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THESES OF DOCTORAL (Ph.D.) DISSERTATION

**PROGENY PERFORMANCE TESTS OF COMMON CARP RACES, STRAINS AND
HYBRIDS**

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DEBRECEN
2004

1. Background and main objectives of the study

Hungary is the sixth biggest market size common carp producer in Europe. The ratio of common carp is 67.4 % from the total Hungarian market size fish production. This ratio shows that common carp is the most important species of Hungarian fish production. Breeding and developing productivity of common carp are one of the most important tasks of Hungarian fish culture. Beginning of Hungarian common carp breeding can be dated to first part of last century, which was started by import of foreign strains as Lausitz, Aischgründ, Galician etc. The selection and breeding were started on bigger fish farms mainly after naturalisation of foreign strains. These strains were adapted to local environment and modified by the breeders' targets and market. By joint results of mentioned factors we can say that the big fish farms had original own local strains at the end of 1950's. The development of common carp breeding was helped by the early recognition of breeders that they can meet all requirements of market with well known genetic background, continuous breeding and selection. First common carp hybrids were produced, as the results of continuous development, which had better productivity with 15-20 % than the original strains in the 1970's. The live fish transportation become easier, and this caused mixing of isolated population. Later they were driven out from production by spreading of hybrids.

More than 300 new hybrids were produced and tested in HAKI during hybridisation research work. Productivity of a new hybrid is evaluated in this work for receiving state approval. During 3 years test (1990, 1991, 1993) different paternal lines were used with same maternal line for hybridisation. These new HAKI hybrids were evaluated by progeny performance test, to select the hybrid with best productivity.

The structure of Hungarian fish production was changed in big volume after change of regime like in other sector. Fish production was finished on one part of fishponds, or they were privatised. New owner had not got knowledge for carp breeding in many cases. They were motivated to realise highest profit during shortest time. Quality control of production was pushed into the back in the transformed economical situation, such as knowledge of genetic background of bred and produced common carp. Quality of Hungarian common carp breeding was declined by spreading of unknown common carp populations. The genetic background of bred common carp strains was also increased.

In first step common carp was introduced into CXIV. Animal Breeding Act (1993) as bred animal. Later regulation of progeny performance test and certificate of origin were introduced. This work is co-ordinated and controlled by National Institute for Agricultural Quality Control (OMMI). The introduced regulations serve for decreasing Hungarian common carp breeding through continuous control of productivity of used strains and hybrids. Tested parameters determine profitability of production like survival rate, growth rate, food conversion ratio, dressing yield and fat content of the meat. This work was started in 1996 and tests were carried out from 1997 to 2001 until this work. Because HAKI co-ordinates and evaluates data of second year during national progeny performance test, the results were evaluated in given years and methodology of test was also examined in this work. Our target was to work out proposals for improving methodology to take more exact the progeny testing in addition to showing results and looking for relation among them.

2. Materials and methods of the surveys

2.1. General description of tests

The examined hybrids were produced with crossing of strains from the live gene bank of HAKI, so their name is HAKI hybrids and strains of national carp performance test were originated from their breeders. The test of strains and hybrids was provided in different years, but the methodology of propagation, nursing and evaluation were same in every year. The tests were carried out on isolated farms from each other. The HAKI hybrids were tested on Milliér, Szeged, Bánhalma and Szarvas fish farms, while national tests were carried out on Mike, Nagybarcska, Szarvas, Nagydobsza, Bikal and Barnahátpuszta fish farms. The tests were started with sample collection in every case, which sample represented the whole population of tested strains and hybrids. Minimum three pair of broodstock were propagated by strain or hybrid and this offspring was mixed during sample collection. The broodstock were propagated on same day in same hatchery in one year. The hatched larvae were stocked into treated nursing pond immediately after air filling into swim bladder. The nursing time was 4 weeks until the nursed fry was ready for harvest. It were need to culture strains and hybrid separate ponds until the end of first growing season, because marking of larvae and nursed fry is impossible. Size of the keeping ponds was 1 hectare in case of HAKI hybrids and nursing and yearling work of OMMI test was carried out at the Temperate Water Fish Hatchery (TEHAG).

Nursing ponds were dried one month before planned stocking and disinfected with lime in 5 g/m² dose. Ponds were fertilised with 0.5 kg/m² animal manure and filled with water until 2/3 part one week before stocking. Zooplankton was selected by organo-phosphoric-acid-ester six days before planned stocking and one week later after chemical treatment ponds were filled with water to normal level. Used stocking density was 100 fish/m². Fish were harvested, sampled randomly and stocked back with a density of 15,000 fish/ha after nursing. The nursed fry were fed ad-libitum with common carp starter food first and later with wheat until the end of first growing season. Fish were harvested and randomly sampled at the autumn, when 1,000 fish were selected from each strain or hybrid. These samples were marked individually with group marking and stocked into same wintering pond.

Fish were sorted out by their marks, balanced to calculate their average body weight and counted after winter. These works and transportation to testing places were carried out same day in every year. Treatment of testing pond in second year was same as described at nursing. The stocking density was 1,500 fish/ha, which made certain that the fish would be market size big to the end of second growing season. Mixed population of tested strains and hybrids was stocked into testing ponds. Test groups were fed with wheat ad-libitum. The fish were harvested at the end of September in every year. Data collection was carried out during the harvest when fish were sorted by mark balanced and counted by strains and hybrids. 30 fish per strain and hybrid were balanced individually also. A cage system was built into one test pond to calculate food conversion ratio. The cages made of wire net with 20 mm holes and 1,6 mm thick wire. Each cage had 165 m² area where 25 fish were stocked by strains or hybrids. This stocking density was same with stocking density of testing pond (0.15 fish/m²). Dressing yield and fat content were examined in lab of HAKI using 20 fish by each strain and hybrid. Dressing yield was examined with method of kitchen processing, while fat content was determined from right side filet with butirometric method. Data were evaluated in natural state as practice on production farms. Basic statistic and variance analyses were calculated with SPSS 9.0 for Windows, however linear regression analyses was carried out with Windows Excel software. The variance and regression analyses were calculated in every year in every test, but they are presented where the treatment effect is significant only. At the end groups of tested strains and hybrids were constituted by phenotype, like mirror, domesticated scaly and wild scaly. Their results were compared by phenotype in test of OMMI.

