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WAY OF LIFE, GROWTH AND FEEDING OF THE YOUNG BURBOT IN RYBINSK RESERVOIR

BY

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Way of Life, Growth and Feeding of the Young Burbot in Rybinsk Reservoir

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The burbot is the sole freshwater representative of the marine family Gadidae. Having immigrated into fresh waters from the polar basin, it retained many traits of the way of life of its marine parents. Despite what would seem to be favorable conditions for life, in no waters does the stock of burbot reach the high abundance which is characteristic for many other species of fish. It has specific importance as a commercial object only in certain bodies of water. Rybinsk Reservoir is one of these waters. The catches of burbot in it increased continuously and reached a maximum in 1961 when the annual catch was 5100 centners. But, beginning in 1962, despite an overall increase in the intensity of the winter fishery, the catches began to decline. Analysis of the size-age structure of the stock shows, however, that the abundance of burbot in the reservoir did not undergo significant changes. The decline of the catches evidently is connected with certain changes of the areas of its spawning and foraging. In order to approach estimation of the true abundance of a stock of any species of fish in bodies of water, it is necessary first of all to study its biology well. In this respect, the burbot has been studied far worse than many other species of fish.

Despite the fact that the literary data on the burbot are relatively numerous and diverse, often they are so contradictory that formation of a specific concept about a number of the biological peculiarities of this species is very difficult. As material for this report served both the literary data and our own observations on the way of life of young-of-the-year burbot in Rybinsk Reservoir, which were captured by hand net along the western shore of Cape Rozhnov at the end of September, 1965. In all, 60 young-of-the-year were caught and subjected to full biological analysis. Growth was determined by the otoliths with slight enlargement under a microscope. For examination, the otoliths were placed under a layer of water in a watch glass. Study of feeding was carried out by the method suggested by K. R. Fortunatova (1951, 1955, 1961).

Description of the stages of postembryonal development of the burbot can be found in the works of Retzius (1845), Sundevall (1855), Ehrenbaum (1909), Nordquist (1914), V. I. Kazanskiĭ (1928) and Muller (1960). Of them, the first three authors describe rather the free embryos (according to the terminology of Kryzhanovskiĭ) or pre-larvae (according to the terminology of Rass), and not larvae. The rest describe larvae which they caught in a body of water. However, the figures presented by these authors differ in extreme schematism, and descriptions of the larval structure are confined primarily to the character of their pigmentation. N. V. Evropeĭtseva (1947) described the period of larval

development of the burbot most completely and adequately. In it, she isolated four larval stages and thoroughly described each of them. Nevertheless, it should be noted that these stages are isolated rather artificially, since the author does not characterize them either by peculiarities of behavior or by the character of feeding. Bulk material collected under natural conditions and corresponding observations are necessary for such characteristics of phases or stages. However, in nature the larvae and young of the burbot lead an extremely secretive way of life, which hinders their capture greatly as well as observations on their behavior. The number of burbot larvae captured by the various authors amounts to only several hundred in all. There cannot even be talk of mass collections of burbot larvae as compared with collections of carp larvae, for example. Nevertheless, despite the rather fragmentary and sometimes even contradictory character of the literary data, it is quite possible to represent the general picture of the way of life of the young burbot.

The hatched embryos are rather active but the directions of their movement are very limited. Before the swim bladder is filled with air they can swim only in a vertical plane. S. V. Gerd (1951) even writes that during the first days after hatching the larvae hang on filamentous algae and feed on microscopic animals. This observation is most interesting since newly hatched burbot embryos lack cement organs.

After the swim bladder is filled with air the larval period of development begins. The larvae start to swim actively, not only in a vertical- but also a horizontal direction, and change to feeding on assorted food. According to V. G. Mel'yantsev (1946) overgrowths serve as food for them during the initial period. Apparently, at this time in lakes they remain close to the spawning ground and live on fine-sand bottom as well as in the water mass not far from shores, where the depth is relatively shallow (Nordaquist, 1914, cited by Evropeĭtseva, 1947; Ponedelko, 1954; Veber, 1961).

