

ICAR Technologies

Breeding and Seed Production of Finfishes and Shellfishes



Indian Council of Agricultural Research
New Delhi

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ICAR Technologies : Breeding and Seed Production of Finfishes and Shellfishes

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MESSAGE



Dr. Trilochan Mohapatra
Secretary, DARE & DG, ICAR

Achieving the second highest position in global fish production and sharing over 6% of the total fish food basket is a matter of great pride for the country. The country's fish production reached all time high of 11.41 million tonnes during 2016-17, with 15-folds increase since independence. The marked shift from capture from open-waters to controlled farming in ponds/tanks in particular, with the later showing transformation to an organised industry, has virtually placed the sector in the forefront of agricultural growth. With aquaculture production sharing about 60% of the total fish produce at present, the sector is further expected to grow at similar pace in coming years too with large-scale utilization of coastal waters for mariculture and inland saline areas for brackishwater shrimp farming. The country's aquaculture production today is largely confined to the three Indian major carps, followed by three exotic carp species and pangas—an exotic large catfish in freshwater and shrimps in brackishwater, together contributing over 95% of aquaculture share. Further, considering the increasing demand of alternative species for making the farming practice more remunerative, the farming in coming days is likely to include diversified fish species spectrum in all sectors.

It is evident from the catch data of the country that the production of several high valued food fishes from open waters have been declining severely, making such species out of reach of the common men. On the contrary, the price of carps by virtue of greater availability is almost constant for last several years. With the production cost becoming dearer, both farming of carps and pangus has become non-attractive for many. Therefore, it is necessary that our focus must be oriented towards new fish and shellfish species which can provide higher income to the farmers and also greater choice for the consumers.

Considering all the above facts, I sincerely believe that the book entitled "*ICAR Technologies for Breeding and Seed Production of Finfishes and Shellfishes*" containing technology resumes of over 60 finfish and shellfish species, would definitely help the farmers and entrepreneurs in identifying and adopting new species to their present aquaculture practices. I, on my own behalf and the Council, compliment the contributors, and the directors of the fisheries research institutes of ICAR for their efforts in bringing out this important publication at a time when Hon'ble Prime Minister of India has called for Blue revolution in the Country and also Doubling Farmers' Income by 2022.



(T. Mohapatra)

4th July, 2019

PREFACE

The pride of India as the second largest aquaculture producer may be linked to the development of the technology of induced breeding of Indian major carps in 1957 at the then Pond Culture Division of the Central Inland Fisheries Research Institute at Cuttack, Odisha. The technology of controlled breeding of carps with assured supply of quality seed of desired species, leading to complete shift from riverine seed collection, virtually steered the commercial carp polyculture of India and brought the country to the brink of the phenomenon 'Blue Revolution'. The technology of this captive breeding was extended to widen the species spectrum with inclusion of several other important indigenous carps, catfishes and several other species of commercial value, and a few exotic species, and also improved further with use of different inducing agents like pituitary gland extract and several synthetic hormones for large-scale adoption by the farmers. In subsequent years, the technologies were improvised for mass-scale seed production with the successful development of eco-hatcheries. Today the country has been able to meet almost cent percent demand of carp seed and several states are even producing much higher seed than that required by those states.

Of late, the brackishwater aquaculture also took a leap with shrimp as the lone commodity. Initially with the mass production of tiger shrimp seed in hatcheries, which dominated for almost over two decades (1985-2005), the industrial-scale shrimp farming in our coastal states could be a reality. Good numbers of hatcheries with low to very high capacities were established in the private sector in coastal India mainly in Andhra Pradesh and Tamil Nadu. The industry further got a fillip with the introduction of Pacific white shrimp, with the seed requirement met from the same hatcheries. Success in development of breeding and seed production technologies of several important brackishwater and marine finfishes in recent years has further widened the scope of system diversification in both pond-based coastal aquaculture and open-sea cage farming in the country.

Although, aquaculture in India has been able to demonstrate consistent annual growth rate of over 6% during last three decades, the country has remained largely carp centric in fish production with over 80% contribution. While aquaculture in some of the top producing country involve more than 60 fish species, the commercial aqua-farming in the countries has been by and large confined to about a dozen of species. The need for species diversification has become quite inevitable not only for meeting the regional preference and increasing profitability of the farmers, but also for tackling the issues of increasing disease threat on farming of particular species, facilitating the conservation measures of several threatened endemic species, meeting emerging demand for species with short-production cycle, increasing species spectrum in polyculture systems, and bringing high value species under diversified farming systems.

The increased emphasis on species diversification during these years has directed for development of breeding and seed production technologies for several finfish species and also important crustacean species. In this endeavor, the research institutes of the Indian Council of Agricultural Research (ICAR) during last six decades have developed breeding and seed production technologies of more than 60 species of freshwater, brackishwater and marine ecosystems in order to meet the demand for both farmers and the market. The species include high valued species having system-specific and region-specific demand, short production cycles and many of them are uncommon/unknown to the aquaculture industry in the country as next generation fishes for farming. The documentation of these technologies in the present book entitled "ICAR Technologies for Breeding and Seed Production of Finfishes and Shellfishes" is an effort to popularize species diversification in fish farming and providing avenues for increasing income of the fish farmers in the wake of Hon'ble Prime Ministers call for Doubling Farmers' Income by 2022. These technology briefs have been compiled from the available information in the form of research papers and other scientific reports published in different ICAR Fisheries Research Institutes. It may be pertinent to mention that the contributors indicated against different species may not be the inventors of the technologies, but have been involved with the demonstration of the technology.

We are thankful to Dr. Trilochan Mohapatra, Secretary, DARE and Director General, ICAR for suggesting such a document and also for consistent encouragement in bringing out this publication. We are also thankful to all the contributors in sharing briefs of the technologies and the Directors of Fisheries

Research Institutes of ICAR viz., CMFRI, CIFA, CIBA, DCFR and NBFGR for their support in the preparation of this document. We also thank the Project Director and the staff of DKMA for publication of this document.

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Catla

Catla catla (Hamilton, 1822)

- ◆ Catla, the fastest growing Indian major carp (grows to 1.0-1.5 kg/yr), constitutes an integral component of carp polyculture system in the country.
- ◆ Matures in the second year of its life and breeds only in flowing rivers and streams during monsoon (May to September).
- ◆ Two to three-year class brooders are raised in the earthen pond(s) at a biomass of 1,500-2,000 kg/ha along with other Indian major carps.
- ◆ Brooders are induced by injecting either pituitary extract or commercial hormones, viz. Ovaprim, Ovotide, Gonopro FH etc. In case of pituitary extract, the females are given two doses of injection of 2-3 mg/kg and 4-6 mg/kg at an interval of 6-8 h, whereas males are given single dose of 2-3 mg/kg. However, with commercial hormone, single dose of 0.4-0.5 ml/kg to female and 0.2-0.3 ml/kg to male, is given.
- ◆ In the present practice of induced breeding in circular echo-hatchery, the ratio of female to male is maintained at 1:1.
- ◆ The injected broods are released in breeding pool. Spawning occurs after 6-8 h of injection. In general, 1.0-1.5 lakh eggs/kg female are obtained and fertilization levels remain over 90%.
- ◆ Eggs are shifted to a hatching tank, where they are kept in floating condition with appropriate water circulation. Hatching occurs within 18-22 h at 27-28°C with 80-95% success.
- ◆ The hatchlings are kept in the same hatching tank for another two days without feeding, as their yolk-sac remains up to 72 h. These free-swimming hatchlings, commonly known as spawn, grow to a size of about 5-6 mm when they are shifted to the nursery.
- ◆ The spawn are reared in earthen nursery ponds and concrete tanks at stocking densities of 3-5 million/ha and 8-10 million/ha for 15-20 days during which they grow to an average fry size of 25 mm with survival rates of 30-35% and 50-60%, respectively.



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Rohu

Labeo rohita (Hamilton, 1822)

- ◆ Rohu is the most important Indian major carp of the Indian Sub-continent.
- ◆ Attains maturity in the second year of its life and breeds only in riverine conditions during monsoon. For captive breeding, brooders of 2+ year-class are raised in earthen ponds at biomass of 1,500-2,000 kg/ha.
- ◆ Sexes are distinct during spawning season with females having bulged abdomen and soft pectoral fins. Male has slender body, rough pectoral fins and oozes milky-white milt from vent on pressing the belly.
- ◆ Captive spawning is undertaken either in hapa or hatchery. In hapa breeding, a sex ratio of 1:2 female to male is maintained. However, in circular hatchery the ratio of female to male is maintained at 1:1.
- ◆ Brooders are injected with either pituitary extract or commercial hormones. With use of pituitary extract, two doses of injection are given to females and one to males. However, a single dose of 0.4-0.5 ml/kg to female and 0.2-0.3 ml/kg to male, is given when commercial hormone is used.
- ◆ Spawning occurs after 6-8 h. One kg female lay about 2.0 lakh eggs, which are round, transparent and semi-buoyant. Rate of fertilization is 80-95%.
- ◆ Eggs are kept for hatching either in hatching hapa or spawning tanks of hatchery, which takes about 8-22 h for hatching at 27-28°C.
- ◆ The hatchlings are kept in the hatching tank for another two days. The 3-days old spawn of 5-6 mm in size becomes ready for further rearing in nursery.
- ◆ The spawn is reared in earthen nursery ponds at stocking densities of 5-10 million/ha in concrete nurseries even at higher density of 10-20 million/ha.
- ◆ The technology of breeding and seed production is widely practiced in all Indian states.



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Kalbasu

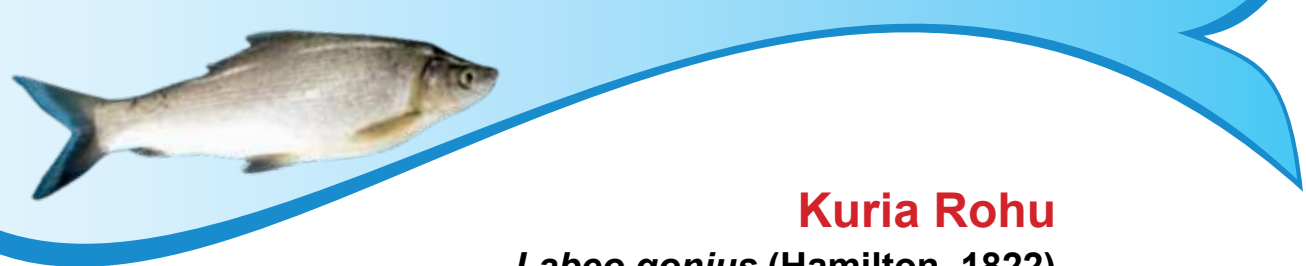
Labeo calbasu (Hamilton, 1822)

- ◆ An important carp species of high consumer preference, with moderate growth rate, is farmed along with Indian major carps in polyculture system at a very low proportion of about 5%.
- ◆ The fish matures in two years in pond condition. Breeding season generally extends from May to July. Brooders are raised in the ponds along with other major carps.
- ◆ For induced breeding, selected brooders are kept in spawning tank of the hatchery in the ratio of 1:2 female to male. Breeding is carried out by single injection of hormonal formulations such as Ovaprim/Ovatide/Gonopro FH at 0.4-0.5 ml/kg and 0.2-0.3 ml/kg body weight to females and males, respectively.
- ◆ Spawning occurs within 6-8 h. Fecundity ranges 1.5-2.0 lakh eggs/kg female weight. Eggs are transparent, demersal and having diameter of 3.0-3.5 mm.
- ◆ The hydrated eggs are shifted to hatching tanks, where they are kept in floating condition with mild water circulation. Hatching occurs within 15-18 h. The hatchlings are kept for another two days in a similar condition with water circulation.
- ◆ The yolk-sacs of these hatchlings which provide required nutrition during these three days of incubation are absorbed within 72 h and spawn becomes ready for feeding, during which they are transferred to the nursery.
- ◆ Spawn is reared to average fry size of about 20 mm in 15-20 days rearing at stocking densities of 5 million/ha and 10 million/ha with survival rates of 30 and 50%, respectively, in earthen nursery ponds and concrete tanks.
- ◆ It is the state fish of Haryana and the seed production is practiced in several states.



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Kuria Rohu

Labeo gonius (Hamilton, 1822)

- ◆ Kuria rohu, a minor carp, is a highly preferred fish in the north-eastern states of India. The species forms a small component in carp polyculture system in certain parts of eastern and north-eastern states.
- ◆ Matures in two years, and breeds during May-August in flowing rivers. The brooders are reared along with Indian major carps in earthen ponds.
- ◆ Sexes are easily distinguishable on attaining maturity, with females having bulged abdomen and smooth pectoral fins, whereas males are slender, having rough pectoral fins and oozes milt on pressing the belly.
- ◆ The fish is induced bred either with pituitary extract or hormonal formulations such as Ovaprim, Ovatide, Gonopro FH etc. Single injection of any of these commercial hormones @ 0.4 ml/kg and 0.2 ml/kg body weight to the female and male fish, respectively, is found to be highly successful.
- ◆ The selected brooders at the ratio of 1:1 female and male, after injection, are transferred to the spawning tank where spawning occurs within 10-11 h. In general, 1.0-1.5 lakh eggs/kg female, are produced.
- ◆ The swelled eggs are transferred to the hatching tanks, where they hatch within 18-20 h. The spawn stage is attained in 50-55 h with 70-80% survival.
- ◆ The spawn is reared in concrete tanks at the density of 10-15 million/ha for 25-30 days to obtain fry of 20-25 mm with 30-40% survival. Rearing in earthen nurseries can be carried out as in case of major carps at lower density of 5 million/ha.
- ◆ The seed production is practiced especially in Assam, West Bengal and Odisha.



