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RESEARCH ARTICLE

MIXED SPAWNING AND INDISCRIMINATE HYBRIDIZATION IN THE CONTEXT OF INDIAN HATCHERY OPERATION

***,[1]Chatterjee, N. R. and [2]Santoshkumar Abujam**

[1]Research Professor, Department of Biotechnology, Govt. of India, Department of Zoology, Rajiv Gandhi University, Doimukh, Itanagar
[2]Research Associate, Department of Zoology, Rajiv Gandhi University, Doimukh, Itanagar

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ABSTRACT

A review of the hatchery operation covering three states of India revealed a very gloomy picture in regards to the sustenance of the prized species of India i.e., Catla, Rohu, Mrigal. An in-depth study of the hatchery indicates that the persons involved in hatchery operation are not only illiterate but are devoid of any scientific training for practices of such a novel technology in captivity. Due to improper dissemination, profit making approaches and greediness on the part of fish breeders and hatchery owner, the technology which was initially implemented for the production of quality seed productivity now became a curse in disguise. Mixed spawning indiscriminate hybridization and several other faulty practices, throughout the years, has resulted in several genetic consequences among the hatchery raised fishes. The consequences includes in breeding, genetic drift and retrogressive hybridization which resulted in the loss of certain economically important traits and resulted in the development of a variant type of fishes in the hatchery sector. If this trend continuous, certainly a different variety of carps will come up due to genetic drift and bottle necking and it will be difficult to rebound to the original species.

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INTRODUCTION

As we know mixed farming, also known as composite farming or polyculture is a scientific culture practice adopted by the fish farmers in almost all the States of India. Composite farming is based on a scientific technology for utilization of all the niches of a water body so that all the food material, specific to particular water level, will be utilized by the fishes. The advantage is that the production and yield will be increased manifold. In this culture practice compatible species of fish are stocked in the same water body so that there will be no competition among the selected species in regard to food and habitat. Most popular practice is the stocking of six different species which thrives on different layers, so the farmers conducting such culture practice, primarily needs to stock fry or fingerling of six different species and accordingly they ask the fish breeders / hatchery owners to supply the said species (6) in recommended proportion as has been proposed in the technology. For example, if the culture practice is undertaken involving three species like Catla, Rohu and Mrigal, then the recommended proportion is 30: 60: 10 respectively. But in case of six species culture, where exotic species are included, the recommended proportion is Catla 1.5: Silver carp 1.5: Rohu 3.0: Grass carp 1.0: Mrigal 2.0: Common carp 1.0 (several modification exists). The cultivators involved in such practice always look for the right ratio of the recommended species from the fish breeders. As we know during captive breeding, brood fishes are induced with pituitary extract or synthetic hormones (Ova prim, ova tide etc.) and after induction the broods are released in Breeding pool (Fig.1), Being stimulated by the hormone injection, the female and male brooders release egg and sperm following sex play. The fertilized eggs are automatically transferred to the hatching pool, situated 6" below that of the breeding pool. To conduct individual species wise breeding, it requires 6 separate breeding and adjacent three sets of hatching pool which involve huge expenditure. To overcome this difficulty, the fish breeders breed simultaneously, all the required species in the same breeding pool. This is a general practice by all the fish breeders of all the States of India which in the language of genetics is known as "mixed spawning". Mixed spawning leads to hybridization in advertantly among different species of carps and exotic species also. As we know fish, the only vertebrate, that produce viable and fertile hybrids when crossbreeding is undertaken at species, genus and even at more higher level of taxa. This is possible due to similarity at genomic constitution among different groups of fishes and can be assigned following criteria

Corresponding author: **Chatterjee, N. R.,**
Research Professor, Department of Biotechnology, Govt. of India, Department of Zoology, Rajiv Gandhi University, Doimukh, Itanagar

- Identical chromosome number (Manna, 1984)
- Identical isozyme gene expression
- Conserved nature of some genetic marker etc (Ghosh *et al*., 1991)

Ease of hybrid (F1) production at large indicates close phylogenetic kinship among different species, genera and even at higher taxonomic category of fishes. When the hybrid (F1) female, produced out of a cross between female *C. Mrigala* and male *Labeo calbasu* are crossed to *Catla* male and also with their parents (back cross), they produce viable F2 offspring (Fig.2 & 3).