In rivers during high water the burbot larvae are carried away from the spawning ground by the current to the flooded littoral zone. Indication of this can be found in Müller (1960), in particular. This author notes that in years without a true spring flood (evidently, there is a slight rise in the water level of the river) the larvae stay at the edge of the submerged shore. He reports also that despite repeated attempts to capture larvae in lakes, he was unsuccessful.

After resorption of the yolk sac the larvae move off to the littoral zone in lakes also. Nordquist (1914) again indicated this. He wrote that larvae with a length of 7 to 14 mm and fry keep to the very shores or on floodplains among weeds (Carex, Sparganium) in very shallow places and never get into the open part of lakes. The data of G. D. Veber (1961) and Vallin (1942) indicate the same thing. However, Alm (1917) accidentally succeeded in capturing burbot larvae at a depth of 20 m (cited by Müller, 1960), and E. P. Radchenko (1935) caught them in Teletskoe Lake at a depth of 120 m.

Evidently, the Rybinsk burbot larvae lead an analogous way of life. Instances are known to us, through the oral reports of L. K. Il'ina, of its capture on pike spawning grounds in Rybinsk Reservoir. The results of our own exploratory catches indicate this indirectly, also. On April 15, 1965, on the spawning ground by the village of Lavrent'evo in the Yuzhnosheksninskiĭ reach of Rybinsk Reservoir we collected far fewer burbot larvae than on April 7-8, although the fishing was done at the very same places. This indicates that the hatching of embryos from their shells was completed by April 15. In connection with unfavorable hydrometeorological conditions in the spring of 1965, we succeeded in going out in search of the burbot larvae only on the 14th of May, i.e. a month after hatching. Careful fishing of the spawning area with a Kora net at various depths and at different water horizons yielded no positive results. We succeeded in capturing only one larva with the remains of a yolk sac and fat globule. This shows that the burbot larvae already had left the spawning area. However, continuous storms did not allow establishing exactly where. Storm winds and the currents driven together by them undoubtedly play a large role in the distribution of burbot larvae in Rybinsk Reservoir. Veber (1961) notes this also in regard to Syamozero. In addition, spring storms can have an effect on the strength of replenishment of the burbot stock in Rybinsk Reservoir. During strong storms, wave action in shallow areas causes a great quantity of bottom material to enter the water, particularly fine sand, which can wound the delicate burbot larvae easily.

At the end of the larval period of development the young-of-the-year burbot abandon the weeds. G. D. Veber (1961) points this out. This is also indicated by the absence of young burbot in the annual collections among the weeds of Rybinsk Reservoir, although very many young of other species are caught. Based on the capture of 13 young-of-the-year burbot by beam trawl in Sheksna Channel in the region of Cherepovets on June 26, 1953, and the absence of young in normal collections, R. S. Sergeev (1959) expressed the hypothesis that as early as the first stages of development the burbot avoids the greatly warmed shallows, sliding off into the deep water areas immediately after hatching. As one of the arguments for this hypothesis he cited the capture of 73 young-of-the-year in pools which were left after drop of the water in Pereborskiĭ Gulf in October. He supposed that they left for shallow water from the channel areas with autumn chilling of the waters. However, if young-of-the-year burbot actually preferred the deep water areas of the reservoir, then they would have to be caught fairly frequently in a bottom fry trawl. The capture of young-of-the-year in constricted pools reveals some other features of their way of life than Sergeev hypothesized; we will stop on this a little later on.