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Fringed-Lipped Carp

Labeo fimbriatus (Bloch, 1975)

- ◆ Fringed-lipped carp, an important minor carp, is suitable for polyculture along with Indian major carps. In India, it is restricted to Peninsular India.
- ◆ Attains maturity in pond condition in two years, but do not breed in captivity. It breeds in flowing waters as other major carps.
- ◆ The males and females are distinguishable at maturity as in other carp species, with smooth pectoral fins and bulged abdomen in females, and slender body and rough pectoral fins in males.
- ◆ For captive breeding, brooders are raised in ponds along with other carp species. Fully mature brooders are selected and paired in a ratio of 1:2 female to male. Number of pairs used at a time depends on the size of spawning tank.
- ◆ Both the females and males are injected with a single injection of commercial hormone (Ovaprim/Ovatide/Gonopro FH) @ 0.30 ml/kg and 0.15 ml/kg, respectively, and are released in spawning pool at a sex ratio of 1:1 for breeding.
- ◆ Spawning occurs after 6-8 h of injection. The hydrated eggs collected in egg collection chamber, are subsequently transferred to the hatching pool.
- ◆ The hatching pools are provisioned with mild water circulation to keep the eggs in buoyant condition. Hatching takes about 14-16 h, and hatchlings reach to spawn size in 50-55 h. Spawn yield usually varies from 0.85-1.00 lakh/kg female.
- ◆ Spawn is reared at stocking density of 10-15 million/ha for raising fry in concrete nursery system for 20-25 days with 40-50% survival. In earthen nurseries, the stocking is done at lower density of 5 million/ha.
- ◆ The breeding and seed production of the species is practiced mainly in Karnataka, Odisha and Andhra Pradesh.



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Pangusia Labeo

***Labeo pangusia* (Hamilton, 1822)**

- ◆ Pangusia is widely distributed in the Indian sub-continent particularly in the Himalayan streams and deeper pools, and considered an important food fish for polyculture with Indian major carps.
- ◆ Sexes are separate and distinguishable at maturity with females having bulging abdomen, soft and smooth pectoral fins and round prominent vent. In contrast, males are slender with large and rough pectoral fins, and ooze white milt on pressing belly.
- ◆ Breeds in flowing waters during monsoon, May-August. Attains maturity in the second year of its life, when 25-30 cm in total length.
- ◆ Broodstock is raised in pond along with other carps in captive conditions for breeding. Brooders of size 35-50 cm are selected for induced breeding in a sex-ratio of 1:2 female to male.
- ◆ Brooders are given hormone injection of Ovotide/Gonopro FH @ 1.0 ml/kg body weight to female and 0.5 ml/kg to male and kept in breeding tank/hapa for spawning.
- ◆ Spawning occurs 6-8 h after the injection and lays 7.5-8.0 lakh eggs/kg body weight with average fertilization of 70%.
- ◆ The eggs are transferred to the hatching pool and are kept under mild water circulation for hatching, which takes about 14-16 h. The hatchlings are further kept in similar condition in hatching tank for further two more days before transferring for nursery rearing.
- ◆ The spawn is reared further in cement tanks for raising fry.
- ◆ The seed production technology was developed in Uttarakhand for hill states.



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Malabar Labeo

Labeo dussumieri (Valenciennes, 1842)

- ◆ Malabar Labeo, a popular endemic carp species of Western Ghats, is distributed up to north Canara in India and also probably in Sri Lanka. Categorized as endangered fish.
- ◆ Mature females have bulged abdomen and eggs ooze out from vent on pressing the abdomen. Mature males have a rough surface of pectoral fins and ooze milky-milt on pressing the belly.
- ◆ Induced bred in captive conditions during monsoon. Fully mature brooders in sex ratio of 1:2 female to male is kept in the spawning tank of circular carp hatchery for breeding.
- ◆ Females are induced bred with pituitary extract of two doses @ 2-3 and 4-6 mg/kg body weight or a single dose of commercial hormone @ 0.3 ml/kg, whereas single injection of 2-3 mg of pituitary extract/kg or 0.2 ml commercial hormone/kg body weight is given to males.
- ◆ Spawning occurs in 9-10 h. Fertilized eggs are spherical, translucent, demersal and non-adhesive with diameter 4.0 to 4.5 mm.
- ◆ The fertilized eggs hatch within 10-12 h with hatching rates of 80-95% in the hatching tank and grow to spawn size within 2-days.
- ◆ The spawn is further reared in tanks to raise to fry.
- ◆ The seed production is practiced mainly in the state of Kerala.



Compiled by: Dr K.K. Lal and Dr V.S. Basheer

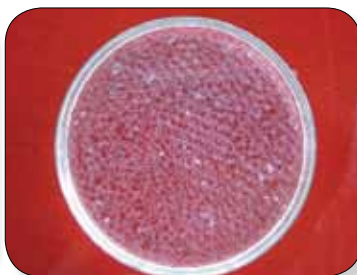
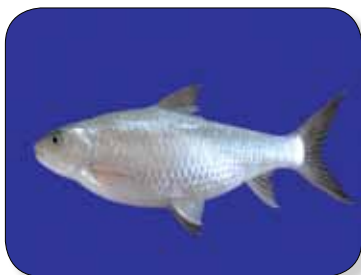
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Bata

Labeo bata (Hamilton, 1822)

- ◆ Bata is acclaimed as a very important and tasty minor carp, particularly in eastern and north-eastern parts of the country. Distributed in India, Bangladesh and Pakistan.
- ◆ Suitable for inclusion in carp polyculture system, the species is now considered important for diversification.
- ◆ Brooders are raised in ponds along with other carps, where they mature within a year. Sexes are separate and well distinguished with female having bulging abdomen and male with oozing milt.
- ◆ Brooders of size 400-500 g are used for breeding in small circular carp hatchery. Several pairs (1 female : 2 males) depending on the size of spawning tank are placed in the tank after giving hormonal injection of Ovaprim/Ovatide/Gonopore FH @ 0.5 ml/kg to female and 0.2 ml/kg to male.
- ◆ Spawning occurs after 6-8 h. Female lays 2.0-2.5 lakh/kg body weight. Eggs are non-adhesive, semi-buoyant and white.
- ◆ The eggs are transferred to circular hatching tank as in case of other carp species. Hatching occurs within 20-22 h with 80-90% hatching rate, and grow to spawn size in around 72 h.
- ◆ Spawn is reared in outdoor nursery ponds/tanks for rearing to fry with formulated powdered feed for about 25-30 days to get fry stage.
- ◆ The seed production is widely practiced in West Bengal, Odisha, Assam, Manipur and Uttar Pradesh.



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Kali Rohu

Labeo dyocheilus (McClelland)

- ◆ Kali Rohu is widely distributed in colder regions of Indian sub-continent and parts of south-east Asia. This minor carp species is having potential for aquaculture in low to moderate coldwater areas.
- ◆ Grows to more than a foot size and suitable for addition in carp polyculture system, particularly in ponds having good periphyton growth.
- ◆ Sexes are separate and distinguishable; females having bulgy abdomen and red vent and males slender having prominent nuptial tubercles on snout, rough pectoral fins and ooze milky-milt on pressing belly.
- ◆ Breeds only in flowing waters during monsoon. Though matures in the first year but for captive breeding, fully mature brooders of age 3+ years (650-700 g) from ponds are used.
- ◆ Pairs of fully mature females and males are made in the ratio of 1:2 and injected with available commercial hormone (Ovatide/Gonopro FH) @ 0.6 ml/kg body weight to females and 0.3 ml/kg body weight to males. After injection, they are kept in spawning tanks of the circular hatchery for spawning.
- ◆ Spawning occurs after 8-10 h with laying of transparent, non-adhesive and semi-buoyant round eggs. The hydrated eggs measure diameter of 2.6-3.4 mm. Higher fertilization levels of 80-95% is generally obtained. Female lays 1.8 to 2.0 lakh eggs/kg body weight.
- ◆ Eggs are incubated in spawning tanks of circular carp hatchery at 18-22°C water temperature with 65-80% spawn recovery.
- ◆ Spawn is reared in outdoor concrete tanks for raising fry at density of 10 million/ha.
- ◆ The seed production is practiced mainly in Uttarakhand and Uttar Pradesh for conservation.



Compiled by: Dr N.N. Pandey and Dr D. Sarma

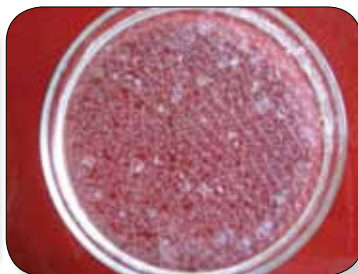
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Mrigal

Cirrhinus mrigala (Hamilton, 1822)

- ◆ Mrigal is considered as one of the three Indian major carps and forms an important component of carp polyculture system.
- ◆ It does not breed in confined water. In nature, it breeds in fluviatile riverine conditions during monsoon.
- ◆ For captive breeding, the brooders are grown along with other Indian major carps in ponds at biomass of 1,500-2,000 kg/ha. It attains maturity in the second year.
- ◆ Successful induced breeding is undertaken during May-August, coinciding with monsoon, when the fishes become fully matured. Sexes are separate and distinguishable at maturity with females having bulged abdomen, soft and smooth pectoral fins; whereas males are slender, having stout and rough pectoral fins and milt oozes on pressing the belly.
- ◆ Brooders are selected and paired in sex ratio of 1:2 female to male in hapa and 1:1 in hatchery systems. They are induced bred with either pituitary extract (PE) or commercial hormone (CH) such as Ovaprim/Ovatide/Gonopro FH.
- ◆ While single injection of CH @ 0.3-0.4 ml and 0.15-0.20 ml/kg body weight to female and male, respectively, are quite effective, the PE requires two doses @ 2-3 and 6-8 mg/kg and @ 2-3 mg/kg body weight at 6 h interval for female, and @ 2-3 mg/kg for male at the time of second injection to female.
- ◆ Spawning occurs after 6-8 h, and hatching takes another 14-16 h. Fertilization is generally 75-90%. Hatchlings take another 55-60 h to attain spawn size with 80-90% survival.
- ◆ Spawn is reared @ 500-1,000/m² in well-prepared earthen ponds for 15-20 days to get fry of 20-25 mm size with 30-50% survival or @ 1,000-2,000/m² in cement tanks achieving survival levels of 60-70%.
- ◆ The breeding and seed production technology is widely practiced in all the states.



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Reba Carp

Cirrhinus reba (Hamilton, 1822)

- ◆ Reba, a minor carp, is a popular food fish in many parts of the country. The species is widely distributed in Indian sub-continent, which grows to about 500 g in weight.
- ◆ Breeds in rivers during May to August. Captive breeding is undertaken by induced breeding in hapa/hatchery.
- ◆ Brooders are raised in earthen ponds along with other carp species, where they mature in a year. Sexes are separate and well distinguished. Males are identified by oozing milt and females by the bulging belly and reddish vent.
- ◆ Owing to its small size, the induced breeding of the fish is often undertaken in hapa, where 1-4 pairs of female and males (1:2 ratio) are kept for spawning. However, mass-scale breeding is taken up in hatchery, where males and females are kept at 1:1 ratio.
- ◆ Females and males are given injection of commercial formulation such as Ovaprim/Ovotide/ Gonopro FH @ 0.5 ml/kg and 0.3 ml/kg body weight, respectively.
- ◆ Spawning occurs after 6-8 h. A female lays 3-4 lakh eggs/kg body weight. The eggs are non-adhesive and semi-buoyant, which at hydration measure diameter of 2.4 mm.
- ◆ Eggs are shifted to hatching hapa/hatching tanks, where hatching occurs in 18-22 h. Spawn stage is achieved in 72 h, when they are transferred to the nursery.
- ◆ Spawn is reared in outdoor nursery ponds/concrete tanks for raising fry, where they grow to 25 mm in 25-30 days.
- ◆ The technology of seed production is largely adopted in West Bengal, Odisha, Assam and Uttar Pradesh.



Compiled by: Dr Sudhir Raizada

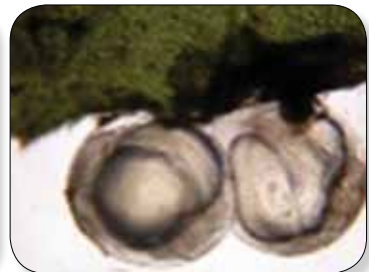
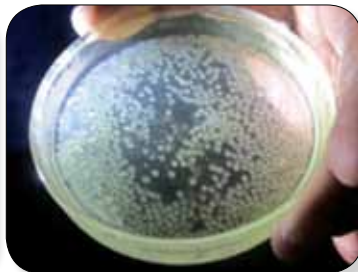
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Olive Barb

Systomus sarana sarana (Hamilton, 1822)

- ◆ Olive barb is distributed all along from Afghanistan to Indian sub-continent and Thailand. Popular cultivable barb in eastern and north-eastern parts of India and commands high market price.
- ◆ Maturity is attained in the first year. However, captive breeding is undertaken with 2⁺ year age class. Sexes are distinguished on maturity with females having bulged abdomen, and males are slender and exude white-milt on pressing the belly.
- ◆ For mass-scale seed production, several pairs of fully mature female and male in the ratio of 1:1 are selected and induced bred with single injection of commercial hormone, Ovaprim/Ovatide/Wova-FH @ 0.3 and 0.15 ml/kg to females and males, respectively.
- ◆ Injected brooders are shifted to a spawning tank of carp circular hatchery. Bunches of aquatic weed such as *Hydrilla verticillata* are kept in spawning tank to facilitate spawning and for attachment of eggs.
- ◆ Spawning occurs after 8-11 h of injection. The weed bunches with attached eggs are transferred to a hatching tank having provision for regular flow of water.
- ◆ Hatching occurs in 14-15 h. Yolk-sac is absorbed in 45-50 h, and free swimming spawn of 4-5 mm length is obtained with average recovery of 70,000-80,000 spawn/kg female body weight.
- ◆ Spawn is reared to fry size in concrete tanks with 1m water depth at stocking density of 1,000-1,500 spawn/m² and 500-1,000 spawn/m² in earthen ponds. Survival levels of 50-70% are obtained in concrete tanks in 1 month rearing period.
- ◆ The breeding and seed production technology is being expanded in the states of Odisha and West Bengal.