Figure 1. Breeding pool in operation in a West Bengal hatchery

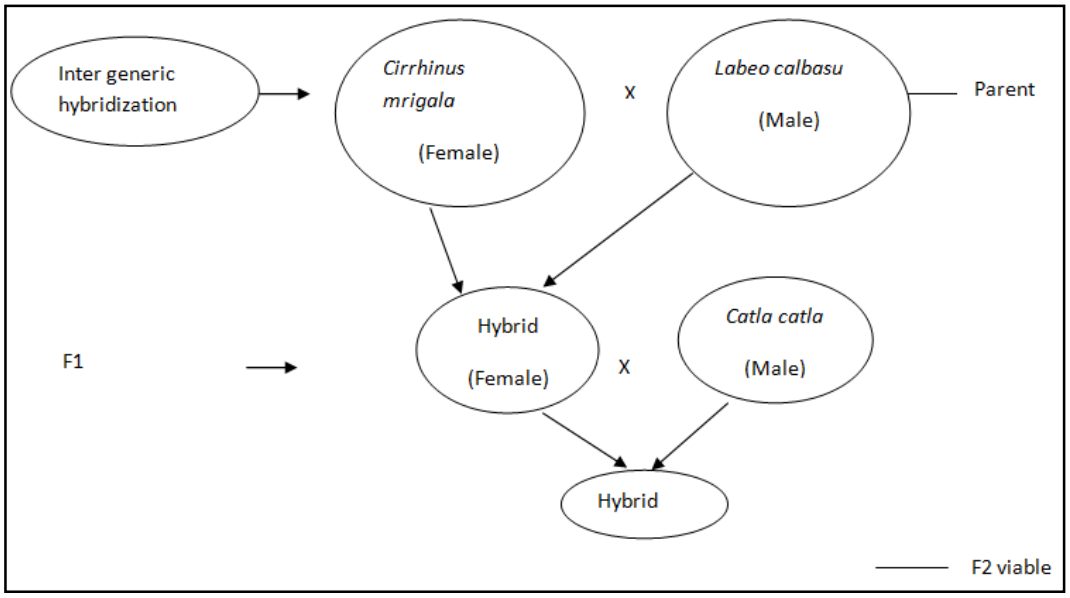

Figure 2. Inter generic cross of mrigala and calbasu and the corss of hybrid with Catla catla produced viable F2 hybrid

