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Review Article

Recent Advances in Murrel (Snakehead) Fish Farming in India

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Abstract

India is one of the world's leading producers of fish. By adding native candidate fish species into system-specific aquaculture, aquaculture diversification is a feasible approach for increasing fish production. Murrels/snakeheads (*Channa* spp.) are an important source of food in freshwater. Its suitability for aquaculture is supported by year-round consumer demand and market demand. Due to its ability to breathe air, murrel is also suitable for intensive farming systems with a high population density. The primary source of murrel production is fishing in natural bodies of water. Presently, murrel production is quite low and seed availability is primarily dependent on natural breeding. The ICAR-Central Institute of Freshwater Aquaculture in Bhubaneswar has recently devised and standardised captive breeding and seed production systems for the striped murrel. For pond culture activities, artificial seed production and the availability of striped murrel (*Channa striata*) are gaining steam in many Indian states. Several hectares of land in the vicinity of the irrigation canals become barren and unsuitable for agriculture. In this flooded region, sufficient resources remain for the expansion of inland fisheries, including murrel farming.

Keywords: Murrels/Snakeheads; Striped Murrel; Hybrid Murrel; Captive Breeding; Fingerlings

Introduction

Aquaculture contributes significantly to the global food and nutritional security. It is one of the world's fastest-growing food-producing industries. Aside from this, consumer demand for fish is raising dramatically due to its health benefits. Therefore, there is a significant opportunity and requirement to increase fish output through aquaculture to fulfill future demand. Aquaculture diversification is a viable approach for increasing fish production with the addition of native candidate fish species. Due to its air-breathing nature and ability to withstand low dissolved oxygen levels, the murrels is regarded as a potential option for high-density aquaculture systems.

Murrels have enormous potential for offering rural poor and unemployed adolescents with work options. Economically, murrels (snakeheads) and catfishes rank highest among freshwater fish species. Murrels have been cultivated commercially in Thailand, Taiwan, and the Philippines for decades. India's commercial culture of striped murrel has recently gained pace. Murrels are a prospective species for aquaculture in Asia due to their great growth rate and ability to be grown at high stocking densities. Among the numerous prospective candidates for domestication, murrels are consistently in high demand in many Indian states. In Indian states of Telangana, Andhra Pradesh, Karnataka, Tamil Nadu, Assam, Bihar, Jharkhand, Uttar Pradesh, Haryana, Punjab, Madhya Pradesh, etc., murrels are

considered popular food fishes with significant medicinal value. These fish are sold alive because they can be kept out of water for several hours in a moist environment. Due to their flavour, meaty flesh with few intramuscular bones, and medicinal characteristics, murrels are favoured by consumers [4]. During the year 2022-23 murrel (snakeheads) fish production is 2.57 lakh tones in the country. Among the Indian states Andhra Pradesh, Bihar and Telangana are the major producers of the murrel fish [2].

Figure a

In India, 21 species of *Channa* have been identified so far based on colouring, morphometrics, scale patterns, fins, etc [Table 1] [1]. Striped murrel (*Channa striatus*), is an economically significant and widespread species; it is favoured by customers and ranks first among edible murrels such as *C. marulius*, *C. punctatus*, and *C. gachua*.

Sl. No.	Scientific name	Common name
1	*Channa amphibeus*	Borna snakehead
2	*Channa andrao*	Redspotted snakehead
3	*Channa aurantimaculata*	Goldspotted snakehead
4	*Channa aurantipectoralis*	Orangefinned snakehead
5	*Channa barca*	Barca snakehead
6	*Channa bleheri*	Bluefinned snakehead
7	*Channa brunnea*	Brown bleheri
8	*Channa diplogramma*	Malabar snakehead
9	*Channa gachua*	Dwarf snakehead
10	*Channa harcourtbutleri*	Burmese snakehead
11	*Channa kelaarti*	Dwarf snakehead
12	*Channa marulius*	Great snakehead
13	*Channa melanostigma*	Lohit snakehead
14	*Channa orientalis*	Walking snakehead
15	*Channa pardalis*	Leopard snakehead
16	*Channa pomanensis*	Poma snakehead
17	*Channa pseudomarulius*	Orangespotted snakehead
18	*Channa punctata*	Spotted snakehead
19	*Channa rara*	Bluefinned snakehead
20	*Channa stewartii*	Rara snakehead
21	*Channa striatus*	Striped snakehead

Table 1: List of *Channa* species reported in India [1].