The data presented in the literature do not leave any doubts about the fact that burbot larvae live in the weeds of the shallow littoral zone; moreover, they hold here extremely tenuously. With the start of the fry period they leave the weeds and begin to lead an even more secretive way of life, which most likely is connected with changeover to the predatory type of feeding. A. V. Lukin (1935) described an instance of the capture of 15 young-of-the-year burbot at the mouth of the Sviyaga River in August 1931. In his words, young burbot were encountered in great number at this time under stones close to the shore of the Volga, at a place

of groundwater outflow. P. A. Dryagin (1949) also indicates that in summer young-of-the-year stay along the shores together with sculpins. According to the data of G. Kh. Shaposhnikova (1964), in the Birsaya River (a tributary of the Ural) young burbot in summer stay under stones together with the loach. S. V. Gerd (1951) also notes that in Karelian lakes young burbot at a length of 8-12 cm often can be found among the rocks close to shore. V. G. Mel'yantsev (1946) points out that in lakes the young burbot lives up to 1 year in the shallows, hiding among the rocks. It also lives among the rocks in rivers and usually selects areas of estuaries which discharge creeks and brooks into the river. Beginning with the second year the young burbot depart to live at deeper and muddier places. These data show that upon leaving the weeds the young burbot does not abandon the littoral zone, but only searches for more sheltered places in which it passes the daylight hours. However, in the report of G. U. Lindberg and G. D. Dul'keĭt (1929) it is mentioned that the young burbot also can emerge from hiding during the day. On August 24, 1925, in Shantarskoe Sea they observed young-of-the-year burbot which kept to the water surface by day. In their words, "the young-of-the-year moved slowly, staying in one place for a considerable time; having been startled, they quickly descended and hid against the dark background of the bottom. It is difficult to see the burbot by day, despite high transparency of the water".

The reports of M. G. Askhaev (1958) and I. V. Evropeĭtseva (1947) on the descent of burbot larvae in rivers are very interesting. The first of them observed the descent of burbot larvae in April along with cisco larvae on the Upper Angar and Kicher (Northern Baikal). Evropeĭtseva, on May 28, 1939, caught 40 larvae in the second stage of development at the site of inflow of the Logmozero into Onezhskoe. She hypothesizes that these larvae descended into Onezhskoe Lake from the Shui River. Apparently, in both cases the authors met with the peculiarities of reproduction of the lake-river form of the burbot.

We discovered young burbot on September 25-28, 1965, along the western shore of Rozhnovskiĭ Promontory in Rybinsk Reservoir. The reservoir bottom in this area is marked by a very sloping incline toward Sheksna Channel. The bottom is clean fine sand with gravel, large pebbles and large boulders. The young-of-the-year burbot were found under small, relatively-flat rocks almost at the very water line at a depth of 5-20 cm. The water temperature during the capture period ranged from 10.7 to 15.7° at these places; the oxygen content --- from 11.4 to 11.8 mg/l; free carbonic acid --- from 4.5 to 4.7 mg/l; electric conductivity --- $\gamma \cdot 10^{-4}$ = 1.70-1.73, and the pH of the water - 7.5. As inspection of this area showed, the young-of-the-year burbot prefer to stay in small quiet coves which are protected from the surf by large boulders. By day they hide under rocks and rooted stumps. The entrance to the burrow is usually completely inconspicuous. Apparently, young-of-the-year to some degree can dig under rocks which are resting loosely. One young burbot was found lying on its side in a very narrow slit between a boulder and a stick, which was pressed by a rather large rock. If the rock under which the burbot is lying is raised, the latter usually swims out from its refuge, but slowly and not far. Having lain for some time in an open

place, it then swims under any stone and conceals itself again. Both in swimming and lying in its refuge the burbot pushes its chin barbel forward. In contrast to the young of other species of fish in this area, young-of-the-year burbot do not even try to swim away upon being approached, even though they certainly feel the water vibrations very well. They did not swim away even when we approached their head with a hand net. This is a peculiarity in the behavior of young-of-the-year burbot which we utilized for their capture. Holding a hand net at the burbot's head and having pressed it tightly to the bottom, we caused the fish to swim directly into the net by touching a hand to the body. Brisk sweepings with the hand net in most cases led to a miss. Despite all of its sluggishness, the burbot usually succeeds in slipping away through the slightest crack between the hand net and the bottom.

