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Culture and breeding of *Ompok bimaculatus*, Pabda (Indian Butter catfish), seed production in North-East, India

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Abstract
A significant freshwater fish species that is raised in subtropical and tropical regions of the world is the India butter catfish (*Ompok bimaculatus*) also known as pabda. The fish is known as a "butter catfish" because of its meat's soft, flavorful, juicy texture and lack of bones. Due to these features, it is regarded as a delicacy in countries like India, Bangladesh, Malaysia, etc., but the species is under great threat, according to the IUCN, and is on the list of "Threatened Species." It is due to a number of factors, including anthropogenic activities, loss of natural habits, overfishing, insufficient breeding, and lack of biological knowledge. Several attempts have been made to protect, improve breeding methods, and utilize the species. This fish has a significant demand in markets at local as well as national level and also holds high potential globally. Moreover, because of its high value in the markets, it can support marginal and local farmers. It may be raised in an integrated aquaculture system as well as in a Polyculture system with other Indian Major Carps. Breeding and seed production of pabda will be covered in this article.

Keywords: *Ompok bimaculatus*, breeding, brood stock management, seed production, hatchery management

Introduction
Ompok bimaculatus, sometimes referred to as Pabda, is a member of the Siluridae family. In Asia, particularly in South-East Asian nations, it is regarded as one of the significant food fish. It has become more significant in aquaculture in recent years because of its commercial potential, high-quality meat, nutritious makeup, and delicious taste. The species is distinguished from other members of the same genus by its elongated body, severely compressed shape, low head, and rounded snout. Its deep forked caudal fin and entire lateral line, anal fin with 2-3 spines, and pelvic fin with one spine all distinguish it from other species. It is also conceived of as a species that can be diversified in order to diversify both species and cultural systems. The species are more frequently cultivated in the seasonal water bodies in the majority of India's North East due to their ability to grow in shallow water. The species can also be smoked, which is a popular delicacy in the North-East. The fish is significant because of its remarkable property of surviving for a long time under conditions, without food or water. When compared to other catfishes, this species gets along well with carps and is relatively calm and quiet.

Fig 1: Pabda Fish

Distribution of species

Ompok bimaculatus is a tropical species with a vast geographic range in South-East Asia, which includes countries like Myanmar, Bangladesh, Sri Lanka, Pakistan, Vietnam, Thailand, Malaysia, and India. It is most prevalent in the Indian states of the North East, Orissa, West Bengal, and Bihar (Day, 1981; Chakrabarty *et al*., 2007; Banik & Malla, 2011; Biswas *et al*., 2018; Dhar *et al*., 2019; Jayaram, 1999, 2009) [14, 6, 12, 26]. Natural habitats for the species include many freshwater bodies, primarily rivers, streams, canals and waters with moderate flows (Sridhar *et al*., 1998; Banik *et al*., 2011) [37, 6]. During the monsoon season, it often breeds in rivers, streams and floodplains. The most ideal habitats, according to Chakrabarti *et al*. (2012) [13], are open Beels and floodplain wetlands like Mauns with plenty of floating and submerged aquatic weeds because they offer cover and hiding places. O. bimaculatus has also been observed to some extent in brackish-water settings in Southern states of India (Debnath *et al*., 2013) [18].

Habit and Habitat

A thorough understanding of *O. bimaculatus'* preferred foods and feeding behaviours is necessary for their effective upbringing and culture. In their study, Arthi *et al*. (2011) [3] described the omnivorous eating habits of *O. bimaculatus* during its juvenile and adult stages, noting that it mostly feeds on plant materials, larval and adult crustaceans, crustacean nymphs, insects, molluscs and minor amounts of other animals. In contrast to this, few researches have documented *O. bimaculatus's* omnivorous dietary habits (Arthi *et al*., 2013; Malla & Banik, 2015; Sivakami, 1982; Mishra *et al*., 2013) [4, 28, 36, 29]. In addition, Qayyum and Qasim (1964) found a piscivorous eating pattern, with tiny fish making up 60% of the diet and insects and crustaceans making up a lesser amount (prawn). Pethiaticto, Pethiaconchonius, Pethia stigma, Esomusdanricus, *Trichogaster* sp., *Mystus* sp., Osteobramacotio and *Amblypharyngodon* sp. are among the fish that make up this group. Insects of all kinds have been seen in *O. bimaculatus's* intestines, including Orthoptera, Hymenoptera, Coleoptera, Odonata, Hemiptera, Ephemeroptera and Plecoptera. Additionally, an insectivorous tendency has been noted in the meanwhile (Parameswaran *et al*., 1970; Hanjavanit & Sangpradub, 2009; Sangpradub *et al*., 2014; Sivakami, 1982) [21, 36]. Furthermore, Debnath *et al*. (2013) [18] described *O. bimaculatus's* adult stages as being cannibalistic and predatory. Substantial growth was recorded, when live fishes like mola carp, flying barbs, and crab sand molluscs were given.

