The European and Hungarian Results of Cage Culture of Fish

Ferenc Muller
Fish Culture Research Institute
Szarvas, Hungary

The cage culture of fish began to spread in Europe during the last 15 years almost simultaneously with the manufacturing of complete formulated fish feeds.

Considerable results were achieved in the Soviet Union with the cage culture of rainbow trout, *Salmo irideus* when its complex technology was elaborated (Miheev, Meszner, Miheev, 1974). They stock 20-30 days old trout fingerlings (weighing about 1 g) at the end of June or first half of July into floating cages made of 3.6-4.0 mm mesh capron net. They found 800 fish per m^3 as the optimal stocking density. The trout reached 9 g average weight by the end of October.

Wintering of the young trouts was also carried out in the cages. They stocked the trouts in 6.5 mm mesh capron net cages for the second year in mid April. The cages were placed in the open waters of the reservoir about 100-150 m away from the reed belt in order to prevent parasitic infections.

It was found that the rainbow trout in its second year tolerates fairly well water temperatures as high as 23-25°C and does not stop feeding if the dissolved oxygen content in the cage is high enough. To avoid damages caused by strong sunlight, deep cages (up to 4 m) were used.

Trout stocked in April was harvested at the end of October. The fish with an initial weight of 7.0-10.3 g grew up to 119-181 g during that time. The highest growth (354 g as an average was obtained by stocking one year old trout with a bodyweight of 20 g.

The trout in the cages was fed with a mixture of minced trash fish, molluscs and crayfish collected in the reservoir (the trout fry was fed with cultivated food organisms).

The technology of cage culture of trout was elaborated in the German Democratic Republic for deep natural lakes of glacial origin (Steffens and Menzel, 1976).

The yield of market-sized bester in cages was 9.3 kg per m^2. The hybrids were fed with ground thrash fish unsuitable for human consumption. Good results were achieved also with pelleted dry feed mixtures.

The sites for cage culture were selected according to the following principles:

- maximum temperatue should not exceed 20°C (higher temperature may occur for a short period only);
- dissolved oxygen concentration early in the morning should be 6 ppm or higher;
- pH should be 8 or less;
- NH_4 should not be higher than 0.5 ppm;
- poisonous pollutants should not occur at all;
- water depth should be at least 4 m;
- oxygen demand of the trout is 600 g/t/hour.

Light metal framed floating cages of 4 x 3 size are used here. The cages are 3 m deep (depth measured from the water surface) and made of 14 mm mesh imprenated nets. The average weight of fingerlings stocked was at least 40 g and 88 fish was stocked per m^3. Feeding was made with 3-5 mm sized pellets of complete, formulated feeds.

The target of cage culture in the German Democratic Republic is to produce market-sized trout exceeding 250 g in weight. At 10 percent mortality they expect a harvest of 80 fish per m^2, which corresponds to 20 kg trout per m^3. One kg fish production was gained by feeding 2.5 kg pellet feed. Preconditions of such conversion rate are adequate water temperature and suitable feeding technology.

Market-sized trout is also raised in sea water in several western and northern European countries (e.g. Great Britain, Norway, etc.). The technology applied here is the following: Young trout is raised up to 15-20 cm length in freshwater. These are stocked in floating net cages anchored in calm bays

of the sea. Th most advanced cage farms use factory made light metal framed cages, the water volume of which is as much as 500 m^3. Formulated, complete dry pellets are used, distributed by automatic feeders. The weight of the market-sized trout raised in the sea is sometimes more than 1-2 kg because the consumers prefer big trout.

In the German Democratic Republic investigations on cage culture of common carp started in 1966.

The experiments started in 3 x 1.5 m sized cages placed in a cooling reservoir of a power plant, average water temperature of which was 24.3°C during the summer season. Two summer old common carp was raised first (Steffens, 1969). The cages were made of a floating metal frame and plastic netting submerged 1.5 m deep into the water, consequently the volume of a cage was 6.5 m^3.

The stocking density was 200-400-600 carp per m^3 in different cages of the experiment. The carp was fed during the first two months 8 times, later 6 times a day with a formulated pellet feed containing 33.7 percent of crude protein. The best result and the highest weight gain was achieved at 200/m^3 stocking density. The one-year old common carp with a 50 g initial weight grew to an average 268 g over a 93-day growing period.

The weight gain decreased by higher stocking densities. The best food conversion rate (1.45) was at 200 fish per m^3 stocking density.

The same cages were subsequently used for production of market-sized carp (Steffens, 1970). The cages were moored to both sides of an old disused barge towed into the cooling water reservoir of the power plant. The water was flowing through the cages with an average flowrate of 0.2 m^3 per second. The cages were stocked with 100, 120 and 200 fish per m^3 using two-year old common carp with an average weight of 250-300 g.

The pellet feed contained also 33.7 percent of crude protein. The feeding season was 75-118 days long, during that period the average weight reached in the different cages ranged between 652-1015 g. The extremes of the feed conversion rates were 1.61 and 2.25, respectively. Based on these results, German experts think that with optimal environmental conditions, about 100 kg per m^3 weight gain can be achieved by cage culture of common carp.

Several large-scale cage farms have been recently established in the German Democratic Republic. One of these is the State Fish Farm of Prenzleu. Here they produce more than 100 tons of market-sized carp annually. The production is carried out in 132 light metal framed cages of 6 x 3 m size made of perlon netting. The depth of the cages is 3 m. Eight hundred (800) to one thousand (1000) market-sized common carp are raised in one cage. Only two persons attend to the farm.

Cage culture of common carp started in the Soviet Union also in the cooling reservoirs of power plants. The growing season of the common carp was extended considerably and good results were achieved in these cooling reservoirs in the middle belt of the country where the growing season in fishponds lasts only three months.

The cage culture of common carp has been spreading in the great reservoirs of the Soviet Union, called "inland seas" (Romanicseva, 1973). Cage farms were established in well protected shallow bays to avoid damages caused by storms developing often on these huge reservoirs.

Soviet experts reported that for raising market-sized carp, floating cages with wooden frames with a surface area of 60-100 m^2 are optimal (ratio of length to width is 2.1). Depth of the 6.5-10.0 mm mesh plastic netting is 2.5-3.0 m.

The stocking rate of these cages is 20 carp with an average weight of 20-25 g per square meter. The expected survival rate is 80 percent. The average weight at harvesting is about 450 g. The protein constituents of the feed were collected in the reservoir itself. The feed was a mixture of minced thrash fish, molluscs, crayfish, etc. and grown cereal grains. The conversion rate was 4.5-7.0 kg.

Experiments were made with cage polyculture of common carp *(Cyprinus carpio),* grass carp *(Ctenopharyngodon idella),* silver carp *(Hypophthalmichthys molitrix)* and bighead *(H. nobilis).* According to the first experiences these fish species adapted themselves well to the conditions in the cages. When raising carp and bighead together the yield was 9.2 kg per m^2; when raising grass carp and bighead together it was 6.2 kg per m^2.

The hybrid of two sturgeon species *(Huso huso* and *Acinpenser ruthenus* (Russian name, "bester") was also successfully raised in cages in the

Soviet Union. This hybrid was produced first in the Soviet Union and proved to be an excellent success. It is very well adapted to the freshwater conditions and grows very fast. It utilizes well the artificial feeds and its flesh has a high market value.

The results of cage culture experiments in Hungary

Cage culture trials in Hungary started in 1972 at the Fish Culture Research Institute in Szarvas. The cages were placed in an oxbow lake of the Koros river which serves as a main irrigation canal during the irrigation season and as a main drainage canal during the winter period. The lake is also used for duck raising.

Three different types of fish culture are practised in the oxbow lake:

a. **Extensive fish culture.** It is based on the natural food production of the lake. The fish do not get any additional feed. About 90 percent of the carp, wels *(Silurus glanis)* and pike perch *(Lucioperca lucioperca)*. The yield in 1978 was 1.3 t per ha.

b. **Superintensive fish culture** in the running water of an elongated enclosure of the oxbow lake. This type of fish culture has many similarities to the cage culture.

c. **Cage culture of fish.** The cages are anchored in the oxbow lake during the irrigation season, out of the main stream of the water.

The main target of the cage culture experiments was to develop suitable technologies for the local conditions for the most important fish species such as common carp, wels, bester, etc.

Types of fish rearing cages tested at Szarvas:

a. For the first experiments 2 x 2 m and 3 x 4 m floating net cages were used. The netting was made of 15-18 mm mesh impregnated perlon net, the floating frame was of zinc-coated steel pipes. The depth of the net was 1.5-1.8 m and it stretched 0.4 m above the water surface. The cages were not covered. The volume of the cages were 3 and 16 m^3, respectively.

b. Closed solid cages made of wire-mesh with a volume of 1 m^3, floated by styrofoam blocks. To prevent corrosion, the wire-mesh was zinc-coated. This type of cage had several disadvantages when rearing common carp or wels.

c. The newest type of cage has a floating frame made of aluminum. One floating unit comprises 3 cages, with surface areas 4 x 4 m each. This unit is kept afloat by 6 spherical or cylindrical aluminum floating devices with a diameter of 400 mm. The netting is made of impregnated perlon net with a mesh of 15-17 mm when raising bigger fish and 5 mm when raising young fish. The depth of the cage is 1.6-1.8 m and the netting is stretched above the water level by 0.6 m. The useful volume of a single cage is 24.5 m^3.

Results achieved by the cage culture of wels

Our cage culture experiment with wels were oriented mainly to elaboration of raising technology for fingerlings two summer old. Wels stocked in the cages adapted very well to the crowded conditions after 10-12 days. Feeding was made two times a day with dry pelleted feed of 3 mm particle size.

The feed was manufactured in the experimental fish mill of the Institute. It contained 10 percent trash fish, 40-50 percent boiled slaughter-house wastes such as liver, spleen, lung, etc., and different cereal grain meals like wheat, rye, rice, etc., extracted soya-bean meal, alfalfa meal, mineral and vitamin premixes. The utilization of slaughterhouse wastes decreased the costs of animal protein ingredients and increased the water stability of the pellets to 2-4 hours. The daily ratio of the feed was 2-4 percent of the actual body weight of the fish population. The feed was offered on plastic trays of 800 x 500 x 100 mm size. The trays were mounted with 30 cm high 1 mm mesh net walls around their perimeter to prevent the washing off of the feed. The feeding trays were hung in the middle of the cages to about 1-1.2 m depth, so the fish could swim easily around and even below the trays.

The best feeding activity and weight gain was found when the water temperature was 20-44 °C and the dissolved oxygen content of the water was between 6-10 ppm. The young wels stocked in the cages had an initial weight of 23 g and during a 165-day growing season in 1974 they reached an average weight of 175 g. In 1975 the stocking weight was 49 g, the growing season 175 days long, and the average weight harvested reached 290 g. In 1976 we introduced an improved method; wels fingerlings were raised in two phases (Table 1). The cages were stocked on 10 May with 55 to 108 one summer old wels per m^2/90 per m^2 as an average. The cages were harvested on 31 July. The best weight gain (20.1 kg per m^2) was achieved when the stocking density was 94 fish per m^2.

The harvested fish was re-stocked to bigger cages, with a stocking density of 32 fish per m^2. The netting of the cages must be cleaned mechanically with strong brush every 2 weeks because the adhering organic sediment and algae would choke the perlon netting preventing water circulation.

Fish health controls

In order to prevent the damages of the white sport parasite *Ichthyophthirius* the wels population was treated regularly once in a month in a bathing solution of 1 ppm malachite-green and 0.2 ppm formalin for a 45-minute period.

The columanris disease *(Flexibacter columnaris)* caused considerable losses during the experiments in 1976 and 1977 (Balazs et al., 1977). To cure that diesease a Hungarian preparation called NEO-TE-SOL was added to the feed in 1 percent. This curative treatment proved to be successful; the mortality decreased to 1.0-1.5 percent against 33 percent in the untreated cages.

Results achieved by the cage culture of common carp

Experiments proved that the different Hungarian common carp land-races and strains adapted themselves very well to the crowded conditions of the cages. During a 172-day growing season in 1975 as high as 63 kg per m^2 weight gain was achieved. The experiments were carried out in two cages (Table 2). One cage was placed in a slow (4-5 cm per sec) water current and 166 one summer old carp was stocked per m^2. The second cage was placed in a faster water current (40-50 cm per sec) and the stocking rate was 125 carp per m^2. The cages were floating net cages with zinc-coated metal frame and 15 x 17 mm mesh impregnated perlon netting.

In order to prevent diseases the carp were fed prior to the stocking with medicated pellet feed containing 1-2 percent of oxytetracyclin and 2 g per kg Furazolidon. In the cages, first 3, later 5 mm sized pellet feed was given on trays sunk to the cages. The fish were fed two times a day. The daily ration was 2-5 percent of the body weight.

The adaptation of the carps to the crowded conditions lasted about 10-12 days, after which period they consumed well the feed offered. The feed ingredients were as follows:

wheat meal	35.0 percent
rye meal	10.0 percent
coarse soya bean meal	20.0 percent
coarse flax seed meal	4.0 percent
Alfalfa meal	2.3 percent
feed yeast	5.0 percent
fish meal	10.0 percent
meat meal	12.0 percent
vitamin and mineral premix	1.7 percent

The crude protein content of this feed was 28.85 percent, the starch value was 743 g per kg, the calculated metabolizable energy was 2988 kcal.

The best growth rate was found when the water temperature was 20-23°C and the dissolved oxygen content of the water was 4-10 ppm. The carp kept in faster water current were compelled to swim continuously and so their food conversion rate was 1 kg more and their weight gain 20 percent less than those of the fish kept in slow current. This was partly due to the fact that the faster water current also swept away some of the feed and more food was consumed in the fishes metabolism. In later experiments demand feeders were compared to hand feeding on trays. By using demand feeders, 10 percent better weight gains were achieved.

Profitability

The cage culture of market-sized carp is not economical in Hungary due to the high costs of formulated complete feeds and the low market price of common carp (the price of the common carp is only 35-40 percent of the price of wels). However, the cage culture of two summer old carp could be profitable, but further improvement of the feeding technology is needed in order to improve economy of production.

Results achieved by cage culture of bester (hybrid of *Huso huso* and *Acinpenser ruthenus)*

The early fry of bester was imported from the Soviet Union. During the first growing season they were raised in cages where they reached an average weight of 80 g (58-113) by the end of the season. From the second season on, detailed experiments were started in order to develop technologies for cage culture of two summer old and market-sized bester.

Raising two summer old bester in cages

Experiments were carried out in six cages (Table 3). The stocking rate varied from 44 to 75 per m^2. The cages were anchored to a slow water current.

Pellet feed with 3 mm particle size was offered 2 times a day on plastic trays similar to those used for feeding wels. The feed amount was 2.5 percent of the actual body weight of the population. The feed quantity was changed within these limits according to the temperature and the dissolved oxygen content of the water. The ingredients of the pellet feed were minced trash fish, boiled and minced slaughterhouse wastes, extracted soya-bean meal, fish meal, meat meal, cereal grain meals, vitamins and mineral premixes. the feed contained 53.4 percent crude protein, 8.2 percent crude fat, 9.4 percent ash and 10.78 percent water.

Growth rate was highest when the temperature of the water was 18-23°C and the dissolved oxygen content was over 6 ppm. The appetite of the hybrids was reduced rapidly when the dissolved oxygen content of the water dropped below 6 ppm and mortalities occured under 3 ppm.

The best result was achieved in the cage stocked with 44 fish per m^2; the weight gain was as high as 40 kg per m2 during the 153 days growing period. Feed conversion rate in this cage was 2.78, the best among all experiments; the weight gain coefficient was 9.42.

The average weight at harvest of the two-summer old hybrids was 583 g; their average daily growth increment was 3.2 g or 4 percent. Adaptation of the bester to the crowded conditions of the cages seems to be the best among all species tested. Bacterial or parasitic infections did not occur. The mortality (14 percent) was entirely due to oxygen depletion.

Raising market-sized (3 summer old) bester in cages

Experiments were carried out in three cages (Table 3). The stocking rate was 23 fish per m^2, initial weight of the stocking material was 465 g. The feed was the same one as mentioned above, but its particle size was bigger (5 mm). The plastic feeding trays were also similar. During a 150-day growing period an average of 1,369 g was reached. The feed conversion rate was 5.29, the survival rate was 95.9 percent and the daily growth increment was 6.02 g or 1.3 percent. Neither bacterial nor parasitic infections occured. Mortality was below 5 percent.

Experience with a polyculture of common carp, silver carp and bighead in cages

Two summer old fish were raised in floating net cages 33 percent of which was common carp, 50 percent was silver carp and 17 percent was bighead. The total number of fish was 188 per m^2. Feeding was made two times a day with pelleted common carp feed described above. During a 169-day growing season the following results were achieved:

	Common Carp	Silver Carp	Bighead
Initial weight (g)	123.0	17.3	18.0
Harvested weight (g)	500.0	126.0	115.0
Survival rate (percent)	99.0	90.0	94.0
	(98-100)	(83-97)	(88-99)

The growth of the common carp was similar to that of the common carp raised in monoculture in other cages. The growth of the silver carp and bighead was about 50 percent less than that of the same fish species raised in fishponds. This low growth rate was due to the scarcity of the natural food available within the cages, which could not be counterbalanced with artificial feeding.

The weight increment varied from 22.2 kg per m^2 to 35.3 kg per m^2, more than 50 percent of which was common carp. The higher loss of the silver carp was due to the fact that the bigger individuals were able to jump over the vertical netting of the cages. To prevent this the cages have to be mounted with more than 40 cm high vertical net walls, or must be covered.

Experiences with a biculture of wels and silver carp in cages

Promising results were experienced in 1978 with the biculture of one-summer old wels and two-summer old silver carp. Altogether, 37 fish was stocked on 1 m^2, 80 percent of which was wels and 20 percent silver carp.

During a 160-day long growing season the wels grew from a62.5 g initial weight to 297 g. The initial weight of the silver carp was 300 g and it reached a weight of 600 g by the end of the season.

In parallel experiments, the same wels grew only to 245 g in monoculture. The survival rate of the wels was also better in biculture. It was observed that the silver carp cleaned the netting of the cages.

Results achieved by a highly intensive fish polyculture in an enclosure

A 0.2 hectare portion of the experimental oxbow lake of the Institute was fenced off by a solid wall on the long side and wire-mesh fences on the shorter sides. The water depth during the growing season was 1.2-1.3 m and about 1 m^3 water flowed through this enclosure per second. As the flow-rate depended on the need of irrigated farming in the region, artificial aeration was provided. Two demand feeders with a volume of 100 liters each were provided for the distribution of the pellet feed. The feed contained 23.8 percent crude protein, 5.6 percent crude fibers, 4.9 percent crude fat, its starch value was 668 and its calculated energy content was 2,354 kcal.

Market fish was raised in polyculture in this enclosure. The stocking density was 46.870 fish per ha 75 percent of which was common carp, 12.8 percent was silver carp, 8.5 percent was bighead, 3.2 percent was grass carp, 0.5 percent was tench, wels and pike-perch.

After a 152-day long growing season in 1978, the gross fish yield reached 40.45 tons per hectare and the net yield reached 29.62 tons per hectare. Feed conversion rate was 3.22 and survival rate 98.9 percent.

In previous years, hand feeding and later automatic feeders, were used in the same enclosure. Demand feeders were installed only in 1978. The fish became accustomed to the demand feeders within 10 days. Compared to the results achieved in the previous years, it can be demonstrated that the introduction of demand feeders improved the feed conversion rate by 0.5-0.8.

Table 1. Results of the cage culture experiments with two summer old wels fingerlings in 1976

first phase - 6 floating cages, 2 x 2 x 1.6 m, impregnated perlon netting
second phase - 5 floating cages, 4 x 4 x 1.8 m, impregnated perlon netting

	I. phase of growing season	II. phase of growing season	Total
Date of Stocking	10. May	1. August	-
Stocking rate /fish/m2/	90 (56-108)	32	-
Stocking rate /fish/m3/	58 (37-72)	18	-
Initial average weight /g/	127 (90-180)	282	-
Stocking weight /kg/m2/	11.4 (9.7-13.5)	9	-
Stocking weight /kg/m3/	7.4 (6.2-8.7)	5	-
Date of harvesting	31. July	4. September	-
Harvested number /fish/m2/	88 (56-106)	29.9	-
Harvested number /fish/m3/	57 (36-71)	16.6	-
Harvested weight /kg/m2/	26 (18-30)	11.9	37.9
Harvested weight /kg/m3/	17 (11.6-6-19.3)	6.6	23.6
Average weight /g/	298 (270-322)	397.5	-
Weight gain /kg/m2/	14.8 (8.4-16.8)	3.3	18.1
Weight gain /kg/m3/	9.6 (5.4-10.8)	1.8	11.4
Individual daily increment /g/day/	2.08 (1.6 percent)	1.71 (0.6 percent)	1.95 (1.5 percent)
Number of feeding days	82	65	147
Feeding conversion rate	3.3 (2.5-4.8)	6.5 (5.5-9.6)	4.5
Weight gain coefficient	-	-	3.13
Survival rate /percent/	88.5	98.0	88.5

Table 2. Results of the cage culture experiments with two summer old common carp in 1975

Number and type of cages: 2 floating cages, 3 x 4 x 1.6 m, impregnated perlon netting

	Cage in fast current 40-50 cm/sec	Cage in slow current 3-4 cm/sec
Date of stocking	7. May	7. May
Stocking rate /fish/m2/	125	167
Stocking rate /fish/m3/	83	111
Initial average weight /g/	107.8	107.8
Stocking weight /kg/m2/	14.0	18.0
Stocking weight /kg/m3/	9.0	12.0
Date of harvesting	22. October	22. October
Harvested number /fish/m2/	124	161
Harvested number /fish/m3/	83	107
Harvested weight /kg/m2/	50	81
Harvested weight /kg/m3/	33	54
Average weight /g/	407	505
Weight gain /kg/m2/	36	63
Weight gain /kg/m3/	24	42
Individual daily increment /g/day/	1.79 (1.66 percent)	2.38 (2.2 percent)
Number of feeding days	167	167
Feed conversion rate	6.0	4.7
Weight gain coefficient	3.8	4.7
Survival rate /percent/	99.4	96.3

Table 3. Results of the cage culture experiments with two and three summer old bester in 1976 and 1977

1976 - 6 floating cages, 2 x 2 x 1.6 m, impregnated perlon netting
1977 - 3 floating cages 4 x 4 x 1.8 m, impregnated perlon netting

	2 summer old bester 1976	Market sized bester 1977
Date of stocking	10. May 1976	15. May 1977
Stocking rate /fish/m2/	60 (44-75)	23
Stocking rate /fish/m3/	39 (28-48)	13
Initial average weight /g/	80 (57.8-113.0)	465
Stocking weight /kg/m2/	4.9 (4.0-5.6)	11.5
Stocking weight /kg/m3/	3.2 (2.6-4.0)	6.4
Date of harvesting	10-15. October 1976	12-13. October 1977
Harvested number /fish/m2/	52	22
Harvested number /fish/m3/	33	12
Harvested weight /kg/m2/	30.3	33.1
Harvested weight /kg/m3/	19.4	18.4
Average weight /g/	583 (428-1065)	1369
Weight gain /kg/m2)	25.4 (20-40)	19.2
Weight gain /kg/m3/	16.3 (12.6-25.4)	10.4
Individual daily increment /g/day/	3.28 (4 percent)	6.02 (1.3 percent)
Number of feeding days	153	150
Weight gain coefficient	7.29	2.89
Feed conversion rate	5.03 (2.78-6.61)	5.25
Survival rate /percent/	86 (73.0-95.7)	95.9

LITERATURE CITED

1. Balazs L., Bekesi L., Csaba Gy., 1977. Columnaris betegseg harcsaallomanyban, Halaszat XXIII. evf. 3.sz. Tudomanyos melleklet.

2. Hickling, C.F., 1962. Fish Culture, London, Faber and Faber. 295 p.

3. Miheev, P.V. - Majszner, E.V. - Miheev, V.P., 1971. Biologicseszkie osznovu foreluh szadkovuh Hozjajsztva na vodohraniliscsah i ozerah. Prudovogo Rubnovo Hozjajsztva, Moskva, 1971. 19. 3-50 p.

4. Muller, F., 1978. Novendek es etkezesi vicsege ketreces nevelesenek szarvasi eredmenyei, Halaszat XXIV. evf. 3.sz. Tudomanyos melleklet.

5. Romanocseva,). 1973. Szadkovoe rubovodsztvo v pribrezsnuh vodah, Robovodsztvo i Rubolovsztvo, Moszkva, 1973. 5. sz. 6-7 p.

6. Steffens, W., 1969. Der internationale Entwicklungsstand der industriemassigen Karpfenproducktion. Z. Fish., 17: 33-45.

7. Steffens, W., 1969. Warmwasseraufzucht von Satzkarpfen *(Cyprinus carpio)* in Netzkafigen bei unterschiedlicher Besatzdichte. Z. Fisch. 17: 353-66.

8. St effens, W., 1970. Warmwasseraufzucht von Speisekarpfen *(Cyprinus carpio)* in Netzkafigen. Z. Fisherei ztg., 18: 1-13.

9. St effens, W., 1970. Optimale tagliche Futtermenge fur Karpfen unter intensiven Produktionsbedingungen. Dtsch. Fisherei ztg. 17: 280-5.

10. Steffens, W. and Menzel H.U., 1976. Technologie der industrimassigen Speiseforellenproduktion in Kafiggrossanlagen. Z. Binnenfish. D.D.R. 23 (4), 97-102.

11. Schmittou, H.R., 1969. Cage culture of channel catfish, Proc. Fish Farming Conf. Annu. Conv. Catfish Farmers, Tex., 1969: 72-5.

12. Schmittou, H.R., 1969. Intensive culture of channel catfish *Ichtalurus punctatus* (Rafinesque) in cages suspended in ponds. Dissertation. Auburn University, Alabama 70 p. (Unpubl.).

13. Sztudeneckim, Sz.S., 1974. Forelevyje szadkovyje hozjajsztva v vodohraniliscsah i ozerah.

14. Toth A., 1974. Vicsege Tenyesztese halos ketrocekben Halaszat, XX. evf. 3.sz. 94.0.