

[Short Communication]**The features of the feeding of Caspian marine shad, *Alosa braschnikowii* (Borodin, 1904) in western part of the Caspian Sea****A. Azizov^{1*}, S. Suleymanov¹, M. Salavatian²**¹-Institute of Zoology, Azerbaijan National Academy of Sciences, Baku, Az 1073, Azerbaijan Republic²-Inland Water Aquaculture Research Center, Bandar Anzali, Iran* Corresponding author's E-mail: aflatunazizov@gmail.com

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ABSTRACT

Feeding habits of Caspian marine shad *Alosa braschnikowii* (Borodin, 1904), inhabiting in the western part of Caspian Sea such as prey spectrum and seasonal dynamics have been studied. As in other parts of Caspian Sea, throughout the year, the main hunt of Caspian marine shad constituted kilkas, gobies and shrimps while other groups of zoobenthos were represented in a lesser extent. Importance of other fishes and zoobenthos in the diet of Caspian marine shad is influenced by their ecological morpho-functional peculiarities. Seasonal changes of species composition and proportions of fodder food items are caused by life cycles of fishes and migrations of fodder entities. The changes of food composition depending length of fishes, the depth and haul region are analyzed. Caspian marine shad most intensively feeds in spring (March - April) before spawning and in summer (July) after spawning.

Keywords: feeding, Caspian marine shad , kilka, gobies, shrimps, amphipods**INTRODUCTION**

In the western part of the Caspian Sea the Caspian marine shad *Alosa braschnikowii* a commercially important fish caught by dragnets and stationary nets (Kostyurin *et al.*, 2006; Suleymanov, 2007; Kuliyevev & Suleymanov, 2010; Kalmykov *et al.*, 2013). Some peculiarities of biology of Caspian marine shad, inhabiting western part of the Caspian Sea were studied insufficiently. The peculiarities of feeding of this predator in north-western part of the Sea have been given in a few papers in the last century (Derzhavin, 1918; Ostroumov, 1947; Shorygin, 1952). Fragmentary investigations of feeding of this species were conducted in western part of the Sea (Smirnov, 1950). However, in the papers of aforementioned author's only general information are given about some feeding peculiarities of this species in shoal and coastal zones of western part. Feeding habits of a Caspian marine shad in the offshore parts of the Sea is explained for the first time in the present study. The relationships between feeding intensity of this subspecies and concentration of fodder organisms in literature are

insufficiently explored, therefore we paid special attention to this question in the present study. Changes of hydrological and hydrochemical regimes of the sea during the last decades, invasion of new hydrobiota in the Caspian basin (Azizov, 2012), intensification of harvesting of a kilka *Clupeonella engrauliformis*, undoubtedly, affected the food of herrings. The purpose of the present work is to study the seasonal dynamics of feeding of Caspian marine shad in the western part of the Caspian Sea. The data obtained allowed us to determine more correctly, scientifically based methods for searching the commercial congregations of Caspian marine shad in different seasons of the year in various parts of the Caspian Sea.

MATERIALS AND METHODS

were caught in a coastal zone with stationary nets (with mesh sizes 28 - 30; 40 - 50; 60- 70 mm), and in offshore areas of the western part of the Caspian Sea at depths 10 - 100 m with dragnets during complex trawling sturgeon shootings on SIS "Alif Hajiyev".

