## Selecting the Broodfish for Spawning

The morphological features described above can be taken as indicators of ripeness. However, a more reliable method of determining whether or not the female fish is ready for spawning is to collect an egg sample from the posterior end of the ovary by means of a catheter. A catheter is a glass tube of 2 mm diameter with a short flexible tubing attached to one end to permit easy movement. The catheter is inserted into the genital aperture and probed to reach the posterior extremity of the ovary. An egg sample is then withdrawn into the glass tube and transferred to a glass bowl into which a solution of 70% acetic acid and 30% alcohol is immediately poured, immersing the ovarian ova sample. Within about 5 minutes, yolk becomes discernible and so also the nuclei of individual ova. A centric or peripheral location of nuclei is a sure indication of readiness of the fish for spawning (Jhingran, 1985). In gametogenesis, the nucleus of the ovum migrates to the periphery before release of the first polar body in meiosis. Should, however, the ova nuclei be found to be centrally located, then such a fish will not respond to hormonal manipulation.

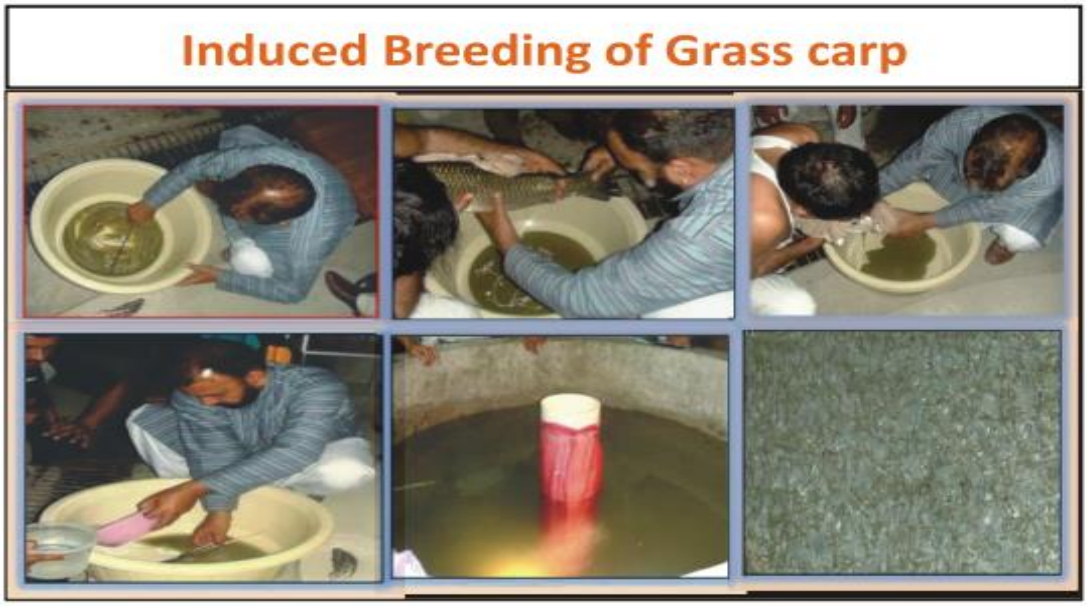
## Induced Spawning of Chinese and Indian Major Carps

The most commonly adopted technique of induced breeding of carps is hypophysation which involves injecting mature female and male carps with extracts of pituitary gland taken from other mature fish generally phylogenetically close to carps (Bhatti *et al.*, 1992; Mirza *et al.*, 1992). The pituitary gland (hypophysis) is an endocrine gland located on the ventral side of the brain of the fish. In order to

prepare fresh extract of pituitary, the gland is removed by exposing the dorsal side of the head of the fish. If the gland is not to be used immediately for preparation of an extract for fish breeding, it may be preserved. Recently the use of Carp Pituitary Homogenate has been replaced with Ovaprim-C which contains LHRH-a and domperidone, a dopamine inhibitor. The use of Ovaprim-C has revolutionized the process of induced spawning of Chinese and major carps. It can be used in a single dose of 0.5 ml/ kg in the case of female fish and 0.1 ml/Kg for male fish (Naik and Mirza, 1992).

**Injecting the Brooders**

For the induced spawning of carps, mature male and female brooders are selected based on external secondary sexual characters. The selected fish are transported to an indoor hatchery facility and kept in holding tanks for at least 12 hours for conditioning. This not only helps the broodfish to become acclimated to the indoor environmental conditions but also helps to defecate the gut contents of the fish and get rid of fecal matter that may contaminate the eggs. After the conditioning, the female brooders to be injected are reexamined for their maturity level and transferred to the circular breeding tanks.




Females are injected intramuscularly with Ovaprim in a single dose of 0.5 – 0.70 ml/Kg body weight, while males are given 0.1– 0.20 ml/Kg of body weight. The males are released with the injected females. The injection dosages vary with stage of fish maturity and water temperature, a relatively lower stage of maturity and cooler water require higher dosages.

