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A Review on the Impact of Agro-Climatic Conditions on the Rearing of *Osteobrama belangeri* (Pengba) in the Valley Areas of Imphal, Manipur

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Abstract: ***Osteobrama belangeri, a minor carp locally known as "Pengba", is an endemic and highly esteemed fish species in Manipur, India. While once a significant component of the state's natural fisheries, its wild population has faced a severe decline, leading to its designation as "extinct in the wild" in Manipur. This has spurred a considerable effort to promote its aquaculture, particularly in the valley areas of Imphal. The success of these rearing efforts is intrinsically linked to the region's agro-climatic conditions. This review paper synthesizes existing literature to analyze the multifaceted impact of agro-climatic factors, including temperature, rainfall, and water quality, on the growth, breeding, and overall productivity of Pengba culture. It explores how seasonal variations and a changing climate influence the species' feeding habits, breeding cycles, and susceptibility to diseases. The paper also discusses the challenges and opportunities presented by these factors, highlighting the need for climate-resilient aquaculture practices to ensure the sustainable conservation and commercialization of this culturally and economically important species.***

Keywords: Pengba, Climatic condition, Manipur, sustainable, seasons

1. Introduction

Osteobrama belangeri (Valenciennes, 1844), or Pengba, is a member of the Cyprinidae family and is celebrated as the "state fish" of Manipur. Its cultural significance and high market demand make it a vital component of the region's economy and cuisine. Historically, Pengba was a prominent species in the natural water bodies of the Imphal Valley, including Loktak Lake. However, due to factors such as habitat degradation from dam construction (e.g., the Ithai Barrage), pollution, and the introduction of non-native species, the wild population has been decimated. *O. belangeri* is reported to migrate from the river Chindwin of Myanmar to the upstream of the river Imphal and its tributaries in Manipur during early monsoon for breeding in the floodplains of the state (Das and Singh, 2017). It is listed among the 91 endangered fish species of India (CAMP, 1997) and according to IUCN Red List status, categorized as 'extinct in the wild' (Das et al., 2020). The pengba also referred to as moderate to highly vulnerable and categorized as 'Threatened' by Reddy (2000), 'Near Threatened' by Waikhom (2010) and as 'Endangered' by Suresh (2000) and Menon (2004). The marketable size of the species is 100 to 500 g in the state of Manipur. It grows to 400-500 g in a year in climatic condition of Manipur (Basudha et al., 2015; Behera et al., 2015). Pengba is omnivore in nature that mainly feeds on algae, small insects, aquatic plants, zooplankton, diatoms, etc. There are other reports on the culture of this endemic carp using locally developed artificial diet (Basudha and Waikhom, 2002). O. belangeri is a seasonal and riverine spawner and normally spawns during June-July (Shashikumar, 1991; Devi, 1993). The fish attains sexual maturity in 2+ years when it weighs around 200-250 g. Breeding and culture of O. belangeri is gaining momentum in the state of Manipur (Yengkokpam, 2014). After the successful seed production technology developed, many private fish farmers have taken up culture of this indigenous fish in the state. However, the increasing trend in its production led to a drop in price from more than 1000 per kg a few years back to 400-800 per kg at present. Recently, many workers from different regions of India have attempted to introduce the fish, propagate and refine farming techniques (Das et al., 2016; Das et al., 2020).

The Imphal Valley, where most of Manipur's aquaculture activities are concentrated, is characterized by a sub-tropical climate. This agro-climatic regime, defined by distinct seasons and fluctuating environmental parameters, plays a critical role in the success or failure of fish farming. For a species like Pengba, which has specific requirements for breeding and growth, understanding these climatic impacts is crucial for developing sustainable and profitable farming techniques. This review aims to provide a comprehensive overview of how the agro-climatic conditions of the Imphal Valley influence the rearing of *O. belangeri*.

