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Assessment of ecological conditions for growing the market-size fish in the Kantivka fattening pond (Khmelnychchyna, Ukraine)

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Contents

Abstract

Abiotic (water quality) and biotic (Phyto-, zooplankton and benthos) factors in the Kantivka fattening pond the Khmelnitskrybhosp Private Joint-Stock Company were studied during the vegetation seasons in 2020. The aquaculture objects in the pond are cyprinid fish species (carp, grass carp, silver carp, pike). The ecological conditions of the pond were evaluated as good enough for the fish fattening purpose. The critical water quality parameters were following traditional values accepted for fish farming in Ukraine. The taxonomic composition of plankton and benthos was represented by widespread and Ubiquiti species mainly. The 124 species and intraspecies taxa of microalgae and the 34 species of zooplankton were identified in the Kantivka fattening pond. The mean abundance and biomass for the phytoplankton were 183.8 million cells/dm^3 and 35.61 mg/dm^3, respectively; for zooplankton, those were as 336600 ind/m^3 and 14.83 g/m^3, and for zoobenthos, those values were as 309.6 ind/m^2, and biomass as 5.84 g/m^2. Such parameters of natural forage base correspond to the optimal values for natural fish food according to fish farming standards in Ukraine. In the late summer, the free-living copepod stages and mature adult females of the parasitic copepod crustacean *Ergasilus sieboldi* Nordmann were registered in plankton. This copepod causes the invasion of fish diseases like infection and destruction of gill arches, which leads to a severe disturbance in fish respiration, emaciation, delaying in growth, and the potential death of commercial fish even. The development of natural fish food in the Kantivka fattening pond is shown an intensive level of biomass and abundance of phytoplankton, zooplankton, and zoobenthos. It is considered sufficient to meet the natural nutritional needs (in combination with artificial feeding) for older age groups of the cultivated cyprinid fish species.

Keywords: natural forage base, phytoplankton, zooplankton, benthos, cyprinid fish species, *Ergasilus sieboldi*.

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1. Introduction

Intensification of fisheries aims to meet the growing demand for fish as the world population grows (Burhaz et al., 2019; 2020; Honcharova et al., 2021). Research investigations on sustainable aquaculture practices, raising the intensity of fish growth and increasing a crop while minimizing environmental and social impacts, concerns about how animals are reared, and the environmental impacts of aquaculture have made sustainability more critical for consumers. Aquaculture offers a way to meet global demand while reducing the pressure on wild capture fisheries. The dynamics of fish consumption and its products in Ukraine have constantly grown from 9.6 kg per person in 2016 to 12.5 kg in 2019 (Public report…, 2019). At the same time, this number has reached 22 kg per person in Europe (FAO, 2020).

Water quality parameters are fundamental for both the health and growth of farmed fish species. The main ecological factors, like temperature, oxygen, chemical, and hydrobiological regimes, directly affect the complexity of production potential and the efficiency of fish farming (Rudenko et al., 2019; Honcharova et al., 2019; Vodianitskyi et al., 2020; Kofonov et al., 2020; Prychepa et al., 2021).

Despite the increase of variety of artificial fish feeds at the Ukrainian market aimed to enhance fishes' growth and gut performance, the natural fish food, namely planktonic and benthic invertebrates, algae, small vertebrates (juvenile fish) is still play great importance. All commercial fish species' fry feeds exclusively on the natural forage base – rotifers, microcrustaceans. E.g., the fry of the one-year yellow perch feeds exclusively on natural food (planktonic and benthic organisms). Thus, this fry weighing 3–5 g feeds on rotifers; at weigh up to 12 g – the 90 % of gut content is mainly cladocerans and copepods, and fry weighing more than 15 g is changing from the uptaking the tiny organisms to large (Sharylo et al., 2018). Pike, catfish, pike perch, and other fish species popular in Ukrainian aquaculture feed similarly. However, the cyprinid fish species are still the most welcomed by Ukrainian customers.

It is known that the nutritional value of alive natural fish food in regards to nutrient content and amino acid composition of the protein is significantly exceeded the nutritional value of artificial feeds. The leading natural food for cyprinid species in fishing ponds is phytoplankton, zooplankton, and zoobenthos. Fishing ponds are considered more productive if green (chlorococcal) algae dominate the composition of phytoplankton. The zooplankton is by cladoceran and copepod crustaceans, and the zoobenthos is by chironomid larvae (Krazhan & Khyzhniak, 2014). At the same time, other ecological, environmental conditions like temperature, dissolved oxygen, a chemical regime of Water significantly affect the productive potential and determine the efficiency of fish farming.