Sexual dimorphism

The brooder's sex is easily discernible based on the morphological characteristics of the brooders, the females' abdomen is swollen and soft, and the genital papilla is wide and blunt, whereas the abdomen of the male fish is firm and round, and the genital papilla of the male is narrow. The pectoral fin spines present in males are usually larger and thicker, while in females, the spines present in the pectoral fins are feeble or absent (Sandipan Gupta., 2018) [20]. Apart from these characters, Hussain, in his research observed that, in the case of males, the maxillary barbell used to extend beyond the pectoral fins.

Life cycle

According to the experiment of Chakrabarti *et al*., 2009 and observation;

1. 30 min after fertilization the blasto disc formation take place over yolk and commencement of 1st, 2nd and 3rd cleavage.
2. After 70 min of post fertilization sixty four cell stage observed.
3. After 2 hrs. Morula stage found.
4. After 5 hrs. yolk plug stage appeared
5. Differentiation of caudal and cephalic end of the embryo after 10 to 15 hrs.
6. Movement of embryo can be seen within the egg after 16 to 21 hrs.
7. After 23 hrs the egg began to hatch out.
8. Then larval rearing is carried out in indoor facilities.

Fig 2: Pabda Seed

Materials and Methods

Hatchery production of seed

Steps involved in establishing a hatchery

The process of setting up a Pabda hatchery is briefly described in the part that follows.

- **Site selection:** For a hatchery to operate well in a given area, a location must be carefully chosen. To successfully reach the production objective, it is also crucial to take into account the following crucial aspects.
- **Climatic conditions:** Pabda is a typical non-air-breathing freshwater catfish found in tropical and subtropical regions of the world. Regarding the spawning season and climatic conditions, different researchers have found different results, according to Renunuan and Silapachai (2005) [33], who documented in their study at Nong Koh Reservoir, Thailand that the spawning season of pabda is from July to September. According to Chakrabarti *et al*. (2009), pabda spawns once a year from June to August (monsoon season), with a peak in July, whereas Arthi *et al*. (2013) [4] and Malla & Banik (2015) [28] found that the fish breeds in lotic water bodies from May to August. Sivakami (1982) [36] have observed pabdabeeds throughout the year, with peak spawning activity seen in

the August and September and October months at Bhavani Sagar and Amaravathy reservoirs in Tamil Nadu.

- **Topography:** Rectangular shaped ponds with an average depth of 1 to 1.2 m are preferable for pabda brood rearing and growth culture due to their round corners, which facilitate proper aeration and easy in management.
- **Soil:** Pabda inhabits different natural water bodies such as rivers, lakes, streams, canals and inundated fields where sluggish to moderate water flow is present. Shallow ponds with an average water depth of 0.5 to 1.5 meters and muddy or musky bottom soil are the preferred natural location for pabda (Banik *et al*., 2011; Sridhar *et al*., 1998) [6, 37]. Pabda thrives in shallow water bodies, making it the best species to cultivate in seasonal water bodies.
- **Availability of adequate freshwater:** For nursery and grow out culture of pabda pond water and ground water can be used effectively.
- **Good physical access to the site:** The pabda hatchery, like other fish and shellfish hatcheries, should have good transportation facilities for easy transport of seed, feed and other hatchery equipment. The hatchery should be located in an area where skilled laborers are frequently available. It is always preferable to construct a hatchery in an area where the local market is not very far from the hatchery site, so that any small farmer or hatchery owner can easily sell the product (seed) in the local market in good condition.
- **Uninterrupted power supply:** In a pabda hatchery, continuous air and water flow is required in all the hatchery units, especially in the rearing units, and one water shower is also provided in the top pool for showering as per requirements (Ajmal Hussan *et al*., 2020) [2], so to maintain all these operations, there should be one generator facility as an additional power backup system.