We were able to catch only two young burbot at great depth. Nevertheless, apparently, the bulk of them lives not along the very water line but somewhat deeper. Due to wave action and blooming of the water we were not able to verify this directly, but the following fact is convincing as to the correctness of such a hypothesis. We made catches in the same places for three days, moreover we turned over and looked under literally every stone in this area. None the less, we caught young burbot in the very same places again both on the next and on the third day, even from under rocks which we had marked where they had been taken the previous day. In addition, in some places there were even more than on the previous day. Evidently, the young-of-the-year swim into the littoral zone at night, where the young of other species stay, and feed here. At dawn part of them probably swims back and part remains wherever the daylight catches them and they hide under the first available suitable cover. The young burbot also can seek shelter under the peat hummocks which are found in this area.

At a fish-receiving point in the village of Gayutino (eastern shore of Rybinsk Reservoir), one of the fishermen reported to us that more than once during the period of ice-over on the open water he saw a fairly large number of dead young burbot in constricted frozen pools in the middle of a flooded woods. The accuracy of this account can be verified completely; R. S. Sergeev (1959) in October, 1955, caught 73 young-of-the-year burbot in such constricted pools along Pereborskii Bay, where they had remained after drop of the water level. When inspecting the shore along Rozhnovskiĭ Promontory, we caught several young burbot in such circumstances. The young burbot is far more sluggish than the young of some other fishes. Evidently, it does not travel much when foraging. Having come upon a favorable feeding place, it remains there for some time. It should be noted in addition that during daylight the young burbot leads a generally motionless existence, hiding in its shelter. Because of this, it can be cut off from the main body of water far more frequently than the young of other species. In winter, as is known, a greater number of them die in constricted bays than of such active young as those of the pike, perch, roach, ide, etc. Consequently, the perishing of young in confined small waters can exert a greater influence on the strength of replenishment of a burbot population, than on other species.

We never found more than one burbot under a stone. Fabricius (1954) made interesting observations in connection with this; he observed young burbot in the first summer of life "vigorously struggling" for possession of grottoes and shelters between the rocks in an aquarium. Aggressive behavior was not observed in adults, even during spawning. Probably this peculiarity of behavior explains the fact that young-of-the-year and even larvae never form schools. The young burbot appears to be more tolerant toward the representatives of other species. Thus, often we found both a burbot and a sculpin under the same stone.

The opinions of authors differ in regard to growth of the burbot in the first year of life. As with other fishes, growth of the young depends to a considerable degree on the peculiarities of the body of water inhabited. V. K. Soldatov (1928) considers that the young burbot grows slowly and fry at the end of the first year of life reach an overall length of 90-120 mm. V. G. Mel'yantsev (1946), on the contrary, asserts that it grows rapidly and that by autumn the fry reach a length of 6-8 cm. According to the data of A. V. Lukin (1935), the burbot in the Volga around Kazan' at one year of age have an absolute body length of 137 mm, while young-of-the-year caught at the end of August in Shantarskoe Sea by G. U. Lindberg and G. D. Dul'keit had a length of 215-396 mm. According to the data of R. S. Sergeev (1959), young-of-the-year burbot in Rybinsk Reservoir at the beginning of September 1955, had an average length of 107 mm and weight of 10.6 g. Sergeev considered that the dimensions of autumn young-of-the-year differ little from the dimensions of yearlings, since the young burbot does not grow in winter. His data on the growth of the burbot in various waters show that in Rybinsk Reservoir the young grow worse than in comparable waters, particularly in the middle Volga.

In our trials the length of young-of-the-year ranged from 70 to 140 mm. Their average length was 101 mm and average weight 9.940 g. Thus, for the elapsed decade the weight and length dimensions of burbot young-of-the-year in Rybinsk Reservoir did not change.

