

AQUABYTE SECTION

Editorial

This issue of Aquabyte is a little thin because we are somewhat short of good material to publish. With so many active NTAS members we should be swamped with papers. We do have quite a few papers for which are awaiting authors' responses to editor's questions. If these comments apply to you, please write soon.

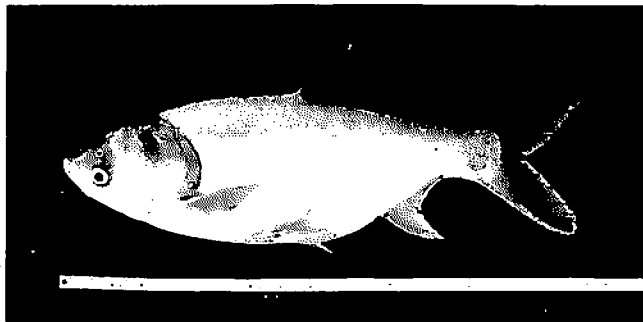
The main articles here illustrate a silver carp breeding

program in Vietnam (part of a long-established breeding program there, mainly on cyprinids) and some interesting ideas on improving the cost-effectiveness of feeding in semi-intensive aquaculture. We also have all the usual features. The results of the questionnaire, sent to NTAS members, will be published in the next issue. *R.S.V. Pullin*

Preliminary Results of a Silver Carp Breeding Program in Vietnam

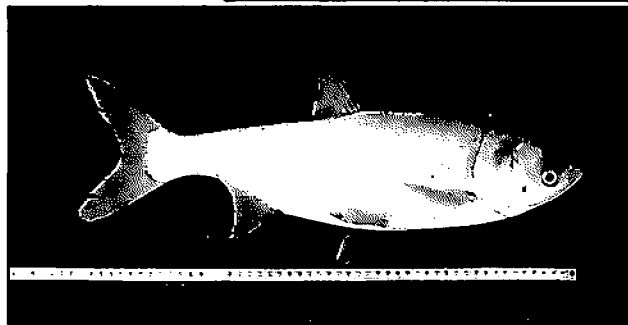
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*The Vietnamese (*Hypophthalmichthys harmandi*) (above) and the Chinese (*H. molitrix*) (below) silver carps. Note the deep body and bigger scales of the Vietnamese species.*



Background

Silver carp is one of the most important cultured fish in Vietnam. Production is about 100,000 t/year, roughly 60% of freshwater fish production. It is predominantly a phytoplankton feeder. There are two species: the Vietnamese silver carp (*Hypophthalmichthys harmandi* Sauvage) and the Chinese silver carp [*Hypophthalmichthys molitrix* (Val.)]. The latter was introduced from China in 1958. Artificial breeding and farming of these carps have been done successfully since 1963, but with little care to keep the



species separate. Hence there has been much genetic mixing. Recently, it was noted that culture performance and the quality of marketable fish became extremely reduced (Tran Mai Thien and Phan Hong Tien 1988). A major research program for selective breeding of silver carp has been underway since 1981. The

main objective of its first 10 years has been to restore the purity of the two silver carp species in Vietnam.

Scope of Work

To get material for a selective breeding program, two pure and separate populations of Chinese and Vietnamese silver carps had to be established. A pure founder population of Chinese silver carp was collected from the Baucai fish farm, Dongnai Province. The broodstock at this farm are pure Chinese silver carp and were not mixed with Vietnamese silver carp from the time of their introduction to the farm until they were transferred to our Institute. To obtain a relatively

pure population of Vietnamese silver carp, we collected them from fish farms, knowing that they obtain fish seed from the Red River; and these riverine stocks are known to be less mixed than others.

We aimed to select from these farm stocks fish with the typical morphological characteristics of Vietnamese silver carp. The characteristics of these selected populations were assessed by determining the degree of heterosis for growth performance in their reciprocal hybrids. Growth rate comparisons were by communal stocking in ponds for groups that could be marked by fin clipping or by use of color dyes (textile dyes in aqueous solution). For young fish (up to about 50 g body weight), separate stocking of groups was necessary.

Research Results

Morphometrics

We have accomplished three generations of selective breeding of silver carp. Two main characters were chosen for selecting Vietnamese silver carp: body height and number of scales on lateral line. According to original descriptions, Vietnamese silver carp has a body height of more than 30% body length (standard) (Chevey and Lemasson 1937), whereas for Chinese silver carp it is less than 30% (Wu Xian Wen et al. 1964). The scales of the Vietnamese silver carp are distinctly bigger than those of the Chinese silver carp and the number of scales in the lateral line is less than 90 for the Vietnamese and more than 100 for the Chinese silver carp.

For Chinese silver carp, the results (Table 1) confirm a pure population because the characteristics were

almost stable through three generations and similar with the original description given in standard taxonomy literature. The first and second generations selected Vietnamese silver carp had body heights more than 30% of body length, and less than 90 scales in the lateral line. These main characters were similar to the original dataset and distinguished them easily from Chinese silver carp. However, some characters for the Vietnamese silver carp were less stable and tended slightly to resemble those for Chinese silver carp. It was concluded that the selected Vietnamese silver carp population is not pure and more selection is needed.

Growth

According to previous results (Tran Mai Thien and Phan Hong Tien 1988), the first selected generation of Vietnamese silver carp grew slightly faster than Chinese silver carp in separate rearing (two-year-old fish) or in communal rearing (three-year-old fish). The reciprocal hybrids had intermediate values for growth between the parental stocks. But the differences among stocks were small.

These tests were then repeated using fish from the second generation of selection (1988). Because of the difficulty in marking young fish (Group I) and the differences

in spawning seasons (Chinese silver carp spawn earlier than the Vietnamese by almost one month), the groups were stocked separately in four 400-m² ponds; stocking density: 15 fish/m². The growth performance of Vietnamese and Chinese silver carps were not significantly different, but both reciprocal hybrids grew faster than their parental groups, especially the hybrid from ♀ Chinese silver carp x ♂ Vietnamese silver carp (Table 2). It also appeared that during the first year of life, Chinese silver carp and the hybrid from ♀ Chinese silver carp x ♂ Vietnamese silver carp grew rather faster than the Vietnamese silver carp, but it was very difficult to establish comparative experiments because of differences on the onset of the spawning season.

Investigations were continued on three-year-old tagged fish of the same populations with communal stocking. The experiments were carried out in three 700-m² ponds; stocking density: 5 fish/m². Table 3 summarizes the trends in growth performance. The pond environment was poor and therefore growth was slow. However, the Vietnamese silver carp performed distinctly better than the Chinese silver carp. The hybrids from ♀ Vietnamese silver carp x ♂ Chinese silver carp grew faster than the hybrids from ♀ Chinese silver carp x ♂ Vietnamese silver carp.

Table 1. Morphometric characteristics of Vietnamese (*Hypophthalmichthys harmandi*) and Chinese (*H. molitrix*) silver carp populations: an original dataset for Vietnamese silver carp, recorded before 1963 and data from successive generations of selection on research populations of both species. The data are means and standard errors.

Characters	Vietnamese silver carp			Chinese silver carp		
	Original records n = 14	Generation I 1984 n = 25	Generation II 1988 n = 25	Generation I 1984 n = 50	Generation II 1988 n = 25	Generation III 1990 n = 25
l (cm)	21.2 ± 0.5	31.4 ± 0.3	29.0 ± 2.9	29.8 ± 0.2	28.1 ± 0.1	14.0 ± 0.5
W (g)	385.0 ± 20.7	619.7 ± 15.5	507.4 ± 0.2	476.7 ± 7.7	380.4 ± 0.2	41.1 ± 4.7
C (%)	28.4 ± 0.8	29.7 ± 0.2	29.3 ± 0.1	27.8 ± 0.1	28.6 ± 0.1	29.0 ± 0.1
Hc (%)	28.4 ± 0.1	23.5 ± 0.1	24.8 ± 0.1	23.9 ± 0.1	24.7 ± 0.1	-
H (%)	33.4 ± 0.8	32.0 ± 0.3	30.1 ± 0.3	29.0 ± 0.2	28.6 ± 0.2	27.5 ± 0.1
aD (%)	55.2 ± 0.8	50.6 ± 0.4	52.1 ± 0.3	49.5 ± 0.2	51.3 ± 0.2	50.7 ± 0.1
IP (%)	22.1 ± 0.6	21.9 ± 0.3	20.4 ± 0.3	21.0 ± 0.1	21.5 ± 0.4	21.9 ± 0.1
PV (%)	21.9 ± 0.8	20.8 ± 0.2	18.7 ± 0.8	21.2 ± 0.4	19.9 ± 0.2	20.5 ± 0.1
IA (%)	17.5 ± 0.9	16.3 ± 0.2	15.3 ± 0.2	15.3 ± 0.2	15.3 ± 0.3	15.0 ± 0.5
PI (%)	13.4 ± 0.6	17.3 ± 0.2	17.4 ± 0.2	17.1 ± 0.3	18.1 ± 0.3	18.9 ± 0.1
ll (#)	89.5 ± 3.2	87.5 ± 0.5	90.0 ± 0.8	103.6 ± 0.5	103.6 ± 0.7	-

l: body length (standard); W: body weight; C: head length; Hc: head height; H: body weight; aD: antedorsal length; IP: pectoral fin length; PV: length between pectoral and pelvic fins; IA: length of anal fin base; PI: caudal peduncle length; ll: number of scale in lateral line. The data given as percentages are percentages of standard length.

Table 2. Growth of selected Group I populations of Vietnamese (*Hypophthalmichthys harmandi*) and Chinese (*H. molitrix*) silver carp populations and their reciprocal hybrids in separate ponds (31 March - 16 October 1987).

	<i>H. harmandi</i>	<i>H. molitrix</i>	♀ <i>H. harmandi</i> x ♂ <i>H. molitrix</i>	♀ <i>H. molitrix</i> x ♂ <i>H. harmandi</i>
Initial weight (g)	50.4 ± 1.3 n = 19	56.3 ± 2.9 n = 20	43.4 ± 1.8 n = 15	80.6 ± 4.4 n = 19
Final weight (g)	232.4 ± 8.0 n = 34	241.5 ± 7.9 n = 29	317.0 ± 6.2 n = 30	373.1 ± 11.6 n = 30
Increase (g)	182.0	185.2	273.6	292.5
Heterosis (% of midparent)			49.0	59.3

*Spawned one month earlier than the other groups.

Table 3. Growth of selected Group II Vietnamese (*Hypophthalmichthys harmandi*) and Chinese (*H. molitrix*) silver carp populations in triplicate communally stocked ponds (April-October 1988).

	<i>H. harmandi</i>	<i>H. molitrix</i>	♀ <i>H. harmandi</i> x ♂ <i>H. molitrix</i>	♀ <i>H. molitrix</i> x ♂ <i>H. harmandi</i>
First set				
Initial weight (g)	230 ± 9	226 ± 11	330 ± 15	378 ± 14
Final weight (g)	627 ± 16	510 ± 17	716 ± 9	744 ± 18
Increase (g)	397	284	386	366
Heterosis (% of midparent)			13.3	7.5
Heterosis (% of best parent)			-2.8	-7.8
Second set				
Initial weight (g)	296 ± 10	304 ± 16	380 ± 11	432 ± 19
Final weight (g)	549 ± 10	547 ± 17	683 ± 14	695 ± 15
Increase (g)	253	243	303	263
Heterosis (% of midparent)			22.2	6.4
Heterosis (% of best parent)			19.8	4.0
Third set				
Initial weight (g)	244 ± 7	256 ± 9	330 ± 16	402 ± 14
Final weight (g)	458 ± 9	416 ± 10	578 ± 9	630 ± 14
Increase (g)	214	160	248	228
Heterosis (% of midparent)			32.8	21.9
Heterosis (% of best parent)			15.8	6.5

Table 4. Comparison of the reproductive characteristics of female Vietnamese (*Hypophthalmichthys harmandi*) and Chinese (*H. molitrix*) silver carp broodstock (April 1990).

	<i>H. harmandi</i>	<i>H. molitrix</i>
Number of fish examined	11	4
Average female weight (kg)	1.66	1.70
Average egg diameter (mm)	1.32	1.66
Average egg weight (mg)	1.73	1.89
Average quantity of eggs spawned by one female (no.)	100,000	120,000

Reproduction

Because of a shortage of broodfish, investigations on the reproductive characteristics of selected silver carp populations has only been possible since 1989. In ponds, these silver carp species become sexually mature as Group II fish (in their third year of life), when about 50% of Chinese and 25% of Vietnamese silver carps are amenable to induced breeding. Early maturing broodfish are small (<1 kg). To obtain good quality progeny, it is best to use only Group III broodfish (average weight was more

than 1.5 kg).

Under the same conditions, the spawning season of Chinese silver carp starts earlier than that of the Vietnamese silver carp by about one month. From our data for Chinese silver carp, the earliest induced spawnings to give good results were on 15 March 1989 and 23 March 1990, when the water temperatures were 22-24°C. For Vietnamese silver carp, the spawning season always started in mid-April, when the water temperature was about 27-28°C. The reproductive characteristics of the two species are compared in Table 4. Differences in egg quality are not clear, but Chinese silver carp is the more fecund species.

Future Work

Selection program to establish pure lines of Vietnamese and Chinese silver carps will be continued. Results so far indicate that there is an increase in heterosis with an increase in the genetic distance between Vietnamese and Chinese silver carp strains. The overall objective, therefore, is to increase by selection the genetic distance between the two strains for establishing a crossbreeding program and to supply hybrid seed to the farmers.

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