

Investigations on intensification of carp fingerling production

2. State of health of fingerlings

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Abstract — An ichthyopathological investigation on one year old carp fingerlings was carried out. The most important diseases of fingerlings were: swim bladder inflammation and invasion of *Bothriocephalus* sp. and *Caryophyllaeus* sp. tapeworms. Compared with the progeny of pure lines the hatch from the crosses of Hungarian carp and the Gołysz line was found to be more resistant to disease. The obtained results did not show any effect of fertilizing methods and kind of feed on the state of health of carp.

Key words: ponds, carp fingerlings, production intensification, diseases.

1. Introduction

The intensification of pond fish culture is among other factors conditioned by sufficient amounts of carp stocking material. These amounts in a great measure depend on the survival rate in the first year of life and the state of health of the one-year-old fish stock. The greatest quantitative losses in the first period of life of carp occur because of the poor resistance of the larvae to unfavourable changes in the environment. Under natural conditions they are exposed to unfavourable climatic factors and the associated food deficiency. With their not yet fully efficient resistance systems, the constant exposure to pathogenic organisms leads to the elimination of considerable numbers of fish in the earliest developmental stages. But the same time, fish in this period are very small, hence difficult to observe and examine, even pathologically. The lack of data concerning the occurring diseases and their etiology, besides the difficulties in using the methods known and applied in older fish in the prevention and treatment of disease, make any wider prophylactic and therapeutic action impossible. Thus intensive studies on carp in the first weeks and months of life are needed.

The complex studies on intensive forms of rearing first year stock carp, carried out at the Fish Culture Experimental Station Gołysz of the Polish Academy of Sciences in the period 1981—1985, also included an ichthyopathological investigation. The aim of the work was to extend and systematize the knowledge of diseases of first year carp, and to determine the degree of threat by separate disorders. A further aim was to show a possible dependence of the state of health of fingerlings on various stock densities, differentiated fertilization, and feeding.

2. Material and methods

The general methodical scheme has been described by Szumiec J. (1987). Throughout the breeding season fishes for ichthyopathological examination were taken from 8—15 small ponds to secure 2—3 replications of each experimental variant and from all ponds at the final catch. Annually, 320—420 specimens of carp were examined. Catching began when the fish reached a size permitting ichthyopathological observations, i.e., in the 4th—5th week after hatching. At first, the examinations were carried out at 2-weekly and then, from August, at 4-weekly intervals. Apart from detailed ichthyopathological investigations, the stocks of the small experimental ponds were constantly observed during the entire breeding season in all years of the study.

Carp were subjected to a classic ichthyopathological examination, which included the observation of morpho- and anatomopathological changes and parasitological analysis. The investigation was carried out using generally accepted methods (Kocyłowski, Miączynski 1960, Amlacher 1972, Schaperclaus 1979).

3. Results

Already in 1981 the first examination showed that almost all the fish were the hosts of a number of parasites of the genera *Trichodina*, *Ichthyobodo*, and *Dactylogyrus*. In some carp single specimens of *Ichthyophthirius multifiliis* were noted. The infestation with parasites was maintained during the entire rearing season, though the species composition and intensity of occurrence of parasitic organisms changed. In July, in some of the fish examined there occurred a growing number of trematodes on the gills of the genus *Dactylogyrus*. In the second half of the season the number of these organisms gradually decreased. Towards the end of July in part of the population, chiefly in fishes with injured gills, invasive numbers of *Trichodina* sp. and *Ichthyobodo* sp. protozoa were observed. In the last two months of rearing single specimens of *Bothriocephalus* and *Caryophyllaeus* tapeworms appeared. Other para-

sitic species which had been observed earlier did not occur towards the end of the season.

Beginning from the investigation carried out in the second half of August the numbers of tapeworms of the genera *Bothriocephalus* and *Caryophyllaeus* increased. In August tapeworms were found in the stock of two, and in September of four ponds out of the investigated ten. In October their occurrence was noted in 21 out of 24 ponds investigated. The extent of infestation gradually rose from 20% in August to 80% in October. The number of tapeworms in the alimentary canal varied from one to tens of specimens, this frequently decreasing the patency of the intestines. *Bothriocephalus* sp. dominated (75% of cases). In numerous cases there both species of tapeworm were noted in carp from the same pond, while in a few cases a mixed invasion occurred. In one fish *Bothriocephalus* sp. and *Caryophyllaeus* sp. were found at the same time. *Bothriocephalus* occurred with greater intensity and brought about significant losses of carp fingerlings. Death caused by tapeworm invasion occurred in four ponds, especially in those stocked with fry from inbred spawning.