As can be seen from table 1, the length and especially the weight of young-of-the-year varied greatly in our catches. The extreme lengths of the fish (males and females together) differed by two times, and weight --- by 10 times. The coefficient of variation of body length equaled 1.73. (σ 1.75; m 0.228). 1/ Naturally, a question arises about the reason for such a difference in the extreme lengths of the young burbot. Most probably, it depends on the difference in feeding conditions of separate individuals, and precisely on difference in the time of transition to feeding on fish, as takes place in all predators; in the pikeperch for example (Romanova, 1958, et al.). If we examine a size series of young-of-the-year, then we see that despite considerable difference in the extreme sizes it represents a normal, symmetrical, variational series, just as in young-of-the-year pikeperch (Vovk and Moiseev, 1958). A group of rapidly growing individuals stands out only among males, and then very indistinctly. Consequently, the transition to predatory

1/ σ - standard deviation; m - mean error.

feeding is accomplished gradually, somewhat earlier in some individuals, and a little later in others.

Table 1: Length and weight dimensions, fatness and oiliness of August young-of-the-year of the Rybinsk burbot in 1965

	Length, mm	Total body weight, g	Body weight without viscera, g	Fatness according to Clark	Oiliness, relative weight of the liver and viscera, %
Males and females . .	70-140 (101)	2.75-24.11 (9.94)	2.34-20.93 (8.54)	0.68	2.07
Males	84-140 (106)	4.85-24.11 (11.00)	4.29-20.93 (9.38)	0.68	2.10
Females	70-124 (97)	2.75-18.05 (8.86)	2.34-15.65 (8.00)	0.67	2.05

Footnote: In tables 1-3 the average values are given in parentheses.

As can be seen from table 1, males grow a little faster than females. Males are oilier than females at the same degree of fatness.

In the majority of natural waters the food of young-of-the-year burbot consists exclusively of invertebrates. These are primarily bottom organisms. Thus, according to the data of G. V. Aristovskaya (1935) and A. V. Lukin (1935), in the Volga basin in August young burbot at a length of 58-86 mm feed on chironomid larvae. In the Latvian lakes Siver and Dridzas (Sloka, 1959), the young burbot feeds initially on lower crustaceans and chironomid larvae, and at the end of summer begins to utilize young fish. In the Ob' basin the food of young-of-the-year consists of the larvae and pupae of chironomids, caddis flies and mayflies, and gammaruses and leeches (Tyul'panov, 1964). The young of other species of fish appear in the diet of the Ob' burbot only in the second year of life. The benthos predominates for food up to the 4-6th year of life. In the lakes of Karelia (Mel'yantsev, 1946; Gerd, 1951) the young burbot also feeds primarily on invertebrates; amphipods and different insect larvae. The literary data, despite their scantness and fragmentary character, show that both in rivers and in lakes and reservoirs the food of the young burbot consists almost exclusively of bottom organisms.

The food of the young-of-the-year which we caught in September, 1965 consisted mainly of bottom organisms. Chironomid and mayfly larvae and molluscs were found most often in their stomachs. We also encountered young-of-the-year of other fishes. Of 60 specimens studied in regard to feeding, food was found in the stomachs of 49 young-of-the-year. The food composition (in %) is as follows:

Chironomid larvae	71.5
Mayfly larvae	30.5
Caddis-fly larvae	10.2
Asellus	14.3
Molluscs	32.6
Crustaceans	12.2
Fish	34.6

As analysis of stomach contents showed, the species composition of chironomid larvae in the food of young burbot is very limited. Limnochironomus ex gr. nervosus (66%) and Glyptotendipes ex gr. gripekoveni (17%) have the greatest importance. As for molluscs, the young-of-the-year eat small specimens of Pisidium and Dreissena.

