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Breeding of Red-bellied Pacu (*Piaractus brachypomus*) – A Promising Aquaculture Species

A. Asiisa[1], S. Aanand[1]
[1]Dr. MGR Fisheries College and Research Institute, Tamil Nadu Dr. J. Jayalalithaa Fisheries University, Ponneri – 601 204
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Introduction

The Red-bellied Pacu (*Piaractus brachypomus*) is a freshwater fish belonging to the order Characiformes and family Characidae. Native to the rivers of Brazil and the Amazon Basin, it has been successfully introduced to several countries, including Iran, Colombia, Ecuador, Peru, Venezuela, India, Bangladesh, Nepal, Malaysia and the Philippines. In India, pacu was first introduced from Bangladesh around 2003–2004 and has since become popular among fish farmers because of its rapid growth, tolerance to poor water quality, and ability to thrive on low-cost, plant-based feeds. Commonly known as pacu, pirapitinga, and rupchanda or roopchand, it is widely available on farms, markets, and even aquaria. Its firm and flavorful flesh makes it a preferred table fish, while its silvery body and reddish fins add ornamental appeal.

As aquaculture continues to expand as a sustainable means of food production, pacu contributes significantly to the diversification of India's freshwater aquaculture sector. Traditionally dominated by carp species, Indian aquaculture has recently seen the rise of species such as pangasius, GIFT tilapia, and pacu. Among these, the Red-bellied Pacu stands out for its adaptability, fast growth, and economic value. Its resilience, efficient feed utilization, and suitability for plant-based diets make it a valuable species for bridging the gap between sustainability, profitability, and consumer demands.

Identification and Biology

The Red-bellied Pacu is a striking and docile species often mistaken for its aggressive relative, the piranha (*Pygocentrus nattereri*). However, pacu differ markedly in terms of feeding habits and temperament. They possess a deep, laterally compressed body with silvery sides, a darker dorsal region, and a distinct reddish hue on the belly, the chin, and the pectoral fins. Juveniles mimic piranhas through dark spots that serve as camouflage against predators, a defense that fades as they age.

Pacu are omnivorous, feeding on fallen fruits, seeds, leaves, flowers, and occasionally zooplankton, insects, snails, and detritus. This dietary flexibility, coupled with fast growth and good flesh quality, makes them an ideal candidate for aquaculture. They typically mature at around 3 years of age and can reach up to 88 cm and 25 kg in the wild; however, growth in captivity is usually smaller due to diet and space constraints. Their hardiness, aesthetic appeal, and adaptability underscore their

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thefishworldmagazineindia@gmail.com

increasing significance in freshwater aquaculture.

Broodstock Management

Effective Broodstock management is vital for achieving consistent breeding success and maintaining genetic diversity. Brooders are selected based on traits such as rapid growth, disease resistance, and feeding efficiency. Ideal brooders, aged 2–3 years and weighing 2–8 kg, are conditioned in ponds at a density of 1,500 kg/ha for 3–4 months before they are bred. They are fed a high-protein diet (approximately 5% of body weight daily) containing fishmeal and oil cake to promote gonadal development, with feeding suspended one to two days before spawning.

Broodstock may be sourced from farmed, cross-farm, or wild populations to ensure genetic diversity, although wild collection should be carried out sustainably. Pacu prefer warm, slightly acidic waters with temperatures between 24°C and 30°C, pH 6.0–7.5, and depths up to 20 m. Proper management ensures viable gamete production, improved spawning performance and consistent seed quality.

Breeding Techniques

- **Induced Breeding:** Pacu typically breed during the rainy season (September to February), with females capable of multiple spawning events. Induced breeding is achieved using synthetic hormones such as pituitary extract, Ovaprim, or Ovatide. Females received a priming dose of 2 mg/kg, followed by a resolving dose of 10–12 mg/kg after 4.5–5 h, whereas males were administered a single dose of 2 mg/kg concurrently with the female's second injection. Maturity was confirmed by examining the abdomen and vent in females and milt release in males. Brooders were kept in hapas or cement cisterns prior to stripping. Temperature plays a critical role, and higher temperatures (34–35°C) often reduce both hormone dosage and the latency period to spawning.
- **Spawning Setup:** Spawning is carried out in tanks or hapas with gentle aeration and stable temperatures of approximately 27°C, maintaining dissolved oxygen near 4 mg/L. Fertilized eggs (approximately 1.2 mm in diameter and weighing 1.6 mg) were transferred to hatching jars or hapas for incubation. The male-to-female ratio ranged from 1:1 to 1.5:1, depending on the milt quantity. A single female can lay approximately 150,000 eggs, with larger individuals capable of producing up to a million. Remarkably, females can be ready to spawn again after approximately 10 weeks.

