A Review of the Fish Breeding Research and Practices in Vietnam

Tran Mai Thien
Research Institute for Aquaculture No. 1
Dinh Bang, Tien Son, Ha Bac
Vietnam

Abstract

In 1992, Vietnam produced over 350,000 tons of fish from aquaculture, of which a considerable part was freshwater fish production. Despite this success, Vietnamese fish culture is now facing many problems, especially around the deterioration of genetic quality in a number of cultivated fish species. The first genetic improvement programs of cultured fish species were done on carp and tilapia. Success has only been achieved on the commercial hybridization of common carp, however, positive results from long-term selective breeding programs were also obtained. Presently, three stocks of fifth generation selected hybrid common carp are being maintained. Experiments were performed on one stock to determine the realized heritability of body weight. They showed that mass individual selection could be effective. A selective breeding program for silver carp has not been done. The first step will be to obtain pure lines of Vietnamese and Chinese silver carps that have been uncontrollably mixed since the 1960s.

Introduction

Over 56,000 ha in small ponds and lakes, 394,000 ha in man-made lakes and reservoirs, and a part of 544,000 ha of rice fields are used for freshwater fish culture in Vietnam. According to Ministry of Fisheries, data reports 351,260 tons of fish were produced by aquaculture in 1992. A considerable portion was obtained from freshwater fish culture. The important cultured fish species in Vietnam are Asian carps, which include common carp (Cyprinus carpio), silver carp (Hypophthalmichthys molitrix and H. harmachi), bighead carp (Aristichthys nobilis), grass carp (Ctenopharyngodon idella), mud carp (Cirrhinus molitorella), rohu (Labeo rohita), mrigal (Cirrhinus mrigala), pungius (Puntius gonionotus) and some species of Clarias, Pangasius and tilapia (Oreochromis mossambicus and O. niloticus). Total annual fish seed production is 4 billion larvae, fry and fingerlings. This production has fulfilled the demand for stocking in Vietnam.

Culture fisheries in Vietnam are now facing many difficulties, including feed and infectious disease problems. The genetic quality of a number of cultivated fish species has been deteriorating since the late 1960s. It was therefore necessary to carry out fish breeding research programs to enhance aquaculture productivity. In the 1970s, genetic research focused on hybridization for commercial production. Selective breeding research programs for cultivated fish species, such as common carp, silver carp and tilapia have been conducted since the 1980s.
Commercial Hybridization

- Preliminary research programs on interspecific crosses of carp and tilapia

Early crosses between female bighead and male silver carps revealed that hybrid viability in the fry and fingerling stages of the hybrid was better than in pure silver carp. However, the growth rate of these hybrids in all the experiments was less than that of silver carp. It was concluded that this hybrid is not profitable for culture (Thien and Tuong 1983).

The tilapia, *Oreochromis mossambicus* and *O. niloticus*, were introduced to Vietnam in 1951 and 1973, respectively. They became a popular species to culture due to their adaptability and ability to thrive in different bodies of water. Since they breed naturally throughout the year in warm water, it is difficult for the fish farmers to control tilapia populations in ponds. High stocking densities and inadequate food supplies in ponds have resulted in low growth rates, small marketable size, low production yield, and low market value.

In 1978, an experiment comparing the growth rate of two species of tilapia revealed that the Nile tilapia grew nearly twice as fast as the mossambica tilapia. The hybrids obtained by crossing these species grew moderately in comparison with their pure sibs (Fig. 1). The hybrid obtained from a cross between female Nile tilapia and male mossambica tilapia grew better than the hybrid obtained from a reciprocal cross.

The sex ratio of the hybrid populations was interesting. In the case of crossing female *O. niloticus* x male *O. mossambicus*, 71% - 80% of the hybrids were males. In a reciprocal cross (female *O. mossambicus* x male *O. niloticus*), only 27% - 32% of the hybrids were male (Thien 1983). Unfortunately, the reasons for these results were not clear. For fish culture in Vietnam it was considered better to use the pure Nile tilapia or its hybrid by crossing female Nile tilapia x male mossambica tilapia rather than using *O. mossambicus*.