2. Agro-climatic Profile of the Imphal Valley

The Imphal Valley is a saucer-shaped intermountain valley located in the central part of the state of Manipur, in northeastern India. Geographically, it lies approximately between 24°30′ to 25°10′ N latitude and 93°45′ to 94°15′ E longitude, at an average elevation of about 780–800 m above mean sea level. The valley is surrounded on all sides by hill ranges of the Indo-Myanmar fold system. It covers an area of roughly 1,800–2,000 km², accounting for about 10% of Manipur's total geographical area, but supports a major proportion of the state's population, agriculture, and economic activities. Hydro logically, the Imphal Valley is drained by the Imphal River and its tributaries, which ultimately flow into Loktak Lake, the largest freshwater lake in northeastern India. Loktak Lake acts as the principal hydrological sink of the valley and plays a critical role in flood regulation, fisheries, irrigation, and biodiversity conservation. The Ithai Barrage, constructed downstream of Loktak Lake, has significantly altered the natural

hydrological regime of the valley. Climatically, the Imphal Valley experiences a sub-tropical monsoon climate, characterized by warm, humid summers, a pronounced monsoon season (May- September), and cool, dry winters. The region is characterized by three main seasons: summer (March to May), monsoon (June to October), and winter (November to February).

Temperature: The annual temperature range can be quite broad, from a low of around 0°C in winter to a high of 38°C in summer. Water temperature, a primary driver of fish metabolism and growth, closely follows these seasonal changes.

Rainfall: Manipur receives high annual precipitation, with the majority falling during the monsoon season. This rainfall affects water levels in ponds, as well as water quality parameters like turbidity and dissolved oxygen.

Daylight Hours and Solar Radiation: Seasonal changes in daylight hours and solar radiation influence the primary productivity of the pond ecosystem, impacting the growth of phytoplankton and other natural food sources for the fish.

3. Impact of Agro-climatic Factors on Pengba Rearing

The success of Pengba aquaculture is highly dependent on how farmers manage their ponds in response to the prevailing agro-climatic conditions. The following sections detail the specific impacts of these factors on different aspects of the fish's life cycle.

3.1 Growth and Feeding Habits

- **Temperature:** *O. belangeri* is a warm-water species, and its growth is directly proportional to water temperature within an optimal range. Studies have shown that Pengba has pronounced feeding activity and a faster growth rate during the post-monsoon and winter months (October to April), when temperatures are favorable. Conversely, feeding activity and growth are low during the peak monsoon season (June to August). This is likely due to changes in water quality and a drop in temperature, which affects the fish's metabolic rate.
- **Food Availability:** Pengba has a herbi-omnivorous feeding habit. Its diet consists of aquatic macro-vegetation, algae, diatoms, zooplankton, and insects. The seasonal availability of these natural food items is directly influenced by agro-climatic factors. For instance, the high rainfall during the monsoon can introduce a flush of nutrients, leading to algal blooms, but can also cause a decrease in the concentration of preferred food items due to dilution. In polyculture systems, where Pengba is often reared with other carps, its herbivorous nature makes it an excellent candidate for utilizing aquatic plants, which are abundant during certain seasons.

3.2 Breeding and Seed Production

- **Seasonal Spawning:** In its natural habitat, Pengba is a riverine spawner, migrating from the Chindwin River in Myanmar to the Imphal Valley rivers for breeding during the monsoon season. This migration is a direct response to the seasonal increase in water flow and changes in water quality associated with rainfall. The reproductive cycle is therefore tightly linked to the monsoon.
- **Induced Breeding:** With the loss of natural breeding grounds in Manipur, commercial seed production relies on induced breeding techniques using synthetic hormones like Ovatide, Ovaprim, and pituitary gland extracts. The success of induced breeding is also sensitive to environmental factors. The breeding season in captivity is typically a short window during the monsoon (June-August) when the fish are physiologically ready. Water temperature and quality at the time of breeding and hatching are critical for high survival rates of eggs and larvae.