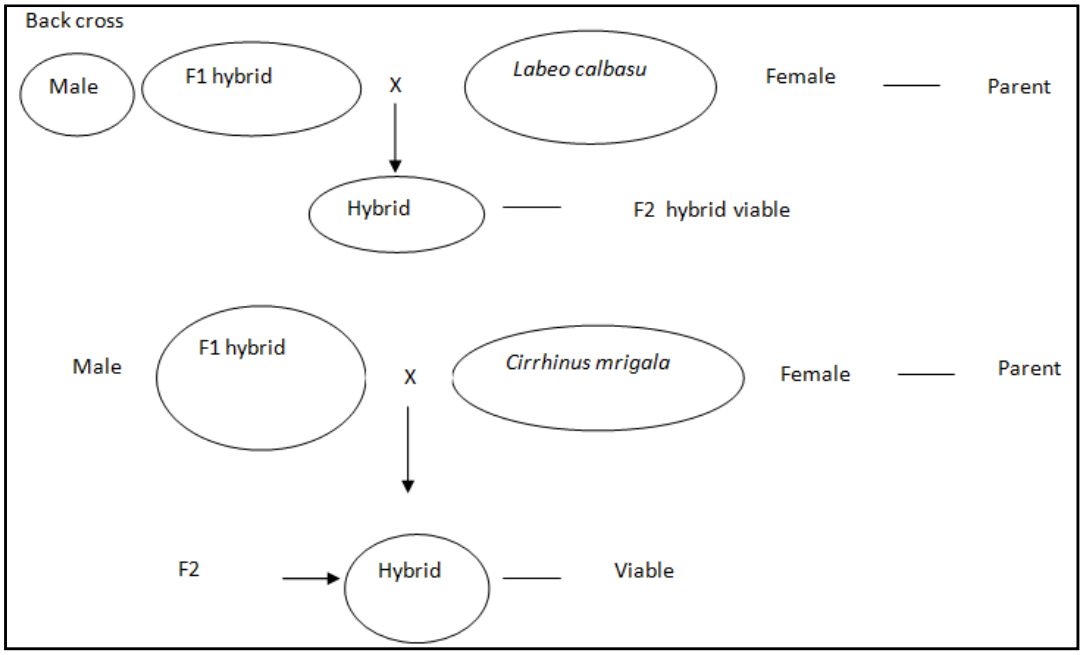

Figure 3. Cross of hybrid male with *Labeo calbasu* female again produced viable F2 hybrid; further cross of male F1 hybrid with female *mrigala* produced F2 viable offspring

The experimental result suggests reproductive isolation is not stringent among different groups of fishes. On the contrary other factors involved in speciation like geographical, ecological developmental and / or behavioural are more crucial than genetic factors. In natural condition interbreeding is prevented by the said non-genomic factors. Hybridization is more frequently observed in fishes compared to other vertebrates - attributed to genomic plasticity and external fertilization. Mixed spawning made hybridization easy due to synchronization of spawning time and other congenial characteristics of these indigenous species. The characters which facilitates hybridization include transparency, non-adhesive and non-floating nature of the eggs of all species, specially freshwater ones. Hatching is also similar and occur within 14-16 hours after fertilization. So it is evident that the practice of mixed spawning always enhances hybridization, not only among carps but also with some other exotic species. Considering the cultural traits, the hybrids, either interspecific or intergeneric, are not much useful. Reciprocal hybrids between Catla and Rohu, when evaluated, are not much useful in regard to cultural point. Reciprocal hybridization are usually undertaken to find out which parent (male or female) are contributing the trait under consideration, to the hybrid. Here, as the cross involved Catla and rohu, so both the parent species are used as male and female alternately in two different crosses as below-

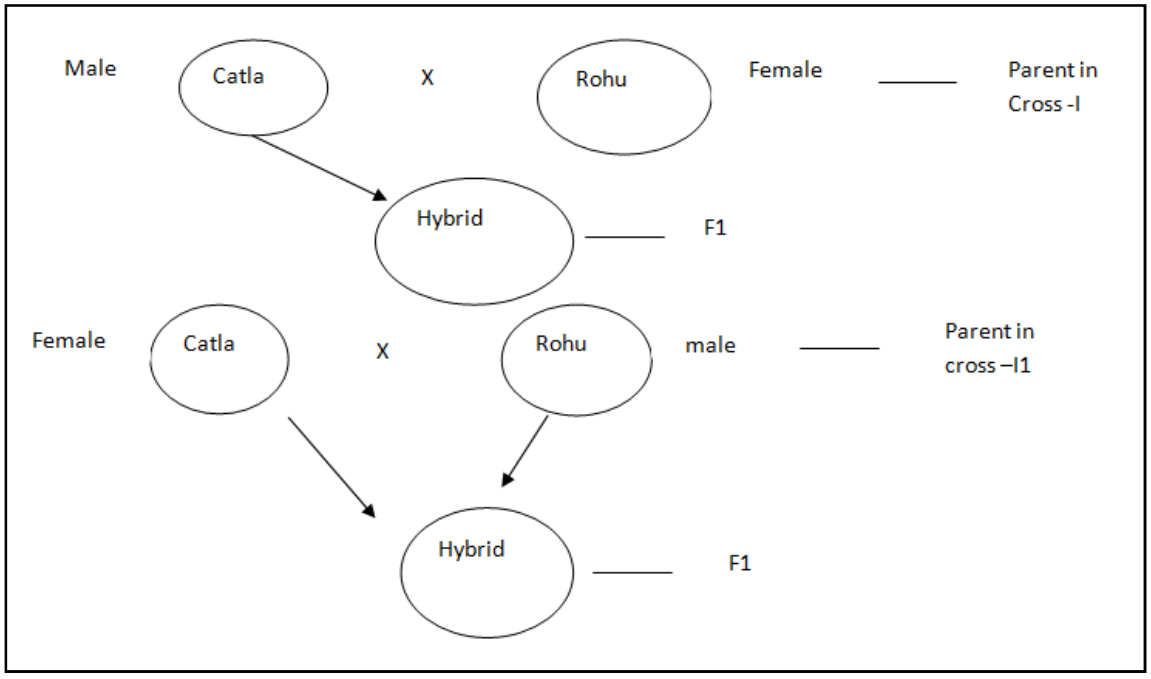

Figure 4. Reciprocal cross between Catla and Rohu also produced viable offspring in each cases

