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ORIGINAL ARTICLE

Practical guide to nutrition and captive breeding of *Channa striatus*, as an ornamental fish in aquarium trade

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Abstract
The snakehead murrel (*Channa striatus*) is a carnivorous, air-breathing freshwater fish increasingly recognized for its potential in both aquaculture and the ornamental fish trade. This study provides a comprehensive guide to the captive breeding, nutrition, and rearing of *C. striatus*, emphasizing its reproductive physiology and dietary requirements. The optimal broodstock diet, containing 45% protein and 18% lipid with 80% of the protein sourced from high-quality animal ingredients such as fish meal and squid meal, was shown to enhance gonadal development and reproductive performance. Key aspects of breeding include its ability to spawn year-round, producing up to 1,000 eggs per cycle, and successful artificial propagation using synthetic hormones like Ovaprim. Growth trials demonstrated significant weight gain under controlled culture conditions, with fish reaching marketable sizes within 9-11 months. The species exhibits resilience to suboptimal water conditions, including low oxygen levels and high ammonia concentrations, making it a suitable candidate for diverse aquaculture systems. This report highlights *C. striatus* as a promising species for the ornamental and aquaculture industries due to its adaptability, robust growth, and economic value.

Keywords: Ornamental fish, Broodstock nutrition, Reproductive performance, Artificial propagation, Economic potential

INTRODUCTION

The aquarium is an enclosed area for keeping and raising fish for observation and research. Several species varying in habit from peaceful to aggressive are being kept by aquarist based on their interest. Among the aggressive species, snakeheads are member of freshwater perciform fish family Channidae, native to Asia and Africa (Alitabar et al. 2023, 2024). They can be easily marked by long dorsal fine, large mouth and shiny teeth. They are potent absolutely predator which can eat pray that are larger than half of the size of the snakehead. The snakeheads are air-breather with the ability to walk on the land to find new water sources (Amilhat & Lorenzen 2005).

Keeping snakeheads, particularly smaller species like *Channa striatus* (snakehead murrel), in aquariums presents unique challenges due to their rapid growth and territorial behaviour. These characteristics necessitate larger aquarium setups to accommodate their needs and reduce aggression towards tank mates (Muntaziana et al. 2013). Smaller snakehead species are often preferred by aquarists because they can thrive in smaller tanks, which are more cost-effective in terms of equipment, energy, and food (Palanisamy et al. 2018). However, even smaller species can exhibit aggressive behaviours, making careful selection of tank mates essential (Magalhães 2015). Additionally, the cultural and nutritional requirements of *C. striatus* must be considered, as they are carnivorous and require a diet that supports their growth and health. The combination of adequate protein and lipid levels is crucial for optimal growth and reproductive success in snakehead murrel, highlighting the importance of a balanced diet tailored to their specific needs (Ghaedi et al. 2013; Hossain et al. 2008).

Currently little attention has been paid to this fish potential as an aquarium species. Introducing *C. striatus* to aquarist communities could promote its cultivation and appreciation, leveraging both its aesthetic and functional benefits. The aim of this report is to introduce the *Channa striatus* to the aquarist communities.

Fig.1. Mature male and female *C. striatus*.

METHODS AND RESULTS

Feeding and nutrition: Fish gonadal development and reproductive performance are strongly influenced by essential dietary nutrients, with protein, lipid, and carbohydrate forming the key macronutrient classes required for reproduction. Broodstock diet improvement enhances gonad development and seed production by providing these nutrients. Protein and amino acids, integral to successful reproduction, are especially critical as the early development of cleidoic fish eggs depends on maternal provision of amino acids during oogenesis. Ghaedi et al. (2019), reported that the optimal levels of protein and lipid in the diet for *C. striatus* broodstock are 45% and 18%, respectively. Therefore, prior to initiating the breeding process, it is essential to provide a diet containing these levels of protein and lipid. Considering that this species is carnivorous, 80% of the protein sources in the diet should be derived from animal-based ingredients such as fish meal, squid meal, and fortified premixes to ensure the nutritional requirements of the broodstock are adequately met.

