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[1]S.M. Shalgimbayeva, [2]N.N. Popov, [3]N. Ibragimova, [1]Zh.S. Omarova, [1]G.B. Jumakhanova, [1]B.K. Kairat, [2]Ye.M. Argynbayeva

[1]Al-Farabi Kazakh National University, Kazakhstan, Almaty,
e-mail: Gaukhar.Dzhumakhanova@kaznu.kz
[2]Kazecoproject LLP, Kazakhstan, Almaty
[3]Kazakh German University, Kazakhstan, Almaty

SOME COMMERCIAL FISH SPECIES NUTRITION IN THE KAZAKHSTAN PART OF THE CASPIAN SEA

Abstract. Investigation of nutrition and nutritional relationships of fish in the Northern Caspian is needed because this part of the water body is a feeding site for many fish species. The nutritional material was selected in the course of conducting comprehensive marine research in the Kazakhstan Caspian Sea waters, in the summer and autumn of 2018. A feeding research of such predatory fish as pike perch, asp, and sabrefish, as well asbream, roach, crucian carp, and golden mullet obtained from trawl catches, made it possible to trace the overall productivity formation of the reservoir and determine the reservoir water content. The researched fish had gastrointestinal tracts sufficiently filled with food. Fish with empty stomachs were rarely seen which indicates good nutrition and active consumption of food. It was revealed also that crustaceans, mollusks, and worms constituted the basis of the food intake of the fish of the benthophagous; while predatory species fed on the advanced fry. This suggests food plasticity and selectivity of fish. Also, benthophagous fish can eat a variety of food, and thus not create competition for each other in the diet. The lowest indices of gastrointestinal filling were in predatory fish species. The basis of the food lump in all analyzed fish was digested food. It can be noted that the fish caught on the digestive organs in the fall had fatty layers indicating that the fish were fed and did not experience a deficit in the food objects. According to the results of the research, the seasonal species diversity of feed objects in the north – eastern part of the Caspian Sea was also established.

Key words: Caspian Sea, food, foraminifera, worms, crustaceans, mollusks.

[1]С.М. Шалгимбаева, [2]Н.Н. Попов, [3]Н. Ибрагимова, [1]Ж.С. Омарова, [1]Г.Б. Джумаханова*, [1]Б.К. Қайрат, [2]Е.М. Арғынбаева

[1]әл-Фараби атындағы Қазақ ұлттық университеті, Қазақстан, Алматы қ.,
e-mail: Gaukhar.Dzhumakhanova@kaznu.kz
[2]«ҚазЭкоЖоба» ЖШС, Қазақстан, Алматы қ.
[3]Қазақ Неміс университеті, Қазақстан, Алматы қ.

Каспий теңізінің қазақстандық бөлігіндегі өнеркәсіптік маңызы бар кейбір балық түрлерінің қоректенуін зерттеу

Аңдатпа. Солтүстік Каспийдегі балықтардың қоректенуін және қоректік байланысын зерттеудің қажеттілігі аталған аймақтары балықтың көптеген түрлерінің өрістеу орны болып табылуымен түсіндіріледі. Қоректену бойынша материал 2018 жылдың жаз және күз мезгілдерінде Каспий теңізінің қазақстандық акваториясын кешенді теңіздік зерттеу жұмыстары барысына жинақталды. Трал көмегімен ауланған көксерке, ақмарқа және қылышбалық сияқты жыртқыш балықтардың, сонымен қатар тыран, торта, мөңке, сингиль сияқты фитофагтардың қоректенуін зерттеу су қойманың жалпы өнімділігін бақылауға және су қойманың азықтылығын анықтауға мүмкіндік берді. Зерттелген балықтардың асқазан-ішек жолдары жеткілікті мөлшерде толған. Асқазаны бос балықтар сирек кездесті, бұл олардың жемделгендігін және қоректі белсенді тұтынуының көрсеткіші. Сондай-ақ, бентофагтардың негізгі рационы – шаянтәріздерден, моллюскалардан және құрттардан, ал жыртқыш рационы – балық шабақтарынан тұратындығы анықталды. Бұл балықтардың қорекке деген талғампаздылығын және қоректік пластикалылығын көрсетеді. Бентос қоректі балықтар түрлі жемдермен қоректенуге қабілетті, осылайша олар бір-біріне қорек үшін бәсекелестік тудырмайды. Асқазан-ішек жолдарының толу индексінің ең төмен мәндері жыртқыш балықтарда анықталды. Талдауға алынған балықтардың барлығының асқазанындағы қорек кесегі қорытылған қорек түрінде кездесті. Ерекше ескере кететін жайт,

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күз мезгілінде ауланған балықтардың асқорыту мүшелерінде май қабатының болатындығы анықталды, бұл балықтардың қоңдылығын және жемдік қоректену объектілеріне тапшылықтың байқалмайтындығының дәлелі. Жүргізілген зерттеулердің нәтижелері бойынша Каспий теңізінің солтүстік-шығыс акваториясының жемдік объектілерінің түрлік маусымдық алуантүрлілігі анықталды.

Түйін сөздер: Каспий теңізі, қоректену, фораминифералар, құрттар, шаянтәрізділер, моллюскалар.

[1]С.М. Шалгимбаева, [2]Н.Н. Попов, [3]Н. Ибрагимова, [1]Ж.С. Омарова,
[1]Г.Б. Джумаханова*, [1]Б.К. Кайрат, [2]Е.М. Аргынбаева
[1]Казахский национальный университет имени аль-Фараби, Казахстан, г. Алматы,
e-mail: Gaukhar.Dzhumakhanova@kaznu.kz
[2]ТОО «Казэкопроект», Казахстан, г. Алматы
[3]Казахстанско-Немецкий Университет, Казахстан, г. Алматы

Исследование питания некоторых промысловых видов рыб с казахстанской части Каспийского моря

Аннотация. Необходимость изучения питания и пищевых взаимоотношений рыб в Северном Каспии вызвана тем, что данная часть водоема является местом нагула многих видов рыб. Материал по питанию был отобран в ходе комплексных морских исследований в казахстанской акватории Каспийского моря в летний и осенний периода 2018 года. Проведенное исследование питания таких хищных рыб, как судак, жерех и чехонь, а также рыб-фитофагов – лещ, вобла, карась, сингиль, полученных из траловых уловов, позволило проследить формирование общей продуктивности водоема и определить кормность водоема. Исследованные рыбы имели достаточно наполненные пищей желудочно-кишечные тракты. Рыбы с пустыми желудками встречались редко, что свидетельствует о хорошей накормленности и активном потреблении пищи. Так же было установлено, что основу рациона питания рыб бентофагов составляли ракообразные, моллюски и черви, у хищных видов – молодь рыб. Это говорит о пищевой пластичности и избирательности рыб. Так же бентосоядные рыбы могут питаться разнообразным кормом, и не создавать тем самым друг другу конкуренцию в питании. Самые низкие индексы наполнения ЖКТ были у хищных видов рыб. Основу пищевого комка у всех проанализированных рыб составляла переваренная пища. У рыб, выловленных осенью, на органах пищеварения были жировые прослойки, свидетельствующие о том, что рыба накормлена и не испытывала дефицита в кормовых объектах питания. По результатам данных исследований так же установлено сезонное видовое разнообразие кормовых объектов в северо-восточной части Каспийского моря.

Ключевые слова: Каспийское море, питание, фораминиферы, черви, ракообразные, моллюски.