When male catla is crossed female Rohu, the hybrid grew smaller than Catla but larger than Rohu (Fig. 5). Different hybridization experiment also indicated that the hybrids phenotypically resemble the female parent and out of the several hybrids this is the only hybrids which bear some beneficial cultural trait. Reports are there (Chatterjee, N.R., Induced Fish Breeding , 2016) for the production of a totally necked or half necked hybrids when both Catla and Rohu.

Female are crossed to mirror carp male (Fig. 6 & 7)

Inadvertent hybridization and back crossing, as well as reciprocal crossing, is a usual practice in the hatcheries of all the States of India due to dire shortage of brooders during breeding season. This causes genetic introgression causing contamination in native gene pool. Introgression, also known as introgressive hybridization, is the movement of a gene from one species into the gene pool of other species by repeated back crossing of an interspecific hybrid with one of its parent species. One reason of such hybridization is because the present day hatcheries are virtually closed to exchange of stocks. Our natural rivers, as it lost its natural qualities with reference to breeding, spawning ground and providing suitable habitat, is no more acts as a source, if so that is meagre, to supplement seed or brood source. Again, considering the declining source, efforts were initiated; both at govt and institutional level, to supplement our natural stock through ranching by releasing the hatchery raised seeds, fry, fingerlings and advanced fingerling to natural system i.e., river. This creates another pathway of introgression of gene from hatchery raised fishes to nature. It is already known that the hatcheries are virtually closed to exchange program as there is dire scarcity of broods in their vicinity, particularly during breeding activities. This has developed as, along with seed production. very little has been done for the development and genetical improvement of brood stock except some *in vitro* development like Jayanti Rohu. Hardly the fish breeders or hatchery owners of all the states are aware of such improvement or development.

This forced the untrained fish breeders (mostly illiterate) to adopt breeding program within the limited stock that are maintained in the hatcheries over the years. . The seeds, raised out of such faulty breeding practices, are affected with all sorts of genetic consequences out of introgressive hybridization. These seeds when find their way into natural system through ranching, floods and other means are bound to interact with the genetic make-up of natural stock. To take a note, it is obvious that 50 years of said unscientific practices, since the implementation of induced breeding technology on field, in almost all the leading seed producing states of India (West Bengal, Assam and Bihar), considered for study, has done irreparable damage to the Aquaculture sectors. Some examples

of indiscriminate hybridization and their consequences are mentioned below (Fig. 8 & 9).

Figure 5. Hybrid produced out of inter generic cross between Rohu female and Catla male

Figure 6. Hybrid produce out of cross between Catla female and Mirror carp male, hybrid became naked

Figure 7. Hybrid produced out of cross between *Labeo rohita* female and mirror carp male, scales developed at pocket

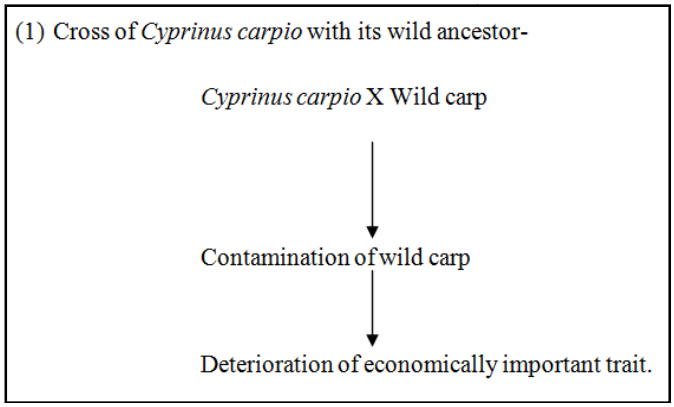

Fig. 8. Deterioration of economically important trait of Cyprinus through hybridization

