Development of the natural fodder base organisms during breeding of carp fish larvae using soy milk in saltwater drainage system of Uzbekistan

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Abstract. In May-June 2019, the development of organisms of the natural food base in fry ponds was studied during the rearing of cultured cyprinids in the brackish water of the drainage system and when using a new type of fertilization/feeding of larvae - soy milk. In the samples, 76 species, forms and varieties of microalgae were noted. The total number of phytoplankton microalgae was 108,512.5 x 103 cl/l, biomass -20.5776 mg/ml. 10 species were found in the zooplankton of ponds (rotifers, cladocerans, copepods); the number of zooplanktoners varied 20.5 - 266.5 thousand ind./m^3, biomass - 0.14 - 406.3 g/m^3. 12 species of organisms have been recorded in the benthofauna. From a technological point of view, the results of rearing with the use of soy milk turned out to be very high: in 1 month of rearing juveniles of cyprinids in monoculture, fry of 4.5 - 9 g in size were grown from prelarvae with a yield of 43 - 49%.

1 Introduction

In the conditions of Uzbekistan, in the cultivation of cyprinids, to cover as much as possible a short warm period for growing prelarvae (free embryos) to fry, prelarvae is as a result of incubation and in May-June. In the subsequent larval period, cultured cyprinids of various species are fed by plankton organisms. To ensure the growth of juveniles, the most important factor is the growth mechanism of the organism of the natural fodder base in the pond, this is achieved through the introduction of mineral fertilizers. Traditionally, the growth of free embryos to fry is carried out in a separate fish-breeding cycle - rearing, which lasts about 20 days - 1 month and provides fry 0.3 - 1 g [1, 2].

In recent years, attention has been drawn to the use of soy milk for growing fish seed, which is developing in China [3, 6] and is still completely unknown in the republic. A significant limitation for arid Uzbekistan is the attachment of technology to fresh water in accordance with the peculiarities of cyprinid biology. Collector-drainage system used to create nursery ponds [4, 7].

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Taking into account the above, in 2019 in the fish farm of LLC ‘Navruz Kut Barakasi’, which was built by those who built breeding ponds in 2018 on the bank of the Central ‘Golodnostep’ collector with a drainage year of brackish water, experiments were carried out on innovative re-growing of prelarvae of carp fishery using soy milk in brackish water. The aim of this work was to study aquatic biocenoses and study the species composition of the community of phytoplankton, zooplankton, and zoobenthos in fish ponds and its quantitative indicators, as well as to identify hydrobionts of the dominant complex of nursery ponds with brackish water using soy milk.

2 Materials and methods

In 2019, prelarvae of silver carp *Hypophthalmichthys molitrix*, carp *Cyprinus carpio*, grass carp *Ctenopharyngodon idella*, variegated silver carp *Hypophthalmichthys nobilis* were raised in monoculture in fry ponds No. 1,2,3,4 (area 1-3 ha each) in May - June, to fry. 6 days before stocking, slaked lime (100 kg/ha), manure (1 t/ha) were introduced into the ponds throughout the bed. Soy milk was applied daily, starting 2 days before the pond was stocked with prelarvae. For this, soybeans, weighed for application the next day, were placed in a metal barrel at 17-00, poured with water so that the beans were covered with a 15-20 cm layer of water and left until morning. The swollen beans at 6-7 o'clock in the morning were thoroughly ground in a blender with the addition of water (the ratio of dry beans to water as a result of the volume was about 1: 10), as a result of which a liquid with the consistency of milk was formed ("soy milk"). The milk was collected completely in plastic cans and immediately sprayed with hand buckets so as to cover as much of the surface as possible. For the entire month, 5 kg of beans/ha were used daily for each pond.

Samples on the development of organisms of the natural food base were collected in May-June in ponds and in a feed channel.