Introduction

The Kazakhstan part of the northern Caspian Sea is the most productive sea part and represents the largest water body in the Republic of Kazakhstan, with an area of 56.3 thousand square km [1, 2]. About 90 % of the total river flow enters the Northern Caspian. Water with low-saline waters warms well during the summer period and is the main water area for the feeding of fry and advanced fry. Therefore, research of the nutrition of some commercial fish species represents overall interest.

According to G.K. Mutysheva [3, 4], the modern high and stable level of the Caspian Sea contributes to an increase in the biological productivity of the sea, but the trophic resources in the Kazakhstan Caspian Sea part are underutilized.

Many fish in natural water bodies have a nutritional degree of similarity, which leads to competition for food resources, especially in places of feeding, so the study of fish nutrition gives patterns knowledge that determines the level of metabolism inherent in each individual species in natural habitats. [5-7]. One of the important factors causing changes in the qualitative composition of fish stocks in inland waters, up to the replacement of some species by others, is interspecific interrelations [8, 9]. External factors replacing some fish species with others are different [10]. Conducted ichthyological research showed an uneven distribution of ichthyofauna in the Kazakhstan part of the Caspian Sea waters in the summer and autumn periods, and species diversity is represented by 12 species of commercial fish, the main of which are: bream, roach, crucian carp, sabrefish, asp.

Roach distributed very widely. Within the Caspian Sea forms several separate herds: the Azerbaijani, Turkmen and, most numerous, the

North Caspian. The distribution range of the North Caspian roach covers the Northern Caspian, for spawning it migrates to the Volga and Zhayik delta watercourses. Leads to the near-bottom lifestyle eat mainly mollusks of the slightly salted complex. In the Northern Caspian, it occupies the largest distribution area compared to other semi-anadromous fish. The roach is found at depths of up to 10-14 m, in waters of salinity up to 12 ‰, but its main concentrations are noted in areas with a depth of up to 6-8 m salinity up to 6-7‰ [11-13].

Bream is represented in the Caspian Sea by the subspecies, the eastern bream *Abramis brama Orientalis*_Berg. Inhabits the North Caspian, Volga, Zhaiyk, Terek, Kure. In the Northern Caspian, there are several local herds of bream: Volga, Zhaiyk, Terek. The life cycle of the bream takes place in the sea and in the Zhayik river delta, here is the feeding of adult fish and its young. In the sea, bream prefer smaller depths than the roach, its distribution area is narrower: it is limited by isohaline 8 ‰, although it is also found at higher salinity. The greatest amount of bream is usually fed at depths of up to 4 m and in waters with a salinity of 4‰. It feeds mainly on crustaceans, mollusks, and worms. At the end of summer and autumn, bream migrate to shallow areas of the sea and the lower part of Zhaiyk, where it remains for the winter. An immature bream migrates back to the North Caspian in spring. The duration of the ripening period of bream varies from 3 to 6 years. In the bulk of the fish for the first time spawn at 4 years old with a length of 24 – 30 cm.

The life span of bream in the eastern part of the Northern Caspian reaches 13 years old, the maximum dimensions and weight are 50 cm and 2.0 kg, respectively [14, 15].

Sabrefish. It has an elongated and flattened body. The back is almost straight with a very weak bulge. The color is typically pelagic: the back is dark, color is greenish, the sides are covered with silvery scales. The lateral line is trip-stitch, behind the pectoral fins descends sharply to the ventral side, at the level of the anal fin, sometimes branches out. Back fin is short, pushed back; pectoral fins long. The mouth is small, top. Pharyngeal teeth double row. Sabrefish forms residential and semi-passable forms. In the North Caspian, it is found at a salinity of 3-4‰, rarely at 9-10‰. Sabrefish is a freshwater fish by origin. Males sabrefish on the Caspian ripen at the age of 3-4 years, females in 4-5 years. On Zhayik, spawning of the sabrefish begins in May and ends in the first half of June at a water temperature of 12ºC. Spawning portion. Embryogenesis lasts 3-4 days [16].

Asp is widespread – the basins of the Northern, Baltic, Mediterranean, Black, Azov, Caspian and Aral Seas. In Kazakhstan, the natural fauna of the subspecies is only in the Caspian waters [17]. This species is confined mainly to the eastern part of the North Caspian. Although the frequency of its occurrence on average in the North part of the sea is lower than in many other species, its high consumer qualities make it a valuable commercial object [18].

Pike perch – belongs to the *Perciformes*, the family Perch (*Percidae*), the genus Perch (*Sander*). The natural range includes the basins of the Baltic, Black, Azov, Caspian, and Aral seas [19]. In Kazakhstan, in its natural range, it lives in the Zhaiyk River and its tributaries, rising above the city of Orenburg, and in the Caspian Sea, in areas with salinity up to 7-9 ‰.

Golden mullet (*Liza aurata*). In the years 1930-1934 the fry of three species of mullet *Mugil cephalus* (Lebanon), *Lisa aurata* (Golden mullet) and *Lisa saliens* (Gray mullet), imported from the Black Sea, were released into the Caspian Sea. Naturalization, i.e. the formation of self-reproducing populations, acquired only golden mullet and gray mullet. Less than 10 years after the introduction, commercial herds formed, and large concentrations of mullets were found off the coast in the southern part of the Caspian Sea, and in warm time — off the coast of the Middle and North Caspian. Golden mullet, compared with Gray mullet, mastered more northern areas [20]. golden mullet winters in the southern part of the Southern Caspian, mainly off the coast of Iran. In March, as the water warms up, feeding migration begins along the shallow waters of the eastern and western coasts of the sea to the Middle Caspian, where the golden mullet appears in April. Then it migrates north to the Mangyshlak peninsula and the Chechen and Tyuleniy islands, where it appears at the end of May. In June-July, he meets at Small Pearl island. During migration, the golden mullet is kept by small sparse shoals in the near-surface layers of water while actively feeding. In September-October, advanced fry migrates to the deep-water part of the Middle and South Caspian (300-700 m), where they spawn. Juveniles do not make extended migrations. Golden mullet research catches are quite rare and in recent years are more likely to be episodic. This is due to the limited number of stations (squares) in the most typical habitat for mullets [20]. In the research catches of 2018, the length of the golden mullet varied from 27.8 to 47.0 cm (average 39.9 cm), weight – from 270 to 1200 g (average 776 g). In Kazakhstan, the annual catch of the golden mullet does not exceed 435 tons [20]. A

rather high reproduction potential of mullet in the Caspian Sea, characterized by relatively early maturation, high values of SMS, fatness, accumulation of lipids, etc., ensures naturalization and their sustainable reproduction [21].

Crucian carp (*Cyprinidae*), the most common species of the carp family. In West Kazakhstan waters, crucian carp is common in all floodplains and lakes of the Zhayik, Emba and Kigach rivers. Crucian carp to the coastal strip and river mouths. In the current year, for the entire observation period, the crucian carp was noted exclusively in the coastal areas affected by the flow of the Kigach river [22].

Materials and Methods

In the summer period of 2018, from individual located stations in the northeastern part of the Caspian Sea, from the catch that was available in the 9 meter net, the material was selected for ichthyotrophologycal research. The digestive tract was selected from: 12 specimens of bream; 13 samples of roach; 5 samples of sabrefish; 5 specimens of pike perch; 5 samples of crucian; 5 samples of asp. In the autumn period, fish were also selected from samples obtained by trawling. The digestive tract was sampled from 17 samples of pike perch; 3 samples of crucian and 5 –and samples of asp.