It is possible to separate three groups among the investigated young burbot, according to the character of feeding. Most of them (65% of all fish) feed only on invertebrates; the second group (24.8%) - only on fish; and finally, the third (10.2%) - mixed food: invertebrates and fish. The smallest burbot feed on invertebrates, and the largest --- on fish. The fish with a mixed character of feeding occupy an intermediate position according to size (table 2).

Table 2:--Size and sex composition of young-of-the-year burbot feeding on different food

Food composition	Size of burbot, mm		Studied specimens		in %	
	males	females	males	females	males	females
Invertebrates	93-116 (105)	92-110 (95)	11	21	34.3	65.7
Invertebrates and fish	89-119 (107)	116-124 (120)	3	2	60.0	40.0
Fish	93-140 (123)	103-124 (111)	7	4	63.5	36.5

It was shown earlier (table 1) that males grow somewhat more rapidly than females. This difference in growth is especially pronounced upon examination of the character of their feeding. Males and females which feed on invertebrates differ little in growth; however, the difference is especially marked in fish that feed on mixed food and fish (table 2). In connection with this, the initial insignificant difference in their growth increases more and more. Feeding on fish also explains the greater oiliness of males in comparison with females.

Besides young burbot, the ichthyofauna of the study area consisted of sculpins (Cottus gobio L.), of which there were more here than burbot, and schools of young-of-the-year perch and roach. The ruff, bleak and loach were encountered less often. Adult sculpins were unsuitable as food for the young burbot due to size; therefore, the fish feeding of the latter consisted of young-of-the-year perch (40%),

ruff (33.3%), roach (20%) and bleak (6.7%). The perch and ruff, which together comprised 73 percent of the total amount of fish consumed, remain the basic food objects of the adult burbot (Ivanova, 1965). The sizes of the perch in the food of young-of-the-year burbot ranged from 25 to 41 mm; the ruff --- from 30 to 50 mm; the roach --- from 32 to 38 mm. The ratio of the size of the prey to that of the predator for young-of-the-year burbot varied from 25.7 to 40.4 percent, whereas in immature and mature individuals it decreases to 13.6-17.0 percent.

The feeding intensity of the burbot studied was not great. The general indices of filling ranged from 0.08 to 10.2 o/ooo, whereas in burbot from the Ob' (Tyul'panov, 1964) they reach 13.2-22.0 o/ooo. Such small indices of filling in the Rybinsk burbot can be explained by the fact that the material was collected in daytime, when the burbot have ceased feeding and, remaining under rocks, only digest their catch. In particular, this is indicated by the fact that the average degree of filling decreases from 2.1 o/ooo in burbot caught from 10:00 to 12:00 AM to 1.6 o/ooo in those caught during the second half of the day. The degree of filling of young-of-the-year that have changed over to feeding on fish naturally is higher (0.9-10.2 o/ooo) than of those feeding on invertebrates (0.08-4.9 o/ooo).

It is a distinctive feeding trait of the burbot in Rybinsk Reservoir to shift to feeding on fish earlier than do the burbot in other waters. Here, it begins to prey in the first year of life at a body length of about 100 mm, whereas in the Ob' (Tyul'panov, 1964) burbot begin to feed on fish only in the second year of life.

Some authors, in particular M. A. Tyul'panov, consider that by devouring chironomid larvae the young burbot is competing with valuable commercial species; therefore, the burbot is an undesirable element in the ichthyofauna of a number of waters. However, it seems to us that it is impossible to speak seriously about competition in the case under consideration, since the young burbot dwells in very specific parts of the reservoir that are not utilized for foraging by the other benthphages.

Studying the feeding of young-of-the-year burbot, we turned attention to the number and size of their pyloric caeca. It is well known that in the adult burbot their number varies extremely. Thus, M. I. Markun (1936) found that in the Kamskoe burbot the number of pyloric caeca ranges from 21 to 67. According to L. S. Berg (1949), there are an average of 86 caeca in the lake-river form of the burbot, while in the lake form - 1.5 to 2 times fewer.

