

Silver barb: A promising candidate

for aquaculture diversification in Meghalaya hills

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Barbonymus gonionotus, also known as 'Java Puti' or 'Silver Barb', offers significant potential for expanding regional aquaculture. This freshwater fish, native to Southeast Asia, has shown impressive adaptability, rapid growth, and strong market demand, making it an attractive choice for cultivation in the cold climate of the Meghalaya hills in Northeast India. This article examines the fish's potential as a sustainable aquaculture species, focusing on its biological characteristics and nutritional value. It explores the aquaculture prospects, as well as the economic, nutritional, ecological, and socio-economic advantages of farming this species, while also addressing the challenges and considerations involved. Key insights are provided to aid in the successful integration of the fish into the aquaculture sector. The adoption of this species has the potential to enhance the diversity, resilience, and sustainability of aquaculture in the Meghalaya hills.

Keywords: Aquaculture diversification, *Barbonymus gonionotus*, Hill aquaculture, Livelihood, Sustainability

The state of Meghalaya, nestled in the northeastern region of India, is endowed with abundant water resources and a favourable climate, making it an ideal location for aquaculture diversification. However, the current practices have primarily focused on a limited number of major carp species, leaving room for the introduction and cultivation of other promising species. *Barbonymus gonionotus* (Bleeker, 1849), commonly known as the Silver Barb or *Java Puti* or *Rajputi* or *Thai Sarputi*, is a freshwater fish species that has gained notable significance in aquaculture due to its adaptability, rapid growth, and high market demand. Originating from Southeast Asia, particularly the Mekong, Chao Phraya, and Mae Klong River basins, this species belongs to the family Cyprinidae and has several synonyms, including *Puntius javanicus*, *Puntius gonionotus*, *Barbus javanicus*, *Barbus gonionotus*, and *Barbodes gonionotus*. With its distinct characteristics and favourable attributes, the fish has

become a focal point for aquaculture aiming to meet the escalating global demand for fish protein. This article explores the potential of *B. gonionotus* as a sustainable aquaculture species in the Meghalaya, highlighting its biological characteristics, aquaculture suitability, and the benefits, challenges, and considerations associated with its cultivation potential in the region.

Species overview

Morphologically, *B. gonionotus* exhibits a strongly compressed body with an arched dorsal profile, often concave above the occiput. The head is small with a pointed snout and terminal mouth. The barbels are very minute or rudimentary, especially the upper ones, which sometimes disappear entirely. The individuals are silvery-white, sometimes with a



Barbonymus gonionotus (Silver Barb) at ICAR-NEH Fish Farm, Meghalaya

golden tint. The dorsal and caudal fins are gray to gray-yellow, while the pectoral fins are pale to light yellow.

It is omnivorous, feeding on algae, plankton, aquatic weeds (*Ipomea*, *Hydrilla*, etc), invertebrates, and commercial feeds and completely harmless to humans. In its natural habitat, it is found at mid-water to bottom depths and prefers stagnant water habitats. While it is a migratory species, its migrations are not over long distances. It is often used as a pituitary donor for artificial propagation. According to the IUCN Red List, it is classified as Least Concern (LC). The largest recorded specimen was 45 cm in total length and weighed 2.1 kg, from Thailand.

B. gonionotus is a dual-purpose fish, meaning it has both food and ornamental value. Historically, *B. gonionotus* has played a significant role in aquaculture practices in several Southeast Asian countries, such as Indonesia, Thailand, and Vietnam, where it has been extensively cultivated for its rapid growth, palatability, and market demand. In the Mekong Delta, *B. gonionotus* is considered one of the 40 economically important species. In India, the species was introduced in 1972 from Java, Indonesia, for the biological control of aquatic weeds, and its culture potential was later realized in the late 1990s.