To research, the nutrition of fish, standard quantitative and weight were used methods [22, 23]. The systematic identity of the organisms found in the food was determined, after the organisms were calculated, dehydrated on filter paper and weighed on torsion weights. In the benthophagous fish research, was noted a certain amount of soil. The relative importance of food organisms individual groups in the food spectrum was estimated by the frequency of occurrence (in % of the feeding fish number in the sample) and by the proportion of individual components in the total content of the food lump (in% mass). Calculated total indices of stomach filling (SPE, $^{o}/_{ooo}$) and the proportion of fish (%) with empty stomachs.

Results and Discussion

Roach nutrition *(Rutilus rutilus)*. The fish taken for research from summer samples was different sizes, their length varied from 205 to 282 mm, and the weight from 94 g to 247 g. Of the 13 gastrointestinal tracts, two were empty, which shows the difficulty of fish in food searches. All the sections of the 11 fish digestive tract contained the digested mass, and (TIF) – the total index of filling their stomachs was equal – 298.31 $^{o}/_{ooo}$. Active feeding of a roach can be identified by fragments of large shells of bivalve mollusks from the *Cardiidae* family, jaws and bristles of worms from the *Polychaeta* class, bones of small fish and digested tissue in the food lump. Roach has 85% of the food lump amounted to *Mollusca* (*Bivalvia*), 6.67% *Vermes* (*Polychaeta*) and 3.33% fish (Figure 1).

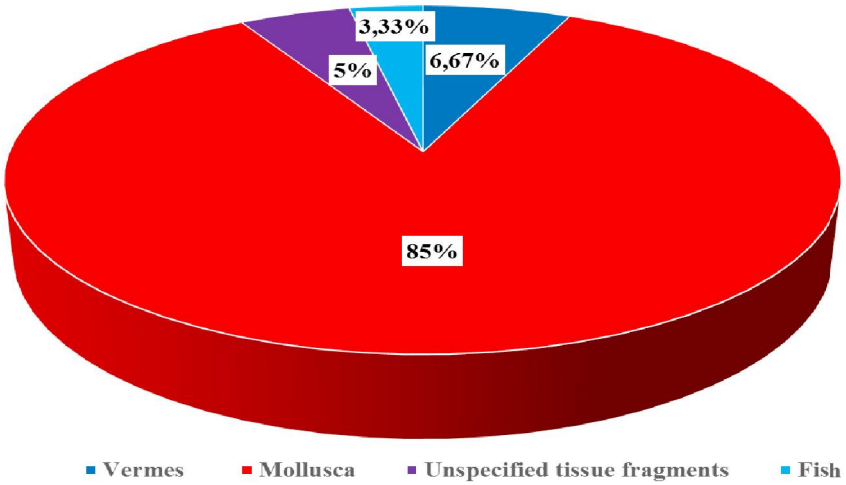

Figure 1 – Roach nutrition spectrum, in %

In addition, unidentifiable organic residues and grains of sand are noted in food clumps. Zooplankton in food clumps of fish is not registered (Figure 2).

Asp Nutrition *(Aspius aspius).* For the summer research, five specimens of asp were selected from 299 to 440 mm long, weighing from 500 g to 650 g. Their total digestive tract index was 236.46 $^{0}/_{000}$. The bulk of the food lump was: *Mollusca, Ostracoda* and half-digested fragments of fish heads and spinal bones. The digestive tract of one fish was empty. In asp in the food lump, 41% fell on *Mollusca* (*Bivalvia*), 30% on *Crustacea*, 24% on fish and 5% on unspecified tissue fragments (Figure 3).

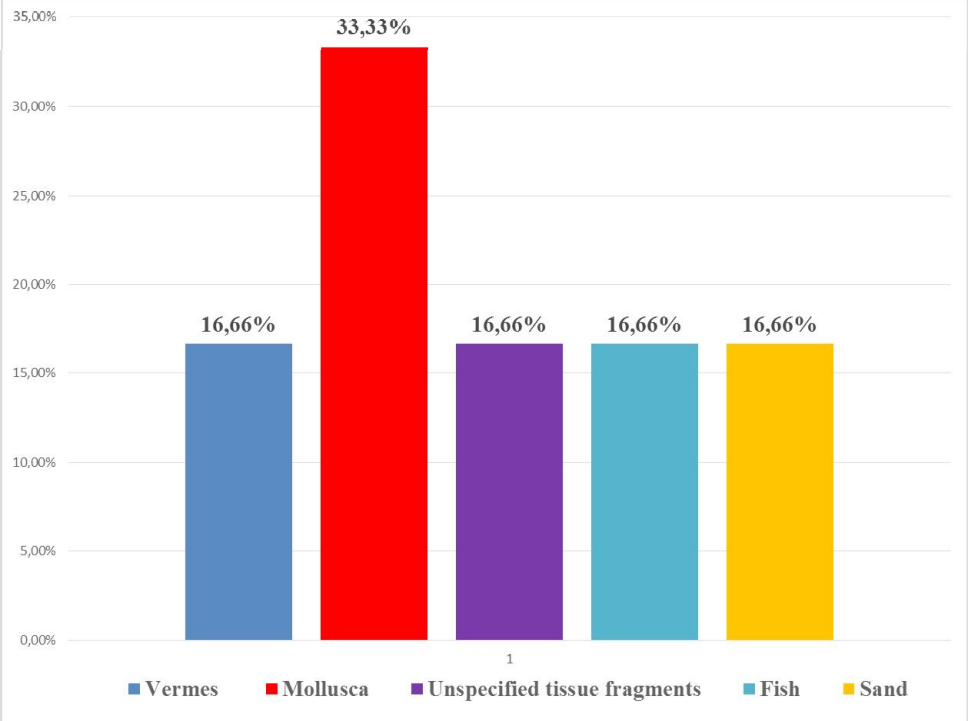

Figure 2 – % of the number of roach components

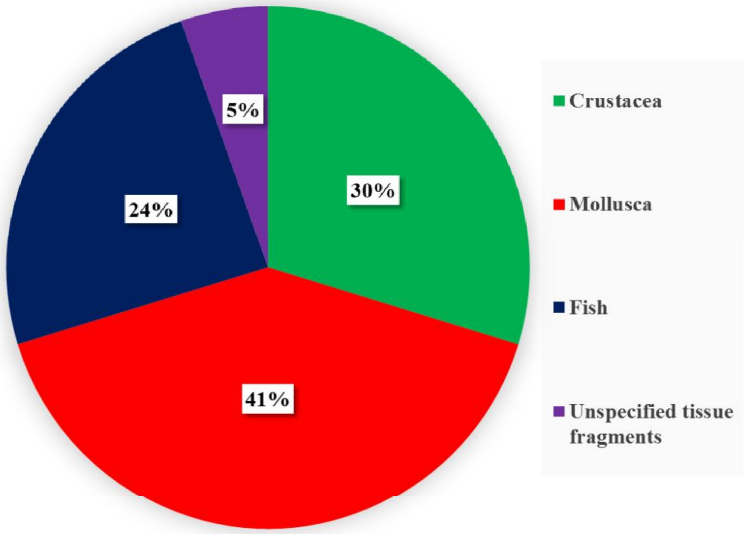

Figure 3 – Asp nutrition spectrum, %

Among the animal components of the asp of the asp, 2 taxa belonging to 2 classes of invertebrates were observed: *Crustacea* (crustaceans), *Bivalvia* (bivalve mollusks) as well as fragments of juvenile fish, and unidentifiable organic residues were noted (Figure 4).