- Intraspecific crossing of common carp

In Vietnam, eight varieties of local common carp were investigated, of which white carp - a variety with high viability - is the most popular (Trong 1983). However, white carp and the other varieties of Vietnamese common carp exhibited slow growth rates and early maturity. Attempts to determine the effectiveness of heterosis by crossing these varieties were not successful. Hungarian mirror carp was introduced to Vietnam in 1970 and scale carp was introduced in 1975. The Hungarian carp showed fast growth and proper maturity, but was susceptible to disease and possessed low viability.

Figure 1. Comparison of growth between *Oreochromis mossambicus* (1), *O. niloticus* (4) and their hybrids: ♀ *O. mossambicus* x ♂ *O. niloticus* (2) and ♀ *O. niloticus* x ♂ *O. mossambicus*.
The first hybrid generation (F₁) cross between Vietnamese white carp and Hungarian carp possessed the best characteristics from their parents, i.e., high survival rate, fast growth and nice appearance (i.e., big body and small head). The percentage of fry and fingerling F₁ hybrids that survived was much higher than that of Hungarian carp (Table 1, Fig. 2). The survival of Vietnamese carp was also higher than Hungarian carp and similar to the hybrids.

Hybrid carp grew much faster than Vietnamese carp in both the mixed culture (same ponds) and monoculture (separate ponds) (Fig. 3). In general, the growth rate of Hungarian carp was considered high, but in most experiments the growth rates of the hybrids were higher (Fig. 4).

The best productivity from our research program was obtained from raising hybrid carp. As a result, over 10 million hybrid carp larvae, fry and fingerlings have been provided to farmers annually, considerably augmenting the cultured carp production in Vietnam. However, due to improper breeding management, the base stocks of common carp were gradually losing their purity, thus decreasing the effectiveness of crossing for hybrids.

### Selective Breeding of Common Carp

Since 1981, research programs have focused on selection of common carp with the intention of creating a fish breed with stable genetic qualities. In the first phase (1981-1985), the program focused on the assessment of initial materials for selection (Thien et al. 1987). To bring together a number of positive qualities from different hybrid varieties and to improve the genetic variability,

![Figure 2. Survival percentage of fry from Vietnamese (V) and Hungarian (H) common carp and their hybrids.](image)
Table 2. Representative data on the mass individual selection of the hybrid stocks of common carp.

<table>
<thead>
<tr>
<th>Year and generation</th>
<th>Stocks</th>
<th>Total number of fish</th>
<th>Body weight, g</th>
<th>Indices collected through selection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Severity</td>
</tr>
<tr>
<td>1986 F1</td>
<td>♀ H x m (YvV)</td>
<td>400</td>
<td>162 ± 6</td>
<td>12.5</td>
</tr>
<tr>
<td></td>
<td>♀ V x m (YxH)</td>
<td>400</td>
<td>178 ± 4</td>
<td>12.5</td>
</tr>
<tr>
<td></td>
<td>♀ Y x m (HxV)</td>
<td>1720</td>
<td>187 ± 8</td>
<td>7.5</td>
</tr>
<tr>
<td>1988 F2</td>
<td>♀ H x m (YvV)</td>
<td>248</td>
<td>152 ± 7</td>
<td>10.1</td>
</tr>
<tr>
<td></td>
<td>♀ V x m (YxH)</td>
<td>258</td>
<td>104 ± 5</td>
<td>9.7</td>
</tr>
<tr>
<td></td>
<td>♀ Y x m (HxV)</td>
<td>253</td>
<td>148 ± 9</td>
<td>9.9</td>
</tr>
<tr>
<td>1989 F3</td>
<td>♀ H x m (YvV)</td>
<td>75</td>
<td>149 ± 8</td>
<td>33.3</td>
</tr>
<tr>
<td></td>
<td>♀ V x m (YxH)</td>
<td>243</td>
<td>155 ± 12</td>
<td>32.9</td>
</tr>
<tr>
<td></td>
<td>♀ Y x m (HxV)</td>
<td>74</td>
<td>310 ± 16</td>
<td>33.8</td>
</tr>
<tr>
<td>1991 F4</td>
<td>♀ H x m (YvV)</td>
<td>200</td>
<td>260 ± 6</td>
<td>20.0</td>
</tr>
<tr>
<td></td>
<td>♀ V x m (YxH)</td>
<td>209</td>
<td>197 ± 5</td>
<td>19.1</td>
</tr>
<tr>
<td></td>
<td>♀ Y x m (HxV)</td>
<td>189</td>
<td>299 ± 6</td>
<td>25.9</td>
</tr>
</tbody>
</table>

V-Vietnamese, H-Hungarian and Y-Indonesian Yellow common carp.