Aquaculture potential in Meghalaya

The region's climate, characterized by high rainfall, moderate temperatures, and abundant freshwater sources, aligns well with the environmental requirements of *B. gonionotus*. This synergy between the species' preferences and the local environmental conditions suggests that Meghalaya's aquaculture sector can greatly benefit from the integration of *B. gonionotus* into its diversification efforts. The ICAR Research Complex for NEH Region in Umiam, Meghalaya, has evaluated the growth performance of the fish in both pond systems and cage culture systems in Umiam lake, with promising results.

Benefits of cultivating *Barbonymus gonionotus*

Adaptability and resilience: *B. gonionotus* demonstrates remarkable adaptability to varying environmental conditions, including fluctuating water quality parameters. Its resilience to low dissolved oxygen levels and wide temperature ranges makes it well-suited for aquaculture systems ranging from extensive ponds to intensive recirculating aquaculture systems (RAS). This adaptability is particularly advantageous in the context of climate change and the associated environmental challenges faced by aquaculture operations.

Ease of breeding and seed production: *B. gonionotus* is highly regarded for its ease of breeding in captivity such as ponds, tanks, etc. This ease of breeding is particularly advantageous for ensuring a consistent supply of seed stock for aquaculture operations, where a reliable seed supply is essential for sustainable production. Sexual maturity in *B. gonionotus* is typically reached around 12 months of age, and the fish spawn from April to August. Females tend to grow faster than males. Broodstock can be used for 2-3 breeding seasons, with each season consisting of 4-5 spawning events spaced at 30-45 day intervals. This reproductive pattern allows for multiple batches of offspring to be produced from a single set of broodstock, maximizing the efficiency of breeding efforts. Spawning can be induced by various methods, including environmental cues such as high water flow or through the use of hormone injections. Females typically require two injections, while males require a single simultaneous injection with pituitary extracts. After hormone treatment, males and females are stocked together in a spawning tank at a 1:1 ratio. Spawning usually occurs within 6-8 hours post-injection. Another key attribute is its high fecundity, with females capable of producing 200,000 to 300,000 eggs per kilogram of body weight. This high egg production rate, coupled with the species' good egg hatchability of 80 to 90% within

17-18 hours at water temperatures of 27-29°C, ensures a high yield of viable offspring. Overall, the combination of ease of breeding, high fecundity, and good egg hatchability makes *B. gonionotus* an ideal candidate for aquaculture diversification programmes.



A parent fish



Quality seeds of *Barbonymus gonionotus* (average weight: 15.5±2.8 g) produced through induced breeding technique

Commendable disease resistance: *B. gonionotus* exhibits a commendable level of disease resistance, although it can still be susceptible to certain pathogens. This resistance stems from various factors, including its natural habitat in fast-flowing streams and rivers, which exposes it to a diverse range of microorganisms. Additionally, the species' ability to thrive in a wide range of environmental conditions, including crowding and handling stress, contributes to its resilience against diseases.

Adaptability and low-input requirements: *B. gonionotus* can thrive on low protein diets, including aquatic plants or supplementary feed, reducing dependence on expensive commercial feeds. For grow-out, it requires a crude protein content of 31.7% in feed. It can adapt to a wide range of environmental conditions such as water temperatures from 15 to 41.5°C (optimal 25-30°C), salinity up to 7 ppm, pH levels from 5.5 to 9 (optimal 7-8), and dissolved oxygen

as low as 0.656 mg/L (optimal above 2 mg/L). This resilience allows for culture in diverse low-management systems with minimal inputs.

Rapid growth and production efficiency: Another of the key benefits of cultivating *B. gonionotus* is its rapid growth rate. The species exhibits an average growth of 0.7 g/fish/day in monoculture and 0.8 g/fish/day in polyculture systems. It can withstand high stocking densities, up to 16,000 individuals per hectare, and attain marketable size (150-200 g) within 3-4 months, reaching up to 1 kg in a year under optimal conditions. This fast growth and efficient feed utilization translate to quicker turnover rates for farmers, enhancing the profitability of their operations. The monoculture of the fish yields an average gross production of 815 to 2,000 kg per hectare after five months, while the polyculture results in a gross production of 1,373 to 2,000 kg per hectare during the same period, with a net benefit of approximately ₹ 24000/ha. In paddy fields, it can attain weights up to 500 g in just 6-8 months.