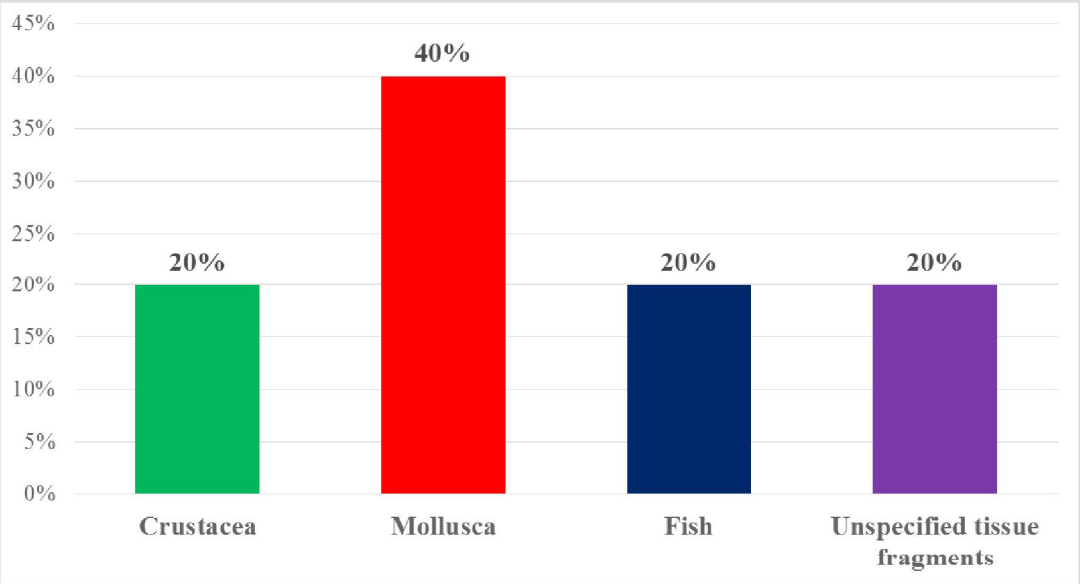

Figure 4 – % of the number of asp components

For autumn researches, 5 specimens of asp were selected; their body lengths ranged from 322 mm to 500 mm, weight from 370 g to 1090 g. There was a weak filling of the gastrointestinal tract, which was associated with components of the food lump, in which 20 % were residual fragments of *Insecta*, and 80 % is not detectable, digested food, just one stomach was empty (Figure 5).

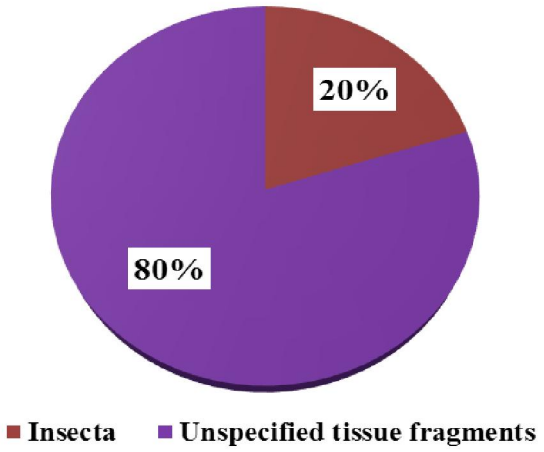

Figure 5 – % indicator of the asp components number

Among the animal components of the asp; 1 taxon belonging to the class of invertebrates: *Insecta* (insects) also unidentifiable organic residues (Figure 6).

The values of the index of the gastrointestinal tract filling in the asp from summer to autumn ranged from 236.46 to 130.32 $^{o}/_{ooo}$ (Figure 7).

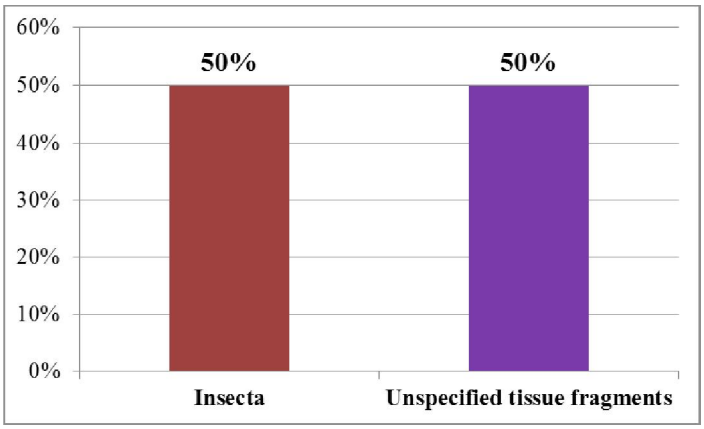

Figure 6 – % indicator of the number of components asp

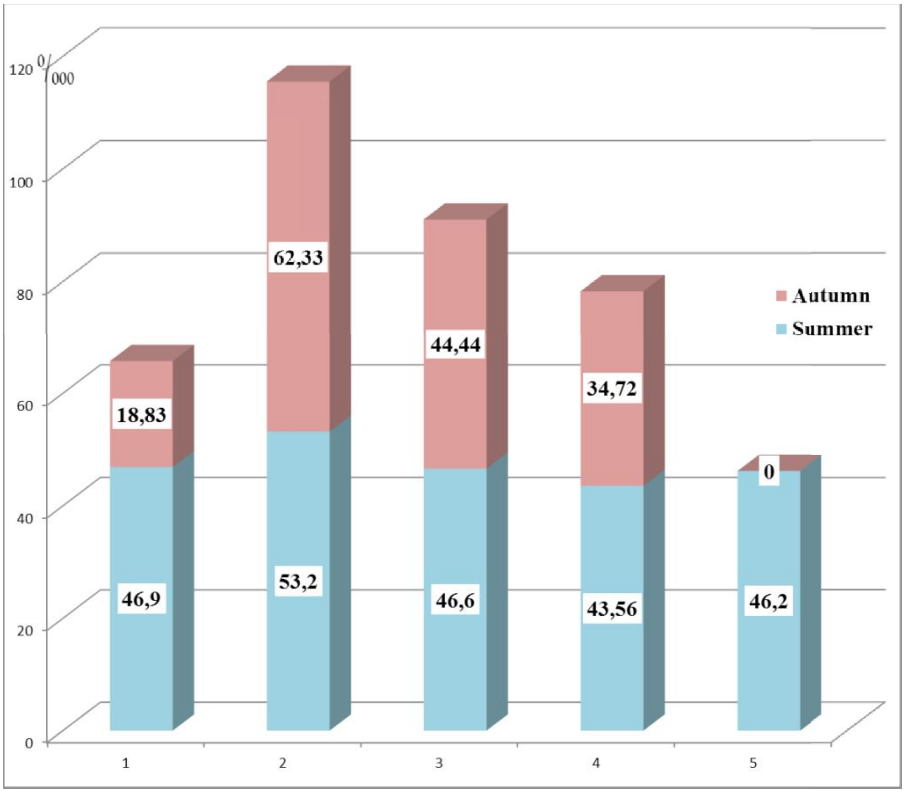

Figure 7 – Indexes of gastrointestinal filling of asp by seasons, in °/$_{ooo}$

The average index of gastrointestinal filling in the summer was 47.29 °/$_{ooo}$, in the fall – 32.06 °/$_{ooo}$ (figure 8).