In mid-August the first signs of swim bladder inflammation were observed in fish from three ponds. However, in September and October the disease was noted in carp from nine ponds, being found in 10–60% of those caught there.

At the turn of August, signs of gill necrosis were noted in 10–15% of the examined fish. There appeared swellings and an irregular blood supply in the gills and small centres of necrosis were observed.

Analysis of diseases prevailing in the rearing of carp fingerlings in 1981 (the intensity and extent of tapeworm invasion and cases of swim bladder inflammation) showed a dependence of the susceptibility to these disorders upon the origin of the stock. The progeny of the cross between

Table 1. Frequency of occurrence of swim bladder inflammation and extent of tapeworm invasion in ponds with an intensive level of production of one-year carp fingerlings in October 1981 as depending upon the origin of the stock. * - the first figure - the number of ponds where a disease was observed, the second figure - the number of ponds from which fish were examined

Origin of stock	Tapeworm invasion		Swim bladder inflammation		Mean survival of the stock %
	number* of ponds	diseased fish %	number* of ponds	diseased fish %	
Crosses:					
W x 3	2/4	10	1/4	15	44
3 x T	3/4	20	2/4	10	61
Inbred:					
7 x 7	4/4	35	1/4	5	31
3 x 3	4/4	60	2/4	12	14
K x K	4/4	65	3/4	40	6

the third Gołysz carp line and Hungarian carp lines W and T was found to be more resistant to the diseases of the first year than that of the pure lines (Table I). The inbred progeny of line K was particularly susceptible to pathogenic factors.

In 1982 the state of health of carp from the experimental ponds was much better, only the carrying of a few species of external parasites being observed. Parasitic protozoa were represented by some species of the genera *Trichodina*, *Ichthyobodo*, and *Apiosoma*, and in a few cases *Ichthyophthirius*. Protozoa occurred in comparatively small numbers throughout the breeding season. Besides, there occurred trematodes of the genera *Dactylogyrus* and *Gyrodactylus*. Both the extent and intensity of occurrence of these parasites were low.

Beginning from the second half of July infestation with *Caryophyllaeus* and *Bothriocephalus* tapeworms was observed in the investigated carp. Small numbers (1—3 specimens) of the parasites occurred in the alimentary canals of 4—5% of the fish, *Caryophyllaeus* sp. being more frequently encountered. Because of the serious effects of tapeworm invasion in 1981, treatment with "Zestocarp" pellets containing the anti-helminthic "Niclosamide", was applied in 1982 immediately after the first tapeworms were noted in carp from the experimental ponds. The only sporadic occurrence of tapeworms in the second half of the season resulted in a great measure from this treatment.

In 2—4% of carp there also appeared signs of swim bladder inflammation and in August and September pathological changes were found in the gills of about 10% of the fish examined (Table II).

In 1983 the health condition of the carp was similar to that in the preceding year. The carrying of parasitic Ciliata, both freely living and attached, of the genera *Trichodina* and *Apiosoma* was noted. Early in the season there appeared small numbers of *Ichthyobodo necatrix* and, slightly more numerous, *Ichthyophthirius multifiliis*. The occurrence of single trematodes, most frequently of the genera *Dactylogyrus* and, more rarely, *Gyrodactylus*, was found in all examinations. In a few cases single specimens of *Argulus foliaceus* of the order *Branchiura* were observed (this is not mentioned in Table II).

In the alimentary canals of 5—10% of the fish single specimens of the genera *Caryophyllaeus* and *Bothriocephalus* were noted. Tapeworm invasion was probably affected by the treatment with "Zestocarp" pellets begun in 1983.

The investigation carried out in July showed a high percentage (24%) of carp with signs of swim bladder inflammation in half the ponds studied. Treatment with detreomycin was begun, the antibiotic being applied in the feed three times at a dose of 1 g per 1 kg of feed with the addition of 0.1 g of methylene blue. In the following months only single cases of damage of the swim bladder were noted.