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Chaguni

Chagunius chagunio (Hamilton, 1822)

- ◆ Chaguni is distributed in the Ganga and Brahmaputra drainages of north and north-eastern India, Nepal and Bangladesh. It grows to about 50 cm and constitutes important fish of low to moderate cold climate areas.
- ◆ Sexes are separate and distinguishable at maturity. Males develop nuptial tubercles, densely covering snout and cheek, black fin tips, and ooze white milt on pressing belly.
- ◆ Breeds during April to June in flowing waters. Average size of 100 g fish spawn 1,500-2,500 eggs in batch in nest under the gravel layer, which is usually prepared by male.
- ◆ Captive maturation of broodstock is undertaken in cement tanks. Induced breeding is undertaken in small tanks/aquaria by simulating water current, arranging sand gravel bed, and regular filtration of water.
- ◆ Fertilized eggs are pale yellow with diameter of 1.8-2.2 mm.
- ◆ Eggs are hatched in floating incubation trays in a closed re-circulatory tank. Embryonic development takes 4-5 days at temperature of 20-22°C.
- ◆ Hatchlings are 9-11 mm in length. Yolk sac is absorbed within 2-3 days. Spawn readily accepts poultry egg-yolk suspension as first feed and grows to fry size with 70-80 survival in aquarium and FRP tanks fitted with re-circulatory system.
- ◆ It is bred in Uttarakhand for conservation of stocks.



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Kalaban

Bangana dero (Hamilton, 1822)

- ◆ Kalaban is widely distributed in Indian sub-continent and Afghanistan to Iran. In India it is found in hilly areas of Ganga and Indus river systems, but migrates to lower stretches of rivers during winter.
- ◆ It grows up to 75 cm in total length. Suitable for inclusion in carp polyculture system.
- ◆ Breeds during monsoon in flowing waters. Sexes are separate and distinguishable on maturity. Females are characterized by soft, enlarged and distended belly while males have prominent tubercles on the snout, pectoral fin rough and oozing of milky-milt on pressing the belly.
- ◆ Brooders are raised in ponds/tanks along with other carps for captive breeding. Fully matured brooders of age 3+ years having body weight 350-650 g are used for induced breeding. Breeding is undertaken during July-August.
- ◆ Hormone dose (Ovatide/Gonopro FH) of 0.6 ml/kg body weight to females and 0.3 ml/kg to males is given for induced breeding. A breeding pair comprises one female to two males.
- ◆ Spawning occurs within 8-10 h of injection and female lays 1.3-1.5 lakh eggs/kg body weight. Generally, fertilization remains at 80-90%.
- ◆ Eggs are incubated in portable carp hatchery at 18-22°C. Yolk-sac of the hatchlings is absorbed in 70-84 h, and spawn with average survival levels of 60-80% are obtained.
- ◆ Spawn is reared in outdoor concrete tanks at stocking density of 10 million/ha for 1 month for raising to fry size.
- ◆ The breeding and seed production technology is expanded to the states of Uttarakhand and Uttar Pradesh, especially for conservation purpose.



Compiled by: Dr N.N. Pandey and Dr D. Sarma

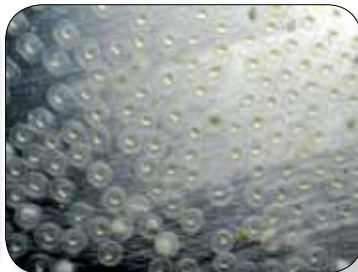
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Pengba

Osteobrama belangeri (Valenciennes, 1844)

- ◆ Pengba, a State Fish of Manipur, is popular food fish of North East India, and distributed in India, Myanmar and China. Potential species for culture in seasonal ponds and carp polyculture system.
- ◆ Attains maturity at 2+ years of age when male and female attain weight of 0.6-0.8 and 0.8-1.0 kg, respectively. Breeds in running waters during July-August.
- ◆ Brooders are raised in earthen ponds along with other carps at biomass of 1500-2000 kg/ha. Sexes are distinguishable with females having bulged abdomen and males with oozing milt on pressing the belly.
- ◆ Two-year class broodstocks are taken for breeding. Breeds easily with commercial hormone, Ovaprim/Ovatide. Matured males (250-600 g) and females (350-1000 g) are injected with single injection @ 0.30 ml/kg and 0.15 ml/kg, respectively, and are released in spawning pool in 1:1 sex ratio for breeding.
- ◆ Spawning occurs after 6-8 h of injection. Hatching takes another 14-16 h. Hatchlings reach spawn size in 50-55 h in tropical climate. Around 0.70-1.0 lakh spawn are obtained per kg female body weight.
- ◆ Spawn are stocked in nursery ponds/tanks at 500-1,000 nos/m³ and fed powdered carp diet for 15-20 days to get fry with 50-60% survival.
- ◆ The species is largely bred in Manipur, Odisha and West Bengal for food and conservation purposes.



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Golden Mahseer

Tor putitora (Hamilton, 1822)

- ◆ Golden Mahseer is an important species in upland fisheries of Himalayan sub-continent by virtue of its economic, ecological, recreational, heritage, cultural and food values. It has been declared an endangered fish.
- ◆ Multiple spawner, spawns in flowing waters during May to September with two peaks during May-June and August-September.
- ◆ Males mature at the age of 3⁺ years while females at 5⁺ years. Sexes are separate and distinct when fully mature, females having bulging belly and males with oozing milt condition.
- ◆ Captive breeding is undertaken with either fully mature brooders collected from wild or reared in captive conditions that require artificial interventions of temperature and photo period control. The fish does not require any hormonal injection.
- ◆ Eggs are fertilized by mixing of ova and milt through stripping of female and male brooders. Ova are lemon yellow/brownish-golden. Fully swollen eggs have a diameter of 2.0-2.5 mm. The fecundity ranges 3,000-9,000 eggs/kg female body weight.
- ◆ Fertilization levels of 90-95% is achieved. Eggs are reared in flow-through hatchery system, where hatching occurs in 80-96 h at 22-24°C with 80-85% survival.
- ◆ Yolk-sac is absorbed in 11-13 days and swim-up fry start moving freely. Swim-fry are then shifted to nursery for further rearing.
- ◆ The breeding technology is largely adopted in Himachal Pradesh, Uttarakhand, Sikkim, Nagaland, Assam and Arunachal Pradesh.



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Chocolate Mahseer

Neolissochilus hexagonolepis (McClelland, 1839)

- ◆ Chocolate mahseer, a highly esteemed food and game fish of Indian sub-continent and south-east Asia, is limited to north-eastern Himalaya in India, and is listed under threatened species.
- ◆ The species is a batch spawner and breeds during January-February and May-September in flowing waters. Sexes are separate and distinguishable at maturity with male oozing milt on pressing the belly and females having bulged abdomen, pinkish vent and anal fin.
- ◆ Captive broodstock of 600-800 g are raised in concrete tanks at stocking density of 2-3 nos/m² and fed on formulated feed containing 30-40% protein.
- ◆ Mass-breeding is achieved with administration of single injection of commercial hormone Ovaprim/Ovatide/Gonopro FH @ 0.2-0.3 ml/kg to male and @ 0.6 ml/kg body weight to female.
- ◆ Stripping is done after 10-16 h of injection, when female shows signs of ovulation. Fecundity of the fish is very low, about 3,500 eggs/kg body weight.
- ◆ Fertilized eggs are demersal having diameter of 2.0-2.5 mm. They are incubated in perforated hatching trays receiving oxygen rich water round the clock.
- ◆ Hatching takes place within 50-60 h at 20-22°C. Yolk-sac is absorbed in 4-5 days and the length of free swimming larva is 8.4-8.6 mm.
- ◆ Spawn is reared in closed re-circulatory tanks equipped with filtration system @ 2,000-3,000 spawn/m³ for about 15 days, fed on yolk suspension for 2-4 days and finally switched on to feed formulated wet diets until the fry stage.
- ◆ The breeding technology has been promoted to north-eastern states.



Compiled by: Dr S.G.S. Zaidi and Dr D. Sarma

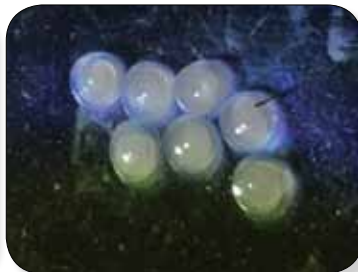
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Dark Mahseer

Naziritor chelynoides (McClelland, 1839)

- ◆ The Dark Mahseer inhabits fast-flowing cold mountain streams of Garhwal Himalayas and parts of Nepal. Potential candidate species for coldwater aquaculture for food and ornamental trade. It is a critically endangered fish species.
- ◆ Sexes are separate. Batch spawner and lays eggs under the gravel. Male and female attain sexual maturity in aquarium and tanks with good management practices.
- ◆ For captive breeding, aquarium and tanks are provided with a thick layer of gravel, continuous filtration of water and aeration. The fish constructs several pits in the gravel and bred naturally in November-December and March-April.
- ◆ Fecundity is generally 800-1,000 eggs/female of 50-60 g. Fertilized eggs are pale yellow and non-adhesive having diameter of 2.0-2.5 mm.
- ◆ Eggs are kept in floating trays in a closed re-circulatory incubation tank, which takes 60-70 h for hatching at 20-22°C.
- ◆ Yolk-sac is absorbed in 2-3 days. Hatchlings of 8-12 mm length become free swimming and feed well on poultry egg yolk-suspension as first feeding. After 2-3 days, they accept wet formulated feed.
- ◆ With good water quality management and efficient water filtration system, survivals of 70-80% are achieved from spawn to fry stage.
- ◆ The breeding technology is being promoted in north Himalayan states.



Compiled by: Dr S.G.S. Zaidi and Dr D. Sarma

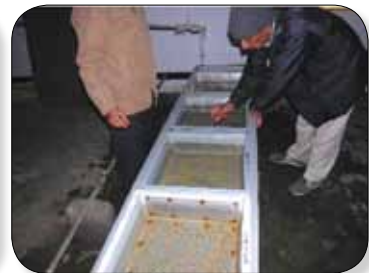
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Snow Trout

Schizothorax richardsonii (Gray, 1832)

- ◆ Snow trout is an important coldwater fish found in upland streams of Jammu and Kashmir, Uttarakhand, Assam, Sikkim and Nagaland.
- ◆ Attains maturity in three years. Breeds twice in a year, during February-May and August-October, in flowing waters.
- ◆ Sexes are separate and distinguishable on maturity. Mature males are slender in shape, have large number of nuptial tubercles on the snout, faint yellowish, reddish fins, pectoral fins rough and oozes white-milt on pressing the belly.
- ◆ The females are characterized by soft pectoral fins, and pinkish soft and distended belly. Fully mature female releases orange and sticky eggs on pressing the abdomen.
- ◆ Fecundity is low, about 16,000-18,000 eggs/kg female body weight.
- ◆ For captive breeding, brooders are raised in concrete tanks, provided with bed of fine pebbles and gravel, and maintenance of continuous water flow.
- ◆ Mass breeding is undertaken during August-October. Female brooders in size range of >70-80 g and males >40-50 g are selected in 1:4.
- ◆ Dry method of stripping is undertaken in dark conditions and eggs are mixed with milt of 3-4 male fishes and washed properly. Good quality eggs are uniform in size with yellowish-orange tinge. Fertilization rate remains at 35-60%.
- ◆ For hatching, the eggs are kept in perforated trays receiving clear and well oxygenated water from a stream. Eggs hatch in 5-7 days at water temperature of 17-21°C with hatching levels of 60-75%. Yolk-sac is absorbed in 84-168 h, and sac-fry are 7.5-9.0 mm in length. Sac-fry develop to swim-up fry with survival levels of 30-45%.
- ◆ The Swim-up fry are further reared in indoor flow-through trays for 60 days @ 1,000-2,000 nos/m² with a water flow of 3-4 l/m for getting advance fry.



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Magur

Clarias magur (Linnaeus, 1758)

- ◆ Magur is widely distributed in Indian sub-continent. It is a popular air-breathing catfish fish having high food value owing to its medicinal importance and a suitable species for aquaculture diversification.
- ◆ Breeds in captive conditions but procurement of seed from wild is very difficult.
- ◆ Captive broodstock is raised in concrete tanks/earthen ponds @ 2-3 nos/m² with intermittent water exchange and fed with compound feed containing 30-35% protein.
- ◆ Matured brooders of 100-150 g are easily identified by pointed and round genital papilla for male and female, respectively. The females are injected with Ovaprim/Ovatide/Wova-FH/ GonoproFH @ 1.0-1.5 ml/kg body weight.
- ◆ Females are stripped after 16-17 h post injection and fertilized with the sperm suspension prepared from the dissected testis of male prior to female stripping. Female of 100 g gives 4,000-5,000 eggs.
- ◆ Eggs are round, dark brown and adhesive. Fertilized eggs after 3-4 washing after stripping are transferred to the hatchery tubs/tanks.
- ◆ The eggs are hatched in 24-26 h and yolk-sac is absorbed in 70-80 h.
- ◆ Spawn is reared in indoor tanks @ 1,000-1,500/m² for about two weeks. Larvae are fed with live feed followed by compound larval feed to obtain a survival level of 80% at fry stage.
- ◆ The breeding and seed production technology has been adopted in several states of the country, especially in West Bengal, Odisha, Assam and other north eastern states.



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Valencienne's Clarid

Clarias dussumieri (Valenciennes, 1840)



- ◆ Valencienne's Clarid is endemic to Western Ghats and distributed in limited locations in the rivers of Peninsular India.
- ◆ Sexes are separate and prominent during spawning season with males having pointed genital papilla, whereas the females have round papilla and bulged abdomens.
- ◆ For captive breeding, brooders are raised in small earthen ponds or concrete tanks and fed with compound diets containing 30-35% protein.
- ◆ Mature fishes of above 150-200 g of 1+ age in equal sex ratio are used for breeding. They are injected with carp pituitary extract @ 20-40 mg/kg.
- ◆ After a latency period of 13-14 h, injected female fishes are either stripped out and eggs are fertilized with pre-driven milt as in *C. magur* or a hide-out is provided in the tank for their natural spawning. In both the cases, the fertilization rate of 60-95% is achieved.
- ◆ Fertilized eggs are incubated in flow-through hatchery system in shallow trays. A female of 200 g size lays approximates 5,000 eggs, which hatch in 16-18 h at 26-28°C.
- ◆ Newly hatched larvae are fed with chicken egg yolk suspension for the first two days and thereafter fed *ad lib* with freshly hatched *Artemia* nauplii for at least 10 days in shallow trays/tanks with water depth of 10-12 cm.
- ◆ Inert feed in the form of thick paste is started from 10 days onwards along with the *Artemia nauplii*, which is gradually withdrawn, and larvae are totally weaned on formulated diet. With good management practices, survival of 30-50% is achieved at fry stage.
- ◆ The breeding technology has been mainly extended to the state of Kerala.