The physiological role of the pyloric caeca is not reliably known. It can be hypothesized that it involves increase of the absorptive surface of the intestines. In addition, the caeca possibly take part in the secretion of digestive juices (Wunder, 1936; Pegel', 1950; Puchkov, 1954, et al.). On an example of 7 different families of fish (Clupeidae, Thymallidae, Pleuronectidae, Gadidae, Percidae, Zoarcidae and Cottidae), A. N. Svetovidov (1934, 1953) showed that "the larger the organisms on which one or another species of fish feeds, the more pyloric caeca it has". A connection between the number of pyloric caeca and the character

of the food of fish is noted by K. R. Fortunatova (1933) in Caucasian trout, and also by A. Belogurov (1939) in Caspian sturgeons. If an interconnection of the character of food and the number of pyloric caeca is shown within different taxonomic groups by these two authors, then Fortunatova succeeded in revealing it within one species in populations living under different ecological conditions.

In the processing of our material we discovered that the number of pyloric caeca varies considerably (from 27 to 66) even within one small intrapopulational grouping. It was found also that the pyloric caeca of individuals differ not only by number, but also by size and even by shape. Assuming that the role of the caeca embraces primarily increase in the absorptive surface, we decided to compare them in different fish not by number, but by the area of this surface. Having taken the shape of each caecum as a cylinder for this, we calculated its area and multiplied the latter by the total number of caeca. A very interesting relationship was discovered upon comparison of the total area of the pyloric caeca in different individuals.

It turned out that the total area of the pyloric caeca in young-of-the-year which feed on fish is two times greater than in those feeding on invertebrates (table 3).

Table 3:--Change in the total area of pyloric caeca in relation to the character of feeding of young-of-the-year Rybinsk burbot

Food composition	Average size of burbot, mm		Number of pyloric caeca		Area of pyloric caeca		Number of fish studied	
	males	females	males	females	males	Females	males	females
Invertebrates.	120	95	20-46 (39)	35-51 (41)	199.0-501.5 (376.3)	245.5-554.0 (422.5)	6	12
Invertebrates and fish . .	119	124	(34)	(42)	(521.2)	(643.0)	1	1
Fish	120	-	36-47 (41)	-	510.7-1200.1 (829.5)	-	6	-

Thus, our data on the feeding of young-of-the-year burbot show that a dependence between the pyloric caeca and the type of feeding is characteristic not only for fish of different taxonomic groups (Svetovidov, 1934; Belogurov, 1939) and separate populations within one species (Fortunatova, 1933), but also for separate intrapopulational groupings of fish. However, this dependence does not pertain to the number of pyloric caeca, but to the total area of their absorptive surface. Change in the character of food during ontogeny leads to change in the area of the absorptive surface of the intestines.

The young burbot leads a very secretive way of life. After hatching out the larvae remain for some time in the spawning area, and then move off to the shallow littoral zone where they live together with the young of other species, but in contrast to the latter remain singly. At the end of the larval period the young burbot forsakes the littoral weeds, and the daily rhythm of its life becomes similar to that of adult individuals.

Young-of-the-year burbot feed primarily on bottom invertebrates and toward the end of summer also on the young of other species of fish. Changeover to feeding on fish is not accomplished by all individuals simultaneously. Males begin to feed on fish first. As a result of this they fatten and grow more rapidly than females. Building of the digestive tract in the young is found to be in direct connection with their feeding peculiarities. The area of absorptive surface of the pyloric caeca in individuals which feed on mixed food is greater than in individuals which feed only on invertebrates, but less than in individuals which utilize only fish.

Stormy weather during the early larval period of development and the death of young-of-the-year due to the drying up of shallow coves upon drop of the water level can exert a strong negative effect on the strength of replenishment.

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