Our work aimed to investigate the ecological conditions like qualitative and quantitative parameters of natural forage base of the Kantivka fattening pond (Khmelnytskyi region, Ukraine), the taxonomic composition, abundance, and biomass of Phyto-, zooplankton, and zoobenthos, as well as to monitor the central hydrochemical values of water quality during the warm season.

2. Materials and methods

The research was conducted during the 2020 warm season in the Kantivka fattening pond (N 49° 60′, E 27° 39′), located in Pylyavka, Khmelnytcky region, Ukraine. This pond operates by the Khmelnitskrybhosp Private Joint-Stock Company, engaged in cultivating market-size fish, breeding processes, and fry growing. The main focus of the aquaculture in the Kantivka fattening pond is growing the market-size cyprinid fish species (carp, herbivorous fishes, pike). The area of the pond is about 155 ha, and the average depth is 1.5 m. Hydrochemical and hydrobiological samples were taken in June, August, and September 2020 and analyzed in the Laboratory of ecological researches of IF NAAS according to the generally accepted methods in fish farming (Alekin et al., 1973). The obtained values were compared with the current standard values accepted in fish farming in Ukraine (Voda rybohospodarskyh…, 2006).

Hydrobiological samples were taken simultaneously with hydrochemical ones. Phytoplankton samples as 0.5 liters of water were taken from the upper horizon at a depth of 0.2–0.5 m in different pond parts: near the top, in the middle, and at the dam and fixed with 4 % formaldehyde. Fixed samples were kept in the dark place for 10–12 days, then concentrated by reverse filtration. The calculation of abundance and biomass of phytoplankton was performed following by Krazhan and Khyzhnyak (2014). Taxonomic identification of planktonic algae is performed under the Micros MC 300 microscope (Austria) followed by Asaul (1973), Topachevsky and Masyuk (1984), Kondratieva (1968).

Zooplankton samples were taken from the different parts of the pond (top, middle, and dam) using a miniature model of the Apstein plankton net (mesh size is № 76), through which 100 liters of Water were filtered. Samples were fixed with 4 % formaldehyde. They were processed and counted following Krazhan and Khyzhnyak (2014). To calculate the biomass, the tables of the wet weight of individuals were used. The species composition of zooplankton was studied under the ULAB microscope (China) using Kutikova (1970), Monchenko (1974), Hudec (2010), Alekseev and Tcalolikhin (2010).

A cylindrical bottom sampler with a square of 0.01 m^2 was used for zoobenthos sampling. One sample was included the soil of three dredgers taken from different parts of the pond. Bentos was washed through a sieve with mesh size № 18 and fixed with 4 % formaldehyde. In the Laboratory, the benthic organisms were sorted into systematic groups, counted, and weighed on torsion balance. Then the abundance and biomass of organisms were recalculated as ind/m^2 and g/m^2, relatively. The species composition of organisms was determined under the dissecting microscope MBS-1 using Alekseev and Tcalolikhin (2010), Pankratova (1983), Krazhan and Lupacheva (1991). The photo-, zooplankton and benthos samples were carried out in the Laboratory of Hydrobiology and Technologies of Cultivation of Valuable Invertebrates, IF NAAS.

3. Results and discussion

Water quality

The water temperature in the Kantivka fattening pond was varied from 20 to 28 ºC during the studied seasons. The chemical composition of pond water is of hydro carbonate class by the calcium group and is common for natural waters of Polissya. Water mineralization was varied from 375.0 to 401.7 mg/dm^3. The hydrocarbons concentration was 256.3–268.5 mg/dm^3, calcium – 42.1–48.1 mg/dm^3, magnesium – 21.9–41.3 mg/dm^3, sodium + potassium – 2.8–30.3 mg/dm^3, and the total water hardness was 4.0–5.0 mg-eq/dm^3 (Table 1). The pH (7.3–7.5) and the content of free ammonia (0.02 mg N/dm^3) did not exceed the normal values.

In general, the chemical parameters of the water quality of the Kantivka fattening pond are suitable for aquaculture. Most of the chemical elements were within the normal values adopted for fish farming in Ukraine. We noticed from permanganate oxidation that the content of soluble organic matters in August and September was higher. In September, it increased significantly by 1.8 times, primarily due to the extinction of microalgae and the accumulation of organic matters in the Water. Also, the nitrite values slightly exceeded the acceptable parameters in August and September, but this is not a significant threat for aquaculture. It was an intermediate temporal product of ammonium when it transformed into nitrates due to bacterial activity. A slightly high iron level in the Water (1.43–2.11 mg/dm^3) was observed during the monitoring.