Breeding in captivity: *C. striatus* is gonochoristic, the sexes are separated where male and female reproductive organ being in different individuals (Fig. 1). Its maturity is at about 8 months at a size of 25-30cm (Ghaedi et al. 2013). Snakeheads appear to form spawning pairs, which build a nest for courtship, spawning and egg incubation. This fish has been spawned with carp and catfish pituitary extract with a dose of 40-80 mg per female in two injections. Nowadays synthetic hormone that called Ovaprim is used for artificial propagation of this fish (Fig. 2). The eggs float, but are spread in a kind of film over the center of the nest. *C. striatus* eggs are yellowish in color, 1.15-1.50mm in diameter, large oil globule, floating to the surface and hatch in 24-35 hours at 28-30°C (Fig. 3). In reproduction, *C. striatus* do not really depend on the spawning season but they breed during most months of the year, laying from a few hundreds to more than 1,000 eggs which hatch in 1 to 3 days. On the day of hatching, the larvae are 3.0-4.5mm long and dark brown in colour. Two days after hatching, fry start to swim vertically with right side up. Orange pigment develops on the fourth day and becomes a red-orange band along the body by day ten. At this time, the artemia nauplii should be given to larvae for maximum growth (Fig. 4). At the end of the fourth week, the fry reaches 2.4-2.6cm in length and are dark grey in colour and thereafter assume the habits of the adult (Fig. 5).

Larvae rearing: The snakehead shows a much better growth rate under culture condition. With proper feed and stocking density, the fish commonly attain 300-

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Fig.2. Female *C. striatus* with swollen abdomen injected with ovaprim for artificial breeding.

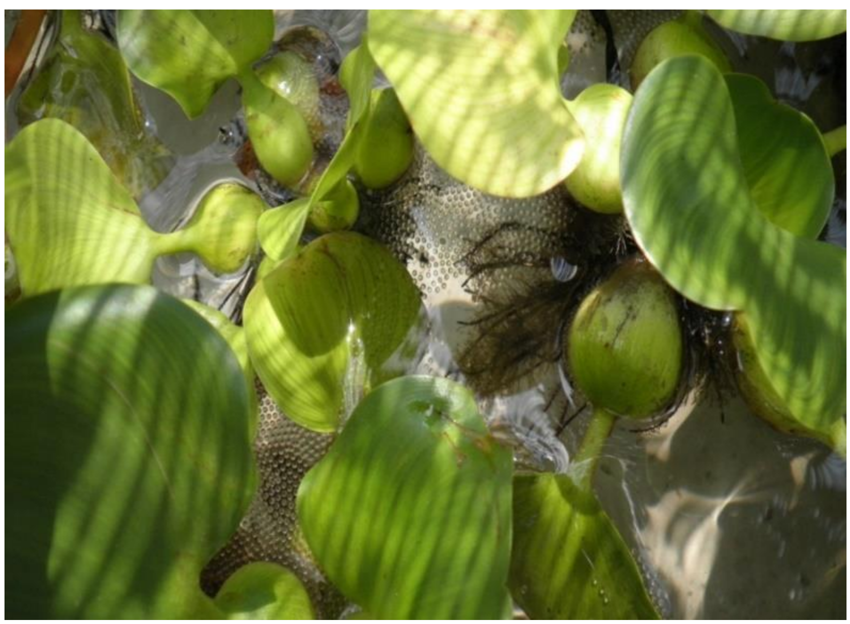

Fig.3. *Channa striatus* floating eggs released one day after hormonal treatment.

500g in 9 months and 500-800g in 11 months. With air breathing apparatus, the snakehead is tolerant of water lacking in dissolved oxygen and can survive without water for a number of months as long as the skin and breathing apparatus are kept moist. The fish can live in water having pH values of 4-5, with desirable range of 6.5-8.5. Positive growth occurs between water temperatures 28-35°C, whereas optimum temperature is 30-32°C.

C. striatus has become a significant species for aquaculture in Southeast Asia, particularly in countries like Malaysia, Indonesia, the Philippines, China, and India. The fish is well-suited for various culture systems, including earthen pond and floating cages. Earthen ponds typically range from 800 to 1600 m^3 in size and 0.5 to 2 m in depth, with stocking densities of 75 to 460 fish per square meter. Cages can vary in capacity from 40 to 625m^3, accommodating 6000 to 10,000 fry per cage (Aminur et al. 2012). Studies indicate that *C. striatus* exhibits

Fig.4. *Artemia* nauplii used as the live food to feed the larvae.