Hatchery facilities

Hatchery building: The Pabda hatchery is made up of several units, the most important of which are the incubation unit, the rearing unit (both of which have three tanks), and an overhead tank (capacity 1000 to 1500 liters). Apart from these, there should be facilities for live food culture, an aeration facility, a power and pump house, a store room for keeping all the hatchery equipment and a residential room for labourers and other office work.

- **Water storage tanks:** To keep water flowing continuously through the hatchery, a least 1,000-liter overhead tank is needed, and it needs to be well-connected to the rearing tanks using pipelines.
- **Brood stock pond:** A crucial factor to be taken into account for effective captive breeding of any fish species is the brood stock raising unit. The optimal pond dimensions for pabda brood fish rearing are 0.2 to 0.5 ha, with a depth of 1 to 1.2 m. The pabda brood fish pond should be covered with net (Pradyut Biswas *et al*., 2018) [12]. It is crucial to provide sufficient nutrition to the brood fish in order to promote better growth and maintain a healthy fish population (Sandipan Gupta., 2018) [20]. Currently, boiling chicken viscera is fed to brood fish at a rate of between 5% and 10% b/w every day (Chakrabarti *et al*., 2009). Feed for pabda brood fish should contain 35% crude protein. The broods can be given a mixture of MOC, Fish Meal, Rice Bran, and Wheat flour in form of dough in remote places where high protein pelleted feed is not often accessible to provide the protein need (Pradyut Biswas *et al*., 2018) [12]. To retain the required level of the water quality parameter, a weekly water exchange from the brood fish pond should be maintained. Pabda broodstock reach maturity in the 7.4-7.8 PH range (Chakrabarti *et al*., 2009). Later they can be transferred into cemented tank for breeding as shown in figure.

Fig 3: Brooder collection from grow out pond

Fig 4: Rearing tank before breeding

- **Larval rearing unit:** Pabda larvae that have recently hatched can be cultured or raised in a pond, a FRP tank, or both. We can efficiently use the pond water for raising pabda larvae (Chakrabarti *et al*., 2009). For the rearing of larvae, the suitable water quality parameters are listed below:

Temperature	Dissolve Oxygen	Alkalinity
25 ± 3 ºC	3 to 5 mg/l	120 to 150 mg/l

- **Artemia cysts hatching tanks:** Since artemia can withstand a broad range of salinities, namely 5 to 20 ppt, it is frequently employed in fish larval rearing (M.S. Islam *et al*., 2019) [24]. Seawater or synthetic seawater can be utilized to hatch artemia dormant cysts. 95% common salt can be added to fresh water to create fake sea water. For an artemia cyst to erupt, the optimal salinity is 30 ppt (A S Bahr *et al*., 2021) [1]. Other significant parameters that affect the hatching of artemia cysts in addition to salinity are temperature, DO, PH, aeration, and others. By turning a clean plastic bottle upside down and utilizing an air hose, you may use it as a container for cyst hatching (A. S. Bahr *et al*., 2021) [1].

Fig 5: Artemia hatching jar

- **Aeration system:** Installing an air pump will ensure that the hatchery receives an adequate amount of oxygen, especially in the raising unit. Aeration must be ongoing for fertilized eggs to hatch.
- **Water supply system:** There should be properly linked pipelines from the above tank to the various hatchery units for a steady supply of water to ensure the success of the production.
- **Power back up system:** All hatchery owners should have a diesel generator as a power backup system to ensure the constant flow of water and air in the hatchery.
- **Laboratory:** Basic laboratory equipment should be available in every commercial pabda hatchery for regular testing of very important, critical and fluctuating water quality parameters such as dissolve oxygen (DO), PH, nitrite, ammonia, alkalinity, and water temperature. Nowadays, most fish farmers have an aquaculture kit to check these water quality parameters for better management of hatcheries.

Hatchery operation

- **Preparation of nursery rearing water:** 800 m^2-1000 m^2 is the optimal size for a nursery rearing pond. The recommended doses of cow dung and lime are 5 to 10 kg per decimal and 250 kg/ha respectively, according to P. Biswas *et al*., 2018 [12].

