivalvia, including: Mytilidae, Dressenidae, Cardidae, Scorbicularidae, and Gastropoda, including Pyrogulidae), worms (Nereidae and Tubificidae), fish larvae (Gobiidae) and planktons (zeoplankton and phytoplankton). An After calculation of food preference percentages, food items were classified in three classes, including main, occasional and random.

Results indicated that main food consisted of molluscs (FP=100%) (*Cardium, Didacna, Mytilaster* and *Abra)*, Worms (FP=89%) (Nereis and oligochaet), and Crustacea (FP=74%) (*Nifargoides, Petrcuma* and *Parmisis*) while occasionally food items (FP=38%) included mollusks, Insects, crustaceans and fish larva and planktons were classified as random food (Table 5).

N. caspius mainly fed on molluscs (100%), worms (89%) and crustaceans (74%) and considered as a euryphagic species (Fig. 8).

Table 5: FP of *N. caspius* populations in the study area

Food group	Main	Occasionally		Random
Food item				
Molluscs	*Cardium* 100% *Didacna* 92% *Mytilaster* 85% *Abra* 98%	Dressena Pyrogulidae	38% 26%	0%
Worms	*Nereis* 89% *Oligochet* 85%	0 %		0%
Crustaceans	*Niphargoides* 74% *Petrcuma* 69% *Parmysis* 61%	Balanus Xantidae Palamon	23% 19% 11%	0%
Insects	0 %	Chironomus	29%	0%
Fish larvae	0%	Gobiidae	14%	0%
Planktons	0 %	0 %		3 %

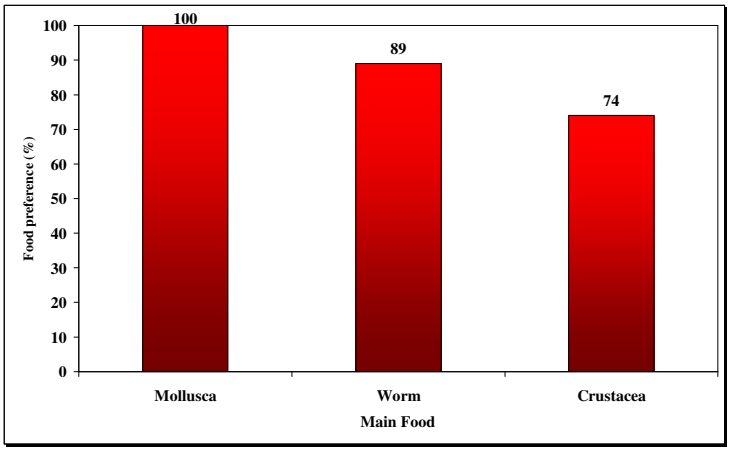

Figure 8: FP percentages of *N. caspius* population in the study area.

Discussion

Most of Gobiidae species are carnivorus (Coad, 2006). In the present study RLG of *N. caspius* in the study area in different age classes was found below 1, hence this species is carnivorous. Rahimov (1991) stated that adult individuals of *Gobiidae* feed on molluscs and fishe larva. On the whole, in some regions where molluscs are low in abundance, the Caspian goby feeds on crustaceans. Results of the present study indicated that molluscs, crustaceans and worms are the main food of *N. caspius,* and therefore it is a euryphagic species but it mostly prefers the molluscus than worms and crustaceans. This contradicts the findings of Rahimov (1991) who stated that crustaceans are the main food items of Caspian goby (*N. caspius*). They feed on crustaceans, worms and molluscs in the north Caspian Sea. There are also numerous studies reporting that most *Gobiidae* feed on benthos such as molluscs, crustaceans, worms and etc. (Simonovic *et al.,* 2001; Thomas *et al.,* 2002; Edward *et al*., 2003; Victoria *et al*., 2005; Fitzsimons *et al*., 2006; Lederer *et al*., 2006; Peter *et al*., 2008).