Crucian carp nutrition (*Carassius carassius*). In 5 samples of crucian carps taken from summer catches, the length ranged from 250 mm to 295 mm., weight from 275 g to 320 g. The total filling index was 95.45 °/$_{ooo}$.

Crustacea, *Mollusca*, macrophytes accounted for the bulk of the food bolus. At the same time, *Crustacea* was 55%, *Mollusca* (*Bivalvia*) – 20 %, macrophytes 12.50 % and unidentifiable organic residues 12.50 % (Figure 9).

Among the animal components of the crucian carp, 2 taxons belonging to *Crustacea* (crustaceans), *Bivalvia* (bivalve mollusks), as well as fragments of higher vegetation, undetectable organic residues and grains of sand (Figure 10).

Crucian carps of the autumn catch were presented in 3 specimens, ranging in length from 205 mm to 260 mm, weighing from 141 g to 320 g, and the total filling index was 121.15 ‰

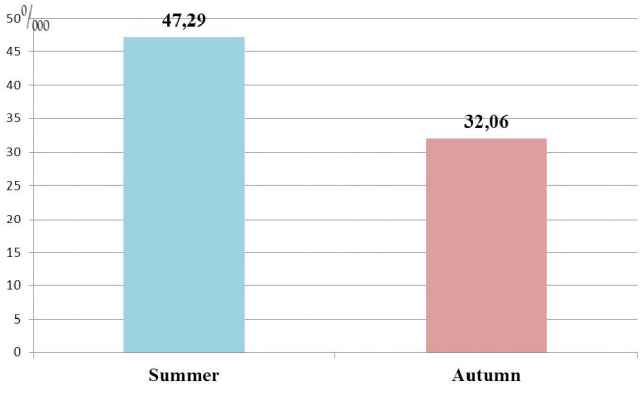

Figure 8 – The average index of filling the gastrointestinal tract in the asp by seasons, in ‰

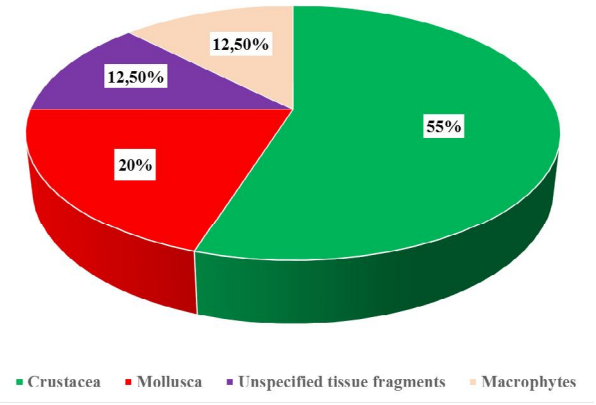

Figure 9 – The food spectrum of crucian carp, %

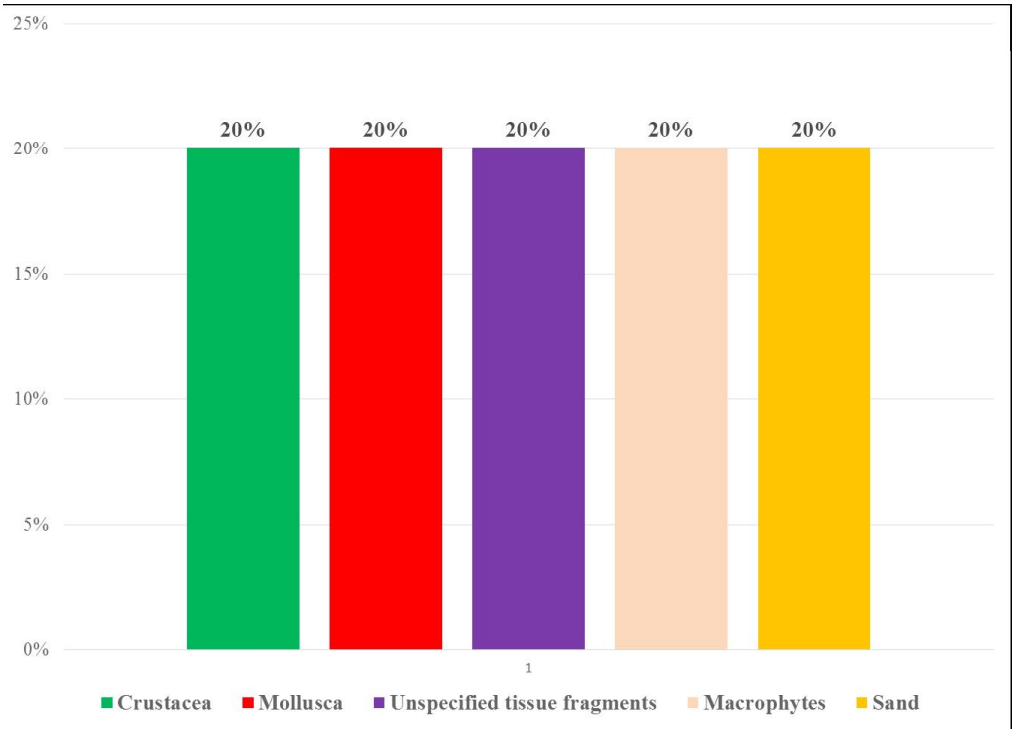

Figure 10 – % of the number of crucian carp components

The bulk of the food pellet of the crucian carp caught in the fall was digested food, in which fragments of the *Mollusca* shells (*Bivalvia*) were determined, which accounted for 43 % of the food pellet. 28.5 % took up macrophytes as well as unspecified fragments of digested tissue that accounted for 28.5 % (Figure 11).

The value of the filling index indicates that the fish are fed, which confirms the components of the food lump consisting of mollusk residues, vegetation, and soil (Figure 12).

The values of the index of filling the gastrointestinal tract in a crucian carp from summer to autumn ranged from 15.13 ‰ to 84.75 ‰. The general index of gastrointestinal filling in the summer was 95.45 ‰, in the fall – 121.15 ‰ (Figure 13).

Bream nutrition (*Abramis brama* L.). In the fish research from the summer catches, the length of the body varied from 164 mm to 320 mm., And the weight from 58 g to 280 g, while the total index of the digestive tract was 391.36 ‰. The digestive tract of one fish was empty, and the food lump mass

of the remaining fish was digested food: *Foraminifera, Vermes, Mollusca, Crustacea* were identified, in 3 fish in the food lump were small to 0.4 mm, *Cardiidae* was whole. In bream in the food lump 5.31 % was composed of *Foraminifera*, 41.44 % *Mollusca* (Bivalvia), 5.31 % – *Vermes* (*Polychaeta*), 47.44 % *Crustacea*, 0.27 % undigested digested tissue (Figure 14).

It can be noted that in all analyzed fish there was no pronounced fat layer, which can be associated with indicators of the number of components in fish (Figure 15).