Table 1
Water quality parameters of the Kantivka fattening pond in 2020

№	Water quality parameters	Sampling time, month			Standard values for pond water
		June	August	September	
1	Hydrogen ion concentration, pH	7.3	7.4	7.5	6.5–8.5
2	Free ammonia, NH_3 mg N/dm^3	0.02	0.02	0.02	≤ 0.05
3	Permanganate oxidation, mg O/dm^3	9.6	17.9	27.2	≤ 15.0
4	Bichromate oxidation, mg O/dm^3	24.0	44.7	68.0	≤ 50.0
5	Ammonium nitrogen, NH_4^+, mg N/dm^3	2.20	1.51	1.83	≤ 2.0
6	Nitrites, NO_2^-, mg N/dm^3	0.06	0.11	0.14	≤ 0.1
7	Nitrates, NO_3^-, mg N/dm^3	0.15	0.08	0.33	≤ 2.0
8	Inorganic phosphorus, PO_4^{3-}, mg P/dm^3	0.33	0.33	0.42	≤ 0.7
9	Total iron, Fe^{2+}+Fe^{3+}, mg Fe/dm^3	1.63	1.43	2.11	≤ 1.0
10	Calcium, Ca^{2+}, mg/dm^3	42.1	48.1	42.1	≤ 70
11	Magnesium, Mg^{2+}, mg/dm^3	23.1	21.9	41.3	≤ 30
12	Sodium + Potassium, Na^+ + K^+, mg/dm^3	30.3	19.3	2.8	≤ 50
13	Hydro carbonates, HCO_3^-, mg/dm^3	268.5	256.3	256.3	≤ 400
14	Chlorides, Cl^-, mg/dm^3	22.5	20.8	25.0	≤ 70
15	Sulfates, SO_4^{2-}, mg/dm^3	8.6	8.6	9.5	≤ 70
16	Hardness, mg-eq/dm^3	4.0	4.2	5,0	5–7
17	Mineralization, mg/dm^3	395.1	375.0	401,7	≤ 1000

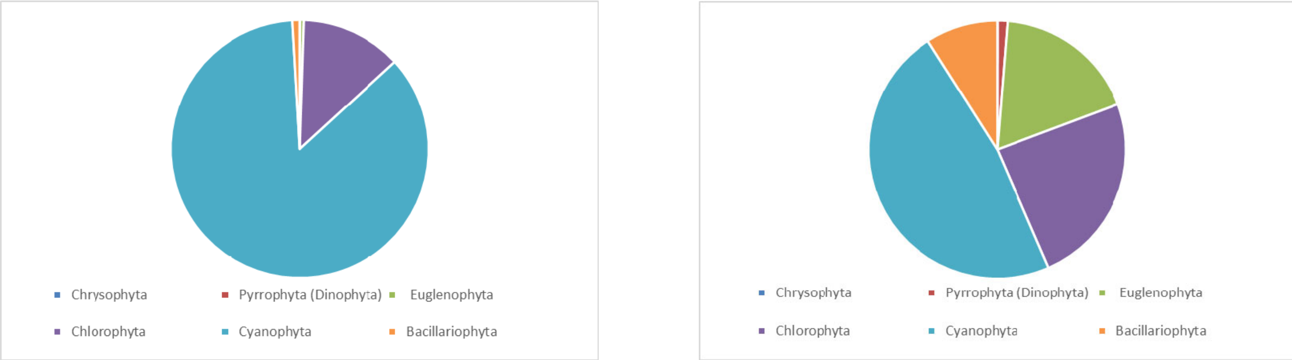
Phytoplankton

During the vegetative season, the phytoplankton of the Kantivka fattening pond was represented by 124 species and interspecies of algae, which belong to six divisions: Cyanophyta, Euglenophyta, Dinophyta, Bacillariophyta, Chlorophyta, and Chryzophyta.

In June, the phytoplankton was represented by species and interspecies that belonged to the divisions: Euglenophyta, Dinophyta, Bacillariophyta, Chlorophyta, and golden Chryzophyta (Fig. 1a). Cyanophyta were absent. A slight floral diversity characterizes this period. The most notable microalgae species (25) were found at the middle part of the pond and near dams 13 and 16, respectively. The development of phytoplankton in June shows low quantitative values. In different pond places, the abundance of algae was varied from 0.92 million cells/dm^3 to 4.946 million cells/dm^3, and biomass was from 0.57 mg/dm^3 to 1.04 mg/dm^3. The average for the pond was 3.141 million cells/dm^3, and biomass was 0.87 mg/dm^3. The phytoplankton (Fig. 1 a, b) was dominated by Chlorophyta (*Scenedesmus* spp., *Ankyra* spp.). Their average abundance in the pond was 2.917 million cells/dm^3, and biomass 0.61 mg/dm^3. These phytoplankton values were insufficient to meet the nutritional needs of cultivated fishes.