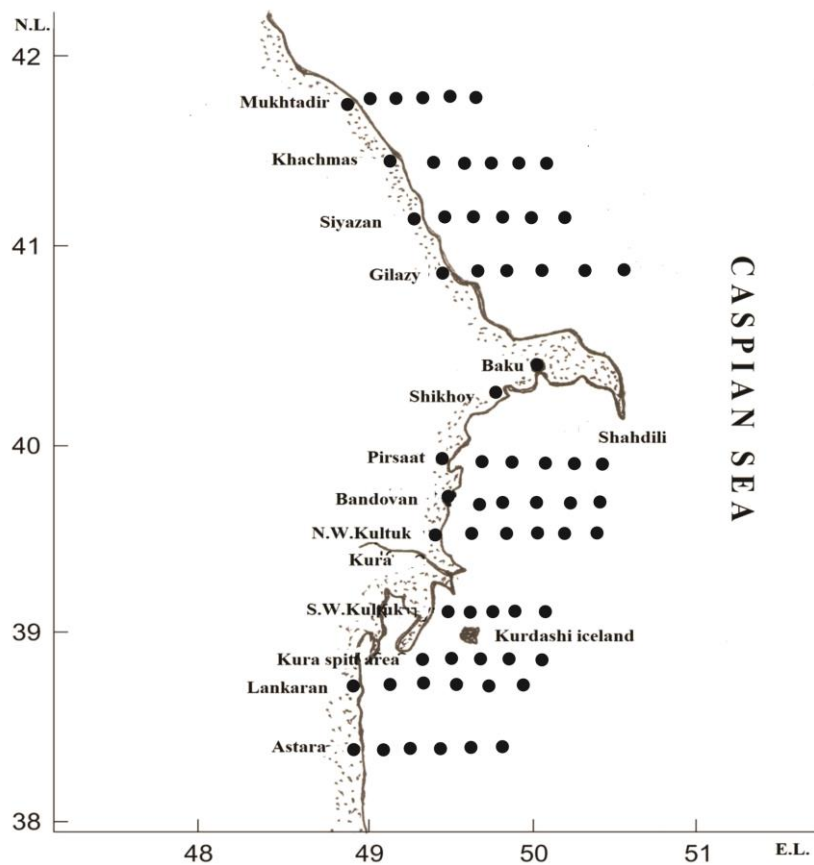


Fig. 1. Stations of the study area

The collected ichthyological material was treated using standard methods (Pravdin, 1966; Borutskiy, 1974). For biological analysis of fishes the following procedures were carried out: measurement (length by Smith - LS), weight (total mass and mass without interiors), determination of sex and stage of maturity (SM), calculation of maturity coefficient (MC) and fatness coefficient. In all fishes the scales were taken for age determination. Fodder objects whenever possible were identified to a species level (Birshtein & Romanova, 1968; Mordukhai-Boltovskoi, 1960; Starobogatov, 1995). Relative value of separate groups of fodder organisms in food spectra was expressed by the occurrence frequency (FO,%) and by the biomass of separate components from their total biomass ($W, \%$). The general index of filling of stomachs (GIF,%) and proportion of fishes with empty stomachs (%) were calculated. Totally, 3150 individual fish with size range, 20.3 - 32.4 cm, were treated, of which 2455 individuals were with food in their stom-

achs. For the characteristic of seasonal dynamics of feeding the following periods were allocated: spring (March - April), summer (July - August), winter (January - February).

RESULTS AND DISCUSSION

The range of a Caspian marine shad covers almost all basin of the Caspian Sea, except for more desalinated zones (Kazanchev, 1981; Suleymanov, 2007). In view of considerable dissociation of areas where the material was collected, and their ecological heterogeneity, the feeding of a studied species of a shad in the western areas of the sea is considered separately. During the total period of migrations in the western areas Caspian marine shad intensively feeds which is related to long distances of spawning areas and absence of individuals in the west with mature or near to a mature gonads. Changing the intensity of nutrition and seasonal change in the composition food of Caspian marine shad during the

year depends on the water temperature, habitat and availability of food (Sul-eymanov et al., 2012). Analysis of the seasonal dynamics of the qualitative composition of the food shows that, depending on the season the ratio of its components has regularly been changing (Fig. 2, Tables 1-2). In the spring, Caspian marine shad, rises to the surface of the water, migrates on coastal sites of the Sea up to the depth of 15 m for feeding and spawning. Water temperature in a coastal zone increases at this time to 10 – 12°C. Spring migration of Caspian marine shad coincides with migration of caspian kilka *Clupeonella cultriventris caspia* to the west shore of the Caspian Sea. Similar relationship is also observed in the remainder time of year. From March through May 2010 the bulk population of Caspian marine shad was found at regions of Kura spit area and Shikhov, where they intensively fed. The mean index of filling of stomachs in individuals in a section of the Kura spit area was 175‰, while in Shikhov's region – was 325‰. Herrings with empty stomachs in a section of Kura spit area made up 24%, while around Shikhov – was 14.8%. Such activity in consumption of food is caused by maturation of sexual glands which reaches in III and III-IV stages of maturity in April. At this time the main prey of Caspian marine shad of 22.6 - 29.0 cm long in study areas were kilkas (*C. cultriventris caspia*, *C. engrauliformis*), constituting 43.0 - 48.4% of the total food. The significance of gobies *Neogobius gorlap*, *N. melanostomus* and shrimps – *Palaemon adspersus*, *P. elegans*