Table 1: Table showing average rainfall, water temperature feeding activity and survival risk for the year 2023-24

Month	Avg_Rainfall in mm	Water_Temp in C°	Feeding Activity	Survival Risk
Jan	10.5	18	Low	Low
Feb	21.6	19	Low	Low
Mar	70.8	21	Moderate	Moderate
Apr	124.1	23	High	Moderate
May	191.6	25	Moderate	Moderate
Jun	218.1	26	Low	High
Jul	229.9	27	Low	High
Aug	194.8	26	Moderate	Moderate
Sep	163.3	24	High	Low
Oct	112.5	22	High	Low
Nov	26.2	20	High	Low
Dec	17.7	18	Low	Low

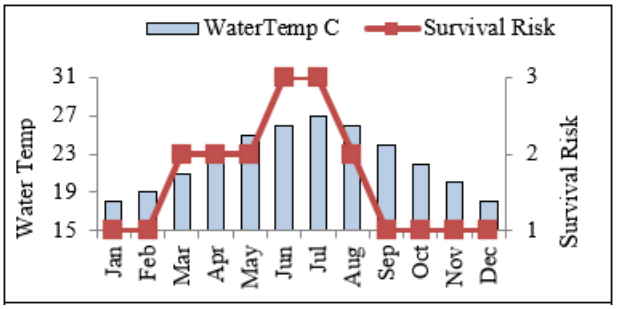

Figure 1: Relation between water temp and survival risk

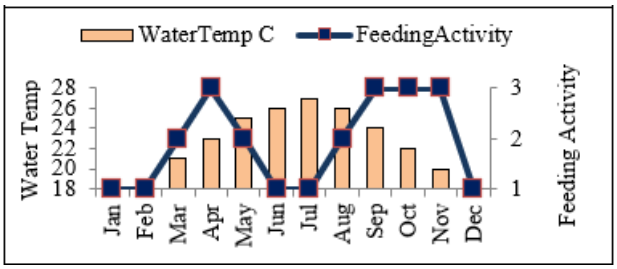

Figure 2: Relation between water temp and feeding activity

3.3 Health and Disease Management

- **Water Quality Fluctuations:** The heavy rainfall during the monsoon season can lead to significant fluctuations in pond water quality. Increased runoff from surrounding agricultural fields can introduce pesticides and fertilizers, leading to nutrient imbalances and the potential for toxic algal blooms. These conditions stress the fish, making them more susceptible to diseases.

- **Disease Prevalence:** Epizootic Ulcerative Syndrome (EUS), a common fungal disease in freshwater fish, and bacterial infections from *Aeromonas* are common ailments affecting Pengba. These diseases are often more prevalent during periods of stress, such as when water quality deteriorates or temperatures drop below the optimal range. Farmers use measures like liming to control water quality and prevent these outbreaks. The use of traditional knowledge in disease management, coupled with modern scientific approaches, is crucial for maintaining a healthy fish stock.

4. Challenges and Mitigation Strategies

The agro-climatic conditions in the Imphal Valley pose several challenges for Pengba rearing.

- **Climate Change:** A significant and growing concern is the impact of climate change. Increased temperature trends, erratic rainfall patterns, and more frequent extreme weather events (e.g., floods, droughts) can destabilize the delicate balance of the aquaculture ecosystem. These changes can disrupt breeding cycles, reduce growth rates, and increase the risk of disease outbreaks.
- **Water Management:** Effective water management is key to mitigating the negative impacts of seasonal variations. Farmers must manage water levels during the dry season and prevent runoff from polluting ponds during the monsoon. The use of rainwater harvesting techniques and a focus on pond design that minimizes erosion and maximizes water retention are important strategies.
- **Feed Formulation:** While Pengba feeds on natural food in ponds, a lack of sufficient natural food, particularly during the low-feeding season, necessitates the use of supplementary feeds. Developing region-specific, cost-effective, and nutritionally balanced feeds that can be used throughout the year is a major area for research.

5. Conclusion and Future Directions

The rearing of *Osteobrama belangeri* (Pengba) in the Imphal Valley is a critical activity for both the conservation of this endemic species and the economic well-being of the local population. The success of this endeavor is highly dependent on the region's agro-climatic conditions. Temperature, rainfall, and seasonal fluctuations in water quality are the primary drivers of growth, breeding, and disease susceptibility. As climate change continues to impact the region, it is imperative to develop and implement climate-resilient aquaculture practices. This includes research on climate-adaptive strains, Advanced pond management techniques, Standardizing breeding protocols, Community engagement. By acknowledging the profound impact of agro-climatic conditions and proactively developing strategies to adapt to them, the people of the Imphal Valley can ensure the long-term viability and success of Pengba aquaculture, thereby safeguarding this unique and valuable component of Manipur's natural heritage.

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