Intramuscular injections are generally given at the base of the dorsal fin and /or above the lateral line on the caudal fin, at the base of pectoral fin or between the anal fin and lateral line. A fish scale should be lifted for inserting the injection needle, and the area should be gently massaged following the withdrawal of the needle after injection to aid distribution of the solvent into musculature and prevent its backflow.


In fish farms and hatcheries where artificially controlled environmental conditions are not available, induced spawning work should be done on cloudy or rainy days. The injection is generally given late in the evening. Such timings generally suit the convenience of workers and the diurnal temperatures are also the lowest when spawning condition of the injected fish is expected (early in the morning). These considerations of timing and weather are of vital importance, especially where breeding and hatching tanks are located in the open, as otherwise the mid-morning sun could cause the water of concrete breeding and hatching tanks to heat up and destroy the ovulated eggs totally. Injected broodfish of Chinese and Indian major carps are released in breeding tanks in appropriately paired sets. Generally, a spawning is made up of one female fish with two males of equal weight. Spawning and fertilization generally take place naturally within 8-12 hours after injection depending upon prevailing water temperature.

## Dry stripping

A soft belly of the female at any part of the abdomen, and a state of shifting softness towards posterior indicates readiness of female for stripping. In this condition slight pressure on abdomen expresses out loosened eggs from the genital aperture. For stripping, the female fish is held by the operator between the side of his body and his arm with the fish slanting head up, tail down and belly facing the vessel and the eggs are collected into a plastic trough by pressing the body of the fish. The process is repeated with males as milt is squeezed out into the same basin as the eggs. Two persons can conveniently manage stripping, with one holding the fish firmly and the other pressing the belly for release of eggs with simultaneous spraying of milt on egg mass. At least three persons are required for simultaneous release of eggs and milt. Eggs are then mixed with milt on them with a clean bird feather to allow fertilization to take place. The fertilized eggs are then washed a few times with clean water to remove excess milt and allowed to stay undisturbed in fresh water for about 30 minutes. The eggs are then hardened and are ready for release in the hatching tanks.

## Hatching and Care of Hatchlings

Naturally spawned and fertilized eggs of carps, if allowed to hatch in stagnant ponds are often exposed to heavy predation and infestation by pathogens and/or to sub-optimal environmental conditions which considerably reduces percent hatching. For this reason, fertilized eggs are generally collected after water-hardening and then transferred to special incubating circular tanks for hatching. Hatching and the care of hatchlings and larval rearing, in fact, constitute the most important aspects of hatchery management and draw a line between success and failure of the operations. The circular hatching tanks are supplied with oxygenated water of the

right temperature and a flow rate of 12-18 liters/minute is maintained in the flow-through system.

After the eggs are hatched, the hatchlings are kept in the tanks for about three days, during which period they need no exogenous food since they subsist on their own yolk sacs. It normally takes slightly more than three days for the yolk sac to be absorbed. After yolk sac absorption their mouths develop and they are ready to take exogenous food.

**Fry Rearing In Nursery Tanks**

Preparation and maintenance of nursery, rearing and stock ponds are important steps in carp hatchery operations. Carp post larvae and fry are delicate and if transferred to poor food and high predator ponds will lead to virtual decimation of the stock. The purpose of nursery, rearing and stock pond preparation before stocking and maintenance after stocking is not only to remove the causes of poor survival, growth and health of the stocked material but also to optimize good husbandry factors for rearing the young of the species concerned.

Larval rearing in a carp hatchery is carried out in two phases. The first phase is the rearing of post larvae to fry stage which is carried out in nursery ponds and the second stage is the rearing of fry to the fingerling stage which is carried out in rearing ponds. In exceptional cases, these steps are combined in one pond. However, instead of rearing post larvae to fingerlings in the same pond continuously over three to four months, it is a better practice to break it up into two operations in two different types of water bodies, nursery and rearing ponds, as stated above. This is because there are differences between the post larvae and fry in their food, stocking rates and environmental requirements as well as it will discourage accumulation of predators and obnoxious organic matter at the bottom.

The next step comprises adoption of the measures in the sequence stated and at timings specified in the following account of nursery pond management. These measures fall into three categories:

1. Steps to be taken before stocking post larvae in the nursery ponds;

2. Procedures to be adopted during stocking;

3. Steps to be taken after stocking until the production of fry and their harvesting either for sale or for further rearing into fingerlings in rearing ponds.