in its diet was moderate and made up 25.2 – 21.4 and 16.4 – 14.0% respectively. In a lesser extent we found atherin *Atherina boyeri caspia* and amphipods *Pontogammarus robustoides*, *Niphargoides similis*, *N. grimmi*, *Dikerogammarus haemobaphes* and *D. caspicus* 5.8 - 9.9 and 7.0 – 3.0% respectively. Among other organisms juveniles of mullets *Liza saliens*, needlefish *Syngnathus nigrolineatus* and mysids *Paramysis baeri*, *P. grimmi* were frequently encountered (Table 1). During the spring (April 2011) in the sections of Kura spit area and Shikhov where the number of empty stomachs of a Caspian marine shad made up 28.5 and 16.7% respectively, the bulk diet of a Caspian marine shad near Kura spit area consisted of kilkas *C. c. caspia* and *C. engrauliformis* (49.8%) and gobies *N. gorlap*, *N. melanostomus* and *N. fluviatilis* (20.3%). Fairly significant roles in food items were played by amphipods *P. robustoides*, *N. grimmi*, *D. haemobaphes* (8.8%), shrimps *P. adspersus* and *P. elegans* (8.1%) and atherin *A. b. caspia* (7.7%). Feeding index of herrings in this region was low (130‰) in comparison to last year. The percentage of individuals fed in spring was 71.5%. The essential place in feeding of Caspian marine shad in Shikhov region belonged to kilkas (51.9%), amphipods (23.3%) and gobies (12.8%). The amounts of shrimps and mysids was insignificant and accounted for 1.0 - 9.2%. Feeding index of herrings in this area was higher (290‰) than in the Kura spit area (Table 2).

After spawning (July) Caspian marine shad

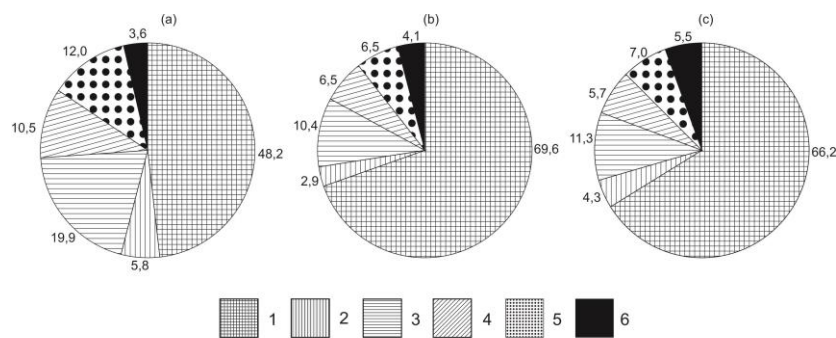


Fig 2. Seasonal dynamics of feeding spectrum (% of mass) of Caspian marine shad *Alosa braschnikowii* in western part of the Caspian Sea from 2010- through 2011.

a - spring; b - summer; c - winter; 1 - *Clupeonella*; 2 - *Atherina*; 3 - *Neogobius*; 4 - Amphipoda; 5 - Decapoda; 6 - others

Migrates from a northern shoal of the Caspian Sea to offshore areas of the Sea where there is the maximum biomass of food or-

ganisms. From the trawling "catches" it is established that the greatest number (averaged the 6 individual /trawl) of Caspian

marine shad during the summer period (July – August) was observed in Mukhtadir and Khachmas areas of Middle Caspian Sea at depths of 20 - 25 m where soil consists of small sand with cockleshell and silt impurity, and also of a black cockleshell (Azizov, 2008). Food items of Caspian marine shad 22.5 - 28.0 cm in length during summer

2010 around Mukhtadir area, dominated by kilka, *C. engrauliformis* (52.0%). Gobies constituted 13.2%, shrimps *P. adspersus* and *P. elegans* - was 10.1% and amphipods *P. maeoticus*, *N. macrurus*, *S. similis* and *D. haemobaphes* - was 8.4% (Table 1).

The percentage of feeding fishes made up more than 90%. The overall index of stomach

Table 1. Seasonal dynamics of fodder objects in the food of Caspian marine shad *A. braschnikowii* in the Azerbaijan sector of the Caspian Sea in 2010 (% of biomass).