Fig. 1. Relative abundance (a) and relative biomass (b) of phytoplankton in the Kantivka fattening pond in June

In August, phytoplankton was represented by species and intraspecies belonging to Cyanophyta, Euglenophyta, Dinophyta, Bacillariophyta, Chlorophyta, and Chryzophyta. The number of species in the pond was varied from 57 to 60 species at different places. Blue-green algae played the central role in forming the number and biomass of planktonic algae, and their contribution to abundance and biomass was 85.9 % and 47.6 %, respectively (Fig. 2a, b). *Aphanizomenon flos-aquae*, *Anabaena flos-aquae*, *Microcystis aeruginosa* were the dominant species.



a b

Fig. 2. Relative abundance (a) and relative biomass (b) of phytoplankton in the Kantivka fattening pond in August

The mean abundance of phytoplankton was 267 million cells/dm^3, and biomass was 40.96 mg/dm^3 in August. The top of the pond was characterized by the highest values of algae development: 325.3 million cells/dm^3 and 50.16 mg/dm^3. Near the dam, the abundance and biomass were slightly lower but were still at the sufficiently high level as 299.2 million cells/dm^3 and 40.83 mg/dm^3, respectively. The development of planktonic algae in the middle of the pond was the lowest and is 176.7 million cells/dm^3 by abundance and 31.85 mg/dm^3 by biomass.

In September, the composition of the phytoplankton was changed. The green algae, mainly chlorococcal, again have become dominant. Thus, the contribution of green algae in the phytoplankton was 54 % by abundance. Blue-green algae were subdominant contributing around 41 % by abundance. However, the formation of biomass in this period was significantly influenced by euglena algae. The total abundance of phytoplankton in September was 281.16 million cells/dm^3, and biomass – 64.99 mg/dm^3, which indicates the highest development values of phytoplankton in this pond. In September, the dominant complex of phytoplankton species has included taxa of the genera *Dictyosphaerium, Scenedesmus, Closterium, Microcystis, Trachelomonas*.

a b

Fig. 3. Relative abundance (a) and relative biomass (b) of phytoplankton in the Kantivka fattening pond in September

Hence, during the studying period, the abundance and biomass of phytoplankton in the Kantivka fattening pond were formed mainly due to the vegetation of green algae. The average phytoplankton abundance and biomass parameters were 183.8 million cells/dm^3 and 35.61 mg/dm^3, respectively, during the warm season (Table 2). These values of phytoplankton development are sufficient to meet the nutritional needs of cultivated filter-feeding fish species in combination with artificial feeds.

Table 2

Biomass values of the natural forage base in the Kantivka fattening pond in 2020 warm season (M ± m, n = 6)

Parameters	Hydrobiological communities		
	Phytoplankton, mg/dm^3	Zooplankton, g/m^3	Zoobenthos, g/dm^2
Averaged values	35.61 ± 18.70	14.83 ± 4.47	5.84 ± 2.65
Optimal values for fattening ponds	25.0–30.0	8.0–12.0	2.0–5.0

Zooplankton

We identified the seven species of rotifers, 13 species of cladoceran, and ten species of copepod crustaceans, single ostracods, and insect larvae in the zooplankton of the Kantivka fattening pond (Table 3). Cladoceran crustaceans were the most diverse group, represented by eight genera belonging to the six families (Sididae, Daphniidae, Bosminidae, Moinidae, Chydoridae, Leptodoridae).