Silk gas plankton net was used to collect phytoplankton samples; were fixed first with Lugol's solution, and then a 40% formalin solution was added [5, 8]. In laboratory conditions, phytoplankton organisms were concentrated by sedimentary method. Quantitative processing was carried out in a Fuchs-Rosenthal chamber with a volume of 3.2 mm^3.

Zooplankton samples were taken with Apstein's conical nylon plankton net, filtering 10–50 L of water from ponds, then the samples were fixed with 70% alcohol. The number and biomass of organisms were calculated in the Bogorov chamber. The individual weights of zooplankters were determined using allometric growth formulas [5, 9, 10].

Zoobenthos samples were taken with a scraper from the bottom of the ponds, the soil was washed through a gas sieve (no. 36), and the samples were fixed with a 4% formalin solution. Subsequent processing of benthos samples was carried out in laboratory conditions using microscopes MBS-10 and MC-300X, electronic scales. The fishery water quality in ponds was measured using a HANNA HI 9147 portable thermal oximeter, pH - using a pHscan 30S portable pH meter [8].

3 Results

In ponds during May-June, the pH value varied from 6.9 to 8.1, the salinity of water in the pond varied from 2.6 to 3.5‰, i.e. was brackish. The content of dissolved oxygen throughout the growing season varied within the range of 3.5 - 5.9 mg/l. The indicators corresponded to the norms of the carp pond polyculture. The water temperature in the canal and ponds in June - September varied from 15.6 to 29.6 °C. The color of the water in the ponds changed: brown, brown-green-red, yellowish-brown, and dark brown-red, dark green, green. The nature of the soil is clay-sandy with moderate fluff and silty-sandy with plant detritus. A month later (in mid-June), thickets of common reed (*Phragmites communis Car.)*, Cattail (*Thypha latifolia L.*), lake reeds (*Scirpus lacustris L.*), and various sedge species (*Carex*) developed well along the coast and in the intertidal areas of ponds. In some places, especially in the coastal areas of the ponds, there was a good development of higher aquatic vegetation in the form of spots of accumulations - duckweed (*Lemna minor L.*).

The number of organisms of ecological groups identified in the samples of ponds and the supply channel is given in Table 1.

Table 1. Taxonomic structure of aquatic biocenoses of the studied fish ponds and the supply channel (May 2019)

Ecological groups of organisms	Growing ponds	Feeding channel
Phytoplankton (microalgae)	72	31
Zooplankton	5	-
Zoobenthos	9	10
Bacterioplankton	2	1
Number of species	**88**	**42**

Phytoplankton. In spring samples, a good development of the qualitative and quantitative development of phytoplankton of 76 species, forms and varieties was noted. The number of species, varieties and forms of microalgae by taxa are shown in Table 2.

Table 2. Taxonomic structure of spring phytoplankton in ponds (Spring 2018)

Taxa	Growing ponds	Feeding channel
Cyanophyta	25	11
Bacillariophyta	10	7
Cryptophyta	2	1
Chrysophyta	1	-
Euglenophyta	4	-
Dinophyta	-	-
Chlorophyta	30	12
Number of species	**72**	**31**

The dominant complex of phytoplankton communities was represented, first of all, by producers, the greatest development and diversity among which reached blue-green (Cyanophyta) - 26 species, green (*Chlorophyta*) - 29 species and diatoms (*Bacillariophyta*) - 14 species of algae. Cryptophyta, Chrysophyta and Euglenophyta algae are noted with little development (1-4 species). The quantitative indicators of algae of different taxa are given in Table 3.

Table 3. Quantitative development of phytoplankton in fish ponds (Spring 2018)
(above the line - abundance (N), cells/l x 10^3, below the line - biomass, mg/ml)

Taxa	Growing ponds	Feeding channel
Cyanophyta	42,025.0 1.5085	21,637.5 0.1180
Bacillariophyta	1,787.5 0.6594	275.0 0.0875
Cryptophyta	225.0 0.285	12.50 0.016
Chrysophyta	125.0 0.0065	-
Euglenophyta	75.0 0.0551	-
Dinophyta	-	-
Chlorophyta	64,250.0 18.0144	3,225.0 0.9489
Total purity, N x 10^3 cells/l Biomass, mg/ml	108,512.5 20.5776	25,150.0 1.1700

The species composition of phytoplankton is presented in Table 4.

Table 4. Phytoplankton species composition of the studied ponds (Spring 2019)

#	Taxa, species, forms of plankton	S	Ponds	Channel
	BACTERIOPLANKTON			
1	*Bacterium sp.*	a-p	+	+
2	*Mucota sp.*- fungi	a	**+**	**-**
	PHYTOPLANKTON MICROALGAE		2	1
	CYANOPHYTA			
1	*Dactylococcopsis irregularis* G.M.Smith.	b	D	-
2	*D.rhaphidioides f.falciformis* Printz	b	D	-
3	*D.acicularis* Lemm.	b	C	+
4	*Synechococcus aeruginosus* Nag.	b-a	D	C
5	*Merismopedia glauca* (Ehr.) Nag.	b	D	+
6	*M.elegans* A.Br.	b	D	-
7	*M.tenuissima* Lemm.	b-a	D	-
8	*Microsistis aeruginosa* Kütz.	b-a	D	C
9	*Coelosphaerium pusillum* van Goor.	b-a	D	-
10	*Gloeocapsa alpina* Nag. end.Brend.	b	D	+
11	*Gl.alpina f. lignicola* (Rabenh.) Hollerb.	b	C	-
12	*Gl.minor* (Kütz.) Hollerb.	b	C	+
13	*Gl.minuta* (Kütz.) Hollerb.	b	C	+
14	*Gl.turgida* (Kütz.) Hollerb.	b	+	-
15	*Gomphosphaeris aponina* Kütz.	b	C	-

16	*Anabaena sp. (caspica?)*	o-b	C	-
17	*Osc.geminata* (Menegh.) Gom.	b	C	-
18	*Osc.limnetica*	o-b	C	C
19	*Osc.planctonica* Wolosz.	o-b	D	C
20	*Spirulina albreviata*	b-a	C	-
21	*Phormidium sp.*	b	+	+
22	*Ph.papillaterminatum* Kissel.	b	D	-
23	*P.mucicola*	b	D	-
24	*Ph.foveolarum*	b	-	-
25	*Lyngbya sp.*	b	C	+
26	*L.limnetica* Lemm.	o-b	D	-
	BACILLARIOPHITA			
27	*Cyclotella comta* (Ehr.) Kütz	o	+	-
28	*C.caspia* Grun.	b-a	D	+
29	*C.Kuetzingiana* Thw.	b	C	-
30	*C. meneghiniana* Kütz.	b-a	D	+
31	*S. minuscula* Grun.	b	-	+
32	*C.placentula v.euglypta* (Ehr.) Cl.	o-b	-	+
33	*Navicula cryptocephala* Kütz.	a-b	+	+
34	*N.cryptocephala v.veneta* (Kütz.) Grun.	a-b	+	-
35	*N.salinarum* Grun.	b-a	+	+
36	*N.viridula* Kütz.	a-b	-	+
37	*M.Smithii v.amphicephala* Grun.	b-a	+	-
38	*Rh.gibba v.gibberulla* (Ehr.) Grun.	a-b	+	-
39	*N.hungarica* Grun.	a	-	+
40	*N.palea* (Kütz.) Grun	a	+	+
	CHRYSOPHYTA			
41	*Chromulina sp.*	o-b	+	-
	CRYPTOPHYTA			
42	*Chryptomonas sp.*	b	C	-
43	*Thrachelomonas sp.*	b	+	+
	EUGLENOPHYTA			
44	*E.sp.(proxima?)* Dangeard.	p-a	+	-
45	*E.intermedia* Schmitz	p-a	+	-
46	*Ph.pyrum* (Ehr.) Mereschk = *(Monomorphina pyrum)* (Ehr.) Meres.	b-a	+	-
47	*Astasia Kiebsi* Lemm.	b-a	+	-
	DINOPHYTA			
	CHLOROPHYTA			
48	*Ankistrodesmus acicularis* (A.Br.) Korsch.	b	D	+
49	*Ank.angustus* (Bern) Karschik.	b	D	-
50	*Ank.falcatus* (Corda) Ralfs.	b	D	+
51	*Ank.minimum*	b	D	-
52	*Ank.spirilliformis*	b	D	-
53	*Kirchneriella lunaris* Mob.	b	C	+
54	*Oocystis marssonii* Lemm.	b	C	-
55	*Oocystis sp.(pusilla?)*	b	C	+
56	*O.natans* Wille.	b	D	C
57	*Chlorella vulrgaris* Beyer.	b	D	-
58	*Chlamidomonas sp.*	b	D	+
59	*Ch.ehrenbergii*	b	C	-
60	*Ch.variabilis*	b	C	-
61	*Chlorococcum humicola* Meneg.	b	D	+
62	*Carteria sp. (vulgaris ?)*	b	+	-

63	*Dictyosphaerium ehrenbergianum* Naeg.	b	D	-
64	*Lagerheimia genevensis* Chodat.	b	+	-
65	*Coelastrum sphaericum* Naeg.	b	C	-
66	*C.microporum* Naed.	b	D	-
67	*Palmella miniata* Leibl.	b	C	-
68	*Scenedesmus acuminatus* (Lagerh.) Chod.	b	D	C
69	*Sc.abundans*	b	D	+
70	*Sc.bijugatus* (Turp.) Kuetz.	b	C	-
71	*Sc.quadricauda* (Turp.) Breb.	b	D	C
72	*Sc.quadricauda v. typicus* West.	b	D	+
73	*Sc.quadricauda v. abundans* Kirchn.	b	D	-
74	*Sc.obliguus* Kütz.	b	C	+
75	*T.minimum* Hansg.(Corda)	b	+	-
76	*Tetracoccus botryoides* West	b	D	-
	Total		**72**	**31**
Note: + - single occurrence (1-9 grades); C - subdominants (10-30 grades); D - dominants (over 31 grades); S - saprobity of organisms.				

Zooplankton. In the spring-summer period, the development of zooplankton in the ponds was very good, large organisms of plankton were often visible even visually. In the zoo-plankton of ponds, 10 species were found, of which 2 species of rotifers - *Brachionus nil-soni* and *Brachionus plicatilis*; 5 species of cladocerans - *Scapholeberis rammneri*, *Daphnia hyalina*, *Daphnia magna*, *Moina brachiata*, *Moina micrura*; 3 species of oar-footed crustaceans - *Eucyclops serrulatus*, *Cyclops vicinus*, *Acanthocyclops trajani*, as well as their copepod and nauplial stages of development.

The number of zooplanktoners varied from 20.5 to 266.5 thousand ind./m^3. The biomass of zoo-plankton is 0.14 - 406.3 g/m^3. Such a difference in abundance and biomass is due to the presence of the cladocerans *Daphnia hyaline* in zooplankton, whose organisms amount-ed to 187.5 thousand ind./m^3 and 288.7 g/m^3 (approximately 70% of the abundance and biomass of zooplankton). *Cyclops vicinus*, a rather large crustacean (up to 1.5 mm long), dominated among copepods, its abundance in zooplankton samples varied from 0.4 to 4.3 thousand ind./m^3, biomass - 0.05 - 0.55 g/m^3 (40-90% of the total indicators of the abun-dance of zoo-plankton). Moreover, cyclops does not occur with daphnia. This crustacean is massively observed in zooplankton in spring. The mass development of zooplankton was observed in late May - early June.

Zoobenthos. The benthos fauna of the studied fish ponds has the greatest qualitative and quantitative diversity in the littoral zone, where only 12 species of organisms were rec-orded (Table 5).