2.2. Examined traits and their evaluation

2.2.1. Survival rate

Fish were counted at stocking and harvesting by their marks. The stocking number gave 100 % and survival rate was determined in percentage of harvested number by each strain and hybrid.

2.2.2. Growth rate

The difference of harvested average weight and initial average weight gave the net weight gain. Regression analyses was carried out and determined distance between harvested weight and regression equation determined weight by trend line. This trend line point was the 100 %. Different strains and hybrids were characterised with difference from trend line point in percentage. Scatter and CV percent were calculated with individual balancing 30 fish/strain or hybrid.

2.2.3. Food conversion ratio (FCR)

The food conversion ratio was examined into the cages where the fish received wheat with known amount day per day, if they used up food from last day. Beside the wheat fish could use natural food also, which was same in every cage. The food conversion ratio was calculated from the amount of used wheat and realised weight gain.

2.2.4. Dressing yield

Examination of dressing yield was started with balancing of wet weight and „kitchen type” processing followed it. First scales and fins were removed. In next step guts were removed, later on head was cut out between 2. and 3. vertebra together gills. Weight difference between wet and cut body weight gave dressing yield in percentage, where 100 % is the weight of wet body.

2.2.5. Fat content

Fat content was determined from the right side fillet of cut body with acido-butirometric method, which described in Carp progeny performance testing code 3.

Tested strains and hybrids are shown in figures 1. and 2. by test year and farm.