Table 3
Taxonomical composition of zooplankton in the Kantivka fattening pond

Species	Sampling time, month.		
	June	August	September
ROTIFERA			
Asplanchna priodonta Gosse, 1850	+	+	+
Brachionus calyciflorus Pallas, 1766		+	+
B. angularis Gosse, 1851			+
B. diversicornis (Daday, 1883)	+	+	+
Keratella cochlearis (Gosse, 1851)	+	+	+
Trichocerca pusilla Jennings, 1903		+	
Polyarthra vulgaris Carlin, 1943		+	+
CLADOCERA			
Diaphanosoma brachyuran (Lievin,1848)			+
D. dubia Manuilova, 1964		+	
Daphnia longispina (O.F. Muller, 1785)		+	+
D. Magna (Straus, 1820)	+		+
D. hyalina- galeata complex	+		+
Ceriodaphnia quadrangular (O.F. Muller, 1785)		+	+
Simocephalus vetulus (O.F. Muller, 1776)	+		
Bosmina longirostris (O.F. Muller, 1785)		+	+
Moina rectirostris Leydig, 1860		+	+
M. micrura Kurz, 1875		+	
Chydorus sphaericus (O.F. Muller, 1785)	+		+
Leptodora kindtii (Focke, 1844)			+
COPEPODA			
Eudiaptomus gracilis Sars, 1873	+	+	+
Cyclops abyssorum Sars, 1873	+	+	+
C. vicinus Uljanin, 1875	+		
C. bohateri Kozminski, 1933		+	
Eucyclops serrulatus (Fischer, 1851)			+
Acanthocyclops trajani Mirabdullayev and Defaye, 2004	+	+	+
Diacyclops bicuspidatus (Claus, 1857)			+
Mesocyclops leuckarti (Claus, 1857)	+	+	+
Thermocyclops oithonoides (Sars G.O., 1863)	+	+	+
Ergasilus sieboldi Nordmann, 1832		+	
Copepodid stages	+	+	+
Nauplii	+	+	
Ostracoda	+	+	
Insecta			
Chironomidae larvae and pupa	+		
Ephemeroptera larvae	+		

At the beginning of summer, zooplankton was represented mainly by crustaceans (Fig. 4, a): copepodids of cyclopoid and calanoid copepods, nauplii, and neonatal stages of cladocers were observed. In June, it should be noted that zooplankton was also mainly represented by numerous larvae of chironomids, Ephemeroptera, and beetles of different developmental stages.

The total abundance of zooplankton in different parts of the pond in June was varied from 15000 up to 40000 and/m^3, and biomass was 2.50–11.78 g/m^3. Cladoceran crustaceans were contributed 96.3 % into abundance, while copepods were contributed 59.2 % into biomass. In August, with increasing the water temperature, the structure of zooplankton groups was changed, and the dominant group as for abundance (up to 66.2 %) as well as for biomass (79.3 %) have become cladoceran crustaceans (Fig. 4, b). Their abundance reached 325000 ind/m^3, and biomass – 16.93 g/m^3, mainly due to the development of big-sized species like *Daphnia Magna, D. hyalina-galeata* complex*, D. longispina*. In August, zooplankton's total abundance and biomass were 490700 ind/m^3 and 21.36 g/m^3, respectively, showing the highest values for the entire studying period.

As the water temperature decreased in autumn, the composition of zooplankton in the pond was changed again. Even though the total abundance of zooplankton has remained at the same level as 494000 ind/m^3, the number of thermophilic crustaceans decreased sharply (approximately twice), and zooplankton became dominated by rotifers, mainly contributing 51 % by abundance. *Brachionus diversicornis, Br. calyciflorus*, and *Asplanchna priodonta* were the main species. However, these are tiny organisms, and their contribution to zooplankton biomass was insignificant (Fig. 4, e). Cold endothermic species of copepods, such as *Diacyclops bicuspidat*e, have appeared in the Water.