Food components	Summer		Winter		Spring	
	Mukhtadir region	Khachmas region	Lankaran region	Kura spit area	Kura spit area	Shikhov region
<i>C. cultriventrif caspia</i>	13.2	8.0	5.2	6.5	35.7	43.5
<i>C. engrauliformis</i>	52.0	63.3	68.0	57.5	7.3	4.9
<i>C. grimmi</i>	-	-	2.0	-	-	-
<i>Cobitis</i>	-	2.0	-	1.9	2.0	-
<i>Atherina</i>	-	4.1	8.7	3.0	5.8	9.9
<i>Neogobius</i>	13.2	10.7	-	14.5	25.2	21.4
Remains of fish	1.0	-	3.0	2.5	-	2.0
Amphipoda	8.4	2.2	-	4.8	7.0	3.0
Mysidacea	-	1.4	-	-	0.6	-
Decapoda	10.1	6.9	13.1	9.3	16.4	14.4
Others	2.1	1.4	-	-	-	0.9
The number of stomachs examined	22	40	30	13	25	27
The share of empty stomachs, %	9.1	15.0	70.0	46.1	24.0	14.8
Index of stomach fullness, ‰	192	127	95	142	175	325
Condition factor (at Fulton)	1.05	1.21	1.24	1.13	1.27	1.23

fullness was equal to an average of 192.5‰. In the Khachmas region the main prey of Caspian marine shad with 20.4 - 32.4 cm long were kilkas (71.3%), gobies (10.7%) and shrimps (6.9%). At this time the number of feeding individuals decreased to 85%. "However" the average value of stomach filled fishes considerably decreased almost in all age groups even though indexes of filled stomachs in some individuals exceeded 189‰. The reason for reducing average indexes of filled stomachs (127‰) during the summer period is that at high water temperature the process of food digestion in Caspian marine shad is much more accelerated. The food does not gather in a stomach. Caspian marine shad in the Khachmas and Siyazan areas consumed similar food items in the summer 2011. In the all studied areas kilkas (63.4 - 76.6%) were the major prey of this species. Proportions of gobies (5.1 - 12.7%), amphipods *P. maeoticus*, *P. robustoides*, *N. caspicus*, *N. similis* (5.3 - 10.3%), shrimps *P.*

elegans, *P. adspersus* (3.0 - 6.0%) and mysids *Hemimysis anomata*, *Paramysis baeri*, *P. grimmi*, *P. lacustris* (2%) in the total food not so high and had moderate values (Table 2). Average indexes of stomach fullness was in an ordered fashion (161 - 243‰). In the "summer" considerable part of fishes (17.2 - 21.6%) continued feeding in studied areas of the Sea. In "autumn" individuals of this species reached the greatest fatness (1.25 - 1.30) that allows them to survive without an intensive feeding in the winter. According to our data (Kuliev and Suleymanov, 2010; Suleymanov *et al.*, 2012) in winter, with decreasing water temperature to 7.8 - 9.2°C, the Caspian marine shad is distributed throughout a large water area of the southwest Caspian Sea in whole 30 - 33 meter depth of water column. During the winter period the food composition is characterized by relative constancy. The herrings of 20.3 - 27.0 cm long in the Lankaran of southern part of the Caspian Sea where fodder organisms are distributed on shelly-

oozy, oozy, sandy-oozy and to a lesser extent on sandy soil, in winter 2010 fed generally on kilka *C. engrauliformis* (68%). Some importance food items were also shrimps *P. adspersus* and *P. elegans* (13.1%) and atherin (8.7%). At this time the number of feeding individuals decreased to 70%. The general index of stomachs fullness averaged 95%. Near the Kura spit the main prey of Caspian marine shad with 23 - 27 cm long were kilkas (64%). Besides, almost one third of the consumed food consisted of gobies (14.5%), shrimps (9.3%) and amphipods *P. crassus*, *P. maeoticus*, *P. robustoides*, *N. similis*, *N. spinicaudatus*, *N. grimmi* (4.8%). The percentage of feeding kilkas increased to 54% in comparison to the previous site and the index of stomach fullness raised to 142%. "Approximately" the same distribution of a Caspian marine shad was observed in winter 2011, but the density of congregations of fishes slightly decreased which is apparently related to extending

overwintering range. In the winter (January - February) in Lankaran and Kura spit area proportion of high-calorific fodder - a kilka *C. engrauliformis* was high and constituted 49.3 and 65.0% respectively. Gobies, amphipods *N. robustoides*, *N. grimmi*, *N. similis*, *D. haemobaphes* and mysids were represented in a lesser extent 16.4 and 14.3%; 11.3 and 7.0%; 1.0% respectively. In Kura spit area the proportion of atherin (5.7%) in food items increased. Considerable percent of fishes with empty (55.6%; 62.1%) stomachs indicates a weak feeding of a Caspian marine shad where average indexes of stomachs fullness was 137 and 112‰ respectively. According to the presented data (Tables 1 - 2) there is evident that the feeding of Caspian marine shad in many aspects depends on their fatness. At high level of individuals fatness feeding intensity decreases and, contrary to the low level where it increases.