Fig 6: Broodstock tank

- **Artificial breeding:** It takes the fish around a year to reach maturity. Male fish mature faster than female fish. Fish that have been sex-segregated are utilized for artificial breeding. External fertilisation occurs in Pabda fish. The genital papilla of male fishes is long and pointed, whereas the genital papilla of female fishes is rounded (Chakrabarti, 2009). When utilizing a lower dose of ovaprine, both males and females should administer 0.03 to 0.5 kg for females and 0.4 to 0.6 ml/kg for males (Sarkar *et al*., 2005) [34]. Ovaprine doses of 1 to 1.5 ml/kg for females and 0.5 to 1.0 ml/kg for men are also possible (Chakrabarti *et al*., 2009). For intraperitonial injection, the pabda's latency duration is 10 to 12 hours (C.S. Chaturvedi *et al*., 2015). To encourage pabda reproduction, a 1 ml syringe is used, and the middle is entered at a 30° angle (Pradyut Biswas., *et al*. 2018) [12]. However, utilizing ovaprine doses of @ o.1ml/kg for females and @ 0.5ml/kg for males had greater results, according to researchers (P.K. Pradhan *et al*. 2014).

Fig 7: Hormonal breeding

- **Larval rearing:** The pabda larvae consume their body's conserved yolk for the first two days after hatching, and then, as their mouths open on the second day, they can be fed little amounts of food (Pradyut Biswas *et al*. 2018) [12]. During the first week of raising, we must gradually increase the water depth in the system to a depth of 15 to 20 cm. Initially, the water depth is kept in the system at 3-4 cm (Chakrabarti *et al*., 2009). The larvae that were fed live food, such as chopped fubifex worm and artemianauplii from the hatchery, four times a day, showed better growth (Pradyut Biswas *et al*., 2018) [12]. Typically, larvae are raised for the first seven days in a small aquarium or plastic tub before being moved to bigger bodies of water. The recommended stocking density for larval rearing in indoor facilities is 1000-2000/m2 (Pradyut Biswas *et al*. 2018) [12]. For the larvae's best chance of survival, we must also supply them with suitable environmental conditions. We can provide them with aquatic weed hydrilla to cover the larvae while they are growing (Chakrabarti *et al*., 2009).

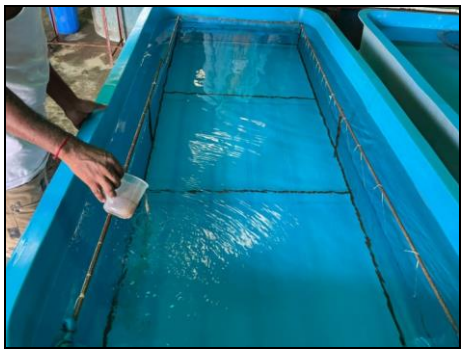

Fig 8: Feeding of larvae

- **Preparation of live feed:** For the larval rearing of pabda, many studies have employed different live foods, including artemia nauplii, tubifex worms, chironomid larvae, and other zooplanktons. But of all the live feeds, chopped tubifex worm is the most popular (Pradyut Biswas and Ramanuj Chakraborty, 2022) [30]. Larvae

accept zooplankton to 15 days after hatching (Chakrabarti *et al*., 2009).

Fig 9: Plankton collection

- **Artemia:** Due to their abundance in vital amino acids, artemia, or brine shrimp, are now the most common larval meal for raising larvae and for newly hatched fish. 90% of the artemia cysts in the world are produced in the Great Salt Lake in Utah. Fish larvae quickly digest artemia without polluting the water (M. S. Islam., *et al*. 2019) [24]. Due of their reduced proportions, artemia are also utilized for fish larval rearing. Fish can readily digest artemia, which can nearly entirely satisfy the nutritional demands of fish larvae (A S Bahr, *et al*. 2021) [1].
- **Egg custard:** Larvae accept egg custard or zooplankton up to 15 days into their rearing cycle, and once they reach the fry stage, we may start feeding them compound diet such a rice polish, silk worm, and boiled eggs mixture (Chakrabarti *et al*., 2009).
- **Tubifex:** The most popular live food is chopped tubifex worm among all other live foods (Pradyut Biswas and Ramanuj Chakraborty., 2022) [30], which can be collected from sewage or cultured in flowing water.

Fig 10: Tubifex (live feed)

- **Hatchery hygiene and prophylactics:** When the spawning process is over, the brooders must be released back into the water by dipping them in 0.1 mg/l of potassium permanganate, KMnO4 (Siddartha Purkayastha, *et al*. 2015).