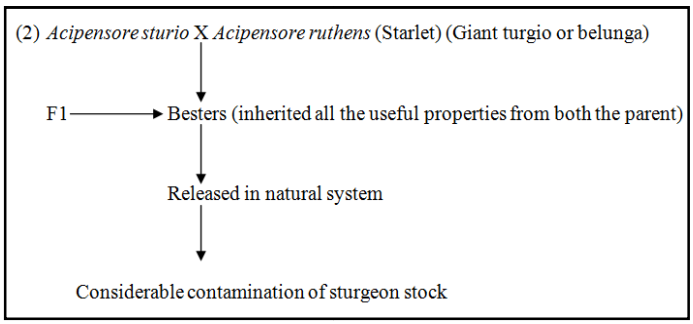

Fig. 9. Contamination of sturgeon stock through hybridization of two different st5ock

The above diagram clearly depicts that hybridization program, if not carefully designed; it causes damage either in the form diminishing the economically important trait or contamination in the gene pool.

Inbreeding and genetic drift

Another genetic consequence, the outcome of several faulty, unscientific and profit making approach is inbreeding and genetic drift. It is well known now that little has been done for the development of brood stock, as well as its steady supply and management practices. The fish breeders/hatchery owners in most case use the same brood stock for undertaking breeding program in the succeeding generations. Again the fish breeders maintained some of the fry/fingerlings in the same farm, to be used as brooders after 2-3 years- an indication of virtual closeness of hatchery to exchange with wild or other sources. Breeding is undertaking among already inbred population which allows all sorts of kinship breeding including brother-sister and parent offspring. The obvious genetic consequence is inbreeding which further aggravates various abnormalities in the generations. This includes increased fry deformity (37.6%), decreased food conversion efficiency (15.6%) and fry survival (19%). If a single cycle of full – sibs mating contribute 10-20% depression, then it is not difficult to gauge of the magnitude of depression that has occurred out of several cycles of such mating among close relatives throughout the years of practice. In breeding lead to homozygosity and inbreeding depression. If in breeding continues for several generation, a heterozygotic population will soon be converted into a totally homozygous population by losing all its variability. On the contrary in breeding depression is the reduced biological fitness of a given population subjected to inbreed for several generations. In other way we may say in breeding depression is the result of population bottle neck. A population or genetic bottleneck is a sharp reduction in the size of the population due to environmental phenomena. For example northern elephant seals lost their genetic variability because of population bottleneck, human inflicted on them in 1890. Hunting reduced their population to 20 in 1980. Now their population rebounded again to over 30,000, but their genes still carry the bottleneck effects, indicating that the present day population is less variant than that of the original population of Southern elephant seals.

Likely the brood fishes that are maintained in the present day hatcheries of India are considerably composed of small number of founder population Due to their long confinement, the broods are subjected to bottleneck effect out of genetic drift, when some of the alleles are lost from the founder population. These two effects are complementary and cumulatively led to

the loss of variability in the founder population. Once the variability is lost the same couldn't be rebuilt or restored so, in course of time, a new variant will develop as hatchery stock. The outcome is that the unique and prized fishes of India such as Catla, Rohu & Mrigal may appear in new variant form quite different from the original founder form. This thing needs serious attention. On January 29 – 30th, 2014 European Commission Project DIVERSIFY (FP7 – KBBE – 2013, GA 60312) had its kick off meeting at the Hellenic Centre for Marine Research in Iraklion Centre, Greece. The fish species considered for study included Meagre (*Argyrosmus regius*), greater amberjack, grey mullet, wreckfish, Atlantic halibut and Pike pearch. A survey on the meagre producers revealed the story acquisition of brood stock from limited resources, resulting in a limited genetic variation of the available brood stock. These are supposed to create negative implications for the future breeding program, which are necessary to move the industry to the next level of efficiency and production. It is understood that socio – economic factors play a key role in developing bottleneck in hatchery raised fishes and it is felt that there is need for more expanded market and diversification of provided products beyond the whole fresh fish. As we know the genetic contribution of an individual to the next generations gene pool, relative to the average for the population, usually measured by the numbers of offspring or close kin that survive to reproductive age known as Darwinian fitness. It refers to the capacity of a variant type to involve and displace the resident population in competition for available resources is now relevant to present day hatcheries of India.

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