The length-age changes in the spectrum

Table 2. Seasonal dynamics of fodder objects in the food of Caspian marine shad *A. braschnikowii* in the Azerbaijan sector of the Caspian Sea in 2011. (% of biomass)

Food components	Summer		Winter		Spring	
	Khachmas region	Siyazan region	Lankaran region	Kura spit area	Kura spit area	Shikhov region
<i>C. cultriventris caspia</i>	4.2	20.3	66	3.0	39.2	46.3
<i>C. engrauliformis</i>	72.4	45.3	49.3	65.0	10.6	5.6
<i>C. grimmi</i>	-	-	2.0	-	-	-
<i>Cobitis</i>	-	3.1	4.5	-	1.7	-
<i>Aterina</i>	3.0	4.3	-	5.7	7.7	-
<i>Neogobius</i>	5.1	12.7	16.4	14.3	20.3	12.8
Remains of fish	2.0	-	3.0	1.5	1.9	1.1
Amphipoda	5.3	10.3	11.3	7.0	8.8	23.3
Mysidacea	2.0	-	-	1.3	-	1.0
Decapoda	6.0	3.0	5.7	-	8.1	9.2
Others	-	1.0	1.2	2.2	1.7	0.7
The number of stomachs examined	29	37	18	29	21	24
The share of empty stomachs,%	17.2	21.6	55.6	62.1	28.6	16.7
Index of stomach fullness,‰	243	161	137	112	130	290
Condition factor (at Fulton)	0.90	1.14	1.16	1.20	1.32	1.25

nutrition Caspian marine shad, like most other fish, expressed in the sequence of the main components and an increase in the size of preys. The basis of nutrition of dogin herring (S.L. 20.3-23.0 cm) up plankton benthic and nekton-benthic forms as *Hemimysis anomata*, *Paramysis baeri*, *P. grimmi*, *P. lacustris*, *N. similis*, *N. robustoides*, *N. grimmi*, *D. haemobaphes*, *P. adspersus*, *P.*

elegans and meroplankton larvae of these organisms, 54 - 63% by weight of the bolus, a significant role in the nutrition are also of juvenile fish - *C. engrauliformis*, *N. gorlap* (33 - 37%). With the growth of fishes (LS 23.1 - 32.4 cm) an excess in some other major components of food was observed: increasing amounts of fishes such as *C. cultriventris caspia*, *C. engrauliformis*, *N. gorlap*,

A. boyeri caspia, up to 66- 90% per weight of the food.

CONCLUSION

In the Azerbaijan water area of the Caspian Sea in summer, winter and spring from 2010 through 2011 Caspian marine shad fed primarily on traditional and favourite high-calorific animal prey (kilkas, gobies, shrimps, amphipods and to a lesser extent on atherin). Quantitative consumption of the mentioned groups of animals was not stable. Since the composition of food herring depends on the seasonal dynamics of food organisms and the composition of the food of the area where dwells the Caspian marine shad. The study area of the Caspian Sea as a significant habitat for this subspecies are of great importance.