Fig.5. Swimming fry of *C. striatus* one week after hatch.

high growth rates and survival in these systems, with optimal stocking densities leading to better production outcomes. For instance, a density of 5000 fingerlings per hectare has been identified as optimal for maximizing growth and survival rates (Aminur et al. 2012). The fish commands high market prices due to its demand, making it a commercially viable species for aquaculture.

DISCUSSION

The reproductive physiology of *Channa striatus* is indeed closely linked to its nutritional status, with dietary components such as proteins, lipids, and essential micronutrients playing crucial roles. Studies have shown that the reproductive performance of *Channa striatus* is significantly influenced by the levels of dietary protein and lipids. For instance, higher protein levels in the diet have been associated with increased growth, gonadosomatic index, and fecundity, which are critical for reproductive success (Ghaedi et al. 2019). Similarly, optimal lipid levels in the diet have been found to enhance reproductive performance, including weight gain and fecundity, by improving the fatty acid profile in the fish (Ghaedi et al. 2016). Additionally, the presence of amino acids and fatty acids in *Channa striatus* contributes to its pharmacological properties, which may also play a role in its reproductive physiology (Shafri & Abdul Manan 2012).

Amino acids play a fundamental role in oogenesis and spermatogenesis in teleost, influencing gametogenesis at multiple levels. During oogenesis, amino acids are crucial for vitellogenesis, where yolk proteins are synthesized in the liver and transported to the ovaries for deposition in maturing oocytes (Finn & Fyhn 2010). This process is essential for the early development of fish, as maternal provision of amino acids during oogenesis supports the growth of oocytes. Essential amino acids such as arginine and methionine are known to promote hormone synthesis, including gonadotropins, which regulate reproductive cycles. Additionally, amino acids serve as precursors for bioactive molecules, including neurotransmitters, that modulate reproductive endocrinology (Finn & Fyhn 2010)

Essential fatty acids (EFAs), including arachidonic acid (ARA), eicosatetraenoic acid (EPA), and docosahexaenoic acid (DHA), are indeed crucial for gonadal development and egg quality in teleost. These EFAs are integral components of cell membranes, affecting membrane fluidity and integrity, which are vital for the proper functioning of gametes (Tocher 2010). EFAs also serve as precursors to eicosanoids, which are signaling molecules that play significant roles in regulating ovulation and spawning behavior. Diets lacking in EFAs can lead to reduced fecundity, poor egg viability, and lower larval survival rates, highlighting their importance in reproductive success (Izquierdo et al. 2001). The dietary lipid-to-protein ratio is indeed a critical factor in optimizing reproductive output in *Channa striatus*. Studies have shown that a diet with 45% protein and 18% lipid significantly enhances reproductive performance, aligning with findings that emphasize the importance of balanced macronutrient levels to meet the high metabolic demands of reproduction (Ghaedi et al. 2016). Animal-based protein sources, such as fish meal and squid meal, are recommended to ensure the provision of essential amino acids, while fortified premixes can address potential micronutrient deficiencies (Ghaedi et al. 2019). These dietary strategies are crucial for sustaining optimal reproductive health and performance in *C. striatus*

The provision of suitable live feed, such as *Artemia* nauplii, is critical for the successful rearing of *C. striatus* larvae, particularly during the early stages of development. *Artemia* nauplii are widely used due to their high nutritional value, which includes essential proteins and fatty acids that meet the metabolic and developmental needs of larvae (Paray et al. 2016) . The small size, high digestibility, and movement of Artemia stimulate the larval predatory response, enhancing feeding behavior and larval performance (War et al. 2011) . Ensuring a consistent supply of high-quality *Artemia* or other live feed options is essential for minimizing larval mortality and promoting uniform growth, thereby improving overall production efficiency in *C. striatus* aquaculture (Paray et al. 2016).