In recent years, striped murrel (*Channa striatus*) culture production has steadily increased, indicating their adaptability and scalability in an artificial culture environment. However, in the majority of South Asian regions, the principal source of striped murrel is capture fishing, as aquaculture still relies on natural seed supply and hence contributes very little. ICAR-Central Institute of Freshwater Aquaculture (CIFA), Bhubaneswar, India, has standardized artificial seed manufacturing processes, and the technology is being distributed to end-users via training and demonstrations. Small-scale commercial hatcheries have only begun in various Indian states [3].

Advances in seed production

The striped murrel (*Channa striata*), one of the most popular native food fishes, is rich in dietary protein, amino acids, and unsaturated fatty acids, and possesses great nutritional and pharmacological value. However, cultivation of this species has not taken off mostly because its seeds are unavailable. The captive breeding and seed production technology for striped murrel has been created and standardised by the ICAR- Central Institute of Freshwater Aquaculture, Bhubaneswar, India and technology is being disseminated to the end-users through training and demonstrations [3]. The commercial hatcheries have just started in some states, particularly in Telangana, Tamil Nadu, Odessa etc.

Identification of male and female brooders

Murrels spawn naturally during southwest monsoon and also in Northeast monsoon in flooded rivers and ponds of India.

The spawning season is different in different regions depending upon the pattern of rainfall. The sexes are distinguished by using secondary sexual characteristics during the spawning season. The female fish develops a bulging soft abdomen due to the development of ovary and the genital pore becomes reddish and oval shape. The head of the male is round shape and has the smaller genital papilla. The male and females can be distinguished only during the spawning season (Table 2 and Figure 1).

Body part	Males	Females
Pectoral fin	Inner surface, facing the body, is rough to touch.	Inner surface, facing the body, is smooth to feel by touch.
Abdomen	Generally shows a slightly bulging and is soft to touch.	Not show a bulge and is not very soft to touch.
Vent	Exhibit pale vent, prominent and papilla like structure with a pointed tip.	Round and reddish vent. The anal papilla is broad, blunt like structure with reddish dots.
Genital aperture	Milky white milt exudes through genital aperture applying gentle pressure to abdomen.	Ova visible inside when gentle pressure applied to abdomen.

Table 2: External distinguishing features of sexes of striped murrel.

Figure 1: Identification of male (left) and female (right) striped murrel brood fish.

Induced breeding operation

After the selection of brood fish the injectable dosage of extract or hormone is calculated terms per kg body weight of the recipient fish. After deciding on the dosage, the quantity required for injecting the selected brood fish is calculated. Both ready-to-use bottled or ampouled extract and freshly prepared extract can be used. For the preparation of fresh extract the required quantity of glands should be taken out, blotted, dried and weighed accurately. The glands are then macerated in a tissue homogenizer with a small quantity of distilled water and further diluted so that each ml of the extract should be equivalent to 20 - 40 mg of pituitary gland. The extract is thereafter centrifuged to get rid of tissue fragments and only the supernatant solution is utilized for the injection [6].

Breeding sets

Each set should consist of both female and male spawners in the ratio of 1:2. The selected breeding sets can be kept either in hapas or in modern breeding enclosures (Figure 2).

Figure 2: Female and male striped murrel brood fish kept ready for inducing.

Dose of injection

The desired dose of carp pituitary extract is 20 to 30 mg/kg and 30 to 40 mg/kg of body weight for male and female fish respectively (Figure 3). The induced breeding work is generally taken up on cool and cloudy days when the water temperature is around 25-30°C.

Figure 3: Hormonal injection to murrel brood fish.

Method of injection

After the injection to the both males and females of the set are released in the breeding hapa or the breeding enclosure. A water depth of 40-80 cm is preferred for spawning tank. The aquatic weed (water hyacinth) should cover one-fifth of the breeding pool, which stimulate the spawning. The recommended temperature for spawning is about 25 to 28°C.

Release of eggs

Fishes have unusual spawning characters and chasing occurs. The spawning usually takes 16 to 18 hrs after the hormone injection. Female fish of 1 kg releases about 10,000 to 15,000 eggs. The eggs are released by the females and are fertilized naturally inside the breeding pool by the milt released by males. The eggs are free floating, spherical, non-adhesive and bright yellow colour. The fertilized eggs are transparent and unfertilized eggs are opaque (Figure 4). Fertilized egg size diameter ranges from 1.2 to 1.5 mm.

Figure 4: Striped murrel fish eggs floating in breeding pool.