REFERENCES

- Azizov, A.P. (2008) Structural-functional characteristics of population *Astaculeptodactylus* Esch. In the West shelf of Azerbaijan sector of the Caspian Sea. *Proceedings of the Azerbaijan Society of Zoologists*. 1: 412-417.
- Azizov, A.P. (2012) Bio-ecological features of distribution of Southern Caspian Malacostraca. *Azerbaijan Proceedings of the Institute of Zoology*. 30: 78 - 85.
- Birshtein, Ya.A., and Romanova, N.N., 1968. Order side-swimmers A phipoda. In Atlas of invertebrates of the Caspian Sea, ed. Ya. A. Brishtein, L. G. Vinogradov, N.N. Kondakov, M.S. Astakhova and N.N. Romanova. Moscow: Pishchevaya promyshlennost press. pp. 241-289.
- Borutskiy Y.V. (1974) A keybook on stuing of feeding and food relations of fishes under natural conditions. Moscow. 254p.
- Derzhavin, A.N. (1918) Feeding by herrings. *Proceedings Astrakhan Ichthyology Laboratory*. 4: 59 -77.
- Kazanchev, E.N., 1981. Caspian Sea and its watershed fishes (In Russian). Translated to Persian by: Shariati, A., 2003. Naghshe Mehr Publishing, Tehran. pp. 224.
- Kolmykov, V.A., Khodorevskaya, R.P., Abdusamadov, A.S. and Smirnov, A.V. (2013) Development of marine shad fishery by Russia at the Western coast of the Caspian Sea. *Preservation and restoration of biological resources of the Caspian Sea. Collection of articles*. Baku. 311 - 316.
- Kostyurin, N.N., Paritskiy, Y.A., Zykov, L.A. and Andrianova, S.B. (2006) Assessment of the stocks and the fisheries of the Caspian Sea fish. *Fisheries Research in the Caspian Sea. Astrakhan*. 273 - 289.
- Kuliyev, Z.M., Suleymanov, S. Sh. (2010) Current ecological state of herrings (*Alosa*) in the Azerbaijan sector of the Southern Caspian Sea. *Proceedings the sciences of Earth NAS of Azerbaijan*. 4: 132 - 137.
- Mordukhai-Boltovskoi, F.D. (1960) Caspian fauna in the Azov and Black Sea basin. Moscow - Leningrad: Izdatelstvo Akademii. Nauk SSSR. 536 p.
- Ostroumov, A.A. (1947) Feeding by Caspian marine shad and big-eyed shad in North Caspian Sea. *Proceedings of the Volga-Caspian Science and Fisheries Station*. 9: 82 - 90.
- Pravdin, I.F. (1966) *Textbook on studying of fishes*. Moscow. 372 p.
- Shorygin, A.A. (1952) *Feeding and food interactions of fishes of Caspian Sea*. Moscow. 267 p.
- Smirnov, A.N. (1950) Feeding by braschnikovian herrings. *Proceedings of Institution of Zoology. Baku*. 14: 29 - 57.
- Starobogatov, Y.I. (1995) *Crustaceans*. Key to freshwater invertebrates of Russia.V. 2. St. Petersburg. pp. 177 - 180.
- Suleymanov, S. Sh. (2007) Biological status of Braschnikow's herrings (*Alosa braschnikowii braschnikowii*) in the Caspian Sea. *Proceedings of the ninth Baku International Congress "Energy, Ecology, Economy"*. Baku. pp. 411 - 415.
- Suleymanov, S.Sh., Nadirov S.N., Azizov A.P. (2012) Some peculiarities of herring (*Alosa*) distribution and behavior in the Caspian Sea. *Tomsk State University Journal of Biology*. 4: 127-137.

بررسی خصوصیات تغذیه ای شگ ماهی *Alosa braschnikowii* (Borodin, 1904) در بخش غربی دریای خزر

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چکیده

بررسی رژیم غذایی شگ ماهیان *Alosa braschnikowii* (Borodin, 1904) در بخش غربی دریای خزر، همچنین طیف غذایی و حرکات فصلی آنها مورد مطالعه قرار گرفت. همانند سایر بخشهای دریای خزر، در سرتاسر سال، صید اصلی شگ ماهیان همراه با کیلکا ماهیان، گاوماهیان و میگوها انجام می گیرد، در حالی که سایر گروه های زئوبنتوزی میزان صید کمتری را نشان می دهند. در رژیم غذایی شگ ماهیان اهمیت سایر ماهیان و زئوبنتوزها به وسیله مختصات عوامل اکولوژیک آنها تحت تاثیر قرار می گیرند. تغییرات فصلی ترکیب گونه ای و نسبت اقلام غذایی گیاهی، توسط چرخه زندگی ماهیان و مهاجرت آنها ایجاد می شود. تغییرات ترکیب غذایی بسته به طول ماهیان، عمق و نواحی ترددشان مورد تجزیه و تحلیل قرار گرفت. بیشترین تراکم تغذیه شگ ماهیان در فصل بهار (ماه های اسفند و فروردین) قبل از تخمریزی و در فصل تابستان (مرداد ماه) بعد از تخمریزی می باشد.

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