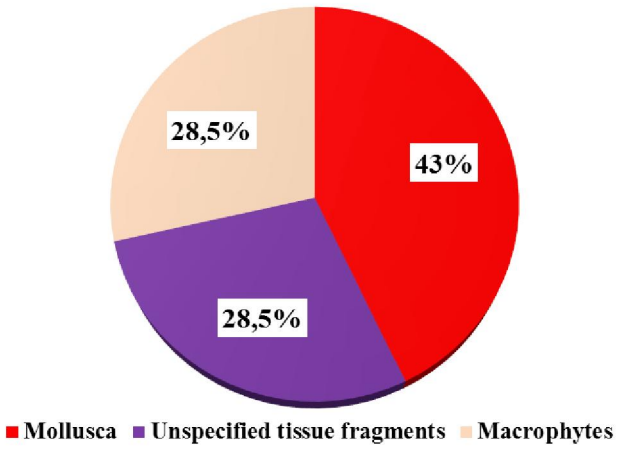

Figure 11 – % of the number of crucian carp components

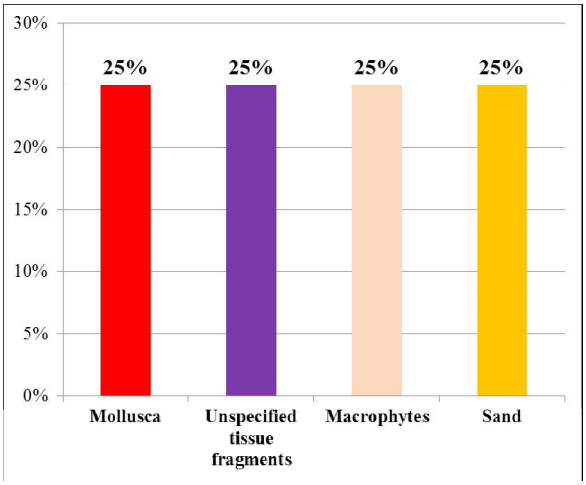

Figure 12 – Indexes of stomach filling of the crucian, ‰

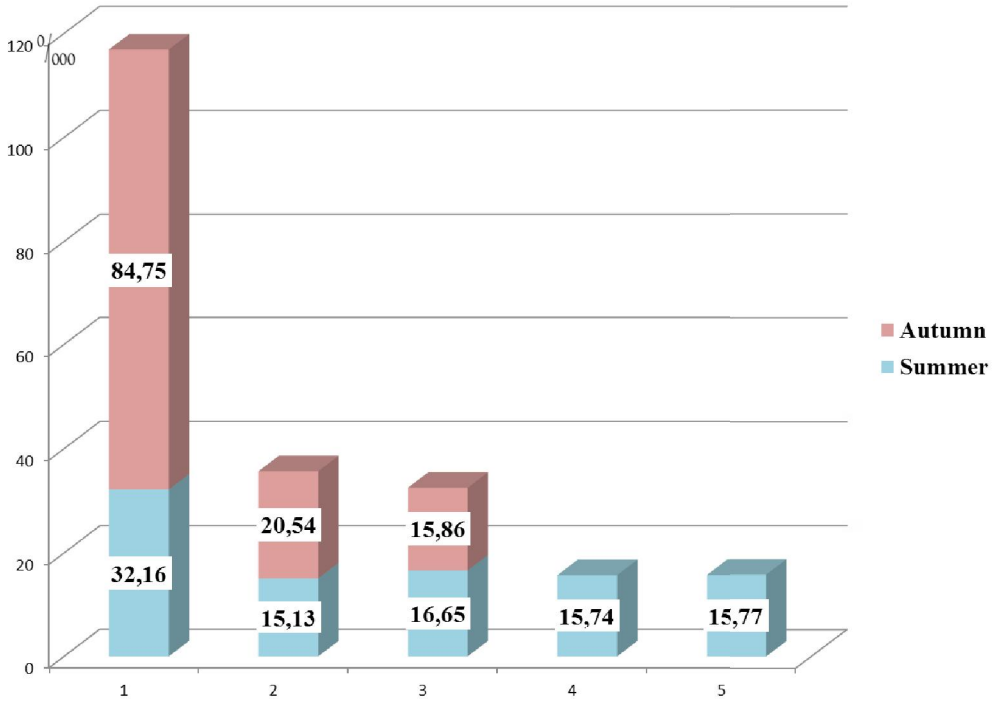

Figure 13 – General indexes of the filling of the gastrointestinal tract in a crucian carp in seasonal, in ‰

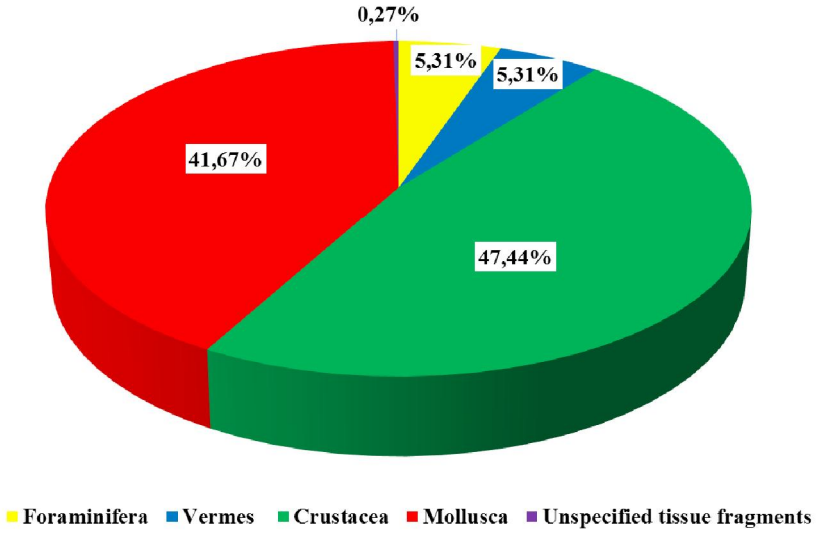

Figure 14 – The nutrition spectrum of bream, in %

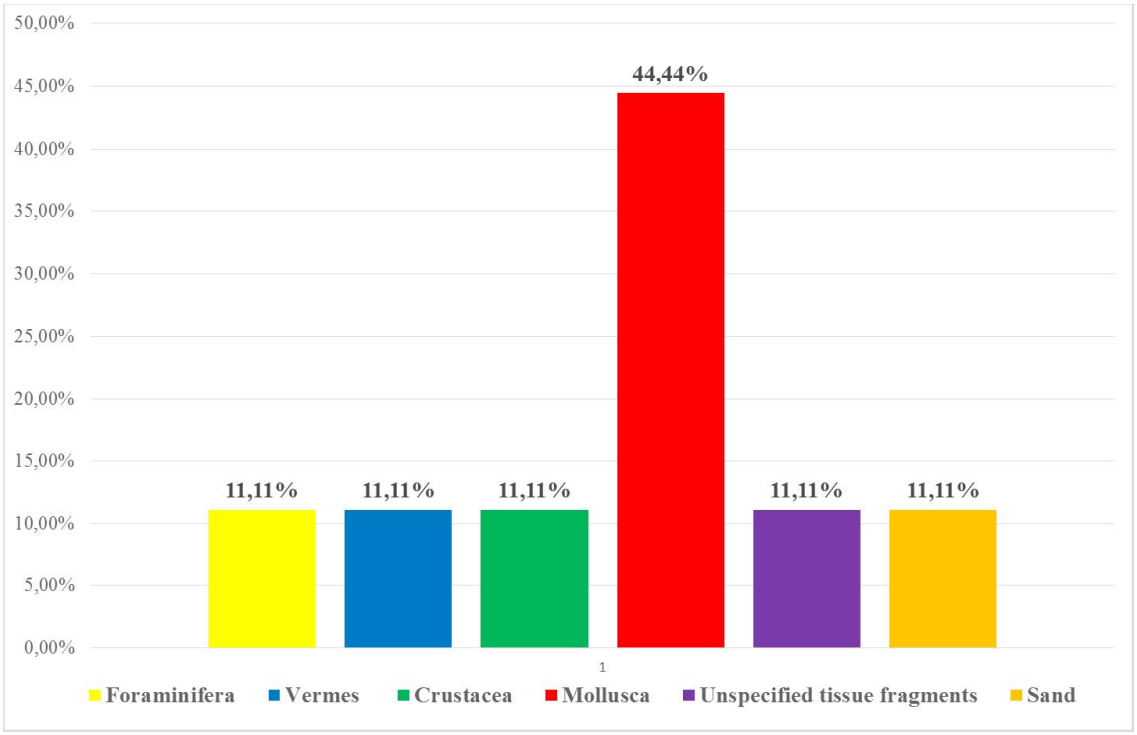

Figure 15 – % of the components number of bream

Pike perch nutrition (*Sander lucioperca*). In the summer catches were 5 samples of pike perch with a body length from 458 mm to 505 mm, weight from 1138 g to 1190 g. The total filling index is 330.33 $^{o}/_{ooo}$. The bulk of the food bolus was digested food, which was represented by fragments of *Atherina* (Table 1).

