# Development of Captive Breeding, Seed Production and Culture Techniques of Snakehead Fish for Species Conservation and Sustainable Aquaculture

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***Abstract*****—**The murrel or striped snakehead *Channa striatus*, a carnivorous air breather, is one of the valuable food fish, which deserves immediate attention for commercial scale seed production and grow-out farming. It is one of the best and excellent table-size fish in Bangladesh, India as well as in South East Asia. It fetches high prices in the market due to strong demand, higher nutritional and pharmaceutical values, food delicacy, and can also be sold alive. The fish is considered as one of the commercially important species in Thailand, Philippines, Malaysia, India, Bangladesh, Vietnam and Cambodia. However, in the recent years, the natural stocks of the fish are decreasing severely due to the increased anthropogenic activities, habitat alterations and unstrained harvesting. As a result, the natural breeding and feeding grounds of this high-valued fish species have been destroyed, which caused havoc to the biodiversity leading to decline in wild stocks. Presently, *C. striatus* is considered as a threatened fish species in Bangladesh. Due to the non-availability of quality seeds and difficulty in induced breeding of this fish, not much could be achieved towards commercialization of the species or conservation. Keeping this in mind, it is now very important to protect this endangered species in a sustainable and worthwhile manner. In the present investigation, advancement of the controlled breeding, seed production and culture protocols have been described and the difficulties faced by the farmers and farm-entrepreneurs in snakehead farming are briefly discussed and suggestions to overcome the problems are accentuated.

***Keywords*****—**Snakehead, *Channa striatus*, Breeding, Seed production, Grow-out culture, Conservation.

## I. Introduction

The snakehead or murrel (*Channa striatus)* belonging to the family Channidae, is one of the important native freshwater fish of tropical Asia and Africa [1]. In Bangladesh, *C. striatus*, locally referred to as 'Shol', is an economically important species along with other species of the genus *Channa* [2, 3]. It is one of the main food fishes in Thailand, Indo-China and Malaysia [2, 3]. The heavy dark skin of snakehead is good for soup and is usually sold separately [4]. Snakehead is commercially cultivated in Thailand, Philippines, Vietnam, Cambodia, India and Pakistan [2, 3, 5, 6]. It is an air-breathing fish and highly regarded as a food in Asia because its flesh is claimed to be rejuvenating, particularly for those recuperating from a serious illness [7] and as a post natal diet [5]. The flesh of this fish is firm, white, practically boneless, and has the most agreeable flavour. It is widely consumed for its nutritional value as well as for its beneficial effect in wound healing [5, 8]. It is also well known for its therapeutic effect in wound healing and pain reduction due to osteoarthritis [9]. Air-breathing fish have substantial advantages for aquaculture, because they can survive in harsh environment with low level of dissolved oxygen and high ammonia content [1, 10], and therefore, are often cultured in grow-out ponds at densities of 40-80 fish $m^2$, with annual yields ranging from 7 to 156 mt/ha [5, 11]. Nowadays, *C. striatus* is also widely cultivated in tanks of Andhra Pradesh and attains a size of 90 cm and grows above 2 kg weight.

*Channa striatus* possesses a pair of suprabranchial cavities for aerial respiration and that is why it is very hardy and can remain alive for long period out of water, if kept moist [12]. On the roof of its pharynx, the fish has also a pair of cavities, which have folded linings, richly supplied with blood vessels for taking in air. These accessory respiratory organs enable these fishes to survive out of water or migrate from one pool to another. They are therefore called "live fishes". This characteristic is valuable for marketing, because live snakehead fetch considerably higher prices than dead fish [5, 13]. There are around 33 snakehead fish species native to Asia, and among them, 11 species (Fig. 1) are biologically and commercially important for aquaculture production and biodiversity conservation throughout the region.

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Fig. 1: Commercially important snakehead fish species endemic to Asian countries

Murrel is predatory in habit and feed on a variety of living creatures including fish, frogs, snakes, insects, tadpoles and earthworms . In Bangladesh, it is considered as one of the common food fish and much favourite to the buyers and consumers due to high taste qualities and delicacies [3, 6]. Once, the fish was abundantly found in open water bodies such as natural depressions, floodplains, inundated paddy fields, ponds etc. However, during the past few years, the production of *C. striatus* from the natural water bodies is declining day by day due to habitat degradation and man-made hazards in aquatic ecosystem. These factors not only caused havoc to the biodiversity but also destroyed the feeding and breeding grounds of this important fish species. As a result, the fish is not very much available in the market and therefore has become gradually endangered.

## II. Breeding and Larval Rearing

Before the onset of the spawning season, *C. striatus* normally build nests to breed in their natural habitat. Construction of nest is very important, and the parents usually clear an area of the water surface surrounded by aquatic vegetation. It usually breeds during the onset of monsoon in ditches, ponds and flooded paddy fields. The absolute fecundity of the fish varies from 16,330 to 56,467 in the size range of 34.2-51.50 cm [3]. The young remain at the surface in shoals guarded by their parents, hiding just below the surface of water. Ali [14] studied the reproductive biology of *C. striatus*, which were collected from the irrigated rice fields of Malaysia and found six developmental stages of oocytes around the year. The continuous observation of different ovarian stages in snakehead revealed that gonadal development and spawning of *C. striatus* occur all through the year. There has been remaining inadequate information about the breeding and feeding of early larval stages of snakeheads [15]. They had also conducted an experiment to breed *C. striatus* in a controlled laboratory conditions. The brood stocks of snakehead were injected with ovaprim hormone with a dosage of 0.5 ml/kg body weight and spawning occurred within 24-26 h, following the injection with the hormone. The fertilized eggs were floating, non-adhesive, straw yellowish in colour and have a diameter ranging from 1.20 to 1.40 mm. The incubation period took 23-24 h at the temperature of 29±1°C with the hatching rate of 80-85%. The newly hatched larvae were 3.4±0.2 mm in length and the yolk absorbed completely within three days after hatching. Two days after hatching, snakehead fry start to swim vertically with the right eye side up. The larvae usually metamorphosed to young juveniles within 20 days post-hatching in the rearing system.

