

Breeding program of Hungarian common carp with special regards to intraspecific hybridization

J. Bakos and S. Gorda
Fish Culture Research Institute
H-5541 Szarvas P.O.Box 47. Hungary

Abstract

Domesticated strains of Common Carp (*Cyprinus carpio* L.) has an old breeding history and formed so called landraces as a result of different environmental conditions and the conscious selection work of fish culturists. One of the most important primary condition of intensive pond fish culture is the highly productive strain or hybrid with fast growth, good viability, economical food conversion, favourable slaughter value and good quality of meat.

Since 1962 thirty different genotypes of common carp has been collected and maintained in the Fish Culture Research Institute. Comparative testing of this landraces demonstrated consistently inherited quantitative characteristics. The main parts of our breeding program are as follows:

- Collecting different genotypes of common carp including Hungarian and foreign landraces.
- Selecting and inbreeding the most productive lines, using traditional selection methods and artificial gynogenesis completed with hormonal sexreversion.
- Crossing experiments, producing two,- three and four lines hybrids, to find out useful heterosis effects.
- Comparative testing of hybrid groups under pond and laboratory conditions.

More than hundred crossing combinations were valuated and three outstanding hybrids has been found. The "Szarvas 215" mirror carp as a three-line hybrid showed 20-25% higher productivity than the parental strains. The "Szarvasi P31" and "Szarvasi P34" scaly hybrids represents good growth rate and wide adaptability to different environmental conditions and become high quality crossbreed of intensive pond fish culture and natural waters as well.

In the last phase of our long-term breeding program the parental lines of hybrids are reproduced, reared and the fish hatcheries and commercial fish farms are provided with selected broodfish of outstanding hybrids.

Introduction

Among the cultivated fish species common carp (*Cyprinus carpio* L.) is the most highly domesticated animal. The oldest breeding history can be find in China, where the controlled reproduction started 4000 years ago while in Europe the breeding back ground of common carp has only 1000 years in his part. (Balon 1974). In the isolated culturing centers so called landraces were developed as a result of different environmental conditions and the conscious selection work. Thirty several landraces of common carp were collected and maintained as a

live gene bank since 1962 at the Fish Culture Research Institute Szarvas (Hungary). The landraces deviate from each other in their qualitative and quantitative characteristics and these traits are inherited consistently in their progenies. (Bakos 1979, Kirpichnikov 1981)

Planning a breeding program it is necessary to take into consideration what are the fundamentals of the given fish species in its cultivation, reproduction and genetics and what are the usable methods for its genetic improvement. In the case of common carp by the scaleness, colour, body formation can be influenced by selection, but the quantitative characters, determining directly the productivity guarantee a very low progress using traditional methods of selection. (Wohlfarth et al. 1983) The high reproductive ability and the artificial reproduction with external fertilisation are advantages of the common carp, but the 4-5 years long generation interval and the low h^2 of quantitative traits causes serious drawbacks.

To enlarge the profitability of Hungarian fish production a comprehensive, long-term carp breeding program has been developed, based on the intraspecific hybridization. The parental lines having good combining ability have been inbred using traditional sibmating and a strict selection. As a result of first crossing experiments two-line hybrids were obtained and positive heterosis effect has been observed in the growth, survival and food conversion by several combinations. The most productive two-line hybrids were used for further crossing experiments producing three- and four-line hybrids. (Bakos 1979) Accelerate the procedure of inbreeding artificial gynogenesis was applied producing all female monosex populations from the female gametes without genetic contribution of male gametes using Cobalt 60 irradiated inactive sperm and a cold shock treatment after fertilisation for fusion of the female pronucleus with the second polar body. Sex-reversion from female to male was carried out by feeding methyltestosterone hormone treated food in the early age of nursed fry. Crossing inbred gynogenetic parents useful heterosis effect was obtained in several hybrid combinations.

Materials and methods

The genetic bases of our breeding program is the live gene bank of common carps containing 30 different landraces completed with inbred forms of the best parental lines. During the crossing experiments 140 hybrid combinations were developed and tested.

Individually marked brood fish were used for artificial reproduction in sex ratio 1 female to 1 male. In the first year the progeny groups were reared in earthen ponds separately, in the second year after marking all the experimental groups were kept in a common pond. For comparative testing of hybrids and pure parental lines the experimental groups were stocked in three different fish farms with several environmental conditions and possible unlike production level. The performances of hybrids were compared to the parental lines, and to the yearly reproduced standard control group (Gall, 1983, Wohlfarth, 1983). The quantitative traits like growth, survival, feed conversion, slaughter value, fat content which are determining the productivity we measured and evaluated at the end of the second year by the marketable size of fish (Gjedrem, 1983).