Environmental conditions, such as water temperature and quality, significantly influence the reproductive physiology of *C. striatus*. This tropical species exhibits optimal reproductive performance within a temperature range of 28-32°C, which also supports efficient nutrient assimilation (Hossain et al. 2008). The air-breathing capability of *C. striatus* allows it to thrive in low-oxygen environments, making it particularly suitable for resource-limited aquaculture settings (Mollah et al. 2009). These adaptations are crucial for maintaining reproductive efficiency and overall health in varying environmental conditions.

CONCLUSION

The reproductive success of *C. striatus* is closely tied to its nutritional profile, with dietary proteins, lipids, and essential micronutrients directly impacting gonadal development, fecundity, and larval viability. This study underscores the importance of a balanced diet, particularly one rich in high-quality animal-based protein sources and essential fatty acids, to support the physiological demands of reproduction in this species.

By providing practical guidelines for broodstock nutrition and breeding management, this study highlights the potential of *Channa striatus* as both an ornamental and aquaculture species. The findings emphasize the necessity of addressing dietary composition alongside environmental factors to maximize reproductive efficiency and economic viability.

Future efforts should prioritize detailed investigations into specific nutritional pathways and their regulatory roles in reproductive endocrinology. Additionally, research on the integration of alternative protein and lipid sources into the diet, as well as their effects on egg and larval quality, will further enhance the sustainable production of *C. striatus*. This species thus holds significant promise for advancing the ornamental fish trade and aquaculture industries, offering both economic and ecological benefits. In addition to its ecological and ornamental value, *C. striatus* possesses notable economic advantages. Its hardiness and adaptability to diverse environments reduce the risk of stock losses, making it a cost-effective option for small-scale aquarists and commercial breeders alike. Furthermore, its rapid growth rate, high fecundity, and year-round breeding potential enable consistent production and market supply. These attributes, combined with its growing popularity in both ornamental and aquaculture industries, position *C. striatus* as a species of significant economic promise, offering lucrative opportunities for both local and global markets.

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مقاله کامل

راهنمای عملی تغذیه و پرورش ماهی *Channa striatus* در اسارت به عنوان یک ماهی زینتی در تجارت آکواریومی

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چکیده: ماهی سرماری (*Channa striatus*) یک ماهی گوشتخوار است که به‌طور فزاینده‌ای به‌دلیل پتانسیل خود در صنعت آبزی‌پروری و تجارت ماهیان زینتی شناخته می‌شود. این مطالعه راهنمای جامعی برای تکثیر، تغذیه و پرورش ماهی سرماری ارائه می‌دهد که بر فیزیولوژی تولیدمثل و نیازهای تغذیه‌ای آن تأکید دارد. جیره غذایی بهینه برای مولدین این ماهی، که شامل ۴۵٪ پروتئین و ۱۸٪ چربی است و ۸۰٪ پروتئین آن از منابع حیوانی با کیفیت بالا مانند پودر ماهی و پودر اسکوئید تأمین می‌شود، که به توسعه گنادها و عملکرد تولیدمثل کمک می‌کند. جنبه‌های کلیدی تکثیر شامل توانایی تکثیر در طول سال و تولید تا ۱۰۰۰ تخم در هر تخم‌ریزی و همچنین تکثیر مصنوعی موفق با استفاده از هورمون‌های سنتتیک مانند اووپرایم است. آزمایش‌های رشد نشان داد که ماهی‌ها تحت شرایط کشت کنترل‌شده، رشد قابل توجهی در وزن داشتند و در مدت ۹ تا ۱۱ ماه به اندازه‌های قابل عرضه رسیدند. این گونه مقاومتی به شرایط آب نامطلوب، از جمله سطوح پایین اکسیژن و غلظت‌های بالای آمونیاک نشان می‌دهد که آن را به گزینه‌ای مناسب برای سیستم‌های مختلف آبزی‌پروری تبدیل می‌کند. این گزارش ماهی سرماری را به‌عنوان یک گونه ارزشمند برای آبزی‌پروری و ماهیان زینتی به‌دلیل قدرت سازگاری بالا، رشد قوی و ارزش اقتصادی آن معرفی می‌کند.

کلمات‌کلیدی: ماهی سرماری، ماهی زینتی، تغذیه مولدین، عملکرد تولیدمثل، تکثیر مصنوعی، پتانسیل اقتصادی