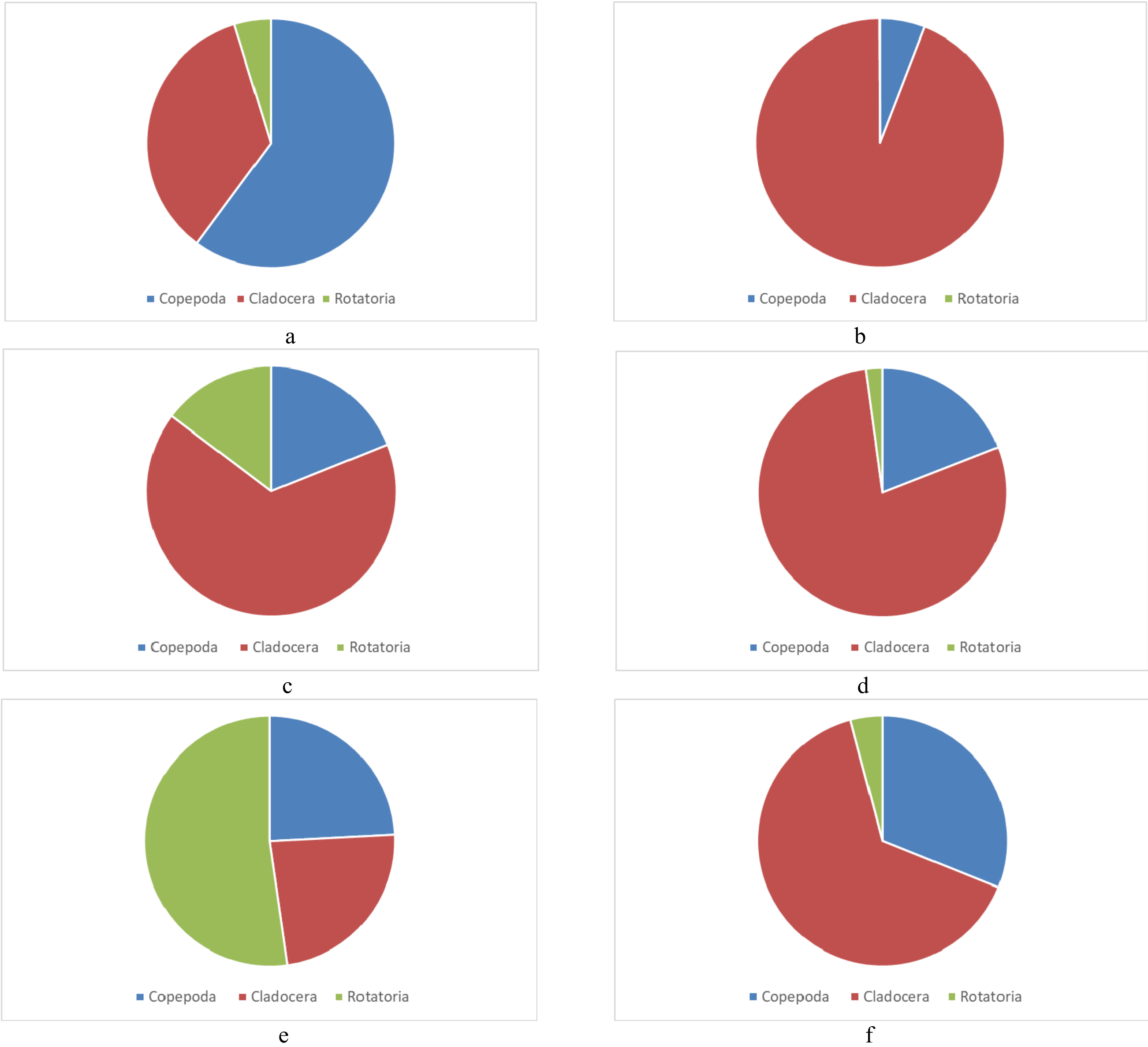


Fig. 4. Relative abundance (a, c, e) and relative biomass (b, d, f) of zooplankton in the Kantivka fattening pond in June (a, b), August (c, d), and September (e, f)

The average biomass of zooplankton in September was 16.86 g/m^3. Despite the high abundance of other taxa (Fig. 4, a, b, c), still, a decisive contribution to the biomass of zooplankton throughout the warm season was made by the large species of cladoceran crustaceans (Fig. 4, d, d, e), such as *Leptodora kindtii, Daphnia Magna, D. galeata-hyalina* complex, *Diaphanosoma brachyurum*. It should be noted that crustaceans are an important natural food source for young and adults of many fish species (Krazhan & Lupachova, 1991). Plankton-eating fishes (e.g., bighead carp) consume large quantities of daphniids, moins, bosmins. Quantitative parameters of the development of this group of crustaceans can indicate the level of productivity of fish ponds and the quality of water in the reservoir.

The mean values of the abundance and biomass of zooplankton in the Kantivka fattening pond during the entire studying period were 336600 ind/m^3 and 14.83 g/m^3, respectively (Table 2), and corresponded to the optimal developmental parameters to meet the nutritional needs of cultivated cyprinid fish species in combination with artificial feeding.

Zoobenthos

During the studying period, the benthic fauna of the Kantivka fattening pond mainly consisted of larvae and pupae of mosquitoes from the family Chironomidae, larvae of midges (Heleidae larvae), oligochaetes, and nematodes.