The landraces involved by the crossing experiments as the best parental lines, represented the following strains:

- The maternal line "Szarvas 22" mirror carp originated from the Sumony fish farm, it was selected and inbred with sibmating during four generations.
- The paternal line "Szarvas 15" mirror carp as a two line hybrid originated from the Hortobágy fish farm (line 1.) and from the Fish Culture Research Institute, Szarvas (line 5.) The F2 hybrid was backcrossed with the Hortobágy strain on his maternal branch. As a two line hybrid showed an excellent growth rate and survival.
- The maternal line "P.3" homozygot scaly cap was originated from the Tata fish farm and selected during three generations take into considerations the better growth and survival rates.
- The Amur wild carp, originated from the Far-Eastern Amur river imported at 1984 from Russia. As a distant strain was used in our breeding program for crossing experiments, and pairing with the P.3 maternal line showed an excellent combination ability.

The parental lines used for hybridization were inbred and selected in his progenies. The main viewpoint of selection was the rapid growth rate during the first two years and the correct body formation.

Increasing heterosis effect the parental lines used for hybridization were reproduced with artificial gynogenesis. As a result highly inbred female lines were obtained. The inbred paternal lines were developed from the gynogenetic females with oral administration of methyltestosterone hormone (Nagy et al., 1984). In the crossing experiments the sex reversed gynogenetic males resulted monosex hybrids.

Result

Elaboration the long term breeding program of common carp those methods of genetic improvement were applied which can be properly fitted to the biological, genetic and production capacity of cultivated carp.

The working processes and time schedule of the developed carp breeding program are as follows:

- | | |
|---|---------|
| 1. Selecting and reproducing the basic populations | |
| 2. Comparative valuation of selected lines by progeny testing | 2 years |
| 3. Poliallel crossing, producing two-line hybrids | 3 years |
| 4. Comparative testing of hybrids | 2 years |
| 5. Rearing and selecting of new parental lines | 3 years |
| 6. Producing three, - and four-line hybrids | |
| 7. Comparative performance test of new crosses | 2 years |
| 8. Preparing parental broodfish of highly productive hybrids. | 3 years |

Realization of our breeding program three different hybrid carp populations has been developed for the commercial pond fish farming in Hungary with outstanding productivity.

The Szarvas 215 hybrid mirror carp originated from the Sz.22 maternal, and Sz.15 paternal lines. As a three-line hybrid has 16.5% better growth and 7.6% higher survival rate comparing to his parental lines. The Szarvas P.31 heterozygote scaly three-line cross originated from the Sz. P.3 homozygote scaly carp as a maternal line and from the Sz.15 mirror paternal line. The

growth rate of this hybrid resulted +10.2% and in his survival +1.9 higher productivity that of the selected parental strains.

The Sz.P.34 homozygote scaly hybrid carp developed by crossing of Sz.P.3 maternal line with the scaly Amur wild carp. Achievement of this hybrid considering the parental lines in his growth rate +26.0% and +3.2% in his survival.

This breeding program demands a continuous and strict cooperation among the research institute, the fish producers and the state officials controlling the breeding value of new hybrids. As a result of this program 80 % of Hungarian carp production is based on the hybrids of Szarvas research institute.

Discussion

Realising this longterm carp breeding program the time factor is cosing serious problem because producing two-lines hybrids needs 8-10 years and the required time for developing three,- or four-line hybrids needs 13-15 years presuming that the first poliallel crossing experiments resulted useful heterosis effects. One of the most effective method to shorten the breeding period of inbreeding is to use artificial gynogenezis, and to accelerate the rearing season for the valuable populations or individuals, moreover using water recirculating aquarium system with standard water temperature during the winter season.

The long term breeding program is closely connected with the research institute having special technical and scientific background to maintain continuously the different common carp strains, to utilize the up to date genetic methods and to guarantee the technical conditions of exact performance tests.

The breeding program has been proved that the genetic potential of different common carp landraces can be utilized for increasing the profitability of intensive fishculture.

References

- Bakos, J. (1979) Crossbreeding Hungarian races of common carp to develop more productive hybrids. *Advances in Aquaculture*. Fishing News Books Ltd. Farnham, 635-642 p.
- Gall, G. A. E., (1983) Genetics of fish: a summary of discussion. *Aquaculture*, 33. 383-394 p.
- Gjedrem, T., (1983) Genetic variation in Quantitative traits and selective breeding in fish and shellfish. *Aquaculture*, 33. 51-72 p.
- Hulata, G., Wohlfarth, G., Rothbard, S. (1983) Progeny-testing selection of tilapia broodstocks producing all-male hybrid progenies-preliminary results. *Aquaculture*, 33. 263-268 p.
- Kirpichnikov, V. S. (1981) Genetic Bases of Fish Selection. Springer Verlag, Berlin, 410 p.
- Nagy, A., Csányi, V., Bakos, J. and Bercsényi, M. (1984) Utilisation of gynogenesis and sex reversal in commercial carp breeding: growth of the first gynogenetic hybrids. *Aquacultura Hungarica*. 4. 7 p.
- Wohlfarth, G. W., Moav, R. and Hulata, G. (1983) A genotype-environment interaction for growth rate in common carp, Growing in intensively manured ponds. *Aquaculture*, 33. 187-195 p.