Compiled by: Dr V.S. Basheer and Dr K.K. Lal

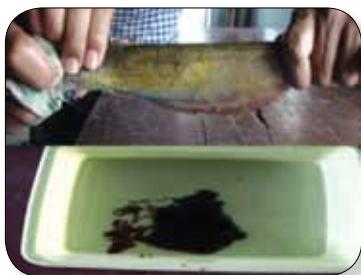
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Singi

Heteropneustes fossilis (Bloch, 1794)

- ◆ Singi or stinging catfish is available all along the Indian subcontinent and is regarded as a potential high-value species for aquaculture diversification. It grows to a size of 200g.
- ◆ Breeds in captivity during monsoon season, but seed procurement from natural resources is very difficult. For hatchery seed production, brooders are raised in earthen ponds or concrete tanks, partly covered with macro-vegetation and given feed with 32-35% protein.
- ◆ Mature females are identified by bulged abdomen and round vent, and males have slender body and pointed anal papilla.
- ◆ Fully mature females and males are segregated in the ratio of 1:1 for breeding. Females are injected with hormones like Ovaprim/Ovatide/GonoproFH @ 1ml/kg body weight or pituitary extract @15-20 mg/kg.
- ◆ Stripping is generally done 12 h post injection. The male milt-suspension in normal saline is prepared prior to stripping. Stripped eggs are mixed with milt-suspension and washed 3-4 times with water.
- ◆ Eggs are spherical, dark-brown, adhesive having diameter of 1.4-1.6 mm and incubated in flow-through hatchery where hatching occurs in 22-24 h. Generally, the fish lay 1,500-2,000 eggs/g ovary weight.
- ◆ Newly-hatched larvae are 2.6-2.8 mm in length. Yolk-sac is absorbed on the fourth day. Larvae are reared at a density of 3,000-5,000/m² for 12-13 days in the hatchery. They are fed with mixed zooplankton or *Artemia* nauplii or tubifex worms to get 12-15 mm size fry.
- ◆ The breeding and seed production technology has been extended to almost all the states of the country.



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Indian Butter Catfish

Ompok bimaculatus (Bloch, 1794)

- ◆ Indian butter catfish, a small-size fish species, is a popular and high value food fish of eastern and north-eastern states of the country. It is distributed widely in Indian sub-continent and south-east Asian countries and listed under endangered category. It is the State Fish of Tripura.
- ◆ Attains maturity during the first year and spawns from May-August in flowing waters. For captive breeding, brooders are raised in earthen ponds @ 40,000 nos/ha.
- ◆ Sexes are separate and well distinguished. Males have prominent genital papilla and rough pectoral fins, whereas females have smooth pectoral fins and bulged belly.
- ◆ Ripe brooders weighing above 80 g males and 120 g females are most suitable for induced breeding. Ratio of 1:2 female to male is taken for induced breeding.
- ◆ Brooders are given injection of Ovatide/Wova-FH @ 1.5–2.0 ml/kg body weight to female and 0.5-1.0 ml/kg to male.
- ◆ Stripping is done after 8-12 h. Around 20,000-25,000 eggs are obtained from a female of 100g, which are mixed with milt suspension prepared prior to stripping.
- ◆ Eggs are shifted to the hatching tanks maintained with mild-flow of water, where hatching occurs within 18-23 h of fertilization at water temperature of 27-29°C.
- ◆ Larvae are given small-size live feed from second day onwards. With the increase in size, they are fed *ad lib.* with heterogeneous mixture of live zooplankton, tubifex worms and egg custard. Fry size is attained after 3-4 weeks.
- ◆ The breeding technology has been largely adopted in West Bengal, Odisha, Assam, Tripura and Uttar Pradesh.



Compiled by: Dr P.P. Chakrabarti and Shri Arabinda Das

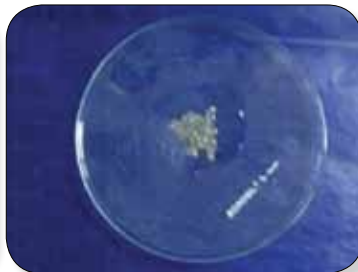
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Pabda Catfish

Ompok pabda (Hamilton, 1822)

- ◆ Pabda, an important small-size high-value catfish, inhabits rivers, tanks and ponds of Indian sub-continent.
- ◆ Attains maturity in the first year and breeds during June-August. Sexes are distinguishable at maturity with females having smooth pectoral fins and bulged belly, whereas males have rough pectoral fins and pinkish-white anal papilla.
- ◆ Captive breeding is undertaken by rearing broodstock in earthen ponds. Adult fishes of 30-40 g are suitable for induced breeding.
- ◆ Commercial hormone such as Ovatide/Ovaprim @ 1.0-2.0 ml/kg body weight to the female and @ 0.5-1.0 ml/kg body weight to the male is injected for induced breeding. Females usually become ready for stripping after 8-10 h of injection.
- ◆ Prior to stripping of ova, milt suspension is prepared by removing testes and macerating in normal saline. Stripped eggs are fertilized with milt-suspension.
- ◆ Fertilized eggs are incubated in flow-through hatchery, where hatching occurs after 22-24 h, and yolk-sac is absorbed after 3 days.
- ◆ Free swimming larvae are reared in separate tanks and fed with plankton *ad lib*. Gradually, chopped tubifex larvae are added in the diet with increase of the larvae size.
- ◆ Larvae are reared in shallow water depth of 3-4 cm initially and gradually increased to 15-20 cm with increase of larvae size (fry stage). A survival of 15-20% is generally achieved at fry stage.
- ◆ The breeding technology has been largely adopted in West Bengal, Odisha, Assam and Tripura.



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Pangas Catfish

Pangasius pangasius (Hamilton, 1822)

- ◆ Pangas is a large-size popular catfish of Indian sub-continent. In India, it is found in large rivers of north, central and southern parts. Potential species for diversification in freshwater aquaculture.
- ◆ Breeds in flowing waters during monsoon season. Brooders are raised in earthen ponds along with other fishes.
- ◆ Sexes are well differentiated at maturity with females having bulged abdomen and males ooze white-milt on pressing the belly.
- ◆ Females are injected with synthetic hormone viz., Ovatide/Ovaprim @ 1.0-1.5 ml/kg body weight for successful stripping after 13-14 h of injection.
- ◆ Dry method of stripping is resorted and ova are fertilized with collected milt. Female lays 1.2-1.4 lakh eggs/kg body weight. Eggs are adhesive and hence sticky layer of egg is removed before shifting eggs to hatching tanks.
- ◆ Hatching occurs in a day and the hatchlings of 3-4 mm size, thus obtained are reared further in a separate tank in hatchery at low stocking density of 500-1,000/m² to reduce mortality due to cannibalism.
- ◆ Larvae are fed with small zooplankton, obtained from repeated sieving of zooplankton or *Artemia* nauplii or tubifex worms from fourth day onwards. Within 15-20 days, larvae attain average weight of 30-40 mg and called early-fry.
- ◆ Early-fry are stocked further in nursery ponds or concrete tanks @ 10-15 nos/m² and fed with crumbled feed daily to get 2-3 g fry size in 1-2 months.
- ◆ The breeding technology is being adopted in the state of Odisha.



Compiled by: Dr S.K. Sahoo and Dr S. Ferosekhan

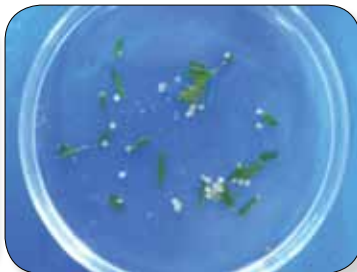
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Freshwater Shark

Wallago attu (Bloch & Schneider, 1801)

- ◆ Largest freshwater catfish of India and distributed from Pakistan to Vietnam and Indonesia.
- ◆ Matures within 2 years and spawn during May-September in rivers and large reservoirs.
- ◆ For captive breeding, broodstock are raised in ponds and fed with small-size fishes.
- ◆ Sexes are separate and distinct. Males have slender body, large pectoral fins with serrations on pectoral spine and swollen pointed genital papilla, whereas females have bulging abdomen, soft pectoral spine and blunt genital papilla.
- ◆ Pairing of both female and male is made in 1:1 to 1:2 depending on size of the fish. Fishes are induced by pituitary gland extract or commercial fish hormone Ovaprim/GonoproFH. Injected with pituitary extract, the females are given in two doses (@ 4 mg/kg and 12 mg/kg) and males are given one dose of 2-3 mg/kg, while with use of commercial hormone single of 0.5-0.6 ml/kg and 0.3 ml/kg is given to female and male respectively.
- ◆ Injected brooders are transferred to spawning tank provided with wooden logs and macrophytes such as *Hydrilla verticellata*. Spawning occurs after 6-8 h of hormone injection.
- ◆ Eggs are sticky and hence attached to the weeds, wooden logs and even to tank walls. Fertilization rate ranged from 70-90%. Eggs are spherical, pale yellow having diameter of 2.2-2.8 mm. Fecundity is around 30,000-40,000 eggs/kg.
- ◆ Hatching occurs within 14-18 h at 28±1°C. Hatchlings start crawling over the tank bottom from 2nd day and feed on their siblings. Hence, feeding them with zooplankton and cut pieces of insect larvae is essential from 2nd day onwards.
- ◆ Yolk-sac is absorbed on 4th day. Spawn is collected and transferred to another tank for growing to fry stage. They are fed on zooplankton and meshed insects and their larvae. Survival is generally poor, 10-20% at fry stage.
- ◆ The species has been successfully bred in Odisha and Uttar Pradesh.



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Long Whiskers Catfish

Mystus gulio (Hamilton, 1822)

- ◆ Long whiskers catfish is euryhaline in nature and thrive well both in fresh and brackish water. Distributed in Pakistan, eastern parts of India, Indonesia and Vietnam.
- ◆ Captive breeding is undertaken by raising broodstock in earthen ponds at stocking density of 3-4 nos/m², fed with boiled chicken offals/ fish waste/formulated feed.
- ◆ Spawn during June-August. Fully ripe females weighing above 80g with bulging abdomen and round genital papilla are selected for induced breeding. Mature males weighing above 50g are selected on the basis of pointed red genital papilla.
- ◆ Brooders are given single injection of Ovotide/Wova-FH@1.5-2.0 ml/kg body weight to females and @1.0-1.5 ml/kg to males for spawning.
- ◆ Sex-ratio of 1:1 are kept for breeding in rectangular FRP tanks with about 300 l water for one pair, provided with macrophytes and maintained with continuous mild aeration. Larger tanks may be used for mass-scale breeding.
- ◆ Spawning occurs after about 5-10 h post-injection, either in single batch or sometimes in multiple batches. Eggs are adhesive and attached to the aquatic macrophyte or walls or bottom of the tank.
- ◆ Eggs are allowed to hatch in the same tank, which takes 18-22 hrs at 27-29°C. Newly-hatched larvae are 3.1-3.6 mm in length with a small yolk-sac attached, which is consumed within 48 h of hatching.
- ◆ Larvae are reared in indoor tanks at stocking density of 2000-2500 nos/m² and fed with cladocerans, copepods and live tubifex till 10-12 days and then gradually weaned to nursery feed till they attain fry stage.
- ◆ Depth of water in the larval tanks is kept 8-10 cm initially and increased to 20 cm with increase in larval size. With good water quality management, a survival of 40-50% is achieved.
- ◆ The breeding technology is being propagated in the states of West Bengal and Odisha.



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Gangetic Mystus

Mystus cavasius (Hamilton, 1822)

- ◆ Popular small-size catfish of high value in parts of eastern India. Widely distributed in Indian sub-continent and some South Asian nations.
- ◆ Breeds in running water during monsoon. Brooders are reared in earthen ponds which attain maturity in one year.
- ◆ Mature brood are identified with presence of long genital papilla in males, whereas females have slightly bulged abdomen.
- ◆ Spawning is undertaken by giving single injection of hormone like Ovatide@ 1ml/kg body weight to female, which becomes ready for stripping after 12 h when eggs come out easily from the vent.
- ◆ The milt-suspension is prepared with extraction of the testes from the males and macerating these with normal saline solution.
- ◆ The female fish is stripped and eggs are fertilized with milt-suspension and washed 3-4 times. A female lays around 12,000-14,000 adhesive eggs having diameter of 0.5 mm.
- ◆ Eggs hatch in 20-22 h in the hatching jars/trough and measure 1.2-1.4 mm in total length. Yolk-sac gets absorbed within 72 h.
- ◆ The hatchlings are reared @1000 nos/m² in the larval rearing tanks and fed on live feed. With good husbandry, a survival of 50-60% is achieved at fry stage after 3-4 weeks of rearing.
- ◆ The technology is largely confined to West Bengal.



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Mahanadi Rita

Rita chrysea (Day, 1877)

- ◆ Mahanadi rita is distributed in the river Mahanadi and its tributaries in the states of Odisha and Madhya Pradesh. It is a popular and moderate value catfish.
- ◆ Breeds in running water during monsoon season. Successful captive breeding is achieved by raising healthy brooders in concrete tanks or earthen ponds and feeding them with pellet feed of 32-35% protein.
- ◆ Brooders of 80-140 g are ideal for captive breeding. Sexes are separate. Males are identified by having long genital papilla, whereas females have bulged abdomen.
- ◆ Females are induced with hormone injection such as Ovatide @ 1 ml/kg body weight and which become ready for spawning in 13-15 h. At that time, the abdomen of the selected male is cut-open, testes extracted and milt suspension is prepared in normal saline.
- ◆ Eggs are stripped out and fertilized with milt suspension. Female of 80-140 g spawn around 12,000-14,000 free floating eggs of 1.3-1.4 mm diameter.
- ◆ Eggs hatch after 20 h and free swimming larva measure 3.5-4.5 mm in total length. Larvae are reared at stocking density of 2 nos/litre and fed *Artemia nauplii* and mixed zooplankton. They grow to 50-60 mg in weight during 3-4 weeks of rearing.
- ◆ The breeding technology is being extended in Odisha.