The fertilized eggs are collected by using the plankton net and are shifted to the Fibreglass reinforced plastic (FRP) container for hatching (Figure 7). The total quantity of good eggs laid is estimated from the total volume of eggs and percentage of fertilization. Fertilized and viable eggs are transparent in colour while dead ones appear opaque under naked eye. Percentage of fertilization is scored from several egg samples examined in a petridish or watch glass. The eggs are measured by a graduated glass jar of 250 ml capacity and collected in plastic tubs (Figure 5, 6). From the plastic tubs, require eggs are collected with the help of a 1 liter mug and spread uniformly in hatching tubs.

Figure 5: Striped murrel fish eggs collection with smooth hand net from breeding pool.

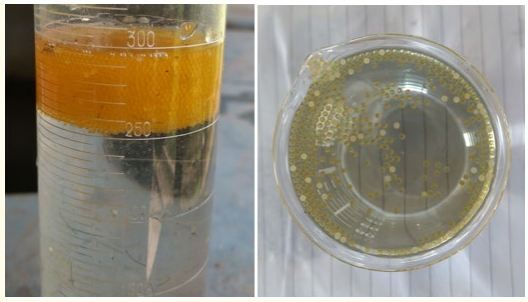

Figure 6: Measuring of striped murrel fish eggs with jar (left) and calculation of fertilized & unfertilized eggs in petri dish (right).

Figure 7: Murrel fish eggs hatching in FRP tubs.

Incubation and hatching

As soon as the egg is fertilized, embryonic development occurs inside the egg until hatching. At this point, the larva tears through the shell and begins an independent life. During the egg development stages, the eggs are susceptible to predation, and

attacks from bacteria and fungus growth. Eggs should be protected from shock, as the cell divisions occurring inside the eggs can be disrupted. Direct sunlight is often a problem, and should be avoided. Hatching time takes between 16 to 18 hrs. The fertilization rate is about 80 to 90 percent and the average hatchling rate is 70 to 90 percent. The newly hatched larvae size range between 3.0 to 3.5 mm. Larval feeding commences after 72 hrs of hatching (Figure 8).

Figure 8: Striped murrel fish (top) hatchlings and spawn (bottom).

Feeding and Fingerlings production

Spawn is reared in prepared nurseries up to fry stage with proper feeding and care. It is a crucial stage of rearing. After hatchling, the digestive tract appears as a straight tube lying to the yolk sac, but with no accessory digestive organs. The yolk sac absorption is very fast after 1 to 2 days of hatching and the digestive tract is developed. After three days, early fry starts to consume the feed such as zooplankton (protozoan's, rotifers, and cladocerans) (Figure 9). This is continued until they grow to the size of 20 to 30 mm. The expected survival rate is about 50 to 60 percent at 20 to 25 days [5].

Heterogeneity and cannibalism are the two phenomena, which affect the growth and survival of the fry of striped murrel in large numbers. The heterogeneity occurs due to improper distribution of food, higher stocking and less space for individual fry. The cannibalism directly enhances the heterogeneity and it is avoided

Figure 9: Collection of zooplankton for murrel seed feeding.

through optimum stocking and high feeding rate. Typically, 2 to 3 percent of fry turn into shoot fry, which leads to increased small size fry. It can be removed through periodic segregation of bigger size fry (Figure 10, 11).

Figure 10: Striped murrel fry.

Figure 11: Shoot fry among fry seed (left) and removal of shoot fry (right).

Initially, the idealist weaning feed quantity is 8 to 10 percent body weight of fish or until satisfaction, which curtails the cannibalism. The artificial feeds are offered after full development of digestive tract, with the protein amount of 40 to 50%. Finely chopped low market value fish are to be fed to the fry. The feeding rate is tweaked according to the intake amount and feeding behaviour of fish, which helps to enhance the survival rate.

Striped murrels fry are stocked with higher density, owing to the presence of additional air breathing organ. A reduction in fish growth is observed when it is more than the optimum stocking density. Studies have attempted to establish standard stocking density of striped murrel, but the stocking rate is extremely variable ranging from 20000 to 50000/ha/yr. A greater survival of 75 percent has been recorded with a stocking density of 15000/ha. Another study assessed the effect of stocking density; a better growth rate was registered with a stocking density of 50 m^2 than those of the 100 and 150 m^2 [5].