High nutritional value and market demand: *B. gonionotus* is a sought-after species in local markets, due to its attractive look, mild flavour, firm texture, and high nutritional value. The protein content of the fish is 65.80% on a dry basis, with a fat content of 2.30% and mineral content of 13.86%. It is also a great source of essential minerals such as calcium (2.50%), sodium (0.54%), potassium (1.48%), and phosphorus (2.63%). Additionally, the fish is rich in omega-3 fatty acids (0.457 g/100g), selenium (71.7 µg/100g), vitamin A (32.2 µg/100g), and zinc (1.44 mg/100g wet weight). The dressing percentage of the fish is around 22%, indicating a relatively high edible portion compared to the total body weight. This high nutritional value and high dressing percentage make *B. gonionotus* a valuable aquaculture species for addressing food security and improving the dietary and culinary diversity of local communities.

Better utilization of seasonal ponds: The majority of fish ponds

in Northeast India, especially in Meghalaya, are small and seasonal, which makes them unsuitable for cultivating large-sized fish such as Indian major carps, Grass carp, and silver carp. These larger species usually take 8-10 months to reach a size suitable for market. In contrast, *B. gonionotus*, being marketable in smaller sizes (150-200 g), is a suitable choice for effectively utilizing small and seasonal ponds for aquaculture enhancement in the region. This potential shift to *B. gonionotus* could lead to a more sustainable and efficient use of resources, benefiting local aquaculture practices and enhancing food security.

Ecological benefits: *B. gonionotus* can contribute to ecosystem restoration initiatives, as the species can play a significant role in checking aquatic weed growth, reducing the reliance on chemical-based management methods. In fact, it ranks next to the Grass carp (*Ctenopharyngodon idella*) in terms of biological control of aquatic weeds. Additionally, its ability to thrive in diverse aquatic habitats, including rivers, streams, floodplains, and reservoirs, presents opportunities for habitat restoration and conservation efforts.

Economic and socio-economic benefits: The successful cultivation of *B. gonionotus* can have a significant

impact on the socio-economic development of local communities in Meghalaya. With a market price ranging from ₹200 to ₹250 per kilogram, its cultivation can generate stable incomes for farmers and create employment opportunities in related sectors, such as processing, packaging, and branding of fish products. This can further enhance the economic value of the species and promote the development of local entrepreneurship and value-added activities.

Diversification and resilience: Historically, Meghalaya's aquaculture sector has been dominated by a limited number of Indian and exotic carp species, leaving it vulnerable to market fluctuations, environmental shocks, and disease outbreaks. By incorporating *B. gonionotus* as an additional aquaculture species, Meghalaya can enhance the diversity of its fish production, reducing the risk of overreliance on a few dominant species. Increased diversification can improve the overall stability and resilience of aquaculture systems in the state. By cultivating a broader range of species, the resource poor farmers can better mitigate the impacts of climate change, disease outbreaks, and other environmental stressors. If one species experiences a setback,



Polyculture of *Barbonymus gonionotus* in ICAR-NEH Fish Farm, Meghalaya



Cage culture of *Barbonymus gonionotus* with other carps in Umiam Lake, Meghalaya

the presence of alternative species can help maintain overall production levels and minimize disruption to the local food supply.

Integration with existing practices: *B. gonionotus* has a peaceful temperament; hence, its cultivation can complement and synergize with the existing carp polyculture practices in Meghalaya. Integration with major Indian carps, such as *Catla catla*, *Labeo rohita*, and *Cirrhinus mrigala*, can lead to improved overall biomass production without significantly impacting the growth of the other carp species. Additionally, periphytic substrates, such as bamboo mats, can be used for its co-culture with other carps. These substrates have been shown to improve water quality, increase plankton availability, and enhance the growth performance of the fish, particularly *P. gonionotus*.

Candidate for open water aquaculture: *B. gonionotus* is also a potential species for cage culture and open water fisheries enhancement. The ICAR Research Complex for NEH Region in Umiam, Meghalaya, evaluated the production performance of *B. gonionotus* through cage culture systems in Umiam Lake, Meghalaya, demonstrating its potential for co-

culture with other species, such as *Cyprinus carpio* (common carp) and *Labeo gonius* (Kurio labeo). The results had been promising, with *B. gonionotus* reaching marketable sizes of 21.52 ± 1.59 cm and 180.5 ± 19.27 g within 6 months, with a survival rate of $74.83 \pm 5.4\%$.

Challenges and considerations

While the cultivation of *B. gonionotus* in Meghalaya's aquaculture systems offers numerous benefits, several challenges and considerations need to be addressed to ensure its successful and sustainable integration.

Disease management and biosecurity: Ensuring the health and well-being of the fish in a new environment can be a significant challenge. Factors such as water quality, disease outbreaks, and pathogen transmission can pose risks to the species' survival and growth. Implementing robust disease management strategies, including biosecurity measures, appropriate treatment protocols, and monitoring systems, will be crucial in mitigating these challenges.

Genetic management and preservation of local genetic resources: The introduction of a

non-native species into Meghalaya's aquaculture systems raises concerns about the potential impact on the genetic integrity of indigenous fish populations. Strategies for genetic management, including selective breeding programs and the maintenance of genetic diversity, must be carefully considered to minimize the risk of hybridization and the loss of local genetic resources.

Ecological impact assessment and mitigation strategies: The integration of *B. gonionotus* into Meghalaya's aquatic ecosystems must be carefully evaluated to assess its potential ecological impact. Factors such as competition with native species, habitat disruption, and the introduction of invasive pathogens or parasites need to be thoroughly investigated and mitigated through appropriate risk assessment and management protocols.

Availability and affordability of suitable feed sources: Feed is a major crisis in aquaculture in Northeast India. Ensuring a consistent supply of high-quality feeds with balanced nutrition can be a challenge in Meghalaya. As an omnivorous species, *B. gonionotus* has diverse dietary requirements,

and the availability and affordability of suitable feed ingredients must be addressed to optimize the species' growth and production.

Technical support and capacity-building initiatives: The cultivation of a new fish species requires the provision of appropriate technical support and capacity-building initiatives for local farmers. Ensuring access to training, extension services, and access to technology and resources will be crucial for the successful adoption and sustainable cultivation of *B. gonionotus* in Meghalaya.

CONCLUSION

Barbonymus gonionotus is a promising candidate for aquaculture diversification in the Meghalaya Hills of Northeast India. Its adaptability to various environmental conditions, rapid growth rate, high nutritional value,

and strong market demand make it an attractive option for enhancing the sustainability and productivity of the region's aquaculture sector. The cultivation of this fish offers significant economic, nutritional, ecological, and socio-economic benefits. It has the potential to contribute to food security, generate stable incomes for local communities, support biodiversity conservation efforts, and promote the overall well-being of the region.

However, the successful integration of *B. gonionotus* into Meghalaya's aquaculture systems requires careful consideration and mitigation of challenges related to disease management, genetic integrity, environmental adaptation, feed availability, and capacity building. Implementing responsible aquaculture practices, fostering stakeholder collaboration, and ongoing research and

technical support will be crucial in maximizing the benefits of this species while ensuring the long-term sustainability of aquaculture operations in the Meghalaya hills.

By embracing the potential of *B. gonionotus* as a sustainable aquaculture species and addressing the associated challenges, Meghalaya can diversify its aquaculture sector, enhance food production, promote socio-economic development, and contribute to the conservation of its aquatic resources. The successful adoption of this species can contribute to the diversification, resilience, and sustainability of aquaculture in the Meghalaya, while also serving as a model for other regions seeking to enhance their aquaculture practices.

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