## III. Seed Production and Culture

Rearing of snakehead larvae is a herculean task, since they are carnivorous, piscivorous and cannibalistic. Captive reproduction and larval rearing of snakehead have been accomplished experimentally, but are not done on a commercial scale [2, 10]. Attempts have been made to develop rearing techniques for snakehead in Hawaii, USA [16]. During the early post larval stage, it is better to feed them with small plankton like rotifers and *Artemia* nauplii [6, 10]. Although, *Artemia* nauplii and rotifers are the common live food organisms mass cultured for hatchery use, there is growing interest for the production of *Cladocera* [17-19]. Successful snakehead culture will therefore ultimately require development of appropriate feeds and feeding methods for successful larviculture [10]. The suitability of wild live food organisms as food in the larval rearing of the fish and prawn larvae was indicated earlier [20]. Many studies reported the utilization of cultured live food organisms as food [2, 21, 22]. For the development of any aquaculture operation, one of the main obstacles to overcome is the availability of fry/fingerlings [23]. The life cycle of any species of fish from hatchlings to fry/fingerlings stage have high mortality, and even 100% mortality is not uncommon. Lakhamanan et al. [24] stated that besides supplementary feed, among other factors, stocking density play a vital role influencing growth and survival of fry and fingerlings in nursery ponds. In the recent study, Rahman et al. [6] reared *C. striatus* at different stocking densities of fry viz., 150,000/ha, 200,000/ha and 250,000/ha in $T_1$, $T_2$, and $T_3$, respectively for eight weeks in earthen nursery ponds), fed with a supplementary feed comprising of fish meal (50%) and mustard oilcake (50) at the rate of 5-8% of the estimated body weight. In addition, chopped trash fishes were supplied at the rate of estimated biomass daily till harvesting. They obtained the highest growth and survival of fingerlings from the treatment ($T_1$) where stocking density of fry was maintained at 150,000/ha than those produced in higher densities.

Snakehead has long been considered as a valuable food fish for the peoples of the Asian countries [4] due to its firm, white and almost boneless tasty flesh and also easy to handle, all these attributes actually made it suitable for commercial aquaculture [11]. Diana et al. [25] reared snakehead juveniles at different stocking densities from 40 to 80 fingerlings/$m^2$ and obtained the survival rates from 13 to 15% after a rearing period of 9-11 months in earthen ponds. Nevertheless, it was unclear from their study that whether the growth of snakehead was affected by varying stocking densities. Rahman et al. [3] conducted a grow-out culture trial of snakehead at different stocking densities of 5000, 6250 and 7500 fingerlings/ha for 10 months and concluded that 5000 fingerlings/ha was the most suitable density for culturing of *C. striatus* in earthen pond for better survival, growth and production. In their study, Yang et al. [26] cultured mixed-sex Nile tilapia with snakehead at different experimental treatments, which were: monoculture of sex-reserved all male tilapia ($T_1$), monoculture mixed-sex tilapia ($T_2$), polyculture of snakehead and mixed-sex tilapia ($T_3$) at ratios of (1:80), (1:40), (1:20) and (1:10). Among the treatments judged, polyculture of snakehead with mixed-sex tilapia (1:80) showed the highest performance by reducing the overcrowding in pond due to fast breeding of tilapia. The predatory snakehead not only acted as biological control of tilapia but also contributed to higher economic gain since it had high market demand. During the recent study, Amin et al. [27] conducted a grow-out culture experiment of the high-valued Chevron snakehead at different stocking densities for the first time in fiberglass tanks. Fingerlings stocked at 20 individuals/$m^2$ were designated as treatment-1 ($T_1$), 30 individuals/$m^2$ as treatment-2 ($T_2$), and 40 individuals/$m^2$ as treatment-3 ($T_3$). After stocking, fingerlings in all the experimental tanks were fed with commercial pellets containing 44% crude protein and 6% crude fat at a rate of 6% of the estimated body weight of fish twice daily. After the culture period of 32 weeks, significantly highest gross and net productions of snakehead were obtained at the highest density ($T_3$) and the lowest at the lowest density ($T_1$). On the basis of the growth and production obtained from the above culture treatments, the stocking density of 40 individuals/$m^2$ was recommended to be the best density for the large-scale culture of chevron snakehead in captive rearing condition.

## IV. Recommendation AND Conclusion

Due the over exploitation, environmental degradation and various man-induced hazards in the aquatic ecosystem, *C. striatus* may become extinct from the natural habitats. However, the demands for *C. striatus* in the Asian market have been increasing day by day due to its excellent taste qualities and white boneless flesh for easy consumption. On the other hand, it has higher nutritional and pharmaceutical properties to speed-up the healing of wound and thus commonly consumed among caesarean mothers, hence making it commercially feasible to culture, especially in tropical Asia. Sufficient information and proper knowledge on breeding, larval rearing, seed production and culture protocols of *C. striatus* will help farmers to develop suitable aquaculture technologies for higher production with minimum costs [28]. Because of the over-exploitation and various ecological changes in the aquatic ecosystem, *C. striatus* may become extinct from the natural habitats in a very near future. Considering the prevailing situation, the findings obtained as well as information generated from the present review would greatly be helpful towards the better understanding of snakehead biology, reproduction, larval rearing and culture, which will ultimately contribute to the aquaculture industry for better production and conservation of this high-valued fish species in the region.

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