The fingerlings consume the zooplankton and small crustaceans (especially insects). The live feed such as Tubifex and earthworm are good food for hatchery rearing fingerlings (Figure 12). The fishes are feed by combination of both low market value fish and rice bran with a ratio of 3:1 to 8:1. This also highly varies due to fish availability in the local market and market value of the fish at a given time.

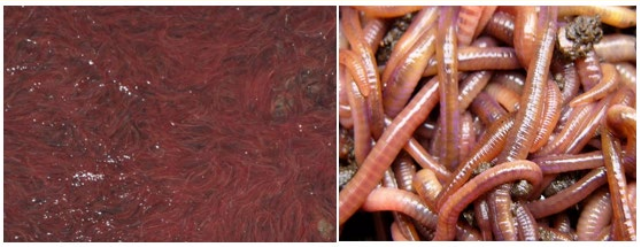

Figure 12: Live feed- Tubifex (left) and Earthworms (right).

However, the fishes have to be practiced to take floating feed rather than low market value fish, to reduce the operating cost (Figure 13). Fishes are fed at 6 to 8 percent of the body weight of the fish. If cannibalism still continues, it is advised to increase the feeding quantity to ensure higher survival rate. The protein requirement of fingerlings of striped murrel is about 40 to 45 percent. The anticipated survival is about 30 to 40 percent. Now the fingerlings are ready for grow-out culture (Figure 13, 14).

Figure 13: Floating pellet feed.

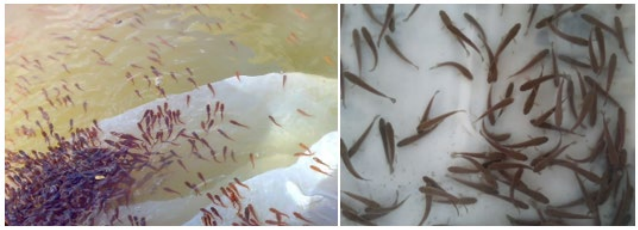

Figure 14: Striped murrel early fingerlings (left) and advanced fingerlings (right).

Production trends

At a supplementary feeding rate of 5% of the body weight, the stocking density of striped murrel fingerlings is around 400 to 600 per hectare in irrigation tanks and 10,000 to 12000 per hectare in exclusive culture ponds. Typically, murrel fish is harvested during the summer months, when the fish attains a marketable size in irrigation tanks. The production ranges from 150 to 250 kilograms per hectare per year in irrigation tanks and 8 to 10 tonnes per hectare per year in culture ponds where supplementary feed is applied. The market price of striped murrel is between INR 350 (USD 4.18) and INR 450 (USD 5.38) per kilogram, compared to INR 100 (USD 1.20) and INR 150 (USD 1.79) for other types of freshwater fish. In various Indian states, hybrid murrel culture is currently being practiced but market price is between INR 250 (USD 2.99) and INR 300 (USD 3.59) per kilogram. Compared to striped murrel, production costs are considerable and price is unattractive.

Figure 15: Supplementary feeding in murrel culture pond.

Figure 16: Striped murrel (left) and Hybrid murrel (right).

Prospects

Air-breathing fishes, such as murrels, may offer a considerable benefit for aquaculture since they can flourish in environments with low dissolved oxygen. Due to its high nutritional value and widespread demand in India, additional research must be conducted on murrel breeding and nutrition before the species can be produced on a commercial basis. Despite India's extensive freshwater resources, only a small portion of land is utilised for murrel farming in different regions. Numerous reservoirs/projects have been built on the rivers and their tributaries in India, causing many hectares of land to become waterlogged and unsuitable for agriculture in the vicinity of the canals of the projects; the vast waterlogged area is available for fisheries development in the command area. As a result, there are still adequate resources for the expansion of inland fisheries activities, such as murrel farming.

The various State Governments in India are aware of the potential of murrel farming; nevertheless, rearing and feeding murrels on a commercial scale is hampered by technological limitations. As a result of embracing murrels as a variety in their fish growing techniques, there is a substantial domestic market for murrels. With the right application of available resources and technology, several states can increase their murrel production, and the aquaculture industry may increase its profits. Capacity building is crucial for boosting the adoption of scientific technologies at the field level, and a significant number of fish farmers should be taught in specific aquaculture technology modules.

Conclusion

Due to its delicious meat, live availability, ease of transportation and capability to thrive in available wetlands, the murrel industry in India has tremendous opportunities for a cost effective business. However, optimal water quality with suitable depth, stocking density, fishers adopting advanced technologies and regular health checks of fish are mandatory in expecting good profits from this culture.

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