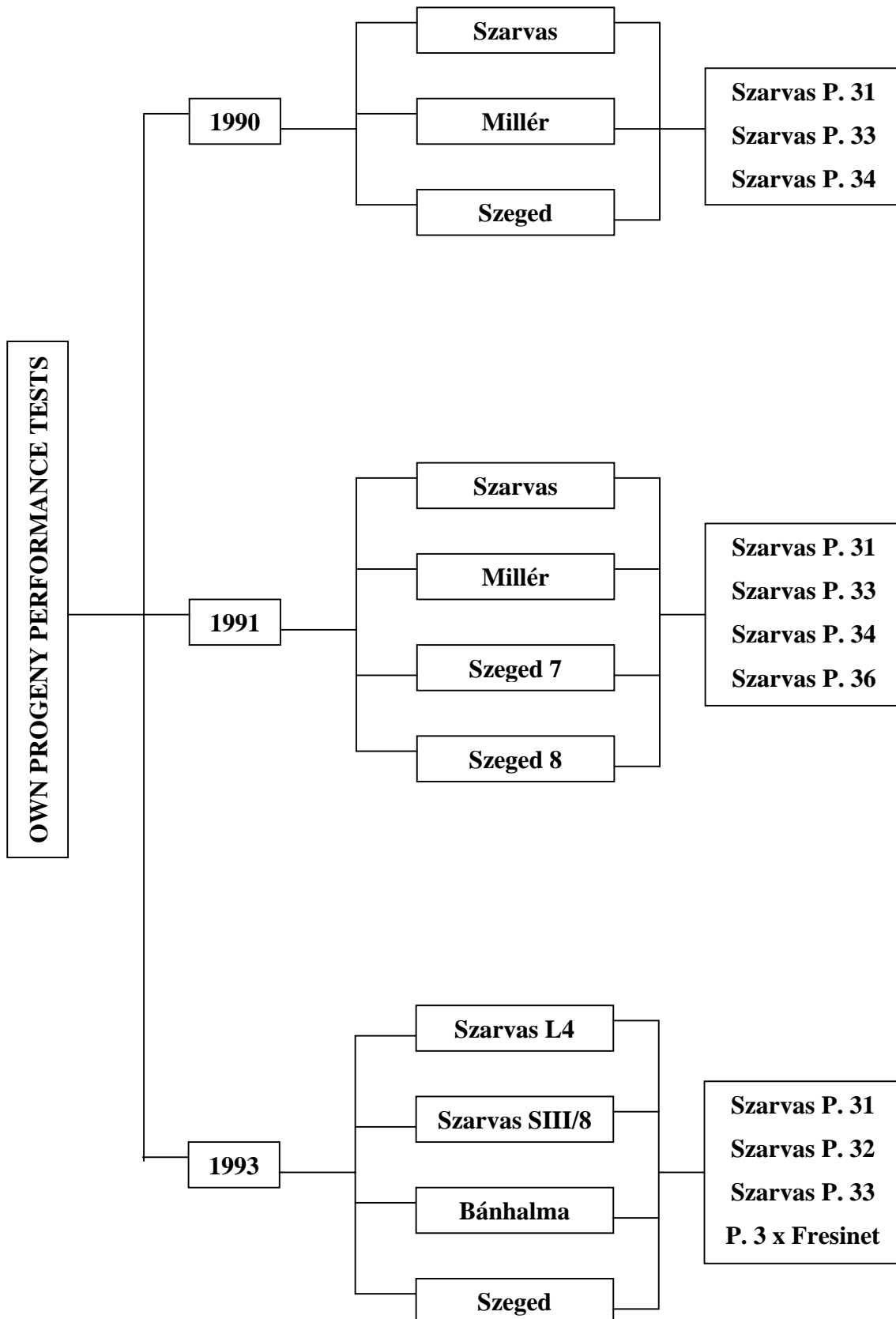


Figure 1: Progeny performance tests of HAKI hybrids

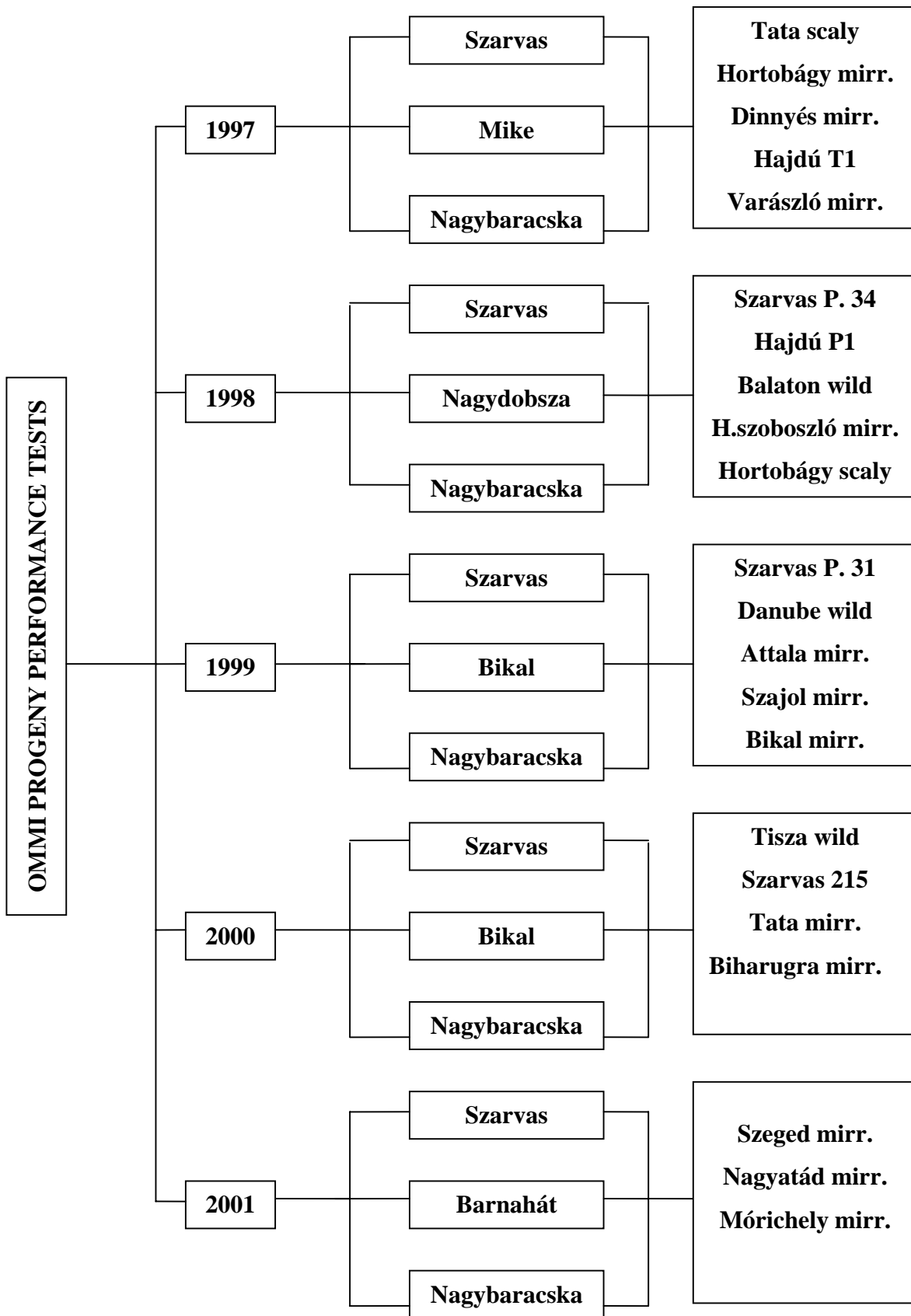


Figure 2: Progeny performance test organised by OMMI

3. Results and major findings of the study

3.2.Examination of HAKI hybrids

The ratios of difference are shown from control in percentage to characterise new hybrids when results of control gave the 100 %.

Productivity of Szarvas P. 34 was better than the control in the first test year in survival rate, while Szarvas P. 33 had disadvantage from control. Ratios of difference were + 8.7 and – 9.0 %. Szarvas P. 34 had a great advantage in growth rate to the control with ratio 41.9 %, while Szarvas P. 33 had lower growth rate the control in this trait too. Szarvas P. 34 used less food for one kilo weight gain during food conversion test. Its result was better with 21 % than control, while Szarvas P. 33 used 11.6 % more food. Both hybrids had better dressing yield than the control but Szarvas P. 34 stored more, Szarvas P. 33 less fat than the control. We can see that Szarvas P. 34 had better productivity than the control and Szarvas P. 33, except fat content. Szarvas P. 33 had lower productivity so its testing in the future is not suggested but it was produced in next year again to confirm its rejection. The results of first test year are shown in table 1.

Table 1: Result of HAKI hybrids and their difference from the control in year 1990.

Hybrids traits	Survival (%)	Weight gain (g)	FCR (kg/kg)	Dressing yield (%)	Fat content (%)
Szarvas P. 31	79.9	437.8	4.3	55.3	13.2
Szarvas P. 34	86.9	621.1	3.4	57.4	13.6
<i>Difference P. 34(%)</i>	+8.7	+41.9	+20.9	+3.8	-3.4
Szarvas P. 33	72.7	426.0	4.8	55.7	12.9
<i>Difference P. 33(%)</i>	-9.0	-2.7	-11.6	+2.6	+2.3

A new hybrid was produced in the second test year the Szarvas P. 36, which has elongated body shape as Szarvas P. 34 and P. 33 has and good for angling. The survival rate of control was low in 1991 so every tested new hybrid had really better results in this trait. The volume of difference was examined firstly in this year and treat. Szarvas P. 33 realised the best result, second was the Szarvas P. 34 and last the Szarvas P. 36. Every three hybrid had better growth

rate than the control. Szarvas P. 36 had the best weight gain, second was the Szarvas P. 34 and it Szarvas P. 33 followed them. The new HAKI hybrids realised better results in food conversion ratio than the control too. Szarvas P. 36 used the less food for one kilo weight gain. The results were same in case of dressing yield; differences were between -0.4 and $+0.4$ %. Szarvas P. 33 showed the lowest fat content but the Szarvas P. 36 also stored less fat than the control. Only Szarvas P. 34 stored more fat than the control. Data are shown in table 2.

Table 2: Results of tested HAKI hybrids compare to control in 1991.

Hybrids traits	Survival (%)	Weight gain (g)	FCR (kg/kg)	Dressing yield (%)	Fat content (%)
Szarvas P. 31	29.4	598.2	5.53	61.0	14.5
Szarvas P. 34	79.4	698.3	2.69	59.6	15.8
<i>Difference P. 34(%)</i>	<i>+169.8</i>	<i>+16.7</i>	<i>+51.4</i>	<i>-2.3</i>	<i>-9.0</i>
Szarvas P. 33	87.1	658.5	2.64	61.4	11.1
<i>Difference P. 33(%)</i>	<i>+195.87</i>	<i>+10.1</i>	<i>+52.3</i>	<i>+0.7</i>	<i>+23.4</i>
Szarvas P. 36	77.6	731.3	2.47	60.9	14.2
<i>Difference P. 36(%)</i>	<i>+163.8</i>	<i>+22.3</i>	<i>+55.3</i>	<i>-0.2</i>	<i>+2.1</i>

The result of Szarvas P. 33 is acceptable, but its new testing is not reasoned because it could be supposed that environment has a greater effect for its productivity than genetic background, so production of this hybrid is risky. Results of Szarvas P. 34 were good in the second test year also. Szarvas P. 36 had a good productivity also, so its more testing is justified. Difference was significant between low survival rate of control and high survival rate of new HAKI hybrids ($p=0.002$). Difference among new hybrids and control were not significant in other tested parameters.

