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Development of Domestication Technology for Wader Puntius Binotatus in the Brantas River Watershed, East Java

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Abstract

Puntius binotatus Wader fish in the Brantas Watershed (DAS) have an important position in society because in addition to being consumed, they are also bioindicators of the health level of public waters. The purpose of this study was to formulate a suitable domestication technique for Puntius binotatus Wader fish in the Brantas Watershed area of East Java. This type of research can be categorized as development research, also known as research and development (R&D). The outcome produced in this study is a sustainable management model for domestication of Wader fish in the Brantas Watershed, East Java. The domestication process of Wader fish was analyzed descriptively, including the stages in the domestication process of Wader fish which are wild fish so that they can be cultivated. Domestication, in addition to preventing extinction, this technology has potential in fisheries businesses. This process aims to increase productivity, control its life cycle, and ensure the availability of Wader fish throughout the year for consumption and conservation. The domestication of Wader fish requires preparation in two key areas: (1) studying their biological characteristics, including morphology, habitat, and distribution; and (2) understanding their reproductive characteristics, including sex differentiation, gonadal maturity, and fecundity.

Keywords: *Domestication, Puntius Binotatus, Bioindicator.*

Introduction

Sustainable development refers to efforts to maintain ecosystems that can support human life and improve the quality of life for both current and future generations (Alpusari & Saam, 2024). Sustainable environmental management in Indonesia still lacks attention, with development focusing more on economic interests than natural sustainability, which threatens natural resources in the future (Herlina, 2017). One of the threats is the biodiversity of freshwater fishes, especially local fishes that are facing decline due to habitat alteration, the introduction of foreign fishes, and overexploitation (Reid & Miller, 1989). Invasive fish that are more adaptable to aggressive and predatory environments pose a threat to local fish, while intensified fishing exacerbates the situation (Hermawan, 2024).

The novelty of this research lies in the development of domestication techniques for Puntius binotatus, a local endemic wader species in the Brantas River Watershed, East Java, which is experiencing population decline due to overexploitation and environmental factors. This research introduces a sustainable management model for the domestication of this species, which aims to conserve its population and ensure its availability for both consumption and conservation purposes. This research fills a significant gap in knowledge, as no previous studies on the domestication of this fish species in the region have been documented.

One type of local fish that is under threat is the Wader fish. This Wader fish usually lives in lakes and rivers, even gutters but with clear water. Wader fish are usually found living in groups at the bottom of small, rocky rivers with calm to moderate currents, with a temperature range of between 220 - 240 °C and a pH of between 6.0 - 6.5 (Froese & Pauly, 2010). In East Java there are two types of Wader fish, namely the Wader Cakul (*genus Puntius*) and the Wader Pari (*genus Rasbora*). (Risjani et al., 1998) found 50 types of local fish in the Brantas Watershed (DAS) of East Java from the *Cyprinidae*, *Gobiidae*, and *Cluppeidae* families,

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including the Wader fish (*Puntius binotatus*) which is classified as the *Cyprinidae* genus.

Wader fish (*Rasbora lateristriata*) is one of Indonesia's native fish commodities that has high economic value, related to public interest and high demand for these fish stocks (Lailiati et al., 2022). The increasing demand for the availability and supply of this fish has led to a rapid decline in the number of wader populations in nature (Lailiati et al., 2022).

The *Puntius binotatus* type of Wader fish found in the Brantas Watershed has differences compared to the types of Wader fish in other regions. In East Java, there are two types of Wader fish, namely the Cakul Wader (*genus Puntius*) and the Pari Wader (*genus Rasbora*) (Hayati et al., 2017). The *Puntius binotatus* type of Wader fish has differences compared to those in Central Java and West Java. This finding is proven by testing to the genetic level (Astuti et al., 2020; Dahruddin et al., 2017). This shows that there is local wealth in the Brantas Watershed that has not been utilized. Therefore, researchers use the *Puntius binotatus* type of Wader fish as an object as a type of local endemic fish that only lives and grows in the waters of East Java.

In addition, the results of *Puntius binotatus* domestication in different regions show significant variations, influenced by environmental factors and farming practices, emphasizing the need for local adaptation of domestication techniques (Fitri & Roesma, 2012). The results of *Puntius binotatus* domestication show challenges that need to be addressed, including a decline in the health condition of domesticated fish compared to wild populations. Variations in feeding habits and non-optimal stocking densities are also factors that affect the success of domestication (Situmorang et al., 2013).

For the Brantas Watershed community, the *Puntius binotatus* type of Wader fish in the Brantas Watershed has an important position in society. Based on the benefits obtained by the community, Wader fish is the most well-known and preferred fish by the community for consumption compared to other types of local fish. Wader fish has a delicious, savory taste and can be eaten directly without removing the bones. The high protein content is 14.8 g / 100g (Setiyoko et al., 2022). Various processed Wader fish are quite well received by the community and have even become regional flagship products (Retnoaji et al., 2022). The high demand and exploitation of Wader fish is not comparable to domestication and intensive cultivation efforts. This will lead to extinction (Retnoaji et al., 2022; Rukayah & Lestari, 2021). People are more accustomed to catching Wader fish in rivers than carrying out domestication and intensive culture. In carrying out fishing activities, people do not know for sure about fish species and their characteristics. They also do not understand whether the activities carried out affect the existing fish stock, growth and sustainability of the species (Iskandar et al., 2023).

Several factors have contributed to the decline of the Wader fish population in the Brantas Watershed of East Java, including: excessive exploitation through illegal fishing, water pollution, environmental degradation, inadequate environmental management, and the lack of techniques for maintaining germplasm and sustainability. The entry of imported or invasive fish into public waters has also triggered a decrease in the number of Wader fish seeds. Several types of fish, such as Tilapia, Catfish and Alligators are one of the invasive fish found along the Brantas River in East Java from Kediri, Jombang, Mojokerto, Gresik to Surabaya Regencies. Based on the Fish Census Book of the Fish Resources Administration Bureau (SDI), the Regional Secretary (Sekda) of East Java Province in 2011-2012 only 12 types of local fish were found, but the Cakul Wader and Pari Wader fish were no longer found. This indicates that the population of Wader fish in public waters is threatened with extinction. Given the important position of the *Puntius binotatus* type of Wader fish in the Brantas Watershed of East Java, it is important to make an effort to maintain its sustainability, one of which is through Domestication. Throughout the literature study, no research has been conducted related to the domestication technique of the *Puntius binotatus* type of Wader fish in the Brantas Watershed of East Java. Thus, the domestication technique is expected to be beneficial both from the academic, practitioner, and community (fishery farmers) side which can help support sustainability and will become a wealth of native East Java germplasm, especially in the Brantas Watershed, East Java Province (Ahmad et al., 2019).

The objective of this study was to formulate appropriate domestication techniques that could facilitate the

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culture and sustainability of *Puntius binotatus* in the Brantas watershed. This includes studying the fish's biological and reproductive characteristics, such as morphology, habitat, distribution, and fecundity. The domestication process is essential to prevent extinction, increase fish productivity, and maintain a stable life cycle, which will ensure a year-round supply of fish for ecological balance and local fisheries businesses. This research is also intended to provide scientific contributions that can support sustainable biodiversity in the region.

Methods

This type of research can be categorized as development research, also known as research and development (R&D) (Khan & Mohsin Reza, 2022). The R&D method is a research method that produces a product in a particular field of expertise, which is followed by certain by-products and has the effectiveness of a particular product (Saputro, 2017). Where the product produced in this study is a sustainable management model for domestication of Wader fish in the Brantas Watershed, East Java

The domestication process of Wader fish is analyzed descriptively, including the stages in the domestication process of Wader fish which are wild fish so that they can be cultivated. This analysis is limited to being carried out only at the Umbulan PBAT UPT. Because Wader fish are "wild" fish that live in public freshwater waters, information about Wader fish cultivation regarding fecundity, the spawning process of Wader fish does not yet exist, so further studies are needed through Wader fish domestication efforts. This is because:

- Not yet properly understood, identification of the morphological characteristics of Wader fish with other river fish.
- It is not yet known how to adapt Wader fish from the wild environment to new environments such as tubs, ponds, and controlled handling.
- The response to artificial feed is not yet known so that it can grow and develop
- The biological, genetic, disease, reproductive, and mature egg characteristics until it can be spawned are not yet known.
- The method of maintaining Wader larvae from spawning until they are enlarged to consumption size is not yet known.

Furthermore, research is carried out continuously by identifying, adapting to artificial and natural cultivation environments and retesting Wader fish domestication techniques through mastery of reproductive biology until the evaluation of the life cycle of Wader fish after domestication can be known. The success of domestication, in addition to later producing seeds to be cultivated by fishery farmers widely, will also be carried out as an effort to restock Wader fish seeds / seedlings in public waters while obtaining approval for release / patent rights from the Minister of Maritime Affairs and Fisheries. The legality of this patent is needed before the Wader fish domestication technique is socialized and replicated to the wider community as one of the new types of fish whose provision and dissemination are supervised by the Government. The successful domestication of Wader fish is expected to provide new scientific contributions that can be utilized and developed by academics, practitioners, and fish farmers. This will help preserve East Java's native germplasm and support the sustainability of Wader fish populations in East Java's public waters, particularly in the Brantas watershed of East Java Province, thereby maintaining biodiversity in a sustainable manner.

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Results and Discussion

Morphology of Wader Fish (Puntius binotatus)

There are still many who do not properly understand the shape/morphology of the Cakul Wader fish (*Puntius binotatus*). The results of a survey at a culinary stall in Trowulan Village, Mojokerto Regency and Ngantang, Malang Regency, Wader fish culinary is generally found to be not pure real Wader fish, only around 25-30% of real Wader fish. The conditions that occur at the trader level even mention that all small fish caught from the river are still recognized as Wader fish. As shown in Figure 1, the results of the Wader fish culinary survey below:

Figure 1. Results of the Wader Fish Survey in the Field

Small river fish are considered to be classified as Wader fish, including: white bader fish, red bader, muraganting, bekepek, keting, nila, mas, nilem, cethol, bethik. Therefore, the correct identification of the morphology of Wader fish is very necessary, to further explain the actual morphology of Wader fish. The morphological characteristics of the Cakul Wader fish (*Puntius binotatus*) are as follows:

- The size of this fish is small to medium, most of which are obtained with a total length of 10 cm, but some of these fish can reach 17 cm;
- Has four small feelers at the tip of its snout;
- Its body is greenish gray or silver;
- Has two small circular marks/spots/small dots located at the base of the rear fin and in the middle of the tail stem.

According to Kottelat et al., (1993) in Fitri & Roesma (2012), *Puntius binotatus* has a smooth body, has four feelers, perfect lateral lines, the last dorsal fin rays are hard and serrated, 4 ½ scales between the lateral line and the beginning of the dorsal fin, black spots on the dorsal fin and the middle of the tail stem, young and adult fish have 2 to 4 points or ovals in the middle of the body.

Domestication Process of Wader Fish

Domestication is an effort to tame animals (fish) that usually live in the wild to be tame so that they can be useful for humans. Domestication of public water fish is an effort to preserve and increase fish stocks in public waters whose existence is increasingly extinct. This extinction can occur naturally or as a result of human activities. Some human activities that can cause ecological changes include: agriculture and plantations, logging and forest control, excessive fishing with various tools and methods, damming for electricity and irrigation purposes and transportation (Maskur, 2002). Fishing for wader fish using fishing gear that is not environmentally friendly, such as using electric shocks, poisons and fish bombs, can result in the extinction of fish because it can kill all organisms in the waters, from the parent fish to the larvae

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and fish eggs.

To overcome this, conservation efforts need to be made through domestication and breeding. This trial activity of Wader fish domestication is limited to the UPT PBAT Umbulan Pasuruan. The steps for domestication of Wader fish carried out at the UPT PBAT Umbulan include four activities, namely:

- Inventory and collection of Wader fish;
- Implementation of domestication;
- Laboratory-scale seed production;
- Mass-scale seed production.

The location of the Wader fish collection activity is as shown in Figure 2 below:

Figure 2. Location of Wader fish collection at Umbulan Spring

The domestication activity of Cakul Wader fish (*Puntius binotatus*) began with the collection of Cakul Wader fish (*Puntius binotatus*) (G0) since early 2018 until it became G3 broodstock in 2021 and continues until now.

Inventory and Collection of Wader Fish

The domestication activity of Wader fish began with collecting 450 test fish from catching Wader fish at Umbulan spring with a length of between 6-13 cm and a weight of between 5-15 grams. The fish were then raised and adapted to the pond that had been prepared at the Umbulan PBAT UPT. The Wader fish were the initial broodstock (G0) used for the production of seeds and first generation broodstock (G1). Cakul Wader fish (*Puntius binotatus*) is a type of fish that is small in size and lives in the wild. This fish usually lives in lakes and rivers, even ditches with clear water. The next step is to conduct an inventory and collect wild fish in nature to then be transferred into a controlled container/place. Inventory and collection of Wader fish species were carried out at the Umbulan spring which is ± 500 m from the Umbulan PBAT UPT office. This activity uses simple equipment, namely using a black net as shown in Figure 3 below:

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Figure 3. Inventory and Collection of Wader Fish at the Umbulan Spring

The results of the collection from Wader fishing activities at the Umbulan spring were inventoried for both types of fish and identification of Wader fish habitat areas. This is useful for knowing the places where they live to lay eggs (spawning ground), where they raise their young (nursery ground) and where adult fish live. There are 2 (two) types of Wader fish caught, namely:

- Cakul Wader (*Puntius binotatus*), as many as 450 fish
- Pari Wader (*Rasbora agyrotaenia*), as many as 260 fish

The Wader caught were then taken to the pond that had been prepared at the UPT PBAT Umbulan.

Implementation of Domestication

Domestication according to Maskur (2002), is an activity of adapting wild fish (wild species) to new environments such as ponds, tubs, artificial feed, handling and controlled handling. The purpose of this domestication is so that fish can adapt to new environmental conditions in a controlled manner and respond to artificial feed so that they can grow and develop and mature eggs and can be spawned.

Wader domestication offers a great opportunity to improve the welfare of local communities through the implementation of sustainable aquaculture practices. By reducing reliance on wild-caught fish, it helps conserve natural fish populations while providing a stable supply of fish throughout the year. This not only supports the local economy but also supports overall environmental sustainability. One of the innovations in this practice is the use of Recirculating Aquaculture Systems (RAS), which can reduce water consumption by 99% and minimize the risk of disease transmission, enabling the development of aquaculture in non-coastal areas (Lal et al., 2024). In addition, domestication allows communities to cultivate fish on a sustainable basis, reducing dependence on specific seasons that often affect wild fishing yields (Fabrice, 2018).

From an economic perspective, technologies such as RAS and other modern aquaculture methods can create new jobs, boost local economic growth, and reduce carbon emissions that typically result from long-distance seafood trade (Lal et al., 2024). On the other hand, this approach also has a positive impact on environmental conservation, by reducing pressure on wild fish populations, which in turn contributes to the preservation of aquatic biodiversity (Lorenzen et al., 2012). However, while offering a range of benefits, wader domestication also has potential ecological risks, such as negative impacts on wild populations if

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domesticated species are released into their natural habitat (Lorenzen et al., 2012). Therefore, prudent management is required to ensure that the benefits gained are not accompanied by significant ecological losses.

At this stage, what needs to be observed is the factor of death of Wader fish due to differences in previous containers in nature then only limited to ponds with certain sizes. Things that must be prepared for domesticated fish are by studying the biological characteristics of Wader fish (morphology, habitat and distribution) and studying the reproductive characteristics of Wader fish (male and female characteristics, characteristics of gonad maturity, fecundity).

The captