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UTILIZING BIOTOPE PRINCIPLES AND TECHNIQUES FOR SUSTAINABLE CULTIVATION AND DOMESTICATION OF AN ENDANGERED *Parosphromenus deissneri*

PRINSIP DAN TEKNIK PEMANFAATAN BIOTOP UNTUK BUDI DAYA BERKELANJUTAN DAN DOMESTIKASI *Parosphromenus deissneri* YANG TERANCAM PUNAH

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Abstract

Parosphromenus deissneri is a freshwater species known exclusively from Bangka Island, Indonesia. According to the IUCN Red List of Threatened Species in 2020, this species is endangered, and the population continues to decrease due to the consequences of open-pit tin mining on Bangka Island harming its natural ecosystem. Despite the fact that this species is regarded as endangered, no known conservation and domestication initiatives have been made to enhance its number in the wild. In this study, we propose to do domestication of *P. deissneri* using biotope principles and techniques to increase the *P. deissneri* capacity for adaptation and reproduction since these species believe they are in their natural habitat. This study was carried out from April to September of 2023 at Bangka Belitung Endemic Fish Laboratory. We designed the biotope concept using an aquarium with dimensions 200 cm x 100 cm x 50cm. Biotopes are equipped with aquatic plants, roots, twigs, dead leaves, sand, rocks, gravel, and water containing natural plankton as biotic and abiotic elements. In this study, a *Parosphromenus deissneri* broodstock of 20 individuals (10 males and 10 females) was maintained for a 5-month period, resulting in an 80% survival rate. During the study, one mating pair successfully produced approximately 14 eggs, 8 of which hatched. Following a 2-month larval development phase, 4 fry survived to adulthood, yielding a survival rate of 25% relative to the total number of hatched eggs. These results underscore the necessity for refined husbandry practices and optimal environmental conditions to improve fry survival and enhance reproductive success in future breeding efforts.

Keywords: Biotope, endemic, fish, blackwater

Abstrak

Parosphromenus deissneri adalah spesies air tawar yang hanya ditemukan di Pulau Bangka, Indonesia. Berdasarkan IUCN *Red List* tahun 2020, spesies ini berstatus terancam punah, dan populasinya terus menurun akibat dampak penambangan timah terbuka di Pulau Bangka yang merusak ekosistem alaminya. Meskipun spesies ini dikategorikan sebagai terancam punah, hingga saat ini belum ada upaya konservasi dan domestikasi yang dilakukan untuk meningkatkan populasinya di alam liar. Dalam penelitian ini, kami mengusulkan domestikasi *P. deissneri* dengan menerapkan prinsip dan teknik biotop untuk meningkatkan kapasitas adaptasi dan reproduksi spesies ini, dengan menciptakan lingkungan yang menyerupai habitat aslinya. Penelitian ini dilakukan dari April hingga September 2023 di Laboratorium Ikan Endemik Bangka Belitung. Konsep biotop dirancang menggunakan akuarium berukuran 200 cm x 100 cm x 50 cm, yang dilengkapi dengan tanaman air, akar, ranting, daun kering, pasir, batu, kerikil, serta air yang mengandung plankton alami sebagai elemen biotik dan abiotik. Dalam penelitian ini, sebanyak 20 ekor *Parosphromenus deissneri* (10 jantan dan 10 betina) dipelihara selama 5 bulan, menghasilkan tingkat kelangsungan hidup sebesar 80%. Selama penelitian, satu pasangan berhasil bertelur sebanyak 14 butir, dengan 8 telur yang menetas. Setelah fase perkembangan larva selama 2 bulan, 4 ekor burayak bertahan hingga dewasa, dengan tingkat kelangsungan hidup 25% dari total telur yang menetas. Hasil ini menegaskan pentingnya perbaikan praktik pemeliharaan dan optimalisasi kondisi lingkungan untuk meningkatkan kelangsungan hidup burayak serta keberhasilan reproduksi dalam upaya pembiakan di masa depan.

Kata kunci: Biotop, endemik, ikan, perairan gambut

INTRODUCTION

Indonesia is a mega biodiversity country with extremely high biodiversity and endemism levels including the fish species which occur in aquatic environments (Hasan et al., 2023). There are around 8.500 fish species that are classified based on the characteristics of their habitats (e.g., salty, brackish, and freshwater) and 1,266 freshwater species which recorded in Indonesia in 2022 (Robin et al., 2023). However, due to habitat and environmental loss caused by land conversion, pollution, and climate change, the diversity of freshwater species is now being significantly threatened (Syarif et al., 2023). Bangka Belitung Island is one of the regions where the population and diversity of freshwater fish have declined as a result of the impact of open-pit tin mining and oil farm plantation (Kusumah et al., 2023; Syarif et al., 2023).

P. deissneri is one of the endemic species that still exist on Bangka Island but whose survival is Endangered owing to disruption to its natural habitat. Even though *P. deissneri* has future prospects as an ornamental fish originating from Bangka Island. The aquarium or ornamental fish business is growing in popularity around the world due to its simple operating system and lower operating costs.

However, *P. deissneri* is Endangered which is difficult to obtain in natural habitat because their populations are declining. In this study, we created a biotope cultivation system by incorporating abiotic and biotic elements into the aquarium as a living medium for *P. deissneri* reproduction. This project is an attempt to expand the production of *P. deissneri* in regulated culture so that it can be utilized as an ornamental fish commodity, which will benefit the people of the Bangka Islands' economy.

MATERIALS AND METHODS

Water Chemistry Simulation

To replicate the water conditions found in the natural habitats of *P. deissneri*, precise control over water chemistry is required. The experiment focused on achieving the following water parameters: pH 4-5, Temperature: 24–28°C. The pH was adjusted using a combination of tannin-releasing organic materials such as Indian almond leaves.

Aquarium Setup

An aquarium with dimensions 200 cm by 100 cm by 50cm with built-in lighting was used. This aquarium's volume is approximated to be 750 liters. A low-power LED light with a light intensity of 0.2 watts per liter was employed, the light was set on a 10-hour day/night cycle to replicate the light-dark pattern in the fish's natural habitat. A small pump lifted the water to a built-in container containing Dacron wool and other bio-filter material. The water is returned to the aquarium, where it is directed by a water diffuser.

Aquatic Plant Selection and Subtrate Setup

The substrate on the bottom of the aquarium where the aquatic plants, roots, twigs, dead leaves, sand, rocks, gravel, and water containing plankton were obtained from natural habitat of *P. deissneri*. Moreover, We use Cryptocorin sp type plants in the aquarium as a shelter and the most common algae, a dark green blanket-like algae were also growing and covering the gravel and plants. *P. deissneri* was collected from the Pelawan Forest River, Central Bangka district Bangka Island, Indonesia.

Breeding Conditions and analysis the HR and SR

Breeding *P. deissneri* in captivity requires careful management of water quality, tank size, and environmental conditions. Pairs of *P. deissneri* species were selected based on observable sexual dimorphism, with males typically showing brighter coloration and elongated fins. Water conditions, particularly temperature and pH, were tightly controlled during the breeding period, with a slight increase in temperature (28°C) to encourage spawning.

RESULT

Biotope componet settings

The biotope concept was developed using an aquarium with dimensions of 200 cm × 100 cm × 50 cm, providing a controlled environment to replicate a natural aquatic ecosystem. The biotope includes key biotic and abiotic elements, such as aquatic plants, driftwood roots, branches, twigs, dead leaves, sand, rocks, gravel, and water enriched with natural plankton. These components collectively simulate the structural and functional dynamics of a natural habitat, promoting interactions between species and their environment (Fig. 1). The inclusion of natural plankton enhances ecological realism by contributing to nutrient cycling and supporting the base of the food web.

Environmental Correspondence

Environmental correspondence consists of substrate and water. As much as 750 liters of water is obtained from the natural habitat containing plankton. Then the substrate is the soil and gravel on the bottom of the aquarium where the plants can take root and grow. We also use Cryptocorin sp-type plants in the aquarium as a shelter and the most common algae, a dark green blanket-like algae were also growing and covering the gravel and plants.

Figure 1. *Parosphromenus deissneri* biotope aquarium (picture by Travonim)

Environmental Quality

The temperature in the aquarium biotope normally varies between 25 and 28 degrees Celsius. We do not treat the biotope environment because its temperature is similar to that of its natural habitat. The pH in the aquarium biotope ecosystem is usually constant at 5. This is generally higher than its normal pH of 3-5 for natural habitat of *P. deissneri.* In the biotope aquarium, we maintain oxygen levels at 4-5 ppm. Dissolved oxygen (DO) is a measure of how much oxygen is dissolved in the water - the amount of oxygen available to living aquatic organisms.

Spawning and Incubating

P. deissneri spawns in small caves or among leaf litter, with males establishing territories centered around a cave constructed from leaf litter. Males display vertical postures with splayed fins to attract females. During spawning, eggs and milt are released in batches during multiple embraces. Both males and females attempt to attach fertilized eggs to the ceiling. After spawning, the female leaves, while the male provides parental care, guarding the eggs for 24-36 hours. The fry becomes mobile in 4-6 days, and after 3-5 days, they become fully free-swimming. Parental care ceases once the fry leaves the cave.

Survival rates of the organism

In this study, a Parosphromenus deissneri broodstock of 20 individuals (10 males, 10 females) was maintained for 5 months, achieving an 80% survival rate. During this period, one pair successfully mated, producing approximately 14 eggs, of which 8 fry hatched. After a 2-month larval phase, 4 fry survived to adulthood, resulting in a 25% survival rate relative to the total number of eggs that hatched. These results suggest a need for improved rearing conditions to enhance fry survival and overall reproductive success.

DISCUSSION

The biotope concept replicates natural aquatic ecosystems by integrating biotic elements like aquatic plants and plankton with abiotic components such as driftwood, twigs, sand, and rocks, simulating habitat complexity and nutrient cycling. Driftwood roots and branches can be used and placed to provide further shelter and potential spawning sites. The inclusion of dried leaf litter enhances the natural feel while also providing additional cover for the fish and promoting the establishment of microbial colonies as decomposition happens (Wang et al., 2020). These can be a valuable secondary food source for fry, and the tannins and other compounds generated by decaying leaves are also thought to be beneficial to blackwater fishes. All of the biotic and abiotic components in this aquarium came from a single source: a natural habitat of *P. deissneri* in the Pelawan Forest River, Central Bangka district of Bangka Island, Indonesia. This biotope concept represents a small part of the peaceful underwater aquatic life from natural habitat of *P. deissneri.*

The environmental setup for the aquarium biotope is composed of two primary components: substrate and water (Kuhnz et al., 2022). Water sourced from the organism's natural habitat and containing plankton, was utilized to ensure ecological stability and nutrient availability (Brieley, 2017). The substrate comprises soil and gravel, which provide an anchoring medium for aquatic plants to establish roots and grow. This substrate is a carefully formulated mixture of natural materials, including shell grit, peat, laterite, and sand. Shell grit serves as a source of calcium, carbon, and trace minerals essential for ecosystem health. Peat contributes organic carbon and enhances the soil's cation-exchange capacity, thereby facilitating the uptake of nutrients and carbon by plants (Heryanto et al., 2021).

Cryptocoryne sp. plants were introduced into the system and collected from the natural habitat to serve multiple ecological functions, including oxygen production, nutrient cycling, and acting as biofilters that contribute to water quality improvement. Additionally, the aquarium supports the growth of dark green, blanket-like algae, which naturally colonize the substrate and plants. This algal growth not only mimics conditions in the natural habitat but also accelerates the acclimatization of organisms to the artificial biotope.

The aquarium system also incorporates a filtration unit to promote the nitrogen cycle by aerating the water and providing a surface area for nitrifying bacteria. These bacteria facilitate the conversion of ammonia to nitrate, a critical process for maintaining water quality. Furthermore, plants in the system play a vital role in the ecosystem by serving as shelters and egg deposition sites for fish, in addition to their contributions to oxygenation and nutrient cycling (Dharmono et al., 2022). By integrating these components, the aquarium biotope successfully replicates the physicochemical and biological characteristics of the organism’s natural environment, ensuring a self-sustaining and ecologically functional system.

The water's physical and chemical properties significantly influence the health and well-being of aquatic organisms in the aquarium biotope. To assess and manage water quality effectively, we monitor key parameters such as temperature, pH, and dissolved oxygen (DO). The temperature within the biotope aquarium is maintained between 25°C and 28°C, closely reflecting the natural habitat of *P. deissneri*. This range is consistent with the thermal conditions of its native environment, and as such, no additional temperature regulation is required.

The pH in the biotope is initially set at 5, which is slightly higher than the natural range of 3–5 observed in the species’ wild habitats. This adjustment accounts for the anticipated gradual decline in pH due to biological processes, including the activity of microorganisms and the accumulation of organic matter (Lund et al., 2020). The gradual shift toward acidic conditions simulates the natural buffering processes observed in the species' ecosystem.

Dissolved oxygen (DO) concentrations are maintained at 4–5 mg/L to ensure optimal conditions for aquatic organisms. DO represents the concentration of molecular oxygen dissolved in the water and is critical for metabolic and respiratory functions in aquatic life. For most fish species, including P. deissneri, a DO level of 5 mg/L is considered ideal, as referenced in established guidelines (Tumwesigye et al., 2022). While the sensitivity to low DO levels varies among species, most fish exhibit signs of stress, when DO falls below 2–4 mg/L, and mortality rates, increase significantly at concentrations below 2 mg/L.

These parameters are carefully managed to replicate the ecological conditions of *P. deissneri's* natural habitat while minimizing environmental stressors in the controlled biotope environment. By closely monitoring and adjusting these variables, we aim to create a stable and sustainable habitat conducive to the health and well-being of the aquarium's aquatic life.

P. deissneri exhibits a breeding behavior typical of many anabantoids, utilizing small caves or leaf litter as spawning sites. Males establish temporary territories centered around these shelters, often constructed from leaf litter, where they engage in courtship displays to attract females. During the nuptial display, the male assumes a near-vertical orientation, with the head positioned inferiorly and the fins fully extended, signaling readiness for mating. Spawning occurs in multiple stages, with eggs and milt being released in batches during a series of embraces, wherein the male wraps around the female's body.

Males construct a bubble nest within the cave, but it is common for both sexes to work in tandem to affix the fertilized eggs to the ceiling of the shelter. Upon successful fertilization, the female departs the cave, leaving the male to assume sole responsibility for egg care. He guards the eggs through an incubation period lasting between 24 to 36 hours, after which the fry exhibit limited mobility. Initially, the larvae swim aimlessly; however, the male actively retrieves and returns them to the nest until they become fully mobile around 4 to 6 days post-hatching. After an additional 3 to 5 days, the fry attain full independence and leave the shelter, at which point the male ceases his parental care. This reproductive strategy emphasizes the male’s role in parental investment, with parental care ceasing once the fry achieve full independence.

A broodstock of *P. deissneri* consisting of 20 individuals (10 males and 10 females) was introduced into a controlled breeding environment for domestication. Over the course of 5 months, the survival rate of the broodstock was recorded at 80%, with 4 individuals (3 females and 1 male) failing to survive, indicating an attrition rate of 20%. During the maintenance phase, a single pair of broodstock was successfully mated, resulting in the production of approximately 14 eggs, of which 8 fry were successfully hatched. Following the hatching, the larvae underwent a maintenance period of approximately 2 months. At the conclusion of this period, 4 fry survived to adulthood, yielding a survival rate of 25% when compared to the total number of fry that had hatched. The observed survival rates of both the broodstock and the fry suggest that while successful mating and hatching were achieved, the survivability of the larvae during the early developmental stages was relatively low. These findings point to the necessity for further research into optimizing rearing conditions, including water quality, nutritional inputs, and environmental parameters, to enhance the survival and growth rates of the fry. Additionally, further studies on the behavioral and physiological requirements of both juvenile and adult stages may provide insight into mitigating the observed mortality rates in subsequent breeding efforts.

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REFERENCES

Brierley AS. 2017. Plankton. *Curr Biol.* 27(11):R478-R483. Doi: 10.1016/j.cub.2017.02.045.

Dharmono M, Irianti R, Fajeriadi H. 2022. Aquatic plants as niche for lay eggs and raising juveniles by freshwater fish in three swamp habitats in South Kalimantan, Indonesia. *Biodiversitas* 23: 1520-1526. Doi: 10.13057/biodiv/d230341

Hasan V., Andraini NE., Isroni W, Sari, L. A., Nafisyah, A. L., Dewi, N. N., Putri, D. N. A., Prasasti, T. A. B., Ramadhania, A. A., Daniel, K., South, J., Vieira, L. O., Ottoni, F. P., Maftuch, M., Faqih, A. R., Wirabuana, Pandu. Y. A. P., Tamam, M. B., & Valen, F. S. (2023). Fish diversity of the Bengawan Solo River estuary, East Java, Indonesia. Biodiversitas Journal of Biological Diversity, 24(4), 2207–2216. Doi: 10.13057/biodiv/d240433

Heryanto R B, Gani R A, and Sukarman 2021 The distribution and characteristics of peat lands in Central and South Bangka Regencies, Bangka Belitung Islands Province.IOP Conf. Series: Earth and Environmental Science. 648 012152. DOI 10.1088/1755-1315/648/1/012152

Kusumah, W., Hasan, V., & Samitra, D. (2023). Rediscovery of the Billiton Caecilian, *Ichthyophis billitonensis* Taylor, 1965, on Belitung Island, Indonesia, after more than five decades. Herpetology Notes, 16, 95–97.

Linda A. Kuhnz, Lisa Gilbane, Guy R. Cochrane, Charles K. Paull. 2022. Multi-factor biotopes as a method for detailed site characterization in diverse benthic megafaunal communities and habitats in deep-water off Morro Bay, California. Deep Sea Research Part I: Oceanographic Research Papers, 190: 103872. Doi: 10.1016/j.dsr.2022.103872.

Lund PA, De Biase D, Liran O, Scheler O, Mira NP, Cetecioglu Z, Noriega Fernández E, Bover-Cid S, Hall R, Sauer M and O’Byrne C (2020) Understanding How Microorganisms Respond to Acid pH Is Central to Their Control and Successful *Exploitation. Front. Microbiol.* 11:556140. Doi: 10.3389/fmicb.2020.556140

Robin, R., Valen, F. S., Nomleni, A., Turnip, G., Luhulima, M. Y., & Insani, L. (2023). Presence of non-native freshwater fish in Indonesia: A review - Risk and ecological impacts. AACL Bioflux, 16(1), 66–79.

Syarif, A. F., Valen, F. S., & Herjayanto, M. (2023). First DNA barcoding and phylogenetics of wild Betta edithae (Anabantiformes: Osphronemidae) from Belitung Island, Indonesia. AACL Bioflux, 16(5), 2626–2636.

Syarif, A., Hafidz, A., Valen, F., Herjayanto, M., & Robin. (2023). A new distributional record of spanner barbs, Striuntius lateristriga (Valenciennes, 1842) (Cypriniformes: Cyprinidae) in Belitung Island, Indonesia. IOP Conf. Series: Earth and Environmental Science , 1289(1), 012011.

Tumwesigye, Z., Tumwesigye, W., Opio, F., Kemigabo, C., & Mujuni, B. (2022). The Effect of Water Quality on Aquaculture Productivity in Ibanda District, Uganda. Aquaculture Journal, 2(1), 23-36. Doi: 10.3390/aquacj2010003

Wang F, Lin D, Li W, Dou P, Han L, Huang M, Qian S, Yao J. Meiofauna promotes litter decomposition in stream ecosystems depending on leaf species. *Ecol Evol.* 2020;10:9257–9270. Doi: 10.1002/ece3.6610.