Szarvas P. 34 gave same productivity as in previous year in the third test year, which proved, that its high productivity is genetically determined and it is able to repeat it under different environmental, keeping and production conditions. Szarvas P. 36 hybrid also had good productivity; even its fat content was lower than fat content of Szarvas P. 34. It would be suitable for commercial production based on its result, but more tests need to decide it.

Productivity of control was sufficient in this year. Improved maternal line of control was tested also but its productivity was lower than new HAKI hybrids. It is not bad because its importance will not be in commercial production but in hybridisation. (Table 3.). The differences among hybrids and control were not significant.

Table 3: Results of tested HAKI hybrids compare to control in 1993.

Hybrids traits	Survival (%)	Weight gain (g)	FCR (kg/kg)	Dressing yield (%)	Fat content (%)
Szarvas P. 31	76.9	510.0	2.67	59.7	15.47
Szarvas P. 34	78.3	524.6	2.85	60.9	12.51
Difference P. 34(%)	+1.8	+6.2	-6.7	+3.4	+19.1
Szarvas P. 36	78.7	613.3	2.52	61.9	9.03
Difference P. 36(%)	+2.3	+11.1	+5.6	+2,2	+41.6
P. 3xFresinet	66.7	456.7	3.47	60.3	18.21
Difference P. 3 x Fresinet (%)	-13.3	-11.6	-30.0	+1.0	-17.7

OMMI proposed Szarvas P. 34 for state certificate based on these examinations in 1992, which hybrid is a two-line, homozygous scaly common carp with elongated body shape. The production of hybrid would be allowed and proposed by OMMI for this time.

3.3.Evaluation of strains and hybrids of national common carp progeny test

Comparison is difficult among results of strains and hybrids were tested in national progeny performance test. The comparison of tested strains should be possible in same year, but it is impossible among different years, because environment and test farms were also different. Special problem that results are not considered statistically because low number of replicates. Neither strain showed really higher productivity than the average so the results of tested strains were same in 1997. Tata scaly was the best strain with 1.8 % advantage, and Hortobágy mirror was the worst strain with 1,4 % lag only in survival rate. Difference of other tested strains was not more than 0.5-0.9 % from average. Same tendency should be experienced on the field of weight gain, where best strain was Hortobágy mirror (+70.5 g from the average), while the worst was Hajdú T1 with 41.4 g lag from the population average.

These differences are not significant so exact order of rank can not be determined among strains in this trait. In case of food conversion ratio minimal differences were measured (0.3 kg/kg), as well as in dressing yield. Lower dressing yield of Tata scaly was caused by its phenotype, because the removed scales produced more waste. Fat content of Dinnyés mirror had higher fat content than average (19.7 %), while Tata scaly had the lowest fat content (14.5 %).

There were not important differences among tested strains neither evaluated trait. The results and their differences from average are shown in table 4. During statistical analyses significant difference was experienced between lowest and highest initial weight only.

Table 4: Results and differences of tested strains in 1997.

Traits	Strains	Tata scaly	Hajdú T1	Varászló mirror	Dinnyés mirror	Hortobágy mirror	Average
Survival (%)		84.6	83.7	82.0	82.3	81.4	82.8
Difference		+0.8	+0.9	-0.8	-0.5	-1.4	0.0
Weight gain (g)		1,105.8	1,063.4	1,075.1	1,104.5	1,175.3	1104.8
Difference		+1.0	-41.4	-29.8	-0.3	+0.5	0.0
FCR (kg/kg)		3.2	3.7	3.5	3.4	3.6	3.5
Difference		-0.3	+0.2	0.0	-0.1	+0.1	0.0
Dressing yield (%)		57.9	60.0	60.3	60.3	61.3	59.9
Difference		-2.1	+0.1	+0.3	+0.3	+0.3	0.0
Fat content (%)		14.5	18.5	16.9	19.7	17.4	17.4
Difference		-2.9	+1.1	-0.5	+2.3	0.0	0.0

There were more important differences among strains and tested hybrid in 1998 compared to 1997. Szarvas P. 34 two-line scaly hybrid had really better results than the average (+ 12.3 %) in case of survival rate. Hortobágy scaly had worst survival. Important differences were experienced on the field of growth rate to both ways negative and positive. Szarvas P. 34 realised result to positive direction than the average with 206.2 g, while Balaton wild showed lower growth rate than average with 252.7g. Hajdú P1 showed the best results in food conversion ratio because it used less food for one kilo growth rate with 0.4 kg than the average. Balaton wild showed the worst result in this trait also. It used more food for one kilo growth rate with 0.5 kg than the average. Hajdúszoboszló mirror gave the best dressing yield but it was understandable because the other tested strains had scaly phenotype. If take this fact into consideration the results of tested strains could be said similar in the trait. Fat content of

the meat was mainly same at every tested strain, only Szarvas P. 34 stored little bit more fat (0.6 %) than the average. The results of second test year are in table 5.

Table 5: Progeny performance test results in 1998.

Traits	Szarvas P. 34	Hajdú P1	Hortobágy scaly	Balaton wild	Hajdúszoboszló mirror	Average
Survival (%)	76.6	69.3	47.8	66.3	61.8	64.4
Difference	+12.3	+5.0	-16.5	+1.9	-2.6	0.0
Weight gain (g)	1,036.7	889.1	862.8	577.7	785.9	830.4
Difference	+206.2	+58.7	+32.3	-252.7	-44.6	0.0
FCR (kg/kg)	2.6	2.4	2.7	3.2	2.8	2.7
Difference	-0.1	-0.4	-0.1	+0.5	+0.1	0.0
Dressing yield(%)	58.4	59.9	60.5	60.3	62.7	60.3
Difference	-2.0	-0.5	+0.2	0.0	+2.3	0.0
Fat content (%)	16.8	15.8	16.1	16.3	16.0	16.2
Difference	+0.6	-0.4	-0.1	+0.1	-0.2	0.0

The higher initial weight of Szarvas P. 34 was significantly different from the initial weight of other tested strains. Differences of final weight and weight gain were not significant among strains.