![Diagram](image1.png)  
**Figure 3a.** Growth of Vietnamese common carp and a hybrid of Hungarian carp and Vietnamese carp by monoculture in separate ponds.

![Diagram](image2.png)  
**Figure 3b.** Growth of Vietnamese common carp and a hybrid of Hungarian carp and Vietnamese carp by mixed culture.
Figure 4. Increase in weight of Vietnamese carp (V), Hungarian carp (H) and their hybrids (VH and HV). Mixed culture in three growout ponds.

the Vietnamese white carp, the Hungarian scale carp and the Indonesian yellow carp were crossed. It was found that in the F1 generation the main characteristics of hybrids depended on the rate of heredity from the pure varieties. However, in the F3 and F4 generation the differences in growth and morphology were no longer striking among the three hybrid stocks. This may have been caused by selection for the same traits through several generations.

In the second phase of the program (1986-1995) mass individual selection has been carried out among the three hybrid stocks over six generations (Fig. 5). Due to a limited number of ponds, the number of experimental fish in each stock was limited. Even though the scale of selection is small (Table 2), the indices obtained proved to be acceptable.

Preliminary assessment of selection effectiveness was made by determining the realized heritability of body weight (Fig. 6). Before mass selection was done, a randomly collected control population was kept. Another group was collected by selecting for body weight (experimental group). The offspring of the two groups were reared in the same ponds to a marketable size. In the 1988 experiments, the results were analyzed and adjusted according to the methodology of Wohlfarth and Moav (1972), because of the difference in body weight between two groups of fingerlings when stocked. The realized heritability ($h^2$) of body weight was 0.2 to 0.29 for hybrid common carps from a cross of female Hungarian x male (Vietnamese x Indonesian) (Table 3). These data showed that research on the effectiveness of mass individual selection with the hybrids could be accepted.

Experiment in Restoration of the Purity of Vietnamese Silver Carp

A native species of silver carp (Hypophthalmichthys huanrensi) was investigated in Vietnam. In 1956, the Chinese silver carp
Table 3. Heritability ($h^2$) of the body weight of hybrid common carp ♀ Hungarian x ♂ (Vietnamese x Yellow).

| Year (Beginning) | Parent's bodyweight, g | Offsprings' body weight, g | Heritability
|------------------|-------------------------|-----------------------------|------------------|
|                  | Contr. Stock | Selected stock | Contr. stock | Selected stock | $h^2 = R/S$
| 1987             | 162 ± 6       | 261 ± 9         | 180 ± 4       | 209 ± 6       | 0.29 |
| 1988             | 218 ± 10      | 312 ± 21        | 316*          | 335*          | 0.20 |
| 1991             | 246 ± 5       | 334 ± 9         | +             | +             | +    |

+ Before adjustment it was 286 ± g and 365 ± 9 respectively,
++ The data will be received at the end of 1993.

*(H. molitrix)* was introduced. Due to the improper management of the pure stocks during artificial spawning, the two species of silver carp were mixed. Crossed uncontrolled crossing occurred. The undesirable silver carp hybrids showed slow growth rate and early maturity.

The first step of the silver carp selection program aimed to restore the pure populations of these two species. Based on the morphological and biochemical indices, the two stocks of Vietnamese and Chinese silver carp were identified (Thien and Tien 1988). The second step of the selective breeding program was to improve the purity and genetic qualities of the identified stocks.

![Diagram](image)

**Figure 6.** Determining realized heritability ($h^2$) of body weight.
Conclusion

A brief review of the fish breeding research and practices in Vietnam showed that despite small and scattered research programs, some initial success was achieved that enhanced aquaculture productivity. Selection of common carp and silver carp will continue in the future. The selective breeding of Indian major carps will also be conducted and will initially focus on selection of mrigal.

A proposal for International Center for Living Aquatic Resources Management (ICLARM) support on genetic improvement of farmed tilapia was submitted and will be approved in the near future. Enlargement of research programs on the genetic structure of fish populations, karyotypes, gynogenesis and chromosome manipulation will also occur.

Acknowledgements

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Literature Cited


