

THE STUDY OF THE VARIABILITY OF MORPHOBIOLOGICAL INDICATORS OF DIFFERENT SIZE AND WEIGHT GROUPS OF HYBRID SILVER CARP (*HYPOPHthalmichthys spp.*) AS A PROMISING DIRECTION OF DEVELOPMENT OF THE FISH PROCESSING INDUSTRY

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ABSTRACT

In water reservoirs, the size and characteristics of fish, in the first place, affect – the composition and clarity of food objects, the number of food competitors and predators, their numbers, industry, and others. Besides, the rate of linear and weight growth are the arteries that determine the value of the species as an object of commercial fishing. The hybrid of silver and bighead carp easily adapts to different growing conditions (from the point of view of the formation of fish-biological indicators), protein in different years depending on feeding conditions, in one reservoir indicators of length and body weight of ribs are inadequate. Evaluating the influence of feeding conditions on the linear growth of the rib, the method of generalized evaluation was used. An indicator equal to the sum of potential fish productivity for phyto-zooplankton was used to characterize the foraging status of a particular condition in a certain period. In terms of the quality of growth indicators, the indicator of the absolute weight of nature with differentiation of farms, age groups, and years was used. The results of the research revealed significant variability in the size and weight characteristics of different groups of silver and bighead carp, which were isolated from ponds and reservoirs. According to the results of experimental studies established for the cultivation of hybrid silver and bighead carp in reservoirs, relatively high rates of linear and weight growth are expected, higher than for similar species, which is provided in the conditions of fish ponds.

Keywords: fish; length; mass; pond; reservoir

INTRODUCTION

Due to the deterioration of the conditions of natural reproduction of populations of industrial fish species, aquaculture is becoming increasingly important in Ukraine as a crucial factor in meeting the needs of mankind in protein food (Archibisova and Suslov, 2018). As fish and fish products occupy a significant place in human nutrition, fish receive about 40% of protein foods of animal origin mainly from aquatic organisms (Jennings, 2016).

Ukraine has all the opportunities for efficient fisheries, increasing domestic production through the development of fish farming, which over the past 5 years, in contrast to the dynamics of industrial catches is characterized by certain stability and provides annual production of 20 – 25 thousand tons of fish products. At the same time, there is a steady trend to increase the share of freshwater grazing aquaculture products in a total catch in inland waters, which has increased to 30 – 35% over the past 10 years (Kozakevych, 2017; Mushtruk et al., 2020).

In modern conditions of fish farming mainly polyculture of carp and herbivorous fish is used, which provides a balanced consumption of the whole complex of forage organisms and the formation of maximum fish productivity. The use of herbivorous fish cannot be limited to growing them only in ponds, these species are no less promising for reservoirs and other complex reservoirs. The technology of commercial fish production in small reservoirs due to grazing aquaculture involves obtaining the bulk of fish products by optimizing the use of natural feed resources, optimally selected species composition of introducers, which allows us to consider this area as a resource-saving and environmentally friendly technology (Orel, 2020).

One of the promising objects of cultivation in reservoirs of different types is a hybrid of silver and bighead carp because it has a rapid rate of weight gain until the end of the growing season. High plasticity in the choice of food objects (phytoplankton, zooplankton, detritus, and in the ponds, also – the remnants of the dusty fraction of carp feed) allows

hybrids to have much less competition than other species (Marenkov, 2018) (Figure 1).

Hypophthalmichthys is a valuable commercial fish with a scrumptious taste. The meat is tender and delicious, belongs to the group of medium-fat (Buchtová and Ježek, 2011; Jia et al., 2018). In terms of calories, it is inferior to grass carp and common carp, but its value increases with age, with increasing linear size of fish, the meat becomes fatter. The fat content of meat varies from 4.5 to 29.0%, a significant amount of it accumulates on the internal organs of fish. A large amount of fat in the body of the silver carp allows it to adapt to starvation in winter and early spring.

Due to the peculiarities of the diet of silver carp meat contains amino acids, polyunsaturated fatty acids of omega-3 and omega-6, with regular consumption, they help prevent the development of malignant tumors, nervous disorders, improve heart function, strengthen blood vessel walls, lower cholesterol and blood pressure in patients with hypertension (Ferguson et al., 2020)

Scientific hypothesis

Morphometric parameters can serve as an integral characteristic of the living conditions of fish in a particular water body. At the same time, among the relevant studies,

this area remains the least studied. Even though ichthyological work in ponds and reservoirs was previously widely carried out.

MATERIAL AND METHODOLOGY

The research was conducted in the spring, summer, and autumn periods from 2017 to 2019 in ponds based on the training-research-production laboratory of fish farming of the National University of Life and Environmental Sciences (TRPLF NULES of Ukraine) of Ukraine, village Nemishayevo, Kyiv region (zone Polissya); State Enterprise "Experimental Farm" Nyvka " of the Institute of Fisheries of the National Academy of Agrarian Sciences (SEEF "Nyvka" IF NAAS) of Ukraine, Kyiv is located on the border of the zones (it is on the river Nivka that the Forest-Steppe is divided - to the south and Polissya - to the north); Bila Tserkva Experimental Hydrobiological Station of the Institute of Hydrobiology of the National Academy of Sciences (BEHS IHB NAS) of Ukraine, Bila Tserkva (Forest-steppe zone), Kosiv, Kyiv region (Forest-steppe zone) and Velykoburlutsky, Kharkiv region (Forest-steppe zone) reservoirs.



Figure 1 Two-year hybrid of white with motley thick-thyme, which was obtained in the autumn period during the oblah nahulna become No10 BEGS IGB NAS of Ukraine.



Figure 2 Collection of ichthyological materials (the second anniversary of the hybrid of white with motley thick-haired) in the spring period during unloading of the wintering rate No1 of the NLDLR NUBIP of Ukraine.



Figure 3 Conducting a morphometric analysis of two-years of the hybrid of white with motley thick-throes, which were obtained in the autumn period during the regional concubination system No1 NNVLR NUBIP of Ukraine.

Samples

The collection of ichthyological material was carried out during stocking and catching fish in ponds and reservoirs. The material for the study was young-of-the-year, annuals, biennials, and triennials of a hybrid of silver and bighead carp (Figure 2). The number of stocks in ponds was 6, and catches – 18; Velykoburlutsky Reservoir 1 stocking, catches – 2, Kosiv Reservoir – 2 each.

Phytoplankton sampling was performed by scooping water from 0.3 m surface water bodies into 0.5 dm³ plastic containers. For preservation of samples 40% formaldehyde was added at the rate of 1 : 100.

Zooplankton samples were taken with an Apstein mesh (sieve No 72) in a container with a volume of 0.5 dm³, while filtering 100 l of water, fixed with 4% formalin. During the research period, 30 samples of phytoplankton and zooplankton were taken from ponds (wintering and feeding).

Chemicals

Formaldehyde (CH₂O, producer «Inter-Synthesis» Limited Liability Company, Ukraine, chemically pure for analysis).

Formalin (water solution formaldehyde, producer «Inter-Synthesis» Limited Liability Company, Ukraine).

Animals and Biological Material:

During the morphological analysis, 330 specimens of silver and bighead carp of different size and weight groups were caught from ponds, and 115 specimens from reservoirs were processed during the morphological analysis.

Instruments

Set of grids with a mesh step from 30 to 100 mm (producer "CrayFish" Limited Liability Company, Finland).

Electronic laboratory scales (TBE-0.15-0.001-a-2, producer «Inter-Synthesis» Limited Liability Company, Ukraine)

Technical electronic scales (BTHE-6-H1K-1, producer "Inter-Synthesis" Limited Liability Company, Ukraine).

Counting chamber of Najotta (producer "Laboratory equipment" Limited Liability Company, Ukraine).

Binocular microscope (XSP-139B LED Ulab, producer "Laboratory equipment" Limited Liability Company, Ukraine).

Apstein's grid (producer "ADS-Lab" Limited Liability Company, Ukraine).

Bogorov counting chamber (producer "ADS-Lab" Limited Liability Company, Ukraine);

Stereoscopic microscope (MBS-9, producer "Laboratory equipment" Limited Liability Company, Ukraine).

Laboratory Methods

To achieve the task of the experiment used standard methods of morphometric analysis **GOST (1985)**.

Processing of ichthyological materials was performed according to standard methods generally accepted in ichthyology (**Sabaj, 2020**).

Thickening of phytoplankton samples was performed by sedimentation.

Determination of the taxonomic composition of algae was carried out according to the determinants (**Mao et al., 2018**).

Phytoplankton biomass was determined by the calculation-volume method (**Mao et al., 2018**).

In-house processing of samples was carried out by the conventional hydrobiology counting-weight method in the Bogorov counting chamber under a stereoscopic microscope MBS-9.

Phytoplankton samples were examined in a special Najott counting chamber 0.01 cm³ under a light microscope, all detected algae species were determined and counted at 1.0 dm³.

Zooplankton organisms were identified to the species using determinants (**Mao et al., 2018**).

To assess the impact of feeding conditions on linear growth, using the method of generalized estimation.

To characterize the forage productivity of a particular pond in a certain period used an indicator equal to the sum of potential fish productivity for phyto- and zooplankton. To characterize the growth of cultivated objects used the indicator of absolute weight gain with differentiation by age groups, years, and by farms.

Description of the Experiment

Over two years, 445 specimens of the white hybrid with variegated silver carp of different size and weight groups were studied. In ponds and Kosiv Reservoir, the number of

repetitions of each experiment was twofold, in Velykoburlutsky Reservoir - one-time.

Statistic analysis

The statistical evaluation of the results was carried out by standard methods using statistical software Statgraphics Centurion XVII (StatPoint, USA) – multifactor analysis of variance (MANOVA), LSD test. Statistical processing was performed in Microsoft Excel 2016 in combination with XLSTAT. Values were estimated using mean and standard deviations. We calculated the arithmetic mean (unweighted) value (M), the arithmetic mean error ($\pm m$), which made it possible to estimate with a certain probability the deviation of the arithmetic mean deviation, Fulton fatness rate. The statistical reliability of the results of the researches was provided by analyzing samples with the number of fish from 10 to 25 specimens.

RESULTS AND DISCUSSION

After caught in the winter pond No 101 SEEF "Nyvka" IF NAAS of Ukraine, the value of the length and body weight of annual fish in 2017 were (min-max values): 116.0 – 204.0 mm, 12.50 – 90.80 g, and in 2018 – 160.0 – 188.0 mm and 37.0 – 60.0 g (Table 1) (Makarenko, Shevchenko and Sytnyk, 2018b).

The length of annual fish in 2017 after catching in the winter pond № 2 TRPLF NULES of Ukraine fluctuated within (min-max values) – 101.0 – 150.0 mm, with a variation in bodyweight – 8.10 – 30.70 g, and in 2018 – 90.0 – 111.0 mm, 5.90 – 11.40 g (Table 1).

The length and body weight of annual fish after catching in the winter pond No 14 BEHS IHB NAS of Ukraine in 2017 were (min-max values): 101.0 – 137.0 mm and 6.50 – 20.70 g, and in 2018 – 102.0 – 136.0 mm, 9.0 – 21.0 g (Table 1).

Table 1 The average values of length and body weight of annuals of the hybrid of silver and bighead carp.

Indexes	Pond No 101		Pond No 2		Pond No 14	
	2017 y.	2018 y.	2017 y.	2018 y.	2017 y.	2018 y.
	M \pm m		M \pm m		M \pm m	
Average body length, mm	157.72 \pm 20.14	176.88 \pm 6.54	117.48 \pm 11.90	99.72 \pm 5.99	120.68 \pm 9.20	117.16 \pm 8.61
Average body weight, g	39.67 \pm 17.59	50.76 \pm 5.97	13.82 \pm 5.53	8.57 \pm 4.32	13.38 \pm 3.46	13.19 \pm 3.30
Fulton fatness (K-factor)	1.72	1.64	1.55	1.62	1.45	1.62

Table 2 The average values of length and body weight of biennials of a hybrid of silver and bighead carp.

Indexes	Pond No 2		Pond No 1		Pond No 10	
	2017 y.	2018 y.	2017 y.	2018 y.	2017 y.	2018 y.
	M \pm m		M \pm m		M \pm m	
Average body length, mm	339.33 \pm 11.69	339.53 \pm 24.47	312.00 \pm 12.68	304.00 \pm 33.66	281.47 \pm 21.70	303.53 \pm 31.98
Average body weight, g	412.47 \pm 60.87	387.73 \pm 81.64	306.93 \pm 42.83	270.60 \pm 72.22	213.60 \pm 47.61	269.00 \pm 83.65
Fulton fatness (K-factor)	1.82	1.98	1.79	1.77	1.78	1.78

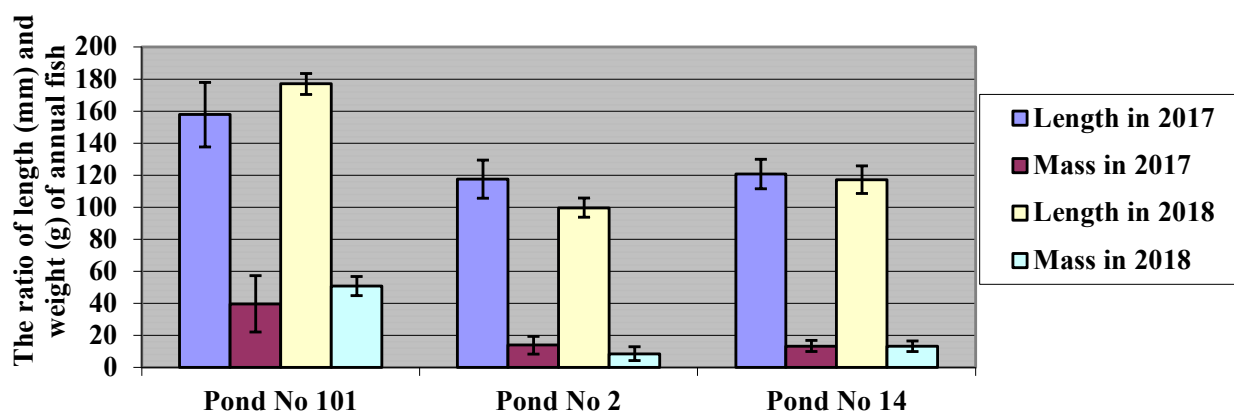


Figure 4 The ratio of the average values of linear growth in length and weight of annuals of the hybrid of silver and bighead carp from the studied winter ponds in 2017 – 2018.

Table 3 The average values of length and body weight of biennials of a hybrid of silver and bighead carp.

Indexes	Pond No 119		Pond No 1		Pond No 13	
	2018 y.	2019 y.	2018 y.	2019 y.	2018 y.	2019 y.
	M±m		M±m		M±m	
Average body length, mm	388.80 ±27.37	340.40 ±54.49	332.73 ±26.95	316.47 ±20.96	301.67 ±39.54	252.07 ±28.38
Average body weight, g	637.40 ±125.65	407.25 ±187.08	368.47 ±113.07	327.07 ±89.33	256.33 ±105.05	142.18 ±48.89
Fulton fatness (K-factor)	1.84	1.83	1.76	1.68	1.76	1.71

Table 4 The rate of linear-weight growth of a hybrid of silver and bighead carp in experimental ponds.

Age group	Indexes	SEEF "Nyvka" IF NAAS of Ukraine		TRPLF NULES of Ukraine		BEHS IHB NAS of Ukraine		
		2017 – 2018	2018 – 2019	2017–2018	2018–2019	2017–2018	2018–2019	
		1-1+	Linear growth rate	mm	181.61	162.65	194.52	204.28
		%	115.15	91.95	165.58	204.85	133.24	159.07
1+2		mm	49.47	0.87	20.73	12.47	20.20	0.51
		%	14.58	0.26	6.64	4.10	7.18	0.83
1-1+	Weight growth rate	g	372.80	336.97	293.11	262.03	200.22	255.81
		%	939.0	663.9	2120.0	3158.0	1596.0	2039.0
1+2		g	224.93	19.52	61.54	56.47	42.73	- 126.82
		%	54.53	5.03	20.05	20.87	20.00	- 52.86

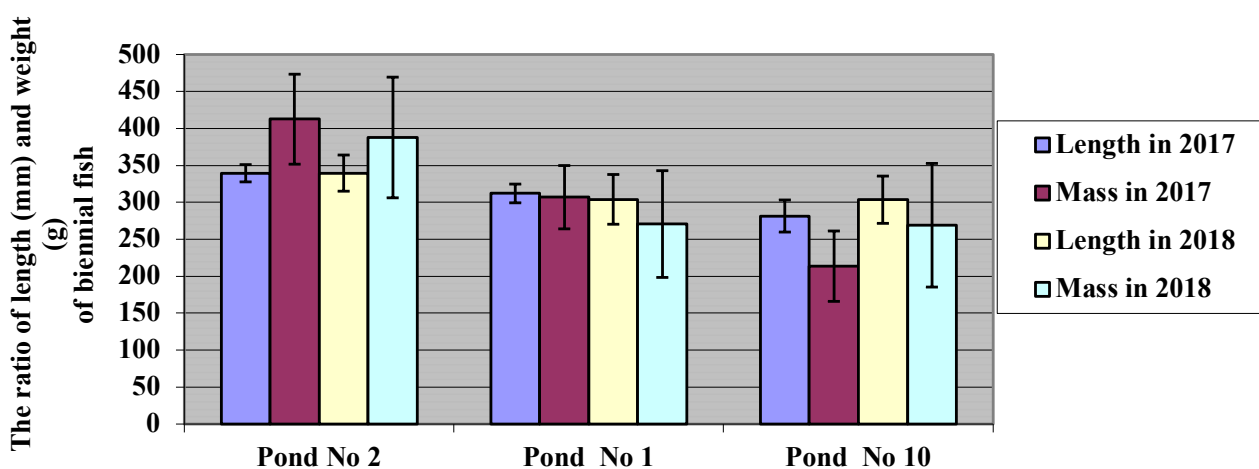


Figure 5 The ratio of the average values of linear growth in length and weight of biennials of a hybrid of silver and bighead carp from the studied feeding ponds in 2017 – 2018.

The difference in the annual growth of a hybrid of silver and bighead carp (Figure 4) usually persists in their later lives, especially in the presence of competition between them for food, which is scarce (Zebreal, et al., 2018; Mion et al., 2018).

A similar trend of differences in biological parameters was observed in older age groups (biennials) of a hybrid of silver and bighead carp. In the autumn during the catch in the pond No 2 SEEF "Nyvka" IF NAAS of Ukraine indicators of length and weight of biennial fish in 2017 (min-max values) – 315.0 – 363.0 mm, 320.0 – 552.0 g, in 2018 – 283.0 – 362.0 mm, 212.0 – 463.0 g; in the pond № 1 TRPLF NULES of Ukraine in 2017 – 293.0 – 327.0 mm, 235.0 –

363.0 g, in 2018 – 264.0 – 398.0 mm, 175.0 – 414.0 g; in the pond No 10 BEHS IHB NAS of Ukraine in 2017 the indicators were in the range – 217.0 – 310.0 mm, 90.0 – 287.0 g, in 2018 – 266.0 – 378.0 mm, 171.0 – 458.0 g (Table 2).

In comparison with the hybrid of silver carp, the average standard weight of biennials grown on farms producing aquaculture products is white silver carp: in the Polissya zone – 300 g, forest-steppe zone – 350 g, variegated silver carp, respectively 350; 400 g (Vdovenko, 2012; Vdovenko, 2013).

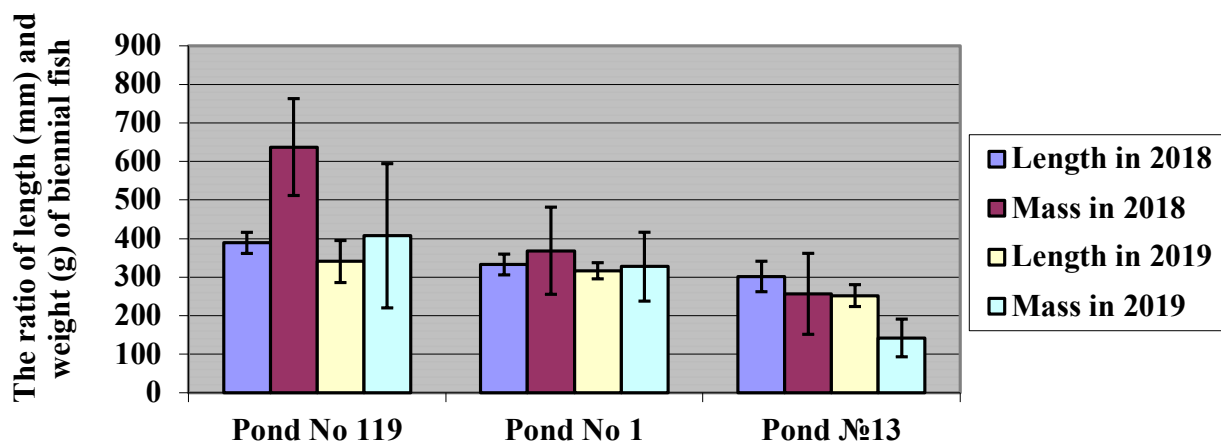


Figure 6 The ratio of the average values of the linear growth of the length and weight of biennials of the hybrid of silver and bighead carp from the studied winter ponds in 2018 – 2019.

Table 5 Performance by Phytoplankton and zooplankton, kg. ha⁻¹.

Age groups		DG "Nivka" IRG NAAN of Ukraine		NNVLR NUBIP of Ukraine		BEGS IGB NAS of Ukraine	
		1+	2	1+	2	1+	2
2017 y.	phytoplankton	5.73	1.40	4.57	1.17	0.82	0.47
	zooplankton	1.75	0.47	1.00	0.30	1.30	0.70
2018 y.	phytoplankton	0.94	0.67	0.48	0.71	1.40	8.10
	zooplankton	0.95	0.10	7.60	1.40	0.26	0.48
2017 y.	performance on the feed base	164.60	41.43	119.97	31.97	53.54	29.40
2018 y.	performance on the feed base	4.59	1.63	22.67	5.42	3.54	17.57

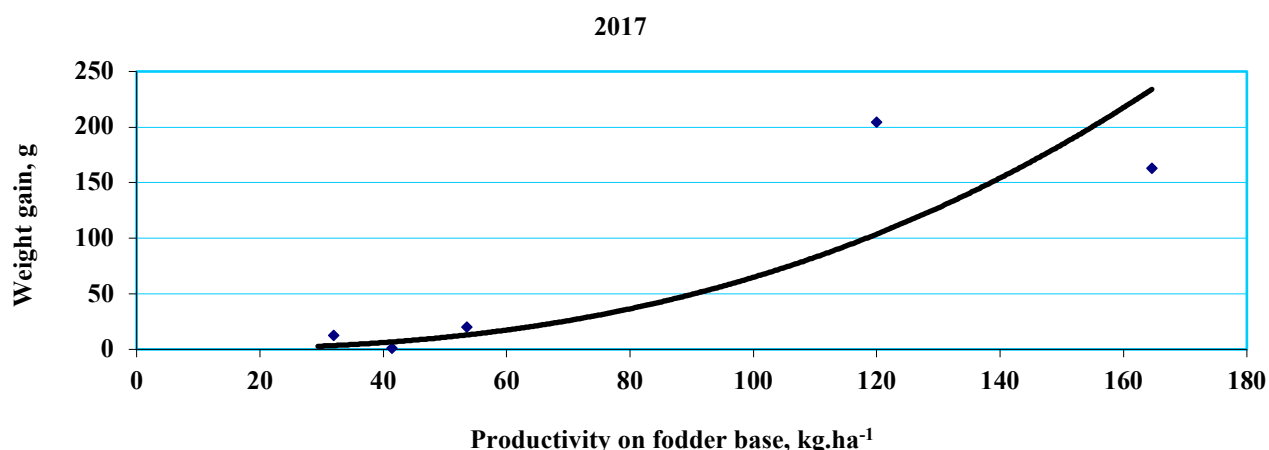


Figure 7 The increase in the mass of younger age groups of the hybrid of silver and bighead carp from the potential productivity of the fodder base in 2017.

Figure 5 shows the ratio of the average values of linear growth in length and weight of biennials of a hybrid of silver and bighead carp.

In the spring during the catching in the winter pond No 119 SEEF "Nyvka" IF NAAS of Ukraine indicators of

length and weight of biennials fish in 2018 fluctuated within the following limits (min-max values) – 285.0 – 363.0 mm, 429.0 – 804.0 g, in 2019 – 225.0 – 360.0 mm, 178.30 – 754.60; wintering pond No 1 TRPLF NULES of Ukraine in

2018 – 251.0 – 333.0 mm, 238.0 – 633.0 g, in 2019 – 236.0 – 298.0 mm, 209.0 – 485.0 g; winter pond No 13. BEHS IHB NAS of Ukraine in 2018 – 191.0 – 302.0 mm, 111.0 – 438.0 g, in 2019 – 155.0 – 236.0 mm, 63.30 – 227.90 g (Table 3).

The ratio of the average values of linear growth in length and mass of biennials of a hybrid of silver and bighead carp is shown in Figure 6.

According to experimental studies in 2017 – 2018 in TRPLF NULES, it was found that from the stocking of annual fish to the catch of biennials, the rate of linear growth was the highest – 194.52 mm, 165.58%; 204.28 mm, 204.85%, respectively, and the rate of weight growth was found to be significantly higher in SEEF "Nyvka" IF NAAS of Ukraine – 372.80 g, 939.0%; 336.97 g, 663.9%. In 2018 – 2019, after wintering in biennials from the pond BEHS IHB NAS of Ukraine, compared with biennials, the weight of fish decreased (– 126.82 g, – 52.86%), due to wintering of fish. In other experimental ponds (SEEF "Nyvka" IF NAAS of Ukraine and TRPLF NULES of Ukraine) after fish wintering, an increase in linear and weight indicators was observed. This may be because the ponds were caught in September-October and the data was also obtained during this period. When transplanting fish into winter ponds, it could still feed on detritus for some time and thus increase in length and weight. A significant difference in the size and weight of fish indicates a difference in living conditions in the ponds (Table 4).

Fish production of ponds for grazing fish retention is determined exclusively by the state of the natural feed base of ponds, the availability of fish feed organisms, the effectiveness of their use by various objects of polyculture (Liangzberg, 2016; Makarenko, 2018; Passos, Vidal and D'Anatro, 2019).

To characterize the foraging of a particular pond in a certain period, an indicator equal to the sum of potential fish productivity for phytoplankton and zooplankton was used (P/V – the coefficient for phytoplankton was taken as 100, zooplankton – 20, forage coefficient: 50 and 7, respectively). As a characteristic of growth, we used the indicator of absolute weight gain with differentiation by farms, age groups, and years (Table 5). The result of regression analysis is presented in Figure 7 and Figure 8.

The analysis of the obtained data showed that the dependence of the weight gain of the hybrid of silver and bighead carp (ΔM) of younger age groups on the potential productivity (P) on the feed base is satisfactorily (coefficient of determination is 0.64 – 0.66) described by the equation $\Delta M = a * P^b$, where $a = 0.001 - 1.182$; $b = 1.85 - 2.57$.

It was found that grown in pond fish farms hybrid of silver and bighead carp had a higher rate of linear and weight growth, compared with the parental forms kept in similar conditions of pond farms (Sukhenko et al., 2019).

Today, much attention is paid to the study of aquatic bioresources of large reservoirs of the Dnieper cascade, small reservoirs of southern Ukraine, and other artificial reservoirs. (Klymenko and Statnyk, 2012; Makarenko, Shevchenko and Sytnyk, 2018a; Liu et al., 2017; Tereshchenko et al., 2016; Tsaryk et al., 2020; Petruk, 2013).

The study of hydrobiocenoses in small reservoirs within the zones of Polissya and Forest Steppe is currently not

comprehensive, its studies are isolated and do not contain a clear interconnection.

When comparing different groups of the hybrid of silver and bighead carp caught from experimental small reservoirs, there is also a significant difference in their size and weight characteristics. In the spring of 2018, during the stocking of the Kosiv Reservoir, the length and weight of annual fish was (min-max values) – 159.0 – 204.0 mm, 35.80 – 74.30 g, and in 2019 – 135.0 – 190.0 mm, 19.90 – 67.90 g. In the autumn of 2019, during the overfishing of the Kosiv Reservoir, the length and weight of triennial fish, fish stock (annuals) stocked in 2018, fluctuated within the following limits (min-max values) – 535.0 – 573.0 mm, 1493.70 – 1907.50 g; triennial fish, stocking of fish planting material (biennials) in 2019, varied – 577.0 – 640.0 mm, 2124.50 – 2722.60 g (Table 6).

The ratio of the average values of linear growth in length and weight of annuals and triennials of hybrid of silver and bighead carp is shown in Figure 9 and Figure 10.

In autumn, during the stocking of the Velykoburlutske Reservoir, the value of the length and body weight of young-of-the-year fish in 2017 was (min-max values): 118.0 – 157.0 mm, 13.30 – 28.80 g; in the autumn when catching biennials in 2018 – 385.0 – 434.0 mm and 592.0 – 884.0 g; in the summer when catching triennial fish in 2019 – 369.0 – 605.0 mm, 601.20 – 1754.20 g (Table 7). During the study pechenizka reservoir (Kharkiv region), it was found that the mass caught three years was 920 g. (Gogol, 2014).

The rate of linear-weight growth of different size-weight groups of a hybrid of silver and bighead carp from the Kosiv Reservoir has not been determined, as not enough information has been collected.

In the study of the Velykoburlutske Reservoir, it was found that during 2017 – 2018 the average linear increase (from young-of-the-year fish to biennials of a hybrid of silver and bighead carp) was 227.18 mm, the absolute increase – 302.74%; for weight growth, these indicators were respectively: 757.74 g and 3.858%. In 2018 – 2019, in triennials, compared with biennials, the length increased by 66.30 mm, 116.02%, and weight – 459.64 g, 159.09%, which may be due to the high feed base of the reservoir (Table 8) (Buzevych and Makarenko, 2020).

An important practical aspect of grazing aquaculture of herbivorous fish is to determine the optimal amount of planting material, in particular, it concerns stocking of reservoirs, which can be carried out in two strategic directions: mass stocking of young fish with low stock and less stocking with large planting material. One of the advantages of the first direction may be a higher growth rate of planting material in reservoirs (compared to ponds). This allows forming a more resistance to the conditions of a particular reservoir initial herd of aquaculture facilities (Raoult, Gaston, and Taylor, 2018; Buzevych and Buzevych, 2017; Khrystenko et al., 2012; Sukhenko et al., 2017; Zakharchenko et al., 2019; Didenko, 2007). To verify this factor, we conducted a comparative analysis of the rates of linear and weight growth of annuals and biennials of hybrids of silver and bighead carp grown in pond conditions and young-of-the-year – triennials in the reservoir.

Table 6 The average values of length and body weight of a hybrid of silver and bighead carp.

Indexes	Kosiv Reservoir			
	Annuals		Triennials	
	Spring 2018	Spring 2019	Autumn 2019 (Fish stocking in 2018)	Autumn 2019 (Fish stocking in 2019)
	M±m	M±m	M±m	M±m
Average body length, mm	172.12 ±9.94	158.20 ±19.19	548.30 ±13.35	617.70 ±20.75
Average body weight, g	45.88 ±8.79	38.81 ±15.03	1714.05 ±148.46	2402.43 ±226.90
Fulton fatness (K-factor)	1.71	1.91	1.71	1.63

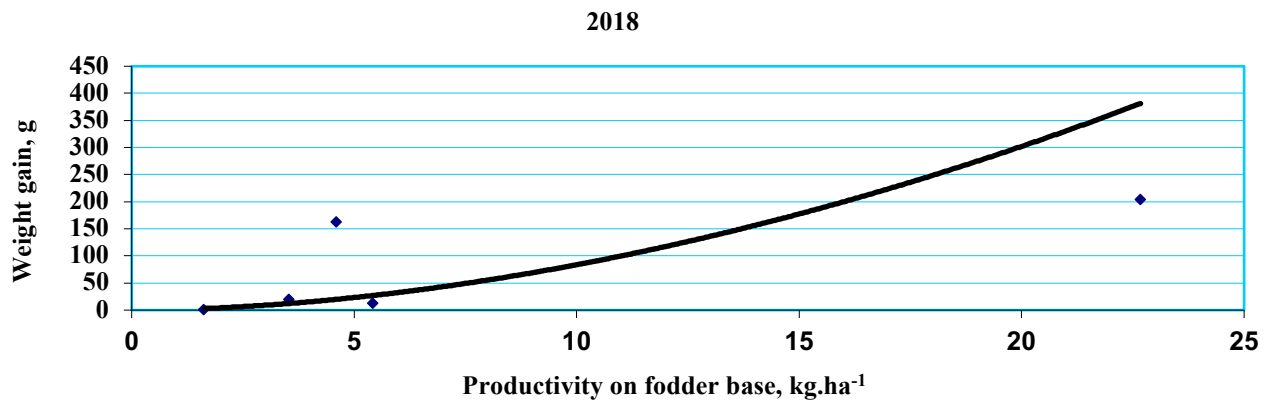


Figure 8 The increase in the mass of younger age groups of the hybrid of silver and bighead carp from the potential productivity of the fodder base in 2018.

Table 7 The average values of length and body weight of a hybrid of silver and bighead carp

Indexes	Velykoburlutske Reservoir		
	Young-of-the-year	Biennials	Triennial
	Autumn 2017	Autumn 2018	Summer 2019
	M±m	M±m	M±m
Average body length, mm	136.72 ±63.30	413.90 ±17.74	480.20 ±95.00
Average body weight, g	20.16 ±5.12	777.90 ±114.70	1237.54 ±509.56
Fulton fatness (K-factor)	1.75	1.83	2.12

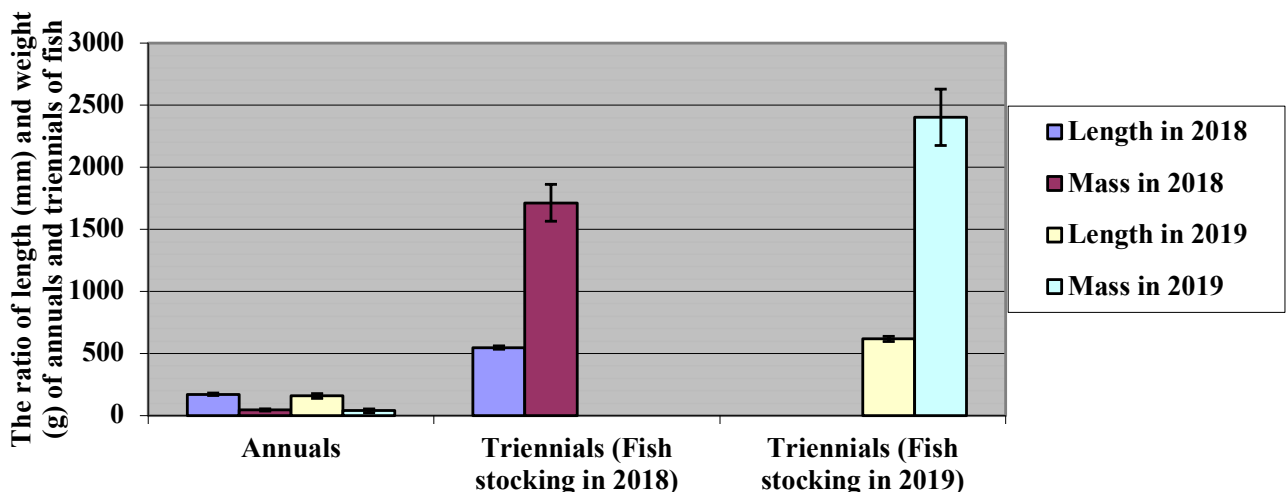


Figure 9 The ratio of the average values of linear growth in length and mass of annuals and triennials of hybrid of silver and bighead carp from the Kosiv Reservoir in 2018 – 2019.

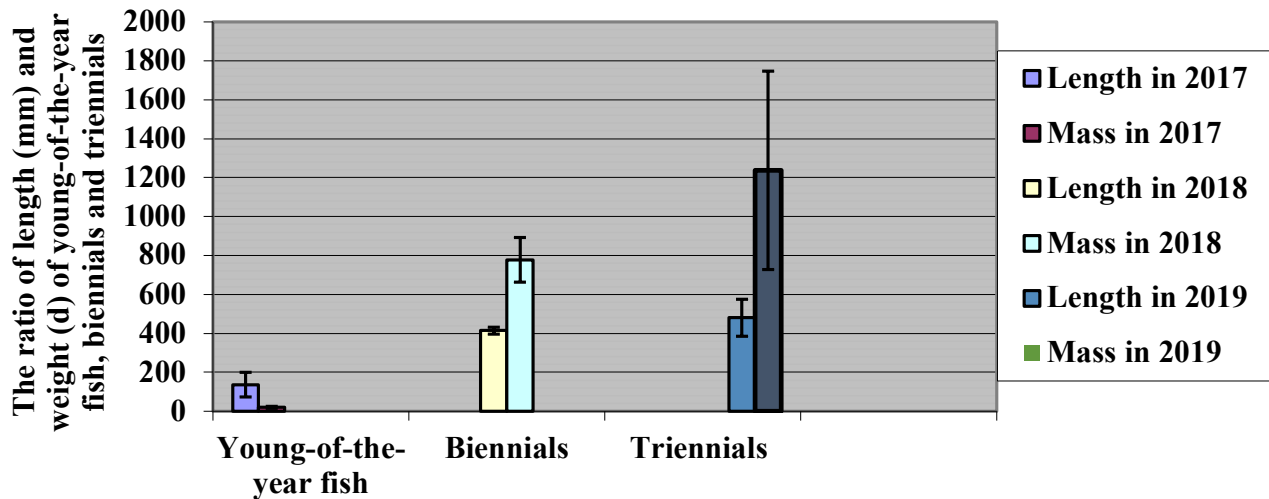


Figure 10 The ratio of the average values of linear growth in length and weight of young-of-the-year fish, biennials, and triennials of a hybrid of silver and bighead carp from the Velykoburlutske reservoir 2017 – 2019.

Table 8 The rate of linear-weight growth of a hybrid of silver and bighead carp from the Velykoburlutske reservoir.

Age group	Indexes	2017 – 2019
0+ – 1+	mm	277.18
	%	302.74
1+ – 2+	mm	66.30
	%	116.02
0+ – 1+	g	757.74
	%	3.858
1+ – 2+	g	459.64
	%	159.09

CONCLUSION

It was found that in 2017 – 2018 in TRPLF NULES from stocking annual fish to the catch of biennial fish the rate of linear growth was the highest – 194.52 mm, 165.58%; 204.28 mm, 204.85%, and the rate of weight growth was found to be significantly higher in DG "Nyvka" IRG NAAS of Ukraine – 372.80 g, 939.0%; 336.97 g, 663.9%. According to the research in 2018 – 2019, after wintering in biennial fish from the pond BEGS IGB of Ukraine, compared with biennial fish, the weight of fish decreased (– 126.82 g, – 52.86%), which is due to fish wintering. In the ponds of DG "Nyvka," IRG NAAS of Ukraine, and TRPLF NULES of Ukraine after wintering a significant increase in linear and weight indicators of fish was observed.

The dependence of the mass gain of a hybrid of silver and bighead carp (ΔM) of younger age groups on the potential productivity (P) on the forage base, which is satisfactorily described by the equation was established.

For the Velykoburlutsky Reservoir, it is shown that during 2017 – 2018 the average linear increase (from young-of-the-year fish to biennials of a hybrid of silver and bighead carp) was 227.18 mm, the absolute increase was 302.74%; for weight growth, these figures were respectively: 757.74 g, 3.858%. In 2018 – 2019, in the studied triennial fish, compared to biennial fish, the length increased by 66.30 mm, 116.02%, and the weight – 459.64 g, 159.09%, which may be due to the high feed base of the reservoir.

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