Table 1 – Composition of food pike perch in the summer of 2018

Components	Mass, g		Cards, pieces	B – % by the occurrence
	g	A -% by weight		
Digested parts of atherina	330,33	100	5	100
Total weight of the food bolus	330,33		5	

In 17 samples of pike perch presented for research in the autumn, there was also a difference in size. The measurements showed that the length of the fish varied from 510 mm to 590 mm, and the weight from 1141 g until 1670 g. Almost all the fish were well fed, which shows the filling of the stomach, both in the whole form and in the half-digested and digested form, mainly the shad fry (*Clupeidae*). Also, one fish in the stomach had a semi-digested goby (*Gobiidae*) and in three fish, in addition to the digested mass, there were also pharyngeal teeth of crucian carp fish (*Cyprinidae*). The presence of obesity and the presence of only one empty stomach indicates the availability of food (Figure 16). The overall filling index was 539.47 $^{o}/_{ooo}$.

The values of the index of the stomach filling in pike perch from summer to autumn ranged from 330.33 to 539.47 $^{o}/_{ooo}$ (Figure 17).

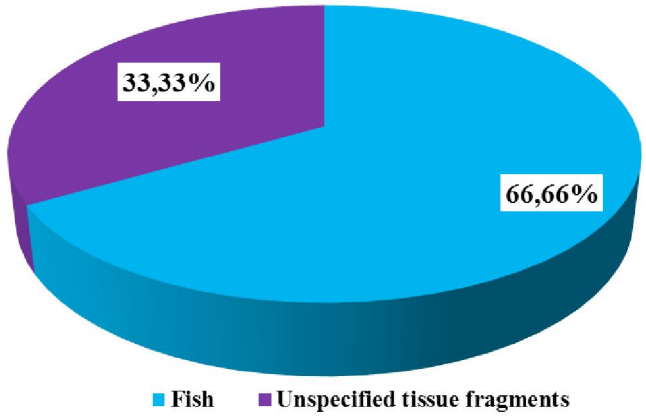

Figure 16 – The nutrition spectrum of pike perch in the fall of 2018, in %

Golden mullet nutrition (*Liza aurata*). From the summer samples of golden mullet, 5 specimens of the digestive tract of fish from 358 mm to 456 mm in length, weighing from 270 g to 630 g, with 76.64 $^{o}/_{ooo}$ – with a general filling index were analyzed.

The bulk of the food bolus was digested food, in which 73.91 % was *Foraminifera*, 0.11 % *Mollusca*, and 25.98 % *Crustacea* (Figure 18).

Low indexes of filling the digestive tract were at golden mullet. The base of the food lump in all researched fish was highly digested food with residual fragments of mollusks, crustaceans, vegetation and a large amount of foraminifera (Figure 19).

Sabrefish nutrition (*Pelecus cultratus*). Analysis of summer digestive tract samples 5 units of Sabrefish showed that body length ranged from 265 to 327 mm, weight from 118 g, to 217 g 158.56 $^{o}/_{ooo}$ – the general index of filling.

The bulk of the food bolus was digested food, which, by fragments of tissue, was determined as fish fry (Table 2).

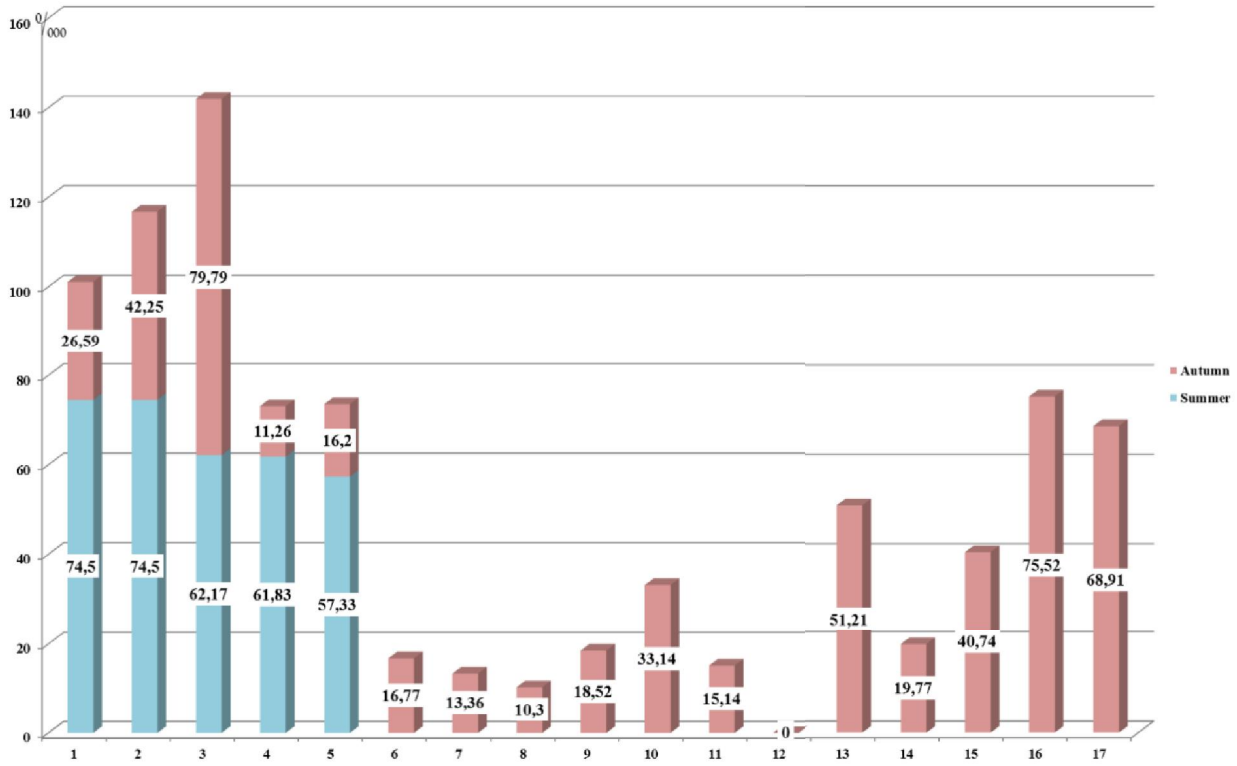

Figure 17 – Indexes of stomach filling of perch in seasonal aspect, in $^{o}/_{ooo}$