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Yellow Catfish

Horabagrus brachysoma (Günther, 1864)

- ◆ Yellow catfish or Sun catfish is a medium sized catfish of food and ornamental importance and distributed only in Western Ghats of Kerala and Karnataka.
- ◆ For captive breeding, the brooders are raised in earthen ponds or concrete tanks and fed with pellet feed containing 30% protein.
- ◆ Sexes are separate. Mature males and females of 2+ year age are well distinguished, with females having bulged abdomen and males ooze free flowing white-milt with slight pressure.
- ◆ Fully mature females are given injection of Ovaprim/Ovatide/Wova-FH @ 1.5 ml/kg body weight. No hormonal injection is given to males.
- ◆ Spawning is undertaken by dry method of stripping after 12-13 h of injection. Freely releasing eggs of female are mixed with milt suspension prepared from extracted testes and macerating with normal saline solution, and fertilized. Generally female lays 15,000-18,000 eggs per 100 g body weight.
- ◆ After 3-4 washings with clean freshwater, free floating eggs are transferred to the hatchery, where hatching occurs in 22-23 h.
- ◆ Yolk-sac is absorbed in three days and larvae start accepting live feed, which is followed with adding inert compound feed (30% protein) at the age of 12-15 days. At rearing density of 500-1000/m², survival levels of 70-80% are obtained during 3-4 weeks of indoor rearing.
- ◆ The breeding and seed production technology has been mainly adopted in the state of Kerala.



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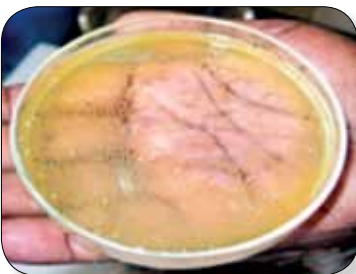
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Striped Murrel

Channa striata (Bloch, 1793)

- ◆ Striped murrel is an important air-breathing food fish, widely distributed in Indian sub-continent and South-east Asian countries.
- ◆ Matured brooders are observed during May-October. In Southern India, however, they are found round the year.
- ◆ Sexes are separate but require careful examination for assessing maturity in both the sexes. On maturity, female exhibit slightly bulged abdomen, round-reddish vent, whereas males exhibit pale vent, small and slender anal papilla but do not ooze milt on pressing the belly.
- ◆ Female and male brooders (0.4-1.0 kg) are injected either with HCG @ 2000 and 1500 IU/ kg body weight or carp pituitary gland extract (PGE) @ 20-30 and 10-20 mg/kg body weight or Ovotide/Ovaprim @ 0.6 and 0.4 ml/kg body weight, respectively.
- ◆ Spawning occur in 16-18 h at 26-28°C. Eggs are spherical, transparent, non-adhesive, free floating and straw yellow in colour. Generally, 10,000-15,000 eggs/kg female body weight is obtained at a time with 70-95% fertilization. The fish can spawn 3-4 times in a year.
- ◆ Hatching occurs within 22-24 h with 70-95% success and yolk-sac is absorbed in 72 h. The spawn are reared for 7-10 days in small tanks and fed *ad libitum* with either zooplankton or *Artemia nauplii*. With good management measures, 50-60% survival is obtained.
- ◆ Fry rearing is undertaken in outdoor tanks, fed with aquatic insects, tubifids and chopped earthworms mixed with powdered fish meal and soya flour (3:1) @ 5-10% of their body weight.
- ◆ Around 2-5% of the fry turns into shoot fry, killing smaller ones and hence should be graded at weekly intervals. Average survival of 25-30% is achieved with regular grading of shooters.
- ◆ The breeding and seed production technology is adopted in West Bengal, Odisha, Telangana, Andhra Pradesh, Tamil Nadu, Uttar Pradesh and Chattisgarh.



Compiled by: Dr Rajesh Kumar

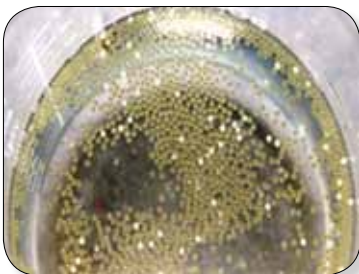
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Giant Murrel

Channa marulius (Hamilton, 1822)

- ◆ The giant murrel or giant snakehead is an important air-breathing high valued food fish. Distributed from Indian sub-continent to many countries in South-east Asia.
- ◆ Broodstocks are developed either in earthen ponds or concrete tanks. Matured brooders are observed from March to October months but round the year in Southern India.
- ◆ Sexes are separate but require careful examination for assessing maturity in both the sexes. On maturity, female exhibit slightly bulged abdomen, round-reddish vent, whereas males exhibit pale vent, small and slender anal papilla but do not ooze milt on pressing the belly.
- ◆ Fully gravid male and female (0.7-1.5 kg) are given first injection of human chorionic gonadotropin (HCG) @ 2000 IU/kg body weight followed with second dose of HCG @ 1500-2000 IU/kg body weight after 24 h interval to both the sexes.
- ◆ Fish spawn 16-18 h after the second injection and lay 8,000-12,000 eggs/kg female. Eggs are spherical, light yellow transparent, non-adhesive and free floating.
- ◆ Fertilization rates are generally high, 85-90%. Hatching occurs within 22-24 h with 80-85% success. Newly hatched larvae are transparent and measure 3.4-4.0 mm in total length.
- ◆ The larvae are reared in small tanks and fed *ad libitum* with either zooplanktons or *Artemia* nauplii. Fry survival of 50-60% is achieved with good management practices.
- ◆ Fry rearing is undertaken in outdoor tanks, feeding with aquatic insects, tubifids and chopped earthworms mixed with powdered fish meal and soya flour (3:1) @ 5-10% of their body weight. Average survival of 25-30% is achieved with regular grading of shooters.
- ◆ The technology of breeding and seed production has been extended to West Bengal, Odisha, Telangana and Uttar Pradesh.



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Spotted Murrel

Channa punctata (Bloch, 1793)

- ◆ Spotted murrel, an important air-breathing fish of Indian sub-continent, is in great demand due to its taste, medicinal importance and high market price.
- ◆ For captive breeding, brooders are raised in concrete tanks or earthen ponds covered with aquatic weeds, where they mature in first year of their life during May to October attaining weight of 50-80 g.
- ◆ Sexes are separate. Matured females have slightly bulged abdomen, and round and reddish vent. Males have several black pin-head size black spots below the lateral line and small-sized anal papilla.
- ◆ Captive spawning is undertaken in shallow concrete/FRP tanks with water depth 15-20 cm, where aquatic weed like *Hydrilla* is uniformly spread. 4-6 pairs of female and male brooders (1:2 ratio) are kept in tank of 6-8 feet diameter and given hormonal injections of Ovaprim/Ovatide @ 0.5 ml/kg to female and 0.3 ml/kg to male.
- ◆ Fish spawn between 12-36 h and lay 500-1,000 eggs per female at one place between aquatic weeds, from where they are scooped out and transferred to the hatching tanks.
- ◆ Eggs are spherical, non-adhesive, free floating and light yellow in colour and hatch in 24-26 h with 90-95% fertilization.
- ◆ The larvae are fed from 4th day onwards with *Artemia* nauplii/small-size plankton 3-4 times in a day for 15 days. Larvae are fed with egg custard *ad libitum* from 15th day onwards till one month, which grow to about 15-20 mm in size with 50-60% survival.
- ◆ Fry rearing is undertaken in outdoor tanks, fed with aquatic insects, tubifex and chopped earthworms; powdered fish meal and soya flour (3:1) @ 5-10% of their body weight twice a day in addition to live feed. With removal of shooters, a survival of 30-35% is achieved.
- ◆ The technology has been extended to West Bengal, Odisha, Assam and Uttar Pradesh.



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Chital

Chitala chitala (Hamilton 1822)

- ◆ Chital inhabits freshwaters, particularly the large rivers of north and central India, countries of Indian sub-continent and south-east Asia.
- ◆ The fish breed in flowing rivers, and also in captive pond condition in presence of appropriate habitat, viz., hard substratum, earthen pots, plastic pipes etc. during monsoon months.
- ◆ Sexes are separate and mature females have bulged abdomen and fleshy but blunt urinogenital papilla. Males are slender and having thin, conical and pointed anal papilla.
- ◆ Induced breeding is undertaken through hormonal intervention, with injection of Ovaprim/Wova-FH/Ovatide @ 1 ml/kg body weight for female and 0.5 mg/kg male.
- ◆ Fully mature female and male in ratio of 1:2 after hormonal injection are released in large tanks where earthen rings or plastic pipes are provided for attachment of eggs.
- ◆ Spawning occurs after 14-15 h. The fertilized eggs are deposited inside and outside the earthen rings or all around the pipes, and remain deeply attached due to adhesive nature.
- ◆ Eggs were milky white in colour at the beginning, which further turns to light yellowish, yellow orange and finally bright orange red in colour within 6-7 days.
- ◆ Hatching takes 168-192 h. Yolk-sac is absorbed in 12-14 days. The hatchlings are light brownish in colour and bearing blood capillaries.
- ◆ Rearing in re-circulatory system on live tubifex, daphnia and boiled egg yolk gives 80% survival at fry stage in a period of 60 days.
- ◆ The seed production technology is mainly adopted in West Bengal, Assam and Odisha.



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Climbing Perch

Anabas testudineus (Bloch, 1792)

- ◆ The climbing perch (Koi or Kawai) is a high value indigenous air-breathing fish of India and South-east Asia.
- ◆ Attains maturity in 5-6 month and spawn during April-August with peak during monsoon.
- ◆ Sexes are separate and distinct. Fully matured female exhibits bulged abdomen and prominent genital papilla, while mature males are slender, having longer anal fins and oozes milt on pressing the belly.
- ◆ Brooders are raised in pond. Brooders of 40-100 g are induced bred with commercial hormone (Ovaprim/Ovatide/WOVA-FH/GonoproFH) injection @ 0.5-1.0 $\mu\text{l/g}$ to female and 0.25-0.5 $\mu\text{l/g}$ body weight to male.
- ◆ Spawning occur in 7-8 h and fish lay eggs having dia of 70-85 μm . Fecundity is 300-400 eggs/g body weight. Eggs are non-adhesive and floating.
- ◆ Eggs are incubated in plastic tubs/FRP tanks where they hatch out in 12-15 hrs at 26-28°C.
- ◆ Newly hatched larvae are 1.6-1.8 mm in total length and reared in indoor FRP/concrete tanks of 500-1000 l capacity with water depth of 50-60 cm.
- ◆ The spawn are reared for 3 weeks in FRP/concrete tanks at stocking density of 1000-1500 nos/m² and fed with zooplanktons for first two weeks when they attain size of 12-16 mm and subsequently on powdered formulated feed with 35% protein.
- ◆ Size heterogeneity and cannibalism occurs during seed rearing and hence, grading has to be done on routine basis for higher survival. A survival of 30-35% is achieved at fry stage.
- ◆ The technology is being adopted in West Bengal, Assam, Tripura and Odisha.



Compiled by: Rajesh Kumar

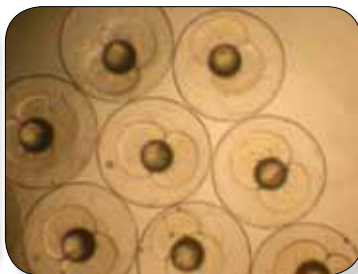
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Asian Seabass

Lates calcarifer (Bloch 1790)

- ◆ Asian seabass is widely distributed from Persian Gulf to South-east Asia and up to Australia. Migrate from estuaries to freshwater river zones.
- ◆ It is a highly predatory fish and fed on frozen fishes like oil sardines and tilapia @ 5% body weight on daily basis for raising broodstock in captivity.
- ◆ Sexes are separate, but sex-differentiation is difficult from external features. Attains maturity as male first when it is less than 3 years of age and subsequently sex changes to female. A multiple spawner, which spawn about 1.0 million eggs/kg body weight in different batches.
- ◆ Male exudes milky milt on pressing the belly. Females are identified with having soft round belly, pinkish genital papilla and emerging of ova from vent on pressing the belly.
- ◆ For captive breeding, pairs are made in ratio of 1:2 female to male. Females with ova size >0.450 mm and oozing males are selected and induced for spawning with injection of LHRHa hormone @ 60-70 µg/kg for females and 30-35 µg/kg for males.
- ◆ Spawning takes place spontaneously after 30-36 h of the injection. The fertilized eggs are round, floating having diameter of around 0.78 mm. Hatching takes place at 17 h and newly hatched larvae are of 1.7 mm in length.
- ◆ Hatchlings are stocked in indoor FRP tanks of 10 t capacity @ 30 no/l and first feeding is initiated with rotifer from 2nd day post hatch (dph) along with the introduction of green algae.
- ◆ *Artemia* nauplii and artificial feed are given from 9th and 17th dph respectively. On 30 dph, seabass fry reaches size of 1.0-1.2 cm with the average survival 40-45%. Fry are cannibalistic in nature and hence frequent grading is required to segregate the shooters and to maintain the uniform size.
- ◆ The breeding and seed production technology of the species is mainly confined to Tamil Nadu and Andhra Pradesh.



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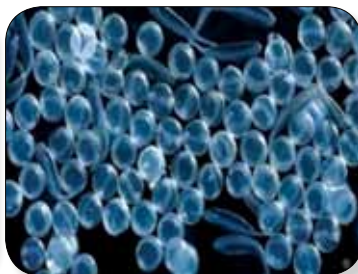
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Milkfish

Chanos chanos (Forsskål, 1775)

- ◆ Milkfish is one of most preferred brackish water finfish for farming in ponds and in pens. Widely distributed in Indo-Pacific region.
- ◆ Spawn twice in a year, during January to April (primary season) and October to November in the wild. However, under captive maintenance, spawning period could be extended from February to September through hormonal manipulation with maintenance of seawater salinity range from 30-35 %.
- ◆ There is no distinct sexual dimorphism. The ova diameter of fully mature female is 650-680 µm during breeding season, whereas males ooze white viscous milt on pressing the belly.
- ◆ Brooders of above 3.0 kg are raised in large tanks, stocked with 1.0 kg/m³ fish and fed floating brood diet for maturation under captivity.
- ◆ The fish requires combined hormone pellet implantation (LHRH-A + 17α-Methyl Testosterone) at regular intervals. Being intermittent spawner, it spawns spontaneously batch by batch.
- ◆ Mother milkfish can spawn 0.3-1.0 million eggs/kg body weight. Fertilized eggs appear slightly yellowish (size 1.10-1.25 mm). Hatching occurs in 24-25 h at water temperature of 27.0-29.0°C. The newly hatched larvae measure 3.2-3.4 mm in total length.
- ◆ Hatchlings are reared in semi-outdoor tanks @ 10-15 no/l. First feeding is initiated with rotifer *Brachionus plicatilis* from 2nd day post hatch (dph) along with the green algae. *Artemia* nauplii is introduced from 14th day dph.
- ◆ Artificial feed (200 -300 µm) is provided from 20th dph. The fry reaches size of 1.5 cm in 30 dph with the average survival rate of 40-45%.
- ◆ The breeding technology developed is being transferred to Tamil Nadu and other adjoining states.