- **Spawning Behavior** : Red-bellied Pacu exhibit distinct spawning behaviors marked by courtship displays and acoustic communication. Males produce vibrating sounds and vivid color displays to attract females and often engage in competitive chasing. Spawning usually occurs in shallow waters, where females release eggs that are externally fertilized by males.

Both parents guard the eggs until hatching, reflecting a notable degree of parental care that enhances offspring survival.

Egg Incubation and Hatching

Fertilized pacu eggs are adhesive and buoyant and hatch within 16–19 h at optimal water temperatures of 28–31°C. Clean and well-aerated water is essential for successful incubation. After hatching, the yolk sac is absorbed within approximately 48 h, after which the larvae begin exogenous feeding and grow into fry. Hatchlings are reared in tanks or ponds until they reach a length of 2–3 cm, typically within 15–20 days.

Larval Rearing

Newly hatched spawns are stocked in nursery ponds at a density of approximately 150,000 individuals per hectare. They were fed a mixture of groundnut oil cake, rice polish, soybean dust, and zooplankton. After 8–10 days, the fry are transferred to rearing ponds (approximately 3 ha) at a density of 100,000 individuals per hectare. Here, they receive artificial feed supplemented with groundnut and sunflower oil cakes, fishmeal, boiled rice, and Canadian peas at approximately 5 kg/ha/day. Juveniles tolerate temperatures of 20–30°C and pH levels of 6–8, reflecting their environmental adaptability.

Grow-out Potential

Pacu farming follows a systematic grow-out strategy aimed at maximizing fish survival and productivity. Fingerlings weighing > 10 g should be healthy, uniform, and sourced from reliable hatcheries with genetically managed broodstocks. Before stocking, they must be acclimatized to the pond conditions. Stocking densities are maintained at 1 fish/m² in monoculture, 15–20% in polyculture with carps, and 30–50% in polyculture with Pangasius. Ponds with clayey loam soil (pH 6.5–7.0) and water pH of 7.5–8.3, at least 1.5 m deep, are ideal and should be prepared using lime and manure to promote the growth of plankton.

Fish are fed floating pellets with 25–30% protein at 5–6% of body weight for juveniles and 2–3% for adults, twice daily. Water quality management involves maintaining the dissolved oxygen level above 5 mg/L, weekly manuring, and partial water exchange (10–15%). Regular health checks, prompt removal of dead fish, controlled use of chemicals, and treatments based on accurate diagnosis are vital for disease prevention and sustainable production.

Challenges and Prospects

Although promising, pacu farming faces several significant challenges that hinder its sustainable development. One of the primary behavioral issues is fin nipping, which can lead to stress and injury among co-cultured species. Additionally, the risk of fish escaping into natural water bodies poses ecological and management concerns for the aquaculture industry. Low dissolved oxygen levels and the incidence of ‘red disease’ are major health challenges affecting stock survival and productivity. The sector also suffers from the absence of standardized farming practices, inconsistent species and hybrid identification, and variable production levels across different farms. Moreover, inadequate biosecurity measures, lack of regulatory oversight, and the absence of mandatory farm registration

increase the industry's vulnerability to disease outbreaks and environmental risks. Limited access to scientific knowledge and technical guidance, as well as the growing influence of ornamental trade and hobbyist releases, further complicate the sustainable management of pacu aquaculture.

The rapid expansion of pacu culture in India, often without proper species identification, raises serious ecological concerns. Highly adaptable and prolific, pacu can compete with native fish for food and habitat, potentially displacing local species and reducing their biodiversity. Hybridization with indigenous fishes and uncontrolled escapes pose additional threats, especially in ecologically sensitive regions such as the Vembanad Lake and Western Ghats. Strengthening scientific monitoring, enforcing regulations, and promoting responsible farming practices are essential to ensure sustainable development of pacu aquaculture in India.

Conclusion

The Red-bellied Pacu has rapidly emerged as a promising species in Indian aquaculture, valued for its fast growth, resilience, and market appeal. However, as an exotic species, it has not yet been officially authorized for culture in aquaculture ponds. Despite this, its compatibility with carps in polyculture systems has been demonstrated, suggesting that, like pangasius, pacu may be permitted for regulated aquaculture in the future. To ensure sustainability, detailed scientific studies are needed to assess the ecological impact and environmental interactions of this species and develop standardized best practices for its culture.

Currently, dependence on seed imports from distant locations raises production costs, highlighting the need to promote artificial breeding in local hatcheries under proper guidelines. Although pacu offers great promise for enhancing fish farmers' income and diversification, challenges such as disease management, water quality maintenance, and escape prevention must be effectively addressed. With scientific regulation, responsible management, and improved farming practices, the Red-bellied Pacu can contribute significantly to sustainable and profitable aquaculture development in India.

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