Grow out culture

- **Nursery phase:** Preferred size of the fry for raising pabda fry in nurseries on 800 m2. Following liming and tilling, 2 days are provided for manure and lime to interact with the soil, resulting in requirements of 5 to 10 kg of cow dung per hectare and 250 kg of lime per ha. Five-day-old fry are supplied at a rate of 15,000/ha in the nursery pond (Pradyut Biswas *et al*. 2018) [12].
- **Pond construction:** Pond construction for grow out culture and brood rearing depends on the species to be cultured and land availability. Different researchers have used different sizes of ponds to carry out their experiments. According to Pradyut Biswas *et al*., in 2022, a rectangular pond having an area of 0.20 to 0.50 and a depth of 1 to 1.2 m is best suited for the brood rearing of pabda.
- **Grow out phase:** An earthen pond or cemented tank may be used for the pabda grow-out culture. For improved development and survival, the stocking density of the fish during the Pabda grow-out period is between 25,000 and 40,000 g/ha (Pradyut Biswas *et al*. 2018) [12] with proper pond management and aeration.
- **Eradication of weed:** Pabda brood fish can be reared in both an earthen pond and a cemented tank (as part of an advanced aquaculture system), but the water body must be free of all aquatic weeds as well as predator and weed fish before stocking. Weeds can be removed manually or chemically in the water body.
- **Liming:** It is mainly based on the pH of the soil. However, the standard dose of lime to prepare the pond i.e. 500 kg/ha to maintain the buffering capacity of pond in the acidic soil of the Tripura (C. Debnath *et al*. 2015).

Fig 11: Liming

- **Fertilization:** Before stocking fish, C. Debnath *et al*. (2015) employed a fertilizing dosage of a combination of 3 tonnes of cow dung and 30 kg of SSP at the ICAR NEH complex in Tripura. C. Debnath *et al*. (2015) employed 500 kg/ha of cow dung as an intermittent dosage of fertilisation, ignoring a fertilizer combination of 10 kg urea and 15 kg SSP. A similar pattern has been observed in the college pond.
- **Stocking of pond:** The acceptable weight of fish for stocking is 5 to 10 g, and the suggested stocking density of fish during the grow-out period is 25,000 to 40,000/ha (Pradyut Biswas *et al*., 2018) [12].
- **Feed management:** Different researchers and scientists have employed different feed ingredients and compositions for the feeding management of pabda larvae and brood stock. According to Hussain's experiment, he used to feed deoiled mustard oil cake and rice bran to his brooders at a rate of 5 to 10% of body weight, along with certain animal protein supplements such crushed mollusks, crab, and aquatic insects. A combination of MOC, rice bran, wheat flour, and fish meal can be used to feed brood (Pradyut Biswas *et al*., 2018) [12]. N. Basavaraja *et al*. fed their brood fish a 1:1 mixture of wheat flour and fish meal in their experiment. In their experimental trial, Purkayastha *et al*. fed their

brooders 5% B/W of a mixture of rice bran and mustard oil cake in a ratio of 1:1 along with some tiny fish (example: Danio, Puntius). Because pabda are nocturnal fish, we may feed them at night.

Fig 12: Feeding to broodstock

Discussion and Results

Constraints and Precaution

a. A healthy and disease-free brooder must be chosen for optimal growth and results.
b. All of the tanks and equipment need to be cleaned and sanitized before and after the hatchery operation.
c. An excessive hormone dose should not be used; a low amount will prevent spawning.
d. We must provide the fish with enough nutrition in order to prevent cannibalism among the fish.
e. Because pabda fry are nocturnal by nature, adequate shedding should take place in the hatchery.
f. Since the *Myxobolus* sp. host organism is the live tubifex worm that we use to feed the pabda larvae, we must take the necessary precautions to control any illness.
g. Regular inspection of all hatchery units.

Poly culture

Polyculture of different species depends on the compatibility among the fishes in terms of feed utilization and space usage. According to recent research by Jahan *et al*. (2018) [25], 14 to 17 distinct fish species are being polycultured with pabda. According to M. Afzal Hossain *et al*., 2019 [22], they experimented with pabda polyculture in several farmers' ponds. A preliminary experiment was carried out by Debnath C *et al*. (2013) [18] on the polyculture of Pabda with UMCs (Indian major carp) in various species combinations such as 40% Catla, 30% Rohu, 15% Mrigal, and 15% Pabda, and the stocking density was 4000 fish/ha. This study showed a better result in the polyculture of Pabda with IMCs, where total production was above 1000 kg/ha in 180 days of culture periods.

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Conflict of interest statement

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