There were not important differences among strains in survival rate, Attala mirror had a little bit lower survival rate (-10.5 %), while Bikal mirror had higher (+7.6 %) than the average only. Szarvas P. 31 had better productivity in weight gain because it showed 101.6 g advantage than the average of tested strains. It was considerably poor growth rate of Danube wild than the average, since its weight gain was less with 199.2 g. There were not important differences among tested strains in food conversion ratio. Szajol mirror showed worse with 0.5 kg/kg, while Szarvas P. 31 in same quantity showed better result. Szarvas P. 31 and Danube wild realised lower dressing yield than the average as scaly hybrid and race, while mirror strains had better result, in nearly same volume, than the average. Danube wild stored most fat because a wild form always includes more fat under pond condition and grain feeding. The results of 1999 test year are shown in table 6.

Table 6: 1999 test year results and differences from average

Traits	Strains	Attala mirror	Bikal mirror	Szajol mirror	Szarvas P. 31	Danube wild	Average
Survival (%)		57.1	75.2	62.2	71.5	72.1	67.6
Difference		-10.5	+7.6	-5.4	+3.8	+4.5	0.0
Weight gain (g)		893.4	798.3	883.7	927.5	626.7	825.9
Difference		+67.5	-27.6	+57.8	+101.6	-199.2	0.0
FCR (%)		2.6	2.4	3.1	2.1	2.6	2.5
Difference		+0.1	-0.2	+0.5	-0.5	+0.1	0.0
Dressing yield(%)		62.1	62.3	62.2	59.2	61.2	61.4
Difference		+0.7	+0.9	+0.8	-2.2	-0.2	0.0
Fat content (%)		16.6	16.9	15.8	17.0	18.4	17.0
Difference		-0.3	-0.1	-1.1	+0.1	+1.5	0.0

Lower initial weights of Danube wild and Szajol mirror were significantly different from other strains, while lower final weight and weight gain were significantly different in case of Danube wild ($p=0.002$ and $p=0.003$) only during the variance analyses.

Only four strains were tested in year 2000 because Szeged mirror was destroyed during the artificial propagation. Strains showed nearly same results in survival rate, only Szarvas three-line mirror hybrid had lower result with 14.3 % than the control. Tata mirror realised the best result, while Biharugra mirror the worst in weight gain. Result of Szarvas 215 was also lower than average opposite that it was high productivity hybrid. The biggest difference was 0.1 kg into both ways negative and positive in food conversion ratio. Szarvas 215 realised the best results of dressing yield with +1.6 % and Tisza wild the worst with -2.0 % than the average. Important differences were realised in fat content between wild and domesticated forms, perhaps Tisza wild had highest fat content. Results are shown in table 7.

Higher initial weight of Tata mirror was significantly different from the lower initial weight of other strains ($p=0.023$). But differences in final weight and weight gain were not significant.

Table 7: Results of year 2000.

Traits	Strains	Tata mirror	Szarvas 215	Biharugra mirror	Tisza wild	Average
Survival (%)		83.1	53.3	74.8	59.2	67.6
Difference		+15.5	-14.3	+7.2	-8.4	0.0
Weight gain (g)		980.1	812.3	763.9	877.0	858.3
Difference		+121.8	-46.0	-94.4	+18.7	0.0
FCR (kg/kg)		1.9	1.9	2.1	2.0	2.0
Difference		-0.1	-0.1	+0.1	+0.1	0.0
Dressing yield(%)		64.7	66.5	65.4	62.9	64.9
Difference		-0.2	+1.6	+0.5	-2.0	0.0
Fat content (%)		17.6	17.6	18.2	19.2	18.2
Difference		-0.6	-0.6	0.0	+1.1	0.0

Three strains were tested only in year 2001 and their productivity can be said nearly same. Nagyatád mirror was a little bit better and Móríchely mirror worse in survival rate than the average. Differences among tested strains were not important in growth rate. Móríchely mirror had poorer growth rate also with 18.9 g and Nagyatád mirror had better with 14.8 g than the average. Results of food conversion ratio were similar of three tested strains as in case of dressing yield Móríchely mirror showed better dressing yield with 0.5 %, while Szeged mirror had lower result with 0.7 % than the average. The best fat content was realised by Szeged mirror stored only 9.4 %, which is lower than the average with 0.8 %. The data are shown in table 8.

Significant differences could not be realised nor in initial weight and nor in final weight and weight gain.

Table 8: Results of year 2001.

Traits	Strains	Mórichely mirror	Szeged mirror	Nagyatád mirror	Average
Survival (%)		42.0	55.1	58.0	51.7
Difference		-9.7	+3.4	+6.3	0.0
Weight gain (g)		1,037.6	1,060.7	1,071.3	1,056.5
Difference		-18.9	+4.2	+14.8	0.0
FCR (kg/kg)		1.3	1.4	1.4	1.4
Difference		-0.1	0.0	0.0	0.0
Dressing yield(%)		66.2	65.0	66.0	65.7
Difference		+0.5	-0.7	+0.3	0.0
Fat content (%)		10.6	9.4	10.6	10.2
Difference		+0.4	-0.8	+0.4	0.0

3.4. Comparison of tested strains by phenotype

There is not significant difference among strains, which were tested, in same year. But there were significant differences during comparison of every tested strain and test year. The better results of Hajdú T1, Tata, Dinnyés, Varászló and Hortobágy mirrors were significantly different from lower results of Mórichely and Nagyatád mirror ($p < 0.05$). Among scaly and wild strains inside the groups significant difference could not be determined as among the average of three phenotypic groups. (Figure 3.).

Initial weights were significantly different among mirror strains on level $p < 0.05$, which significant differences were disappeared to the end of second growing season, as in final weight and weight gain could not be calculated. Scaly strains showed same results with mirror strains when the differences were significant among initial weight ($p < 0.05$), but these differences was not realised in final weight and weight gain. Among wild carps, higher initial weight of Tisza wild was significantly different ($p < 0.05$) than others but the difference in final weight and weight gain were not significant. Differences of average initial weight were not significant during comparison of three phenotypic groups. But lower average weight gain of wild forms was significantly different from average of mirror and scaly strains ($p = 0.021$). There was not significant difference between average weight gain of mirror and scaly groups. The results of phenotypic groups are showed in figure 4.