Quantitative parameters of zoobenthos development were the highest in June when the abundance in different parts of the pond was varied in the range of 440–760.1 and/m^2, and as for biomass was 9.68–12.67 g/m^2 and averaged over the pond, respectively 551.1 and/m^2 and 10.85 g/m^2. In this case, the abundance (87.9 %) and biomass (94.5 %) of zoobenthos were formed due to the development of effective forms of chironomid larvae – *Chironomus plumosus*, *Ch. f. l. semireductus*, *Ch. thummi* (Fig. 5). Further, there was a decrease in the quantitative parameters of zoobenthos development, Thus, in August, the total mean abundance in the pond was at the level of 211.1 and/m^2, and biomass – 4.84 g/m^2, and in September – 166.6 and/m^2 and 1.83 g/m^2 indicating the active feeding of fishes by benthic forms. It should be noted that in August, the abundance (84.2 %) and biomass (96.5 %) of benthic fauna were created due to the development of chironomid larvae; in September, oligochaetes were predominated (80.0 %) by abundance, while chironomid larvae (82.0 %) by biomass.

So, during the studying period, the average abundance of zoobenthos in the pond was 309.6 ind/m^2 and biomass – 5.84 g/m^2 (Table 2), corresponding to the optimal developmental values according to fish farming standards.

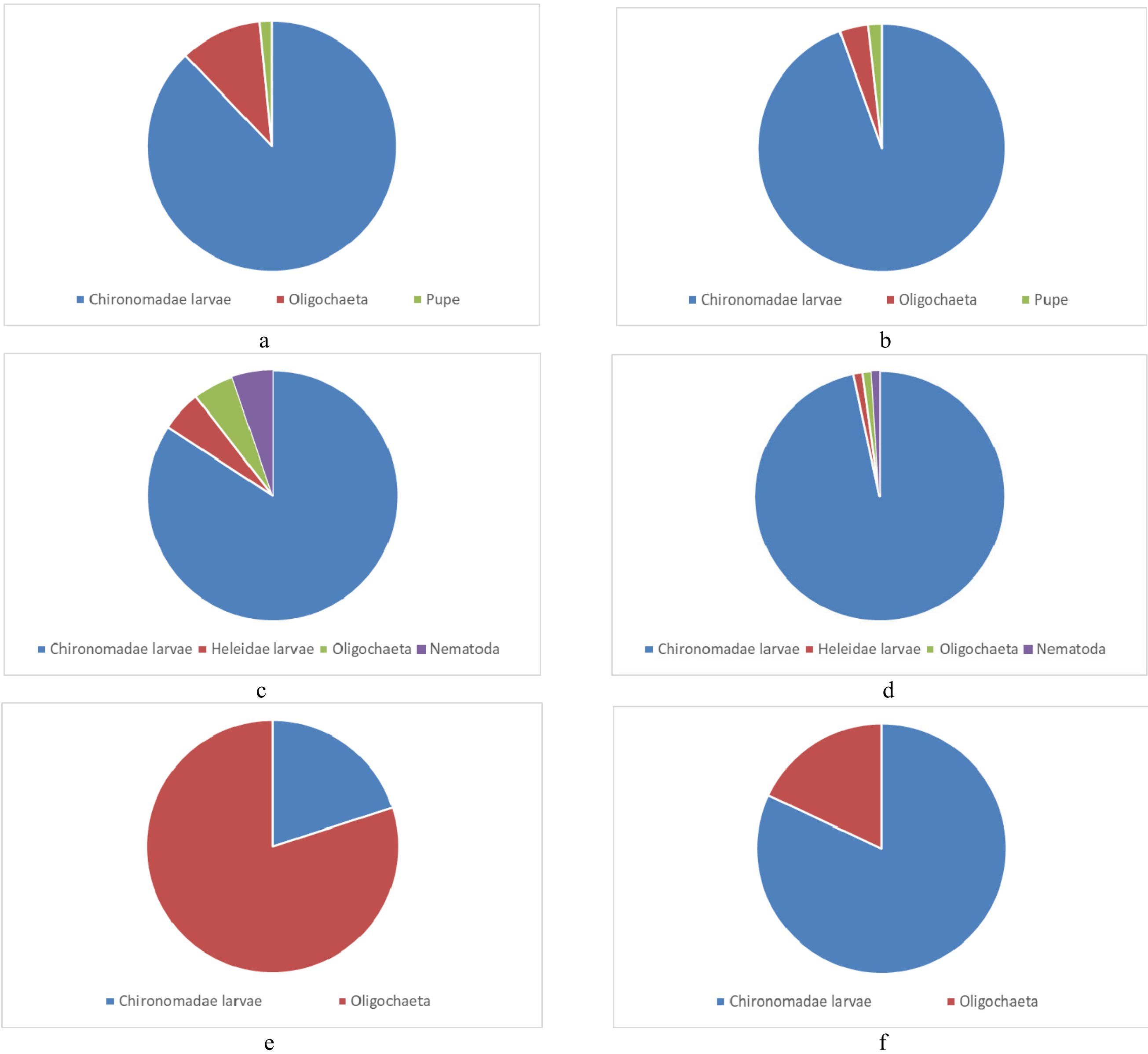


Fig. 5. Relative abundance (a, c, e) and relative biomass (b, d, f) of zoobenthos in the Kantivka fattening pond in June (a, b), August (c, d), and September (e, f)

Parasitic zooplankton crustaceans caused invasive fish diseases.