In the present study, intensity of fullness of *N.caspius* population was investigated and results showed that no significant differences between different stations were observed. However, in term of depths there is significant difference ($P<0.05$) and intensity of fullness also increased along with age increase ($P<0.05$). IF in this region was uniform and found in the favorite range. In fact, south west coastline of the Caspian Sea is rich in nutrients because of a common estuary generated from connection of several rivers estuaries together. Therefore, intensity of fullness in this region occurred uniform and grouped in favorite degree.

So far there is no data reported on food intensity of *N. caspius* species in other part of the Caspian Sea or other ecosystems. In the present study, according to Biswas (1993), the IF value was below favorite

degree from October to March and showed unfavored level specially from December to February, while from April to October was favorite. In overall, the IF value in the study area was in the favorite range (400< IF < 900) indicating suitable feeding conditions for this species in the study area. The lowest feeding intensity for *N. caspius* population is most probably related to the cold conditions in winter and the maximum IF value in the August is due to the suitable feeding conditions in warm months. Decrease in feeding intensity in cold months has also been reported by Rahimov (1991) for *N. caspius* in the north Caspian sea. Victoria *et al* (2005) reported that IF value of *Neogobius melanostomus* in Great lakes increased with temperatures as high as 26°C before sharply decreasing.

In conclusion, *N. caspius* is a carnivorous species and there is suitable feeding conditions for *N. caspius* in the area investigated in the present study. Furthermore, *N. caspius* mainly fed on molluscs, worms and crustaceans, and therefore should be considered as a euryphagous species.

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شاخص‌هاي تغذيه‌اي گاو ماهي خزري (*Neogobius caspius*) در آبهاي سواحل جنوب غربي درياي خزر (استان گيلان)

علینقی سرپناه سورکوهی[1*]؛ غلامرضا قاسم‌زاده [2]؛ شعبانعلی نظامی[1]؛ علی شعبانی[3] ؛ آنی کریستیانوس[4]؛ بهاره شعبانپور[3] و چیروز بن سعد[4]

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چکیده

گاو ماهی خزری (*Neogobius caspius*) یکی از گونه‌های بومی دریای خزر می‌باشد که در زنجیرهٔ غذایی بعنوان ماهی شکارچی نقش مهمی ایفاء می‌نماید. هدف عمده تحقیق حاضر مطالعه برخی از شاخصهای تغذیه‌ای گاو ماهی خزری در سواحل جنوب غربی دریای خزر می‌باشد. نمونه‌برداری ماهانه در سه ایستگاه (آستارا، انزلی و چابکسر) و در سه عمق (۵-۰،۱۰- ۵ و ۱۵-۱۰متر) از مهرماه سال۱۳۸۳ تا شهریور سال۱۳۸۴ بوسیله ترال کف روب انجام شد. طول نسبی روده (RLG) کوچکتر از ۱ اندازه‌گیری شد. بنابراین گاو ماهی خزری گونه‌ای گوشتخوار محسوب می‌شود. با افزایش سن، طول نسبی روده کاهش و طول مطلق روده بطور قابل توجهي افزایش می‌یابد ($P>0.05$). شدت پر بودن شکم (Index of Fullness) در همهٔ ایستگاهها طی ماههای گرم مطلوب بوده ($400<IF<900$) که حاکی ار مناسب بودن شرایط تغذیه‌ای گاو ماهی خزری در منطقهٔ مطالعاتی می‌باشد. گاو ماهی خزری بطور عمده از نرمتنان (FP=100%)، کرمها (FP=89%) و سخت‌پوستان (FP=74%) تغذیه می‌نماید، از طیف غذایی وسیعی برخوردار بوده و لذا Euryphagus محسوب می‌شود.

کلمات کلیدي: گاو ماهی خزری، شدت تغذیه، طول نسبی روده، ترجیح غذایی، دری‌ای خزر، ای‌ران

۱- موسسه تحقیقات شیلات ای‌ران، تهران، صندوق پستی ۶۱۱۶-۱۴۱۵۵
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۴- دانشکده کشاورزی دانشگاه پوترا، شماره ۴۳۴۰۰ سردانگ، سسلانگور، مالزی
× پست الکترونیکی نویسنده مسئول: a_sarpanah@yahoo.com