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Pearl Spot

Etroplus suratensis (Bloch, 1790)

- ◆ Pearl spot is a native cichlid species of India; economically valued as food and ornamental fish.
- ◆ It breeds naturally in captivity on getting optimal environmental conditions. Captive breeding in hatchery is undertaken in re-circulatory modular tanks (1000 l) and net cages. It breeds without hormonal manipulation.
- ◆ Broodstocks of 100-150 g are developed in small net cages (2 m x 1 m x 1 m), fixed in ponds or open waters, at 100 numbers per cage.
- ◆ Sexes are separate but morphologically it is difficult to differentiate. However, gravid brooders can be identified by pink to red genital papilla which is pointed in males and with enlarged ovipositor in females.
- ◆ In Modular system of pearl spot seed production (MSPS), each tank is provided with a small rectangular plastic tray containing clay soil to facilitate monitoring of pair formation and breeding. The non-parent fish were separated following the first breeding.
- ◆ Readiness for breeding can be observed through increased aggression and territorial defense. Eggs are laid on hard vertical surfaces. After 70-72 h of egg laying, the larvae hatched out; 600-1900 nos/batch. The newly hatched larvae are separated from the parent fish by siphoning.
- ◆ Larval rearing is conducted in plastic or FRP tanks (50-100 l). Feeding is done using live rotifer, *Brachionus plicatilis* @ 20-25 nos/ml or *Artemia* nauplii at 8-15 nos/ml. The larvae are weaned to artificial feed in the initial days of feeding.
- ◆ Larvae attain 300 mg weight on co-feeding with live and inert feeds in 40 days. Survival rates of 80-90% can be attained with good feed, water quality and health management.
- ◆ The technology is largely adopted in Kerala and Tamil Nadu.



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Spotted Scat

Scatophagus argus (Linnaeus, 1766)

- ◆ Spotted Scat or 'Butter fish' is an important food and ornamental fish, and distributed in Indo-Pacific region. The fish is euryhaline in nature and in India it is found in coastal and mangrove regions.
- ◆ Sexes are separate. Breeds during June-December with two protracted seasons. During breeding season, mature males (> 80 g body weight) and females (> 150 g body weight) can be identified with oozing milt and distended belly respectively.
- ◆ Fully mature females having oocytes of >400 μm are induced to spawn with administration of hormones (HCG and LHRH-a) followed by stripping of eggs and mixing with milt for fertilization.
- ◆ Fecundity ranges 1.15-1.50 lakh/kg body weight. Eggs are pelagic with single oil globule and having diameter of 750 μm .
- ◆ Hatching takes place in 16-17 h. The newly hatched larval size range from 1.5 to 1.6 mm.
- ◆ The larvae are reared in indoor/semi-outdoor larval rearing tanks with the introduction of green water and fed with rotifers (2-10 dph) and *Artemia* nauplii (11-20 dph) followed by weaning on microparticulate feeding regime. During a month of larval rearing in the hatchery, the fry reaches a size of about one cm.
- ◆ The breeding technology is being extended in Tamil Nadu.



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Crescent Perch

Terapon jarbua (Forsskal, 1775)

- ◆ Crescent Perch or Target fish is an important food and ornamental fish species. It is distributed in Indo-Pacific region from Red Sea and East Africa to Australia.
- ◆ Euryhaline and can tolerate fresh to seawater salinity. Spawn in the sea and juveniles migrate into freshwater for growth.
- ◆ Sexes are separate, but difficult to differentiate. Generally, bigger sizes are female and smaller are males. Mature males exude white milt on pressing the belly, whereas female are identified through cannulation of eggs and measuring ova diameter.
- ◆ Broodstocks of 100-150 g are developed in small net cages (2 m x1 m x1 m) in ponds or open-water bodies at 100 nos/cage.
- ◆ A 100 g female release about 80,000-1,00,000 eggs. Hatching can be noticed after 16-18 h and the hatchlings measure 2.0 mm in size.
- ◆ Larval rearing is done by stocking the larvae in 10 ton FRP tanks @ 10-15 nos/litre with addition of green algae, *Chlorella salina* and rotifer, *Brachionus plicatilis* as initial feed and later with *Artemia salina* nauplii. The larvae can be easily weaned to artificial feed at the fry stage.
- ◆ By 45 days, the larvae reach to fry size of 2.0 cm and weigh 300-400 mg. Survival rates of 30-40% can be attained with good feed, water quality and health management practices.
- ◆ The technology is being extended in Tamil nadu.



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Cobia

Rachycentron canadum (Linnaeus, 1766)

- ◆ Cobia is a high-value marine migratory pelagic finfish, distributed worldwide in tropical, subtropical and warm-temperate waters. Considered an important fish for mariculture.
- ◆ Wild caught sub-adults of cobia (5-6 kg) are developed into broodstock in sea cages. Gravid males and females are identified through cannulation and tagging since sexual dimorphism is not distinct in this species.
- ◆ Mature fishes weighing around 8-10 kg and above, with female having more than 20% of the intra-ovarian egg diameter above 700 μm , are transferred to the spawning tank (>60 tonne capacity) for spawning induction with a female: male ratio of 1:2.
- ◆ Spawning is induced through single injection of HCG@ 500 IU/kg body weight for female and 250 IU/kg body weight for males. Fish breeds naturally in the tank and lay 0.5-2.5 million eggs.
- ◆ Eggs are incubated in 2 tonne capacity tanks at stocking density of 200-500 eggs/litre, which hatch within 18-22 h and develop to larvae in 60-72 h.
- ◆ Larval rearing is carried out in 2-5 tonne capacity tanks at stocking density of 5-10 nos/litre with mild aeration. Green water culture technique is undertaken.
- ◆ Newly hatched larvae fed on enriched rotifer. Inert feed is started from 15th day and switched entirely to artificial feed from 20 days dph. Size grading is done every third day to avoid/reduce cannibalism. The metamorphosis of the larvae takes 18-21 days.
- ◆ The breeding technology is mainly confined to the states of Tamil Nadu, Andhra Pradesh and Kerala.



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Silver Pompano

Trachinotus blochii (Lacépède, 1801)

- ◆ Silver pompano is a commercially important high priced marine finfish, widely distributed in the East and West Coasts of India, Atlantic and Pacific Oceans. It forms an important candidate for cage aquaculture.
- ◆ Fishes weighing about 1.0-1.5 kg are either wild caught or selected from grow-out cages and stocked in indoor flow through or re-circulation systems for raising gravid brooders.
- ◆ Four sets of brooders (each set of 1 female and 2 males) are transferred to an FRP tank of 10 tonne capacity with photoperiod of 15L h at 2000 Lux and temperature of 27-32°C for final oocyte maturation.
- ◆ Females with intra-ovarian egg diameter above 450 µm and milt oozing males are induced to spawn using HCG @ 350 IU/kg body weight for both the sexes. Alternatively, GnRH can be used at a dosage of 150 µg/kg body weight.
- ◆ Spawning occurs within 36-40 h of induction. Hatching takes place between 18 to 22 h. Single female fish lay 50,000 to 250,000 eggs with fertilization rates of 75-90%.
- ◆ The floating fertilized eggs are collected using a 500 µm mesh-size net and stocked in a 2 tonne FRP tank for hatching. The freshly spawned eggs measure 900-1000 µm.
- ◆ Tanks of 5 tonne capacity are ideal for larviculture with maximum stocking density of 10-15 nos./litre. Green water technique is followed during the larviculture.
- ◆ *Brachionus* and *Artemia* nauplii are used as live feeds. The black colour larvae metamorphose to silvery-white ones in 18-21 days.
- ◆ The breeding technology is mainly confined to the states of Tamil Nadu, Andhra Pradesh and Kerala.



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Indian Pompano

Trachinotus mookalee (Cuvier, 1832)

- ◆ Indian pompano is an important marine food fish, widely distributed in shallow coastal waters of Indo West Pacific region and is considered to be suitable for mariculture.
- ◆ It breeds during February-April. Adult males and females weighing 2.5-3.0 kg are raised in Re-circulating Aquaculture System (RAS) @ 1 kg/m³ and fed with vitamin-mineral mixed squid and clam meat twice a day.
- ◆ Three months after stocking, females undergo final oocyte maturation with vitellogenic oocytes measuring more than 500- μ m in size and males are found in milt oozing stage.
- ◆ Both the females and males are injected with human chorionic gonadotrophin @ 350 IU/kg body weight. Spawning occurs within 36-38 h after injection and the number of eggs spawned ranges 0.6-1.5 lakhs/spawner.
- ◆ The eggs hatch out after 20-22 hrs at temperature of 28-30°C and salinity of 30-32%. Newly hatched larvae measure 2.1-2.2 mm in total length.
- ◆ Larvae are stocked in green water at 10 nos/l and are fed a combination of rotifers and copepod nauplii (2 nos/ml) initially, followed by *Artemia* nauplii and artificial feed.
- ◆ The metamorphosis of the larvae starts on the 17th day post-hatch and is completed by 22nd day post-hatch by which time it reaches a size of 1.6-1.7 cm.
- ◆ The breeding technology is mainly confined to the states of Tamil Nadu and Andhra Pradesh.



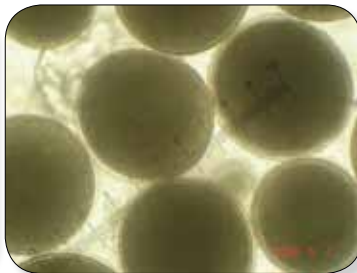
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Orange-Spotted Grouper *Epinephelus coioides* (Hamilton, 1822)

- ◆ Orange-spotted grouper is a reef-associated marine fish, distributed along the east and west coast of India and considered an important fish of high value for mariculture.
- ◆ It breeds during October - November and March - April.
- ◆ Adult fishes weighing 2.0-2.5 kg are raised in concrete tanks @ 1 kg/m³ and fed with squid, supplemented with vitamin-mineral mixture twice a day in re-circulating aquaculture system (RAS).
- ◆ Groupers are protogynous hermaphrodite and hence sex reversal for getting males is carried out by hormonal implantation using a combination of 17- α methyl testosterone and letrozole at 5 mg and 0.2 mg/kg body weight, respectively.
- ◆ Gravid female is identified when around 65% of the ova are more than 400 μ m in size and sex-reversed gravid males are identified when they are found in milt oozing stage.
- ◆ Natural spawning is observed for 3-15 days in every month with laying of 1-2 lakhs egg/spawner.
- ◆ Eggs are hatched after 18-22 h of incubation at 28-30°C with average fertilization and hatching rates of 80% and 85%, respectively. Newly hatched larvae measure 1.2-1.6 mm in total length.
- ◆ Larvae are stocked in green water at 10 nos/l and are fed a combination of rotifers, copepod nauplii and artificial feed. Larvae metamorphose to juveniles at about 33-37 days post hatch, by which time it reaches a size of 1.5-2.0 cm.
- ◆ The technology is being extended in Tamil Nadu and Andhra Pradesh.



Compiled by: Dr Ritesh Ranjan

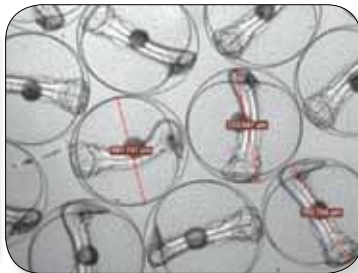
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Pink-Ear Emperor Bream

Lethrinus lentjan (Lacepede, 1802)

- ◆ Pink ear emperor is a high value marine fish found along the east and west coasts of India.
- ◆ Broodstock can be developed by stocking wild caught fishes of 500 g-1 kg in a 10 tonne Recirculation Aquaculture System (RAS) @ 1kg/m³ and rearing for a period of 4-5 months.
- ◆ Brood fishes are fed *ad libitum* with fishes like sardine, mackerel or anchovies, and squid supplemented with vitamins and minerals. They also have to be fed intermittently with compounded semi-moist feed at the rate of 2% of body weight to improve quality of egg produced.
- ◆ The fish is a protogynous hermaphrodite and sexes cannot be easily recognized by external appearance. Spawning occurs without any hormonal injection in re-circulatory aquaculture system (RAS).
- ◆ Spawning takes place in early morning. Fertilized eggs are of dia 700-740 μ , and are transparent, pelagic and non-adhesive in nature. The newly hatched larva measures 1.35-1.54 mm.
- ◆ Mouth opens on 3rd day of post-hatch and the larval rearing is done in green-water medium (*Nanochloropsis salina*, *Isochrysis galbana*, *Chaetoceros calcitrans* in the ratio of 3:1:1). Nauplii of copepod species like *Acartia* sp. and *Pseudodiaptomus serricaudatus* are used as first food. From day 5th to 16th, rotifers at density of 4-6 nos/ml are provided as food.
- ◆ *Artemia* can be given from 15th dph onwards and weaned on pellet feed from 20 dph (200-400 μ). Larvae become benthic from 25-30 dph onwards.
- ◆ Juveniles attain the size 27-28 mm and 0.26-0.28 g in 45-50 dph.
- ◆ The technology is being extended in Tamil Nadu, Andhra Pradesh and Kerala.