Among the ten copepod crustaceans noted in the plankton of the Kantivka fattening pond, the eight taxa are intermediate hosts of parasitic pathogens of fish diseases. Thus, for *Cyclops vicinus*, a cold-endothermic species that we observed in the spring in the Kantivka pond, about 15 species of helminths are known. For *T. oithonoides* and *M. leuckarti*, these numbers are 37 and 68 species of helminths from the classes of cestodes and scrapers (Monchenko, 1974). The diaptomid calanoid copepod *Eudiaptomus gracilis* showed the most significant susceptibility to parasitic infection by oncospheres of fish parasite *Ligula intestinalis*, a common and widespread pseudophyllidean cestode being strongly pathogenic for many freshwater fish populations throughout Europe (Dubinina, 1980). Of course, not all of these species of helminths are represented in the fauna of the Kantivka pond. However, some of these helminths are undoubtedly present at different stages of their developmental cycle in planktonic crustaceans as intermediate hosts and parasitize in the intestines of fishes, ducks, and other aquatic domestic wild birds that inhabit and visit this pond.

In August, free-living stages of the parasitic crustacean *Ergasilus sieboldi* Nordmann, 1832 were observed in the plankton of the Kantivka pond with an abundance of 30 ind/m^3. The peculiarity of this species is that only the adult females parasitize on fish (Fig. 6). They are attached by the second pair of harpoon-shaped antennae and live in the gills, feeding on the blood and gill tissue of the fish. These parasites are visible on the fish gills in white dots with sizes up to 2 mm. In case of heavy invasion, fishes suffer from difficulties with breathing, delay in growing, which sometimes can cause death (Figurkov, 2016). The massive appearance of this species in nature occurs in July-August, while it reproduces and nauplii appear in May.

Fig. 6. Adult female of *Ergasilus sieboldi* (Photo by L. Samchyshyna)

Ergasilus includes species with high pathogenic potential, responsible for significant mortality among cultured fishes in freshwater and brackish environments (Lin & Ho, 1998; Piasecki et al., 2004). It was estimated that the parasite numbers in the overwintered fish stock in the Rutland Water reservoir were approximately 12 million in April 2003, 8.3 million in April 2004, and 1.2 million in April 2005. *Ergasilus sieboldi* can cause high mortality in tench, trout, and carp fish farms (Dogel, 1933).

Ergasilus can be treated successfully with a combination of 0.5 ppm copper sulfate and 0.2 ppm ferric sulfate for 6 to 9 days. A 3 % salt dip, followed by 0.2 % prolonged both for three weeks (Arya et al., 2015). Medical treatment of fish invasion by *Ergasilus* can also be carried out with disinfectants Javel-Clyde (France) or Diamond (Institute of Veterinary Medicine NAAS, Ukraine) following the guidelines of Matvienko and Oliynyk (2013).

As general recommendations for aquaculture management in the Kantivka fattening pond are reducing the number of overwintering fishes. However, the best control method is not to introduce and move infected fish from this pond into other "healthy" fish ponds.

4. Conclusions

Ecological conditions of the Kantivka fattening pond were generally favorable for the growth of commercial cyprinid species of fishes. The water temperature was varied in the range of 22–28 °C. The hydrochemical regime of the pond is well managed. Most of the chemical parameters were within the typical values adopted in fish farming in Ukraine.

According to the level of development of phytoplankton, zooplankton, and zoobenthos, the pond can be classified as high-feeding. The fact that plankton contains parasitic forms of copepod crustaceans of *Ergasilus* genera should aware fish farmers against the introduction of infected fish from the Kantivka pond to other "healthy" reservoirs. It is recommended to decrease the abundance of overwintering fishes in the pond and organize periodical observation of health/gill tissue/fishes in the pond to monitor the population dynamics of parasitic crustaceans in zooplankton.

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Author contributions

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Conflict of interest

The authors declare that there is no conflict of interest.

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