Table II. Results of examination of the state of health of carp from experimental ponds with an intensive level of production of one-year carp fingerlings. a - the first figure - the number of ponds where the given disease was observed, the second figure - the number of ponds from which fish were examined; b - percentage of fish with signs of disease or parasite invasion; c - intensity of diseases: M - carrying or slight changes; MM - medium changes; MMM - massive invasion or severe changes

Disease	Month	1982						1983						1984						1985					
		J	J	A	S	O	J	J	J	A	S	O	J	J	J	A	S	O	J	J	A	S	O		
Trichodinosis	a	3/8	12/15	12/12	12/12	19/24	8/8	9/12	10/12	15/15	24/24	4/12	9/12	8/8	12/24	3/12	7/12	16/16	12/12	24/24	4/12	7/12	16/16	12/12	24/24
	b	40	45	25	28	30	80	45	53	62	65	7	60	78	60	33	60	80	80	100	M	M	M	M	M
	c	M	M	M	M	M	M	M	M	M	M	M	M	MM	M	M	M	M	M	M	M	M	M	M	M
Coetiosis	a	4/8	7/15	6/12	1/12	-	2/8	2/12	-	-	-	-	-	-	-	4/12	2/12	2/16	-	-	12	20	25	-	-
	b	50	14	5	5	-	10	5	-	-	-	-	-	-	-	12	20	25	-	-	20	25	-	-	-
	c	M	M	M	M	M	M	M	-	-	-	-	-	-	-	M	M	M	-	-	M	M	M	-	-
Attached ciliata	a	9/15	7/12	2/12	2/12	2/24	4/8	2/12	2/12	2/15	12/24	5/12	11/12	6/8	4/24	5/12	6/12	6/16	2/12	1/12	5/12	6/12	6/16	2/12	1/12
	b	32	40	20	20	2	56	8	5	3	32.5	50	75	80	42	40	65	60	40	20	40	65	60	40	20
	c	MM	MM	M	M	M	MM	M	M	M	MM	MM	MM	MM	M	M	MM	MM	M	M	M	MM	MM	M	M
Ichthyophthiriosis	a	2/8	-	-	-	-	5/8	4/12	1/12	5/15	-	6/12	8/12	-	-	1/12	6/12	6/16	2/12	-	1/12	6/12	6/16	2/12	-
	b	15	-	-	-	-	50	10	12	12	-	20	20	-	-	20	35	22	20	-	20	35	22	20	-
	c	M	-	-	-	-	M	M	M	M	-	M	M	-	-	M	M	M	M	-	M	M	M	M	-
Trematode invasion	a	5/8	3/15	4/12	5/12	11/24	3/8	1/12	1/12	1/15	3/24	8/12	8/12	-	-	2/12	3/12	2/12	2/12	-	2/12	3/12	2/12	2/12	-
	b	28	4	2	8	15	20	3	4	2	5	41	15	-	-	20	15	-	10	-	20	15	-	10	-
	c	M	M	M	M	M	M	M	M	M	M	M	M	-	-	M	M	-	M	-	M	M	-	M	-
Tapeworm invasion	a	-	2/15	2/12	3/12	6/24	1/12	6/12	3/15	3/15	5/24	-	-	-	2/24	2/12	2/12	5/16	3/12	8/24	-	-	5/16	3/12	8/24
	b	-	4	4	4	5	5	5	10	7	6	-	-	-	20	15	22	22	20	20	-	-	22	20	20
	c	-	M	MM	M	M	-	M	M	M	M	-	-	-	M	-	-	M	M	M	-	-	M	M	M
Swim bladder inflammation	a	3/15	-	1/12	1/12	1/24	6/12	4/12	2/15	2/15	1/24	-	-	-	4/8	21/24	6/12	12/16	12/12	11/24	6/12	12/16	12/12	11/24	
	b	4	-	2	2	2	24	7	4	4	1	-	-	-	30	37	25	50	40	33	25	50	40	33	
	c	MM	-	M	M	M	M	M	M	M	MM	-	-	-	MM	MM	M	M	M	M	M	M	M	M	
Gill necrosis	a	3/15	2/12	3/12	3/12	3/24	1/8	2/12	-	-	-	2/12	4/12	2/8	-	1/12	1/12	3/16	1/12	1/24	1/12	1/12	3/16	1/12	1/24
	b	4	5	5	5	2	3	4	-	-	-	3	10	5	-	5	5	25	20	10	5	5	25	20	10
	c	M	M	M	M	M	M	M	-	-	-	M	M	M	-	M	M	M	M	M	M	M	M	M	M

In some fish small changes in the gills were also observed. In Table II only those cases in which even points of necrotic changes were found in the gills are included.

In 1984 the state of health of fingerlings differed significantly from that observed in the two preceding years. A distinct increase in the intensity and extent of occurrence of parasitic Ciliata *Trichodina* sp. and *Apiosoma* sp. was noted, found in maximum numbers at the turn of August. In the first half of the season single specimens of *Ichthyophthirius multifiliis* and trematodes of the genera *Dactylogyrus* and *Gyrodactylus* appeared. At the end of the rearing season tapeworms were recorded in 20% of the fish in two ponds. Tapeworm invasion was prevented by a single treatment with „Zestocarp“.

In 1984 the number of cases of swim bladder inflammation also increased, the first specimens with pathological changes being noted in the last decade of August. By September the disease was found in 30% of the fish examined and in autumn the intensity of pathological changes in swim bladder and frequency of occurrence rose. In October swim bladder inflammation was noted in 21 out of 24 investigated ponds. Pathological changes in the swim bladder were found in over 37% of fingerlings and in many fishes they were fairly advanced. There appeared abscesses and inflammation in adjacent internal organs.

The number of cases of gill necrosis rose slightly in comparison with the previous years. Gill damage in the form of small necrotic changes was usually observed in the full breeding season from August to September.

In 1985 the state of health of fingerlings was similar to that in 1984. Throughout the rearing season there occurred large numbers of slightly pathogenic Ciliata of the genera *Trichodina*, *Trichodinella*, *Apiosoma*, and, more rarely, *Epistylis*. In the first months of fish rearing in a few to about twenty per cent of carp were observed single specimens of the parasitic protozoans, more dangerous for fingerlings *Ichthyobodo necatrix* and *Ichthyophthirius multifiliis*. The number of these parasites gradually fell in the second half of the season. Also found were small numbers of *Dactylogyrus* and *Gyrodactylus* trematodes, most frequently parasitizing the gills.

Dissection showed an increasing number of fish with tapeworms in the alimentary canals. Most frequently these were *Caryophyllaeus* sp. and in single cases only *Bothriocephalus* sp. The extent of tapeworm invasion was maintained at the level of 20%, but the intensity was low, varying from one to a few tapeworm in an alimentary canal. The increase in the number of tapeworms in the fish as compared with the previous years was probably because the treatment with antihelminthics had been discontinued.

In 1985 swim bladder inflammation affected almost half the carp in-

vestigated in August. However, the observed pathological changes were not great, being limited to a thickening of the walls of the first chamber of the bladder, fibrinous concretions, gelatinous infiltrations, and small congestions. In the last two months of the season the disease gradually disappeared, probably owing to the two treatments with detreomycin.

The number of cases of gill injury rose. Gill necrosis was limited to comparatively small changes and the occurrence of very small necrotic foci. Gill injury was more frequent in fingerlings with swim bladder inflammation.

In the final catches single specimens of *Argulus foliaceus* were noted.

4. Discussion and conclusions

The collected material is not representative enough to permit determination of dependences between the application of different fertilization in ponds and different feed of varied protein content, and the state of health of fingerlings. The subjective estimation of the state of health, especially in the case of infectious diseases, with slight differences between the 24 investigated ponds, does not allow any far-reaching conclusions to be formulated.

With regard to the state of health the period of investigation may be divided into 3 sub-stages: the year 1981, the years 1982—1983, and 1984—1985.

In 1981 the experimental ponds were stocked with carp fingerlings from the inbred spawning of pure lines and from crosses between the third Gołysz line and Hungarian lines T and W (Szumiec J. 1987). The progeny of the crosses was found to be more resistant to disease (Table I).

In 1982—1983 the state of health of fingerlings was much better than in the previous year and in the following years. Only infestation with a few species of external parasites was observed. Both the intensity and extent of occurrence of internal parasites were low.

The years 1984—1985 were characterized by a deterioration of the state of health. The number of external parasites rapidly rose, while swim bladder inflammation became more common in the fingerlings. 1984 was particularly detrimental in this respect. Because of damage to the swim-bladder, the quality of fingerlings was poor and the winter brought numerous losses. The threat of swim-bladder inflammation was also maintained in 1985.

The described variability in the occurrence of disease in carp fingerlings was in a great measure associated with the climatic conditions of the particular years. The years 1982—1983 when there were comparatively few problems with the health of fingerlings were characterized by the most favourable weather conditions (Szumiec M. A. 1987).

The threat to carp fingerlings by the different diseases changed in the successive years. In the first year of the study the invasion of *Bothriocephalus* sp. tapeworms played a great role, causing the death of fish. In the following years the intensity and hence the threat of tapeworm invasion were diminished and the frequency of occurrence of *Bothriocephalus* was reduced. From 1982 *Caryophyllaeus* sp. dominated. On the other hand, the threat of swim bladder inflammation increased. In the years 1984—1985 this disease played a serious role. It is true that did not cause death during the rearing season, but deaths did occur during the winter.

External parasites, including trematodes, *Ichthyophthirius*, and *Ichthyobodo*, which are thought to be dangerous for young carp, were sometimes fairly numerous (Table II) but presented no great threat. This is confirmed by the fact that in the second half of the rearing season the number of external parasites fell; was did gill necrosis present any real problem.

The diseases occurring in first-year carp are also typical for older fish (Markiewicz et al. 1985). A comparison of the present study on fingerlings with earlier investigation on first-year carp (Markiewicz et al. 1977) shows a greater effect of tapeworm invasion on the production results.

The fairly high level of intensification of the production of fingerlings (stocks of 90—150 thousand per hectare and a catch of 2—3 thousand kg per hectare) did not bring about any great deterioration in the state of health of the fish reared.

Taking into consideration the intensity of invasion and of pathological changes it may be concluded that the infectious and invasive diseases recorded during the rearing season could not have brought about the death of the fish. Exceptions were the year 1981 and also single ponds in 1984—1985, though there the cause of death was not altogether clear. No deaths occurred in the period July-October. This may suggest that the quantitative losses of 30—60% found in the final catches took place in the first 2—4 weeks of life of the carp. Future ichthyopathological studies should be concentrated on this period in order to elucidate the causes of death in the youngest stages of fish development.

5. Polish summary

Badania nad intensyfikacją chowu narybku karpia

2. Stan zdrowotny narybku

Przeprowadzono badania ichtiopatologiczne narybku karpia w celu poszerzenia wiedzy o schorzeniach występujących w pierwszym roku życia karpia, określenia stopnia zagrożenia ze strony poszczególnych jednostek chorobowych, jak również wyka-

zanie ewentualnego związku zróżnicowania obsady, nawożenia stawów oraz paszy ze stanem zdrowotnym.

Fakt znacznego zróżnicowania stanu zdrowotnego w kolejnych latach utrudnia jednoznaczne określenie stopnia zagrożenia dla chowu narybku karpi ze strony poszczególnych jednostek chorobowych. Dominujące znaczenie miały inwazje tasiemców *Bothriocephalus* sp. i *Caryophyllaeus* sp. oraz zapalenie pęcherza pławnego. Inne schorzenia, jak nekroza skrzeli i pasożyty zewnętrzne, nie stwarzały większych problemów.

Potomstwo pochodzące z krzyżówek między liniami karpi gołyskich i węgierskich okazało się bardziej odporne na występujące choroby niż potomstwo czystych linii rozmnażanych wosbnie (tabela I). Zebrane dane nie wykazały związku między zróżnicowanym nawożeniem stawów oraz zróżnicowanym żywieniem a stanem zdrowotnym.

Wahania stanu zdrowotnego narybku karpia (tabela II) związane były w dużej mierze z warunkami klimatycznymi w poszczególnych latach. Lata 1982—1983, w których narybek charakteryzował się stosunkowo najlepszym stanem zdrowotnym, były jednocześnie latami o najbardziej korzystnych warunkach meteorologicznych.

Opierając się na stałej obserwacji stawów oraz uwzględniając intensywność występujących schorzeń można stwierdzić, że większość ubytków ilościowych występujących przy chowie narybku ma miejsce w pierwszych 2—4 tygodniach życia karpia. W celu poznania przyczyn śnięć najmłodszych stadiów rozwojowych ryb badania ichtiopatologiczne należałoby w przyszłości skoncentrować właśnie na tym okresie.

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