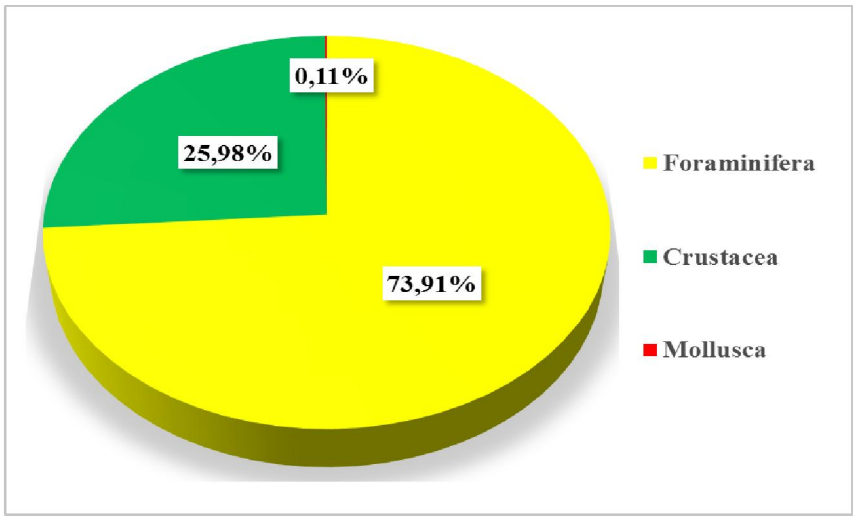

Figure 18 – The power spectrum of Golden mullet, in %

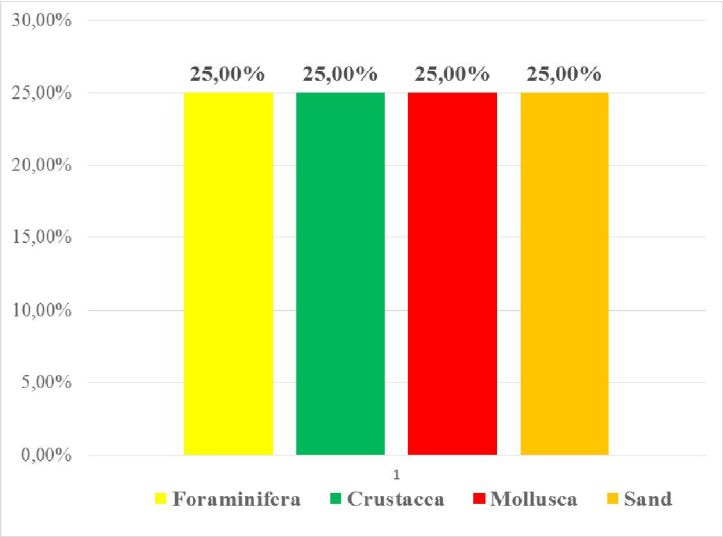

Figure 19 – The number of golden mullet food components, in %

Table 2 – The composition of food sabrefish in the summer of 2018

Components	Mass, g		Cards, pieces	B -% by the occurrence
	g	A -% by weight		
Fry	158,56	100	5	100
Total weight of the food bolus	158,56		5	

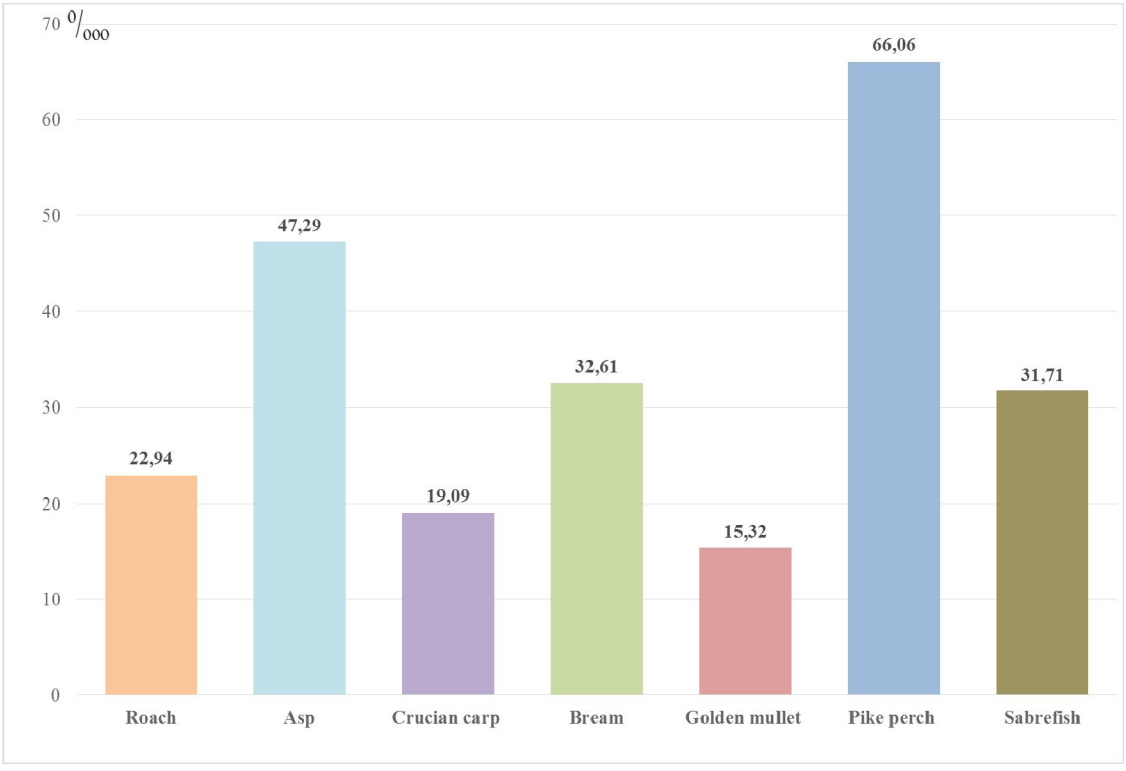

Figure 20 – Average filling indexes of the researched fish digestive tracts in the summer ‰

Analysis of the researched fish nutrition shows that the fish feeding depends on the composition and amount of food in the places of their feeding and migration, which is reflected in the average indexes of the total filling index of their digestive tract (Figure 20).

Based on the above, the feed base of the Kazakh Caspian Sea part showed good quantitative indicators in 2018 compared with the data for 2016 [25].

Analysis of the researched fish nutrition in the summer – autumn period of 2018 shows:

Conclusion

1. Feeding of fish depends on the composition and quantity of food in the feeding and migration sites, which is reflected in the average indexes of the total digestive tract filling index.

2. The digestive tracts of all examined fish contained digested food, the number of empty stomachs was single, indicating the density factor of consumers and their victims.

3. According to the indicators of the average index of the total digestive tract filling, the pike perch was the most fed, the food ration basis was fish of the family (*Clupeidae*), (*Gobiidae*), (*Cyprinidae*).

4. The basis of sabrefish small nutrition specimens also consisted of fish, the average index of the fullness of the gastrointestinal tract was lower than that of pike-perch.

5. Asp, bream, and roach also had good performance; the basis of the diet was mollusks, worms, and crustaceans.

6. Lower numbers of crucian carp were the diet basis of which was made by ostracods, small mollusks, macrophytes and the golden mullet whose diet was formed by foraminifera and ostracods.

According to the results of these research, it can be said that the species diversity of food objects creates favorable conditions for the growth and development of fish in the North-Eastern Caspian Sea part.

Conflict of interest

All authors have read and are familiar with the content of the article and do not have a conflict of interest.

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