**Pre-Stocking Practices**

For preparing the nursery ponds for post larvae in nursery tanks, they should be dried and ploughed to get rid of excess organic matter present in the pond bottom. If the nursery pond cannot be dried, then some suitable pesticide should be used to kill the existing fish stock and other harmful organisms present in the ponds. This is especially true to reduce the risk of predation and cannibalism. For thorough disinfection of a pond, a dose of 1,000 kg/ha of quicklime is required, but if liming has been regularly done annually in the past, 100-200 kg/ha are enough unless the pond soil is very acidic or very poor in carbonates. Quicklime alone can be used in place of a toxicant to kill wild fish, insects and tadpoles and additionally bestowing on the pond the other benefits of liming. For this purpose, a dose of 900 to 1,050 kg/ha of quicklime is necessary if there is little water in the pond. If the pond is full of water up to the brim, the dose of quicklime should be increased to 1,575 to 2,250 kg/ha.

Successive treatments with quicklime and suitable pesticide give most effective results in killing unwanted pond biota, including predatory and weed fish as well as in giving the benefits of liming.

The advantages of liming a pond are numerous. In general, liming enhances pond productivity and improves its sanitation. It is both prophylactic and therapeutic. Specific advantages are that it kills bacteria, fish parasites and their intermediate life-history stages; hence, especially efficacious in a pond where there has been outbreak of an infectious disease. Secondly it builds up alkaline reserve and effectively stops fluctuations of pH by its buffering action which renders acidic waters usable for aquaculture by raising their pH to alkaline levels; and promoting mineralization. The commonly available and used forms of lime are calcium carbonate (ground limestone), calcium hydroxide (slaked lime) and calcium oxide (quicklime). Calcium carbonate dissolves slowly and is of special value for pond fertilization and building up alkaline reserve also leading to calcium enrichment. Quicklime rapidly binds acids and influences pH rapidly, producing results similar to other forms of lime in half the quantity. Lime can be applied to the pond bottom, added to water at inlets or uniformly broadcast on the water surface depending on the form of lime used and the purpose of application. Calcium hydroxide and calcium oxide are best applied on the pond bottom after it has been drained.

Then ponds are fertilized with organic and inorganic fertilizers for sustained production of adequate quantities of zooplankton which form the natural food of carp hatchlings and fry. In the early days of carp culture, the production of any species of zooplankton, whether a cladoceran, a copepod, a rotifer or a protozoan, regardless of size, was considered adequate in nursery ponds. However, in recent times it has become clear that the post larvae of carps survive and grow best if they are fed on smaller planktonic forms like free-living protozoa and rotifers; and that fry and fingerlings, whose mouths are bigger than those of post larvae, grow best if fed on larger planktonic organisms like cladocerans and copepods. In fact, it has long been known that some species of copepods prey on carp larvae and post larvae.

For production of zooplankton, nursery ponds are treated either with organic manures (such as cattle, pig or chicken manure) alone and/or with inorganic fertilizers such as NPK mixtures. If both organic manures and inorganic fertilizers are used they may be applied either one, following the other or as a mixture. If animal manure is to be used alone, its dose should depend on the fish toxicant used for the eradication of unwanted fishes. The cattle manure should be applied at an initial dose of 10,000-15,000 kg/ha about a week before the anticipated date of stocking followed by further manuring at the rate of 5,000 kg/ha seven days after stocking. These manuring rates produce enough zooplankton for a single crop of post larvae stocked at 1.5 million/ha. If two or more crops of fry are required from the same nursery pond, then the pond should be fertilized with 2,000 kg/ha of cattle dung about a week before each subsequent stocking. If poultry manure is to be added instead of cattle manure, one-third the dose of the cattle waste is sufficient since it is at least three times richer in nitrogen, phosphorous, potassium and calcium than cattle manure.

If organic manures are not available, then commercial compost, as used for agriculture, may be applied as a substitute. The recommended dose for compost is 5,000 kg/ha two weeks before the anticipated date of stocking, followed by 5,000 kg/ha a week after stocking. If, however, compost is to be produced in the carp hatchery itself, then the procedure to adopt is to dig the requisite number of pits about 4 m x 3 m x 2.5 m deep at an isolated location and dump green vegetation in heaps about 30 cm high, alternating with 7.5 cm high layers of cattle manure, both dusted liberally with calcium superphosphate. A ratio of 10:1 carbon to nitrogen is required for rapid decomposition of vegetable matter in composting. For this purpose, 25 kg sodium nitrate (per 1,000 kg of compost) should be applied with 4,000 liters of water to provide the necessary humidity in the compost pits. The compost should be turned initially three weeks after dumping and thereafter after every five weeks

again. Compost may be expected to be ready in a total period of about 12 weeks after filling the pit at temperatures ranging from 18°C to 25$^0$C.

A mixture of organic and inorganic manures applied at the following rates has given good results: cattle manure at the rate of 20,000-25,000 kg/ha per year and inorganic fertilizer mix (ammonium sulphate + single superphosphate + calcium nitrate in the ratio 11:5:1) at the rate of 1,380-1,725 kg/ha per year applied in 4-10 equal installments is spread over the year.