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Grass Carp

Ctenopharyngodon idella (Valenciennes, 1844)

- ◆ Silver carp is native to Asia, from China to Eastern Siberia. It is cultured all over the world due to its compatibility in polyculture system.
- ◆ Breeding in captivity is attained through artificial inducement, for which brooders of 2+ year-class are raised in earthen ponds at biomass of 1500-2000 kg/ha.
- ◆ Sexes are distinct during spawning season with females having bulged abdomen and fleshy genital pore with soft pectoral fins. Males are slender, having rough pectoral fins and ooze milky-white milt from vent on pressing the belly.
- ◆ Captive spawning is undertaken either in hapa or in circular hatchery. In both cases, a sex ratio of 1:1 is maintained. Brooders are induced by injecting either pituitary extract or commercially available synthetic Gonadotropin hormones (CH).
- ◆ Pituitary extract to females is administered in two doses; 1st dose of 2-3 mg/kg and 2nd dose of 6-8 mg/kg body weight at an interval of 6-8 h, whereas males are given a single dose of 2-3 mg/kg at the time of 2nd dose to females. However, in case of CH, a single dose of 0.5-0.6 ml/kg to female and 0.2-0.3 ml/kg to male is given.
- ◆ Stripping is done when kept in hapa, but breeds naturally in spawning tanks of circular hatchery. Fecundity of this species is around 1.5 lakh/kg body weight of female. Under ideal conditions, the rate of fertilization is generally 90-95%.
- ◆ Eggs hatch in 18-22 h at a water temperature of 28-30°C and yolk-sac is absorbed in 72 h, and the free-swimming spawn of size 5-6 mm is developed with a hatching rate of 70%.
- ◆ Spawn is reared to fry size (20-25 mm) at a density of 500-1000/m² in earthen nursery for 15-20 days with 30-35% survival. Concrete tanks at stocking density of 1000-2000 spawn/m³ yields better survival of 50-80%.
- ◆ The breeding technology is widely practiced in all the states of the country.



Compiled by: Dr Sudhir Raizada and Dr P. Routray

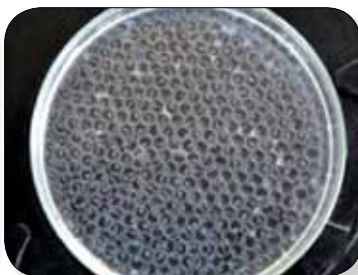
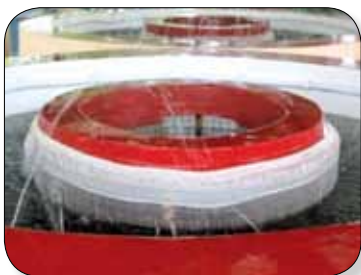
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Silver Carp

Hypophthalmichthys molitrix (Valenciennes, 1844)

- ◆ In India, the fish matures in two years of age. Brooders of 2+ year-classes are raised in earthen ponds along with other carps. Induced spawning is undertaken during monsoon months.
- ◆ Sexual dimorphism becomes clear in the spawning season. Females have bulged abdomen and soft pectoral fins, whereas males are slender, having rough pectoral fins and oozes milky-white milt from the vent.
- ◆ Captive spawning is undertaken either in hapa or hatchery. In both cases a sex ratio of 1:1 (number and weight) is recommended. Brooders are induced spawned by injecting either pituitary extract (PE) or commercially available synthetic gonadotropin hormones (CH) such as Ovaprim/ Ovatide/ Ovulin/ Gonopro/ WOVA-FH.
- ◆ PE to females is administered in two doses. First dose of 2-3 mg/kg and 2nd dose of 6-8 mg/kg body weight is injected within an interval of 6-8 h. Males are given a single dose of 2-3 mg/kg. However, in case of CH, a single dose of 0.5-0.6 ml/kg to female and approximately half of the dose (0.2-0.3 ml/kg) that is administered to female is given to male.
- ◆ After 6-8 h of hormone administration, egg and spermatozoa are stripped out into a dry bowl/tray and mixed for fertilization. One kg female lay around 0.8-1.0 lakh eggs. Rate of fertilization is generally 50-60%. Eggs are kept for hatching either in hatching hapa or incubation chambers of hatchery.
- ◆ Yolk-sac of the hatchling is absorbed in 65-76 h at a water temperature of 28-30°C and free-swimming spawn (size 5-6 mm) is developed with a hatching rate of more than 70%.
- ◆ Spawn is reared to fry size (20-25 mm) at 500-1000/m² density in prepared earthen nursery for 15-20 days with 30-35% survival. Concrete tanks at stocking density of 1000-2000 spawn/m³ yields better survival of 50-80%.
- ◆ The breeding technology has been widely adopted in all the states of the country.



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Common Carp

Cyprinus carpio (Linnaeus, 1758)

- ◆ Primarily native to the parts of Europe and Asia, common carp is the most widely cultured species all over the world.
- ◆ Attains maturity in the first year of its life and breeds in confined waters, almost throughout the year with two peaks of July-August and March-April.
- ◆ Sexes are distinct during spawning season with females having comparatively large bulged abdomen in comparison to male, and the later exudes thick white milt on pressing the belly.
- ◆ Captive spawning can be undertaken both in hapa and the hatchery. In both hapa breeding and in circular hatchery, a sex ratio of 1:1 female to male ratio is maintained.
- ◆ Brooders are induced by injecting either pituitary extract (PE) or commercial hormone (CH) in mild doses. Females are induced with a single dose of PG extract @ 2-3 mg or CH @ 0.1-0.2 ml/kg and males injected with PE @ 2 mg or CH @ 0.1 ml/kg and brooders are released into spawning pool/hapa in the ratio of 1:1. Since common carp eggs are sticky, either aquatic weeds or polythene/netting strips are spread in the spawning tanks substratum.
- ◆ Spawning occurs within 6-8 h of hormone administration. One kg female lay around 1.5 lakh eggs. Rate of fertilization is generally 80-95%.
- ◆ Stripping method of spawning is also practiced. In this method, male and female gametes are collected by stripping and fertilized by mixing them. As soon as eggs come in contact with water it becomes sticky. Therefore, it is essential to remove the stickiness to enable them proper handling and successful hatching, which is performed by using salt carbamide (fertilization solution) (30 g carbamide + 40 g NaCl dissolved in 10 l clean water) or cream milk method (20 g of full cream milk powder, fat content 26-28% in one litre of water).
- ◆ Eggs are kept for hatching either in hatching hapa or spawning tanks of hatchery, where they hatch within 36-48 h. The yolk-sac of the hatchling gets absorbed in 72 h and free-swimming spawn is developed with hatching rate of more than 70%.
- ◆ Spawn are reared in nursery ponds or concrete tanks for 15 days for raising fry.



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Silver Barb

Barbonymus gonionotus (Bleeker, 1849)

- ◆ An exotic barb of south-east Asia, has long been domesticated in India for culture in seasonal ponds as well as a component in carp polyculture system. A preferred fish species in eastern and north-eastern India.
- ◆ An aquatic weed feeder and hence preferred for culture in weed infested ponds and tanks for their control.
- ◆ Attains maturity in the first year and breeds twice in a year. Sexes are well distinguished at maturity with females having large bulged belly and red vent. Males are slender and ooze milky-white milt when abdomen is gently pressed.
- ◆ Brooders are reared in pond either alone or along with other carps. Mature brooders of 2+ year age having size 400-700 g, in sex ratio of 1:1 female to male are used for breeding.
- ◆ For induced breeding, commercial hormone (Ovaprim/Ovatide/GonoproFH) @ 0.30 ml/kg and 0.15 ml/kg is injected to females and males respectively. Spawning occurs 6-7 h after injection in circular hatchery.
- ◆ Eggs are transferred to hatching tank, where hatching occurs after 14-15 h. Female lays 5-7 lakh eggs/kg body weight. Spawn stage is achieved in another 45-50 h.
- ◆ Spawn of this species are very tiny (3 mm in length) in size and needs setting of small mesh filter cloth (1/80 mesh size) in the central overflow outlet of the hatching tank.
- ◆ Spawn is reared for 40-45 days in tanks for obtaining fry. They are fed on concentrated feeds such as milk powder, soya milk, egg custard and gradually weaned on to finely powdered oil cake, rice bran and fish meal mixture.
- ◆ The technology is widely adopted in West Bengal, Odisha, Tripura and Assam.



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Rainbow Trout

Oncorhynchus mykiss (Walbaum, 1792)

- ◆ Rainbow trout is a promising high value freshwater cultivable food fish of coldwater and has considerable scope for its expansion in uplands region.
- ◆ Breed during November to February and attains maturity after three years. It breeds in wild in running conditions. Captive broodstock development requires cold (9-14°C), clean and highly oxygenated water (>7 mg/l) and good feed with 45-50% protein.
- ◆ Sexes are separate and distinguishable on maturity with females having bulgy abdomen and reddish vent, whereas males are slender with pointed snout, hooked lower jaws and oozes white milt on pressing belly.
- ◆ Males and females are segregated 2 months prior to spawning and reared at density of 5-10 kg/m³ and sex ratio of 1:2 female to male. Brooders mature fully without hormonal application but do not naturally spawn.
- ◆ Fertilization of eggs is done by dry method of stripping. Fertilized eggs are lemon-yellow or light green in colour having diameter of 4-5 mm. A mature female lays around 1500-1800 eggs/kg body weight.
- ◆ Eggs are incubated in meshed trays (mesh size- 1.5-2.5 mm diameter) @ 2000 eggs/tray with provision for flowing water, where they hatch in 40-60 days and called sac-fry or alevin due to large yolk-sac attached with them.
- ◆ Sac fry (1.5-1.8 cm, 45-50 mg) are reared for 10-14 days in trays until metamorphosed to swim-up fry stage, when yolk-sac is fully consumed and larvae start feeding.
- ◆ Free swimming fry are fed 10 times a day @ 5-10% of biomass with starter feed. After one week, feeding frequency is reduced to 3-4 times a day and thereafter they are transferred to outdoor concrete tanks.
- ◆ The technology is in practice in the states of Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh.



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Giant Freshwater Prawn

Macrobrachium rosenbergii (DeMan, 1879)

- ◆ Giant freshwater prawn is the largest and fastest growing freshwater prawn widely distributed in Indian rivers confluent of the sea. It migrates between river and estuary.
- ◆ The sexes are separate, males are considerably larger having large cephalothorax, and long and robust second chelate legs than females.
- ◆ Females mature 3-4 times in a year with peak during the monsoon season (June to September). Breeding occurs in freshwater and the fertilized eggs are carried by the female in its brood-pouch under the abdomen. They are incubated for 18-21 days, during which the colour of eggs changes from orange to grey.
- ◆ For captive breeding, wild or pond reared berried females having grey egg-mass are collected. The egg-masses contain 20,000-1,60,000 eggs depending on prawn size. One to several females are kept in a hatching tank containing freshwater, where hatching occurs within 1-3 days during night hours.
- ◆ The hatched larvae, known as zoea, are shifted to larval tanks containing low saline water of 3-4‰, which is gradually increased to 10-12‰ within 24 h and maintained during complete 11-stage larval cycle.
- ◆ Two-phase clear water larval rearing methodology is recommended, i.e. high stocking density of 100 larvae/l in the first phase (up to V larval stage) and 40 larvae/l in the second phase (V-XI larval stage). It takes about 35 days to complete the larval cycle.
- ◆ The larvae are fed exclusively with freshly hatched brine shrimp nauplii (BSN) 3-4 times in a day up to 10 days. BSN is gradually replaced with egg-custard till larvae complete zoea-XI stages and metamorphosed to post-larvae (PL).
- ◆ PL are shifted to another tank and gradually acclimatized to freshwater, where they are reared for 10-15 days before shifting to the nursery tanks. Survival of 35% is achieved at PL stage.
- ◆ Seed production technology is adopted in the coastal states and in a few land-locked states.



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Indian River Prawn

Macrobrachium malcolmsonii (Johnson, 1973)

- ◆ Indian river prawn is the second largest freshwater prawn, distributed in the Ganga, Mahanadi, Godavari, Cauvery and Brahmaputra river systems.
- ◆ The sexes are separate. Males are larger and have large and robust second walking legs.
- ◆ The breeding season coincides with monsoon (June to September). Adults mature and breed in the rivers and lakes, and the larvae migrate down to estuarine waters, where they pass 11 larval stages in 40-60 days before metamorphosed to post-larvae.
- ◆ Fertilization is external and females carry fertilized eggs in brood chamber under the abdomen for 10-15 days where colour of eggs change from orange to grey. Fecundity ranges from 3,500 to 80,000 nos/individual depending on size.
- ◆ For seed production, the berried females carrying grey egg-mass are collected either from wild or pond and kept in indoor hatching tanks containing freshwater for hatching of eggs. Hatching occurs within 2-3 days.
- ◆ The hatched out larvae are reared in the larval rearing tanks in the hatchery at salinity of 15-20‰ and fed 3-4 times freshly hatched *Artemia* nauplii initially. The quantity of *Artemia* nauplii is gradually reduced and supplemented with *Moina* and/or egg custard.
- ◆ There are XI larval stages (zoea-I to zoea-XI), which takes 40-60 days, before they metamorphosed to post larvae. The post larvae are acclimatized to freshwater and reared for another 10 days before stocking in ponds.
- ◆ The seed production technology is adopted mainly in the states of Odisha and Andhra Pradesh.



Compiled by: Dr B.R. Pillai and Dr D. Panda

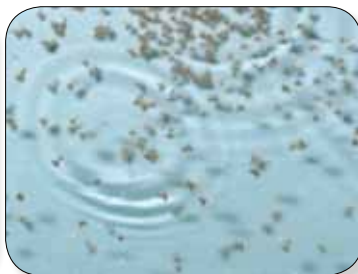
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Ganga River Prawn

Macrobrachium gangeticum (Spence Bate, 1868)

- ◆ Ganga river prawn is one of the largest freshwater migratory prawns found in India in the middle and upper stretch of Ganga and Brahmaputra river systems. It grows up to 100 g in weight.
- ◆ The sexes are separate with males having proportionately larger head, long and robust second walking legs than females. Breeds in freshwater in both flowing and captive waterbodies.
- ◆ The breeding season extend from May to October. Fecundity ranges from 6,400 to 78,000 depending on the size. Fertilization is external. The fertilized eggs are incubated in the brood chamber of the female for 18-21 days on the ventral side of the abdomen. Colour of the eggs changes from orange to grey with embryonic development.
- ◆ For seed production, the berried females having grey egg mass are procured from wild or rearing ponds/tanks and kept in hatching tanks in freshwater, where hatching occurs within 2-3 day.
- ◆ The larvae require brackish water after hatching and hence they are shifted to another tank where salinity is increased gradually and finally maintained at 10-12%.
- ◆ The larvae are fed on freshly hatched brine shrimp nauplii 3-4 times in the beginning and then gradually switched on to feeding on eggs custard. 30-40% tanks water is changed every day during tank cleaning.
- ◆ Larvae metamorphose to post larvae (PL) within 22-30 days, which are reared for another 10 days in another tank before stocking in the nursery ponds/tanks.
- ◆ The seed production technology developed by CIFA is yet to be adopted on commercial scale.



