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GENETIC IMPROVEMENT AND DISSEMINATION OF ROHU (*Labeo rohita*, Ham.) IN INDIA

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SUMMARY

For the first time in India, selective breeding was carried out to genetically improve one of the most preferred carp species (Rohu). Under the program a range of selective breeding techniques (production of fullsib groups, individual identification by PIT tags, communal pond rearing, estimation of breeding value and ranking of individuals in different year classes) were used. In five generations of selection for greater harvest weight an average 17 % genetic gain per generation was obtained. On farm trials have proven the strain's superiority and it is being disseminated to farmers.

INTRODUCTION

The Indian Major carps, the Catla (*Catla catla*), Rohu (*Labeo rohita*) and Mrigal (*Cirrhinus mrigala*) are the natural inhabitants of the perennial river network of India, Bangladesh and Pakistan and enjoy a wide distribution. With the success of induced breeding by the hypophysation technique (Choudhuri and Alikunhi, 1957), seed production was commercialized in all India. The fecundity of these fish is very high (0.1-0.3 million per kg of female) so most of the hatchery owners use a limited number of brood stock for seed production. Many hatcheries also function as isolated, genetically closed, units raising their own replacements to produce seed for the grow out culture. The number of replacement brood stock they use is very limited, so inbreeding builds up in those stocks (Eknath and Doyal, 1990). To compensate for this negative effect, some hatchery owners catch wild carp from the river and breed them with their own brood stock. This reduces inbreeding in the population but at the same time counteracts any positive effects of natural selection in the ponds and of selection for growth and other desirable traits (Gjerde *et al*, 2005). This situation signaled a need for better procedures of seed production, and that the presently used stock may not be the best for a genetic improvement program or for production. A collaborative project between the Central Institute of Freshwater Aquaculture (CIFA), India and AKVAFORSK, Norway was initiated in 1992, and in this paper we summarize the main outcomes to date.

MATERIAL AND METHODS

Base population and mating procedure. Rohu fry or fingerlings were obtained from five rivers in India, the Ganga, the Yamuna, the Brahmaputra, the Gomati and the Sutlej and raised at CIFA for 2 to 3 years until they were sexually mature (Reddy *et al*. 2002). A CIFA farm (local) rohu was also added to the base population. The fry or fingerlings collected were under quarantine for about two weeks in cement cisterns. After quarantine, fingerlings were marked by fin clipping, M-procaine blue dye marking or by combinations of both. The marking methods did not appear to affect fish survival or performance. They were stocked in communal ponds for rearing until sexual maturity.

Breeding Program Design Initiatives

The technique followed to induce ovulation of females and to allow sperm collection (milting) from males consisted of injecting a synthetic hormone (Ovaprim) to obtain the gametes. To date 13 year classes of fullsib and half sib families have been produced with six complete generations (Table 1). A nested mating design (two males nested within a female or vice versa) was used. Approximately 60 full sib families were produced in each year class. The artificial induction of ovulation and sperm release enabled the production of full sib families within a small period of time, thus resulting in a narrow age range at stocking. In order to estimate the magnitude of heterosis for harvest body weight two 3 by 3 diallel crosses were made as described in Table 2. The local stock was represented in both diallel crosses.

Table 1 Production of different generations

Generation	Year classes	
0	1993	1994
1	1995	1996
2	1997	-----
3	1999	2000
4	2001	2002
5	2003	2004
6	2005	2006

Table 2 Rohu stock included for two diallele crosses

Male parent	Female parent				
	Ganga	Yamuna	Local	Brahmaputra	Sutlej
Ganga	X	X	X		
Yamuna	X	X	X		
Local	X	X	X	X	X
Brahmaputra			X	X	X
Sutlej			X	X	X

Tagging. Passive Integrated Transponder (PIT) tags were used to individually identify the fingerlings from different families. Ten to 15g fingerlings were suitable for tagging (Das Mahapatra *et al*. 2001).