Table 5. Species composition of benthic organisms

#	Taxa, species of zoobenthos	S	Pond	Channel
	Ephemeroptera			
1	*Baetis sp.*	b	+	-
2	*Caenis sp.*	b-a	-	**+**
3	*Caenis macrura*	b-a	+	**-**
	Odonata			
	Nematoda			
4	*Nematoda gen. sp.* 1.	a-b	+	**+**
	Tubificidae			
5	*Oligochaeta gen.sp.*	a-b	+	**+**
	Chironomidae			
6	*Chironomidae gen.sp.*	a-b	+	**+**

7	*Tanytarsus sp.*	a	+	**+**
	Simuliidae			
8	*Simuliida sp.*	b-a	+	**+**
	Amphipoda			
9	Water beetle	b-o	+	**+**
	Corixida			
10	*Heserrocorixa linnae*	b-a	+	**+**
	Mollusca			
11	*Sphaerium sp.*	b-a	-	**+**
	Decapoda			
12	*Macrobrachium nipponense asper*	b-a	-	**+**
	Total		9	10

The predominant group of benthic communities of the reservoir was a truly benthic fauna, represented in bottom sediments by iliotivorous forms of the oligochaete-chironomid complex, namely: a-p-saprobic species of small-bristled worms of the family. The ecological structure of the truly benthic complex of organisms is extremely simplified; by the type of feeding, detritivorous-ingesting feeders prevail.

4 Discussion and conclusion

In local fish farming, plankton development is stimulated in fry ponds due to the aggressive introduction of organic (manure - 4-5 t/ha) and mineral (ammophos, ammonium nitrate and others - up to 300 kg/ha) before or immediately after flooding the pond. Yes, with water, so that as the fish prelarvae switch to external nutrition, the smallest forms of plankton are massively available for them [1, 2]. In our experiment, we used a legume (soybeans) rich in nutrients, which was introduced in a semi-dissolved and finely ground form. Chinese researchers argue that this approach creates favorable conditions for the development of a natural food base. For comparison, we applied much less manure (up to 1 t/ha), and did not use mineral fertilizers at all during growing. Nevertheless, from the fish-breeding point of view, the results of rearing were very good. After 1 month of rearing all carp species in monoculture, fry 4.5-9 g in size were caught from the ponds, i.e. much higher than the norm, with an output of 43 - 49%, which fully complies with the norms for the VII zone of fish farming, which includes Uzbekistan.

Ponds are stagnant reservoirs, subject to rapid eutrophication, in which the limnic and profundal zones are practically absent, and the littoral zone is well developed. Ponds are temporary reservoirs filled with water immediately before stocking, which affects the quantitative and qualitative indicators of the development of various ecological groups of organisms of the natural food base. At the same time, during rearing, the formed plankter communities are constantly subject to massive grazing by the growing larvae of cyprinids.

When using soy milk in fry ponds in the spring, good development of phytoplankton communities was also observed. The dominant complex, the main abundance and biomass of the studied fish ponds were planktonic forms of blue-green and green (dysmidia and protococcal) algae, represented by unicellular, colonial and filamentous species with a wide ecological valence - freshwater, freshwater brackish water and algal water forms.

Zooplankton communities are well developed. An outbreak of zooplankton development is noted after the application of organic fertilizers. As a result, the number of bacteria and unicellular protozoa increases, which feed on zooplankton organisms. At the same time, the abundant development of zooplankton leads to a decrease in the biomass of phytoplankton (in these fish ponds, a massive outbreak is given by *Daphnia hyalina*, which feeds on microalgae).

The bottom fauna of fish-breeding ponds was not very diverse; the predominant group of benthic communities is the ilivorous forms of a-p-saprobic species of chironomid larvae, *Chironominae* and small-bristle worms of the family, *Tubificidae*, as well as b-a-saprobic species of nematodes and oligochaetes, typical for eutrophied and moderately polluted waters.

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