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Giant Tiger Shrimp

Penaeus monodon (Fabricius, 1798)

- ◆ Giant Tiger shrimp is the largest penaeid shrimp in the world and widely distributed in the Indo-Pacific region.
- ◆ It is a closed thelycum species, with distinguishable sexes as petasma in males and thelycum in female. Size at first maturity in the wild caught broodstock is about 35 mm (30 g) in male and 46 mm (60 g) in female. However, larger size of brooder (>100 g females and >80 g males) are procured for hatchery production of seed.
- ◆ Brooders can also be raised in captivity in maturation tank maintained with a density of 4 nos/m² with male: female ratio of 1:2 and fed with live feed like polychaetes, squid or maturation feed. Induced maturation is performed by unilateral eye stalk ablation (ESA).
- ◆ Ready to spawn females are transferred to the spawning tank. Just after spawning the females are removed and eggs are incubated for hatching after rinsing several times with clean seawater.
- ◆ Eggs hatch in 12-17 h to nauplii (hatching rate >80 %) which are stocked in larval rearing tank @ 0.5-1.0 lakh/tonne of clean disinfected water.
- ◆ Nauplii (6 stages) are non-feeding larvae which metamorphose to protozoa stages (3 stages) and further to Mysis (3 stages). The protozoa and mysis stages require 3-5 days each to complete their development, which further metamorphose to post-larvae and protozoa and mysis stages are fed with live algae viz., *Chaetoceros* and *Skeletonema*, the post-larvae are fed with *Artemia nauplii* along with live algae or microparticulate diet.
- ◆ The survival levels till harvest remains at 30-40%. The post-larvae are reared in the hatchery for another 15-20 days before stocking in ponds.
- ◆ The seed production technology is widely adopted in most of the coastal states.



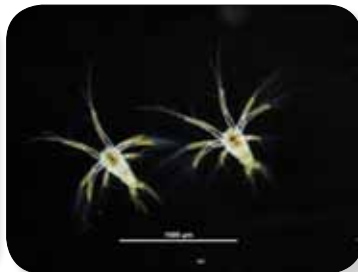
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Indian White Shrimp *Penaeus indicus*

- ◆ Indian white shrimp is widely distributed in the Indo-Pacific region.
- ◆ The species attains first maturity at size of about 148 mm and 35 g in female, and 128 mm and 25 g in male. Hatchery operation is undertaken by collecting either gravid female from the wild or inducing maturity through unilateral eye-stalk ablation (ESA) and rearing in captivity up to gravid condition.
- ◆ The brooders are screened for all important diseases like WSSV, IHHNV, MBV and EHP before shifting to the hatchery. After 3-4 days of acclimatization, the females are subjected to ESA for maturation. The broodstocks are reared in FRP/concrete tanks of 5 tonnes capacity at a density of 6/m², with a male: female ratio of 1:2.
- ◆ Total tank volume of 80-100 tonnes is required to produce one million post-larvae. Ablated brooders are reared in maturation tanks (>5 tonnes) and fed with live feed like polychaete worms, squids or molluscan meat and pellet feed.
- ◆ Fecundity of 1.0-3.5 lakh is observed from a female size of 35-80 g and in optimum condition, a hatching rate of 85-90% is obtained. Nauplii are free swimming and non-feeding and pass through six moults (N1 to N6) and stocked separately in larval rearing tanks @ 1 lakh larvae/tonnes.
- ◆ The larvae further pass through 3 stages of protozoa, 3 stages of mysis, and then to post-larvae, which are reared in different larval rearing sections using microalgae like diatoms (*Chaecoceros*, *Thalassiosira* @ 40-130 thousand cells/ml) during protozoa and mysis stages.
- ◆ Live *Artemia* nauplii (4-5 nos/PL) and microencapsulated particulate diet is given during PL1-PL20 stages. During PL 15-20 stages it becomes ready for stocking in ponds. Overall survival levels of 70-80% are obtained till PL 5 stage in commercial hatcheries.
- ◆ The seed production technology is adopted only to a limited scale in certain hatcheries of coastal states.



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Banana Shrimp

Penaeus merguensis (DeMan, 1988)

- ◆ Banana shrimp is widely distributed in the Indo-West Pacific region in both tropical and subtropical waters and forms an important fishery in South-East Asia and Australia.
- ◆ Females above 25 g and males above 20 g are used for the hatchery seed production. Gravid females are usually collected from the wild for seed production. Maturation can be induced in adult female by unilateral eyestalk ablation.
- ◆ Spawning takes place in the late night and the fertilised egg hatches out within 8-12 h after spawning depending upon the temperature with hatching rate 80 to 90%.
- ◆ The nauplii are free swimming and non-feeding larvae which are stocked in the larval rearing tank (LRT) @ 50,000 to 100,000/tonnes water metamorphoses to protozoa through six moults.
- ◆ The larvae pass through 3 stages of protozoa, 3 stages of mysis and then to post-larvae, which are reared in different larval rearing sections, provided with primarily with microalgae like diatoms @ 80,000-1,30,000 cell/ml during protozoa and mysis stages.
- ◆ During the commercial production cycle, an antibiotics-free protocol is to be followed with probiotics/bioremediation as part of the management tool.
- ◆ Live *Artemia* nauplii (4-5 nos/PL) and microencapsulated particulate diet is given during PL1 to PL12 stages. PL 5 larvae are transferred to PL nursery tanks and PL 15 stages onward the post-larvae become ready for stocking in ponds.
- ◆ A larval survival of 40-50% is achievable from Nauplius to PL 5 stage, following which up to PL 15, a survival of 75-85% can be achieved.
- ◆ The seed production technology is yet to be adopted at commercial level.



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Kuruma Shrimp

Penaeus japonicus (Bate, 1888)

- ◆ The Kuruma shrimp is distributed in the Indo-west Pacific region, from South East Africa to south-east Asia to north Australia.
- ◆ Broodstocks of an average weight above 40 g for female and above 20 g for males are recruited for the hatchery productions after quarantine screening for all important diseases.
- ◆ Induced maturation is practiced by unilateral eye-stalk ablation and/or hormonal treatment in hatchery conditions.
- ◆ Female shrimp reaches final reproductive maturation within 1 to 2 weeks after eye-stalk ablation and lays 80,000 to 3,00,000 eggs depending on size.
- ◆ Fertilized eggs hatches to nauplii which metamorphosed to six such stages (N 1-N VI) and further to three stages of protozoa followed by three stages of mysis. Larval rearing is completed within 10-11 days and larvae metamorphosed to post-larvae.
- ◆ A feeding regime starting with microalgae like diatoms maintained at 80,000-1,30,000 cell/ml is followed during protozoa and mysis stages following which live *Artemia* nauplius (4-5 nos/PL) and microencapsulated particulate diet is given during PL1 to PL20 stages.
- ◆ PL 5 from each larval rearing tanks are transferred to PL nursery tanks where they can grow up to PL 15-20 stages, which become ready for stocking in commercial shrimp ponds.
- ◆ Routine health check following the level of assessment and complying with HACCP principles and code of conduct of responsible fisheries should be part of good hatchery management.
- ◆ The seed production technology is yet to be adopted at commercial level.



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Green Tiger Prawn

Penaeus semisulcatus (De Haan, 1844)

- ♦ Green tiger prawn is a commercially important penaeid shrimp species, dominant in the coastal waters of Tamil Nadu. Grows to 230 mm and 270 mm in TL in case of males and females, respectively.
- ♦ Gravid females are recorded round the year with two peaks, one during July-September and the other during February-March. Female lays 2-4 lakh eggs.
- ♦ Seed production can be carried out using wild spawner or hatchery developed broodstock. Gravid females can be identified by observing the gonadal development from the dorsal exoskeleton of the shrimp.
- ♦ Hatching occurs 12-14 h after spawning.
- ♦ Larval stages comprise six naupliar stages (NI-VI), three protozoa stages (PZI-III) and three mysis stages (M I-III), and last mysis stage moults to post larval stage (PL-1). It overall takes 9-10 days, to complete the larval stages.
- ♦ Nauplii larvae are stocked @ 100 nos/litre and feeding starts with first protozoal stage (PZ-I). Larvae, from PZ-I to M-III stages are fed with *Chaetoceros* spp by maintaining at 1000 cells/ml in the rearing tanks. PL-1 to PL-20 are fed with microencapsulated diet (@ 2-4 mg/larva/day) and *Artemia* nauplii (@1-2 no/ml).
- ♦ Survival of the N-I to PL-20 is around 32%. Salinity in the range of 32 to 35 ppt is ideal for larval rearing.
- ♦ The seed production technology is yet to be adopted at commercial level.



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Sand Lobster

Thenus unimaculatus (Burton and Davie 2007)

- ◆ Sand lobster is distributed in Indian Ocean from West to East and is one of the most promising candidates for lobster aquaculture in India.
- ◆ Breeds all along the Indian coast from December to March. Captive maturation and breeding can be successfully done in FRP and concrete tanks of 3-20 tonnes.
- ◆ Sexes are separate. Mature males are identified on the basis of bright coloured genital opening at the base of the 5th walking legs and general yellowish pigmentation with oranges pleopods and uropods in females.
- ◆ Females mature in a rearing system with 12:12 D:L photoperiod at 26-28°C.
- ◆ Mating occurs during morning and fertilized eggs get attached to the pleopodal setae for incubation, where they incubated for a period of about 5 weeks with change of colour from orange to blackish. A 60-102 mm CL female lays 20,000-60,000 eggs.
- ◆ Late stage ovigerous females are shifted to hatching tanks of 200-300 L capacity, with a filter gun and flow-through to separate hatched phyllosoma stage larvae.
- ◆ Day-one hatch phyllosoma larvae starts feeding in 3 h time and fed with live feeds or particulate diets (clam meat) ranging from 400-2000 microns in sizes as per the molt stages at 6 h interval. There are four phyllosomal stages and each stage takes nearly 4-5 days to moult and grow.
- ◆ Fourth phyllosomal stage changes to post-larval nisto stage before it metamorphoses to a seed. The cycle is completed in 26 days in the lab conditions in water salinity 35-37 ppt.
- ◆ The seed production technology is yet to be adopted at commercial level.



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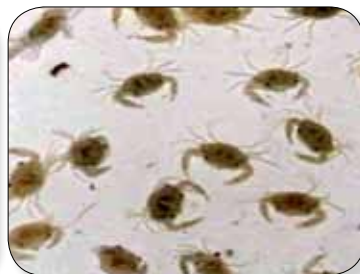
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Indo-Pacific Mud Crab

Scylla serrata (Forsskal, 1775)

- ◆ Distributed in Indo-West Pacific region, from East and South Africa to southeast and east Asia.
- ◆ Mature females are obtained from estuarine/coastal waters or from brackishwater ponds. Mature females of size above 450 g (carapace width: >12.5 cm) with dark orange ovary, indicative of having fertilized eggs, are transported to the hatcheries. Male brooders are not required, as female has already mated with male at this stage.
- ◆ Mature brooders can also be raised in hatchery without any inducement. For faster maturity, broodstock can be unilaterally eyestalk ablated. Sand filled tanks are kept in the broodstock tank to facilitate successful spawning.
- ◆ Feeding is done by giving squid/trash fish at 5-10% of body weight.
- ◆ Females spawn within one month based on the reproductive condition and eggs after release accumulates under the abdomen as single egg-mass and called berried female. Hatching occurs within 10-12 days and hatched crabs are released back to the maturation facility for further spawning.
- ◆ Hatched Zoea are reared in the larval rearing tanks at stocking density of 80-100 Zoea/l. This crab has five Zoeal stages (Z1 to Z5), and each Zoeal stage takes 2-3 days to metamorphose to the subsequent stage. Zoea 5 stage metamorphoses into megalopa stage and megalopa takes seven days to convert to Crab Instar 1.
- ◆ The first two Zoeal stages (6-8 days) are fed with rotifer at a density of 15-20 individual/ml. Third Zoeal stage onwards are fed with newly hatched *Artemia* nauplii (1-2 no/ml). Zoea 5 and early megalopa are fed with 5-7 day old *Artemia*. Megalopa 3 onwards are grown in net cages in the brackishwater ponds at a stocking density of 50 no/m². Megalopa in the net cages are fed with minced fish and clam meat. Crab instars 2-3 are harvested within 7 days.
- ◆ Seed production technology is mainly adopted in Andhra Pradesh and Tamil Nadu.



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Blue Swimmer Crab

Portunus pelagicus (Linnaeus, 1758)

- ◆ Blue swimmer crab is one of the most important marine crab in India, distributed all along the east and west coasts with a dominant fishery at Palk Bay and Gulf of Mannar.
- ◆ Suitable species for marine farming. Males grow to a maximum size of 650 g and females 550 g.
- ◆ Captive brood stock is raised either through hatchery raised crab instars or wild collected juvenile crabs in recirculation systems. It is a continuous breeder and berried females are available throughout the year in major fishing areas of the species.
- ◆ Female may lay 0.06-1.90 million eggs/spawning depending on the size of the mother crab.
- ◆ Larval stages comprise of four zoeal stages (Zoea I-IV) and a megalopa stage which moults to the crab stage (Crab Instar-I), which takes on an average 17 days with an average survival of 5%.
- ◆ Zoea-I larvae is stocked and reared in tanks of 1-2 tonne capacity @ 50 nos/ litre. Fine filtered seawater of 30-32% salinity is used for larval rearing.
- ◆ Larval feeding is initiated as soon as the zoeae are hatched out. The larvae are fed with a combination of enriched rotifers, freshly hatched nauplii of *Artemia* and egg custard at megalopa stage.
- ◆ The seed production technology is yet to be adopted at commercial level.



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60.	<i>Scylla serrata</i>	Dr. C.P. Balasubramanian, Mr. Antony Jose and Mr. R. Aravind, ICAR-CIBA, Chennai, Tamil Nadu E-mail: cpbalasubramanian@yahoo.com
61.	<i>Portunus pelagicus</i>	Dr. Josileen Jose, ICAR-CMFRI, Kochi, Kerala E-mail. drjoslin@gmail.com



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