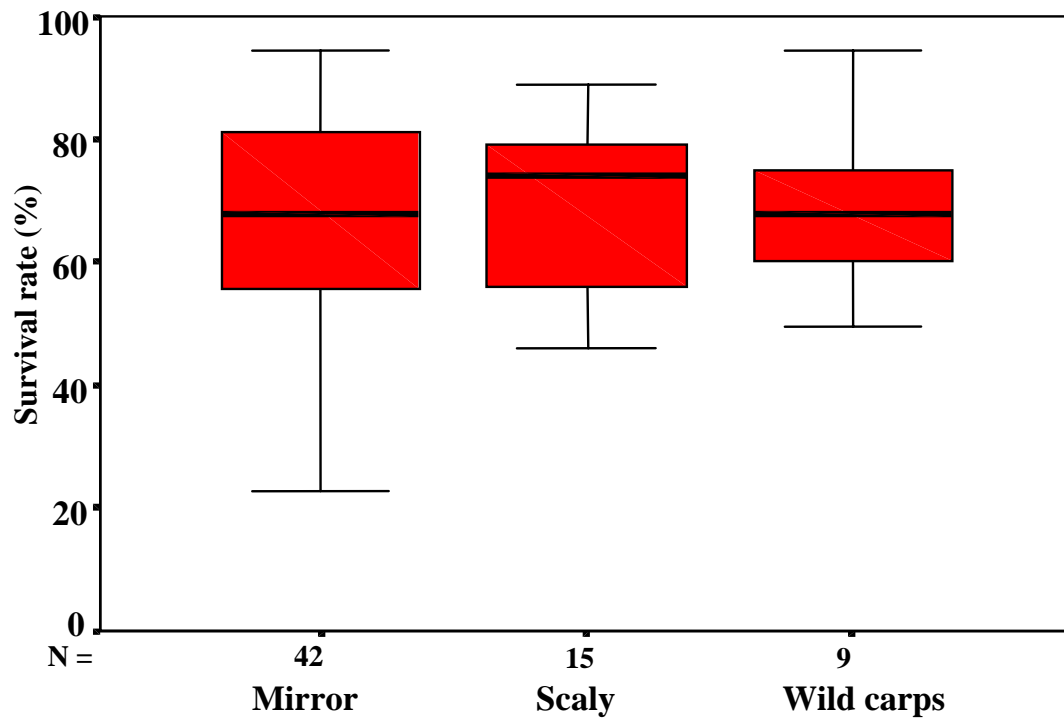


Figure 3: Survival rates by phenotypes

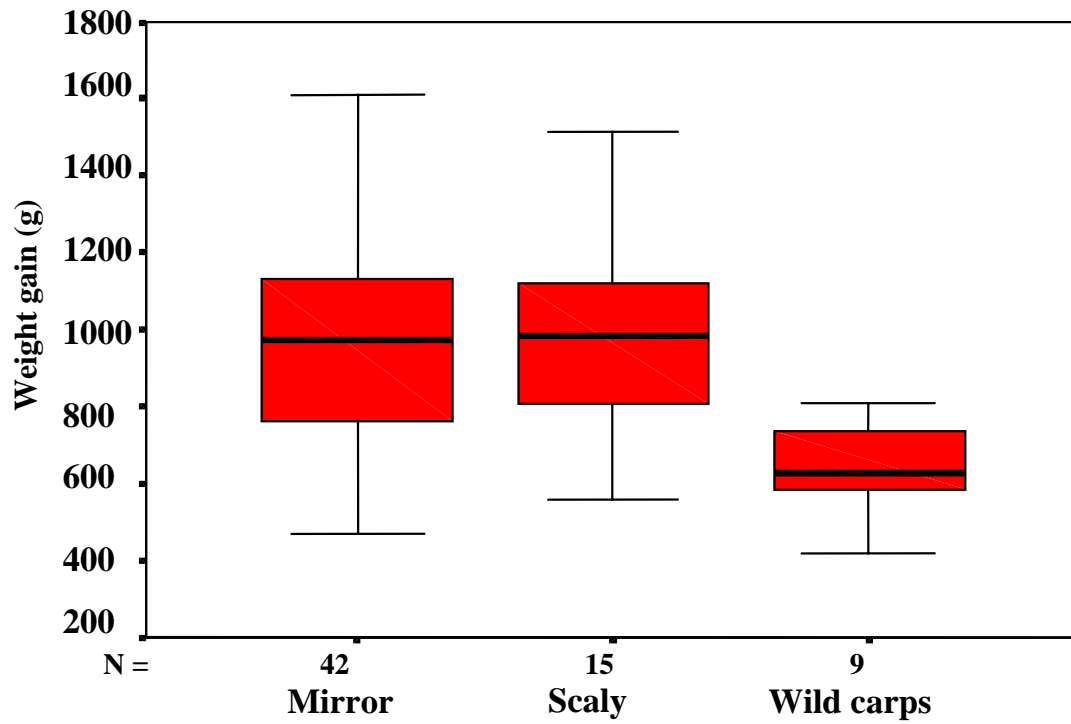


Figure 4: Differences among phenotypes in weight gain

It was not possible to determine important difference among tested strain in food conversion ratio, which was justified by examination of phenotypic groups. There was not significant difference among groups. The results of food conversion ratio are shown in figure 5.

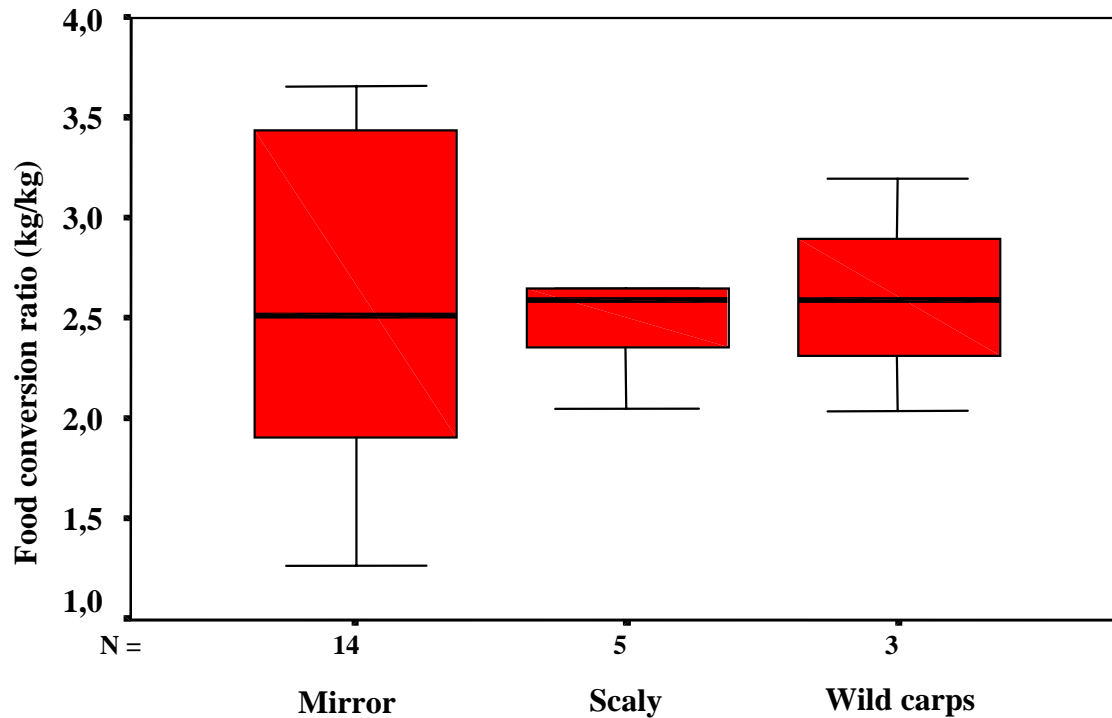


Figure 5: Food conversion ratio

High utilisation of wild carps traces back to little natural food and high amount of grain.

The better dressing yield of mirror forms is understandable because the scale is not composing lot of waste. It is interesting that dressing yield of wild carps is better than the scaly forms with rounded body shape, while wild carps has “quadratic” body shape. However the scales are heavier of wild carps than scales of domesticated scaly carps (Figure 6.).

Fat content of tested strains is correspond to average in pond, there is not important difference among tested strains, which is true for wild forms too. It is different, wild carps showed that highest fat content of meat. This traced back to little amount of natural food, which was used short time by carps and high amount of grain and little movement (natural food collection is not important), as described earlier (Figure 7.).

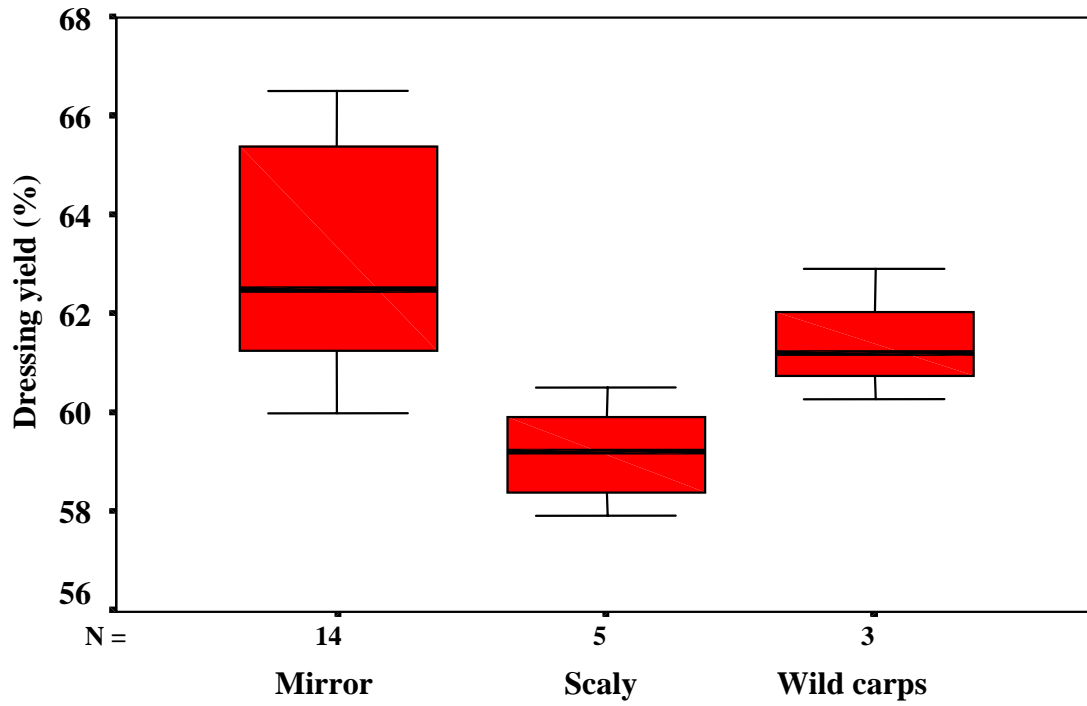


Figure 6: Results of dressing yield results among phenotypes

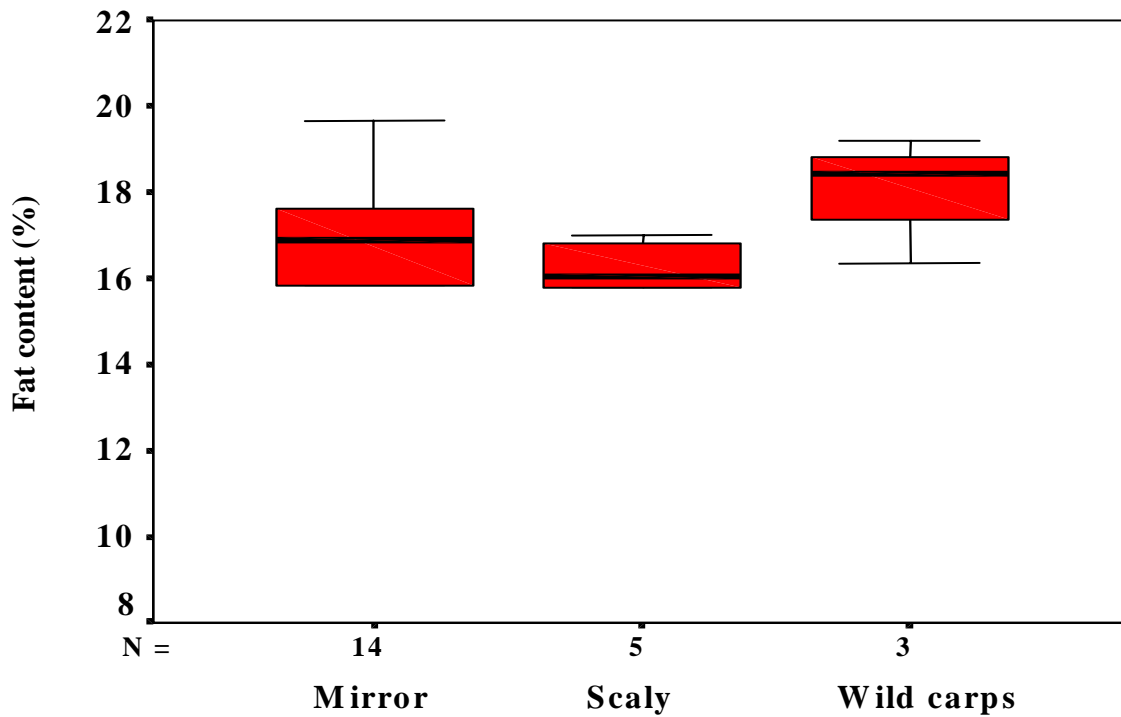


Figure 7: Fat content of the meat

Important differences were showed in growth rate and weight gain among tested races, strains and hybrids, when the growth rate of wild carps were significantly lower than growth rate of domesticated forms. The difference is also important between wild carps and scaly forms in dressing yield. It can be determined that wild form can not realise their good natural food selection ability so they use same amount of grain for 1 kg of weight gain as domesticated forms under farm condition. Their fat content is also higher than domesticated forms because of eating grain opposite their slow growth rate.

4. Summary of new scientific results

4.1. Results of HAKI hybrids testing

The produced and tested Szarvas P. 34 common carp hybrid received state approval from National Institute for Agricultural Quality Control after Szarvas 215 and Szarvas P. 31. I have 30 % breeding ratio among the breeders who produced this hybrid. By this time it proved true that this hybrid is able to show good productivity and profitability under different farm conditions with its genetically determined productivity. Today it is the widely used hybrid for commercial production in Hungary. It realised better survival rate and growth rate in every year than the control. Its food conversion ratio was same with the control but its dressing yield was better generally.

The Szarvas P. 36 need more tests. Maybe it will be so good as Szarvas P. 34 in its productivity would. Based on its test results it could be receive state approval. It was missed because of the change of certification system. The system of progeny performance testing was changed in its last test year. The tests were centralised and organised by OMMI because the common carp was introduced into CXIV Animal Breeding Act as domesticated animal. In spite of this its using for anglers can provided after collection of given certificates from OMMI. It realised better results in every trait than the control approved Szarvas P. 31 hybrid in every test year.

Szarvas P. 33 hybrid was not suggested for state approval based on its results on progeny performance test. Its productivity was changeable by test place and test year. Its productivity is unforeseeable, which really increase the risk of production so its testing was finished after

two years. Its body shape is same with body shape of Szarvas P. 34 and P. 36 but its productivity was poorer than productivity of other hybrids.

4.2. Result of dressing yield and fat content evaluation

The used method is adequate to evaluate dressing yield. The wild carps had more edible part than the domesticated scaly forms with rounded body, perhaps it should be suggested to select for quadratic body shape to realise better dressing yield. The tests confirm this fact because wild carps had 61.86 % of dressing yield, while domesticated scaly had 59.27 %. Szarvas P. 34 is a hybrid with elongated body shape, which produced better dressing yield (60.50 %) during national carp performance test opposite with dressing yield of other tested scaly strains (from 57.94 % to 59.87 %).

It is proved true that environment has greater importance than genetic background in fat content of strains and hybrids. This was justified by high fat content of wild carps, which is traceable to missing of natural food and high amount of grain. Fat content of common carp from natural waters is half, third part of fat content of under farm condition bred common carp. High amount of fat content of wild carps confirmed that the trait is determined by feeding method first and secondly determined by genetic background only. The modification effect of environment is stronger than genetically determined level.

4.3. Results of growth rate examination

Only difference of Danube wild was significant in growth rate with its lower weight gain during the progeny performance test (average final weight 688.6 g, $p=0.002$, net weight gain 626.7 g, $p=0.003$). The Danube wild may consider free of domestication genetic effect, because difference of other tested strains and hybrids were not significant. The problem of statistical analyses may caused by methodology (there were not significant differences) of test therefore it may proposed that examinations would be happen in more replications on same farms. It was effective in Czech Republic where the differences were significant among tested strains and crossings.

4.4. Results of national carp performance tests

There was proved in examination of different phenotypic groups, which was produced by scalyness and body shape, that the mirror and domesticated scaly strains has nearly same productivity, namely the differences were not significant. The results of wild carps were different from these two phenotypic groups only, which showed that these wild forms are genetically different from domesticated forms not only in body shape. Productivity of Danube wild is definitely different inside the wild carps phenotypic group.

There were significant differences among mirror strains during examination of whole group in survival rate, but differences were not significant during examination of different years. In our opinion may not be tested strains and hybrids, which has significant difference in survival rate because of high number of tested strains and hybrids. To produce possibility of comparison among different test years with standard control would be available to make priority among strains and hybrids, which may urge owner of strain to improve productivity of their strain and hybrid.

5. The practical applicability of the results

5.1. Results of carp breeding work

The Szarvas P. 34 is widely used hybrid for production because it able to high productivity under different environmental conditions. It is used in highest volume for commercial production from common carp hybrids.

Szarvas P. 36 is able to good production too like Szarvas P. 34, which hybrid may be adequate for commercial production after state approval, mainly for stocking into anglers' ponds.

5.2. Results of national carp performance test evaluation

There was proved in examination of OMMI tests, that the mirror and domesticated scaly strains has nearly same productivity. The results of wild carps were different from these two

groups only, Danube wild first, which showed that this wild form is a genetically different from. Its maintenance may give the background of future genetic and breeding work.

It is suggested that during the test a standard control will be used to produce possibility of better comparison of tested strains and hybrids. Results of control would be the basis and results of strains could be compare to this, which could be adequate to characterise them and produce order among them.

Other way could be to establish a central progeny performance testing station as used in case of other domesticated animal. The strains could be tested in more replicates together with standard controll.

During dressing yield evaluation became sure, that “quadratic” body shape includes bigger amount of edible meat, than carps with rounded body shape. It can be used during the selection work for better dressing yield.

6. List of publications treating the subject of the dissertation

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