Test environment for rearing. Tagged fish were stocked in three communal ponds of 0.1Ha each under mono-culture and two 0.4Ha ponds under poly-culture practice. In poly-culture, rohu was stocked with Catla and Mrigal in the ratio of 1.2 : 1 : 1, respectively. This practice was continued until 1997. After 1997, only mono-culture was practiced, as a high correlation between the performance in mono and poly-culture was observed.

Statistical analysis. Editing of the data and basic statistical analyses were performed using SAS (SAS Institute Inc., 1990). The statistical model fitted is described by Gjerde et al. (2002). For each year class full sib, half sib and individual data were considered for breeding value estimation

purposes. Individuals (10 females and 10 males) with average breeding value were chosen as controls and in every generation their progeny was compared with that of selected (greatest breeding value) individuals.

Field testing. Field trials were arranged in several parts of India, namely: 1.Rahara, West Bengal; 2.Ludhiana, Punjab; 3. Vijayawada, Andhra Pradesh; and 4. State Fisheries Department, Orissa. In 2005 and 2006 demonstrations were also arranged at farmers' ponds in different states of India. A comparison of improved rohu was made with local rohu and with the control group from the research center.

Dissemination of improved rohu. Dissemination was carried out in three states (Andhra Pradesh, Orissa and West Bengal). The nucleus resides at CIFA, and it provides improved rohu seed to the multiplier units. Multiplier units are raising the brood fish, producing seed and distributing the seed to farmers.

RESULTS AND DISCUSSION

Characterization. Characterization of the six base population stocks indicated a wide phenotypic and genetic variation within each stock. The variation within stocks was greater than that between stocks (Reddy *et al*. 2002).

Estimation of genetic parameters. Heterosis estimated from the diallel mating was low or negative. It was concluded that genetic improvement of rohu by crossbreeding would be futile (Gjerde *et al*., 2002). At tagging, the heritability (h^2) for body weight was very low whereas the combined maternal and environmental effect common to full sib families (c^2) was very high (Table 3). At sampling and final sampling the heritability was moderate. The data available did not enable a separation of maternal and common environmental effects.

Table 4 Heritability and full sib effects for body weight

Body weight at:	h^2 ± se	c^2 ± se
Tagging (6 mo)	0.05 ± 0.07	0.82 ± 0.09
Sampling (14 mo)	0.23 ± 0.09	0.38±0.09
Final sampling (20 mo)	0.23 ±0.06	0.32 ±0.06

The phenotypic and genetic correlations between sampling and final sampling weights were 0.92 (± 0.01) and 0.98 (±0.01), respectively, indicating that they were virtually the same trait.

Realized selection response. Each generation a control was created by mating average individuals. The progeny of these was compared with that of selected parents in the selection line. Over five years the average response to selection per generation in final body weight was 17 per cent.

Field trials. In field trials in different parts of India the improved rohu showed significantly greater growth rate in comparison to the control and to the local rohu. A growth rate superiority of up to 75 per cent was observed by improved rohu over local rohu. In farmers' fields, the evaluation of the fifth generation of improved rohu showed 98 to 117 per cent greater growth rate than the local rohu. Growth rate is of paramount importance in the prevailing production systems. When harvest is after a production cycle of fixed duration it results in bigger fish, where as when fish of a particular size are sought, greater growth rate shortens the duration of the production cycle.

Dissemination. Dissemination has been very effectively implemented through a private hatchery located in Andhra Pradesh. A memorandum of understanding was signed with the hatchery to ensure continuity in the distribution of rohu seed to fish farmers. CIFA monitors the price of seed.

CONCLUSION

The marketing name given to the improved rohu line is 'Jayanti', as it was first released during 1997 (50 years of Indian independence). Jayanti rohu is the first genetically improved fish developed in India through selective breeding. This constitutes yet another proof of the value of selective breeding as an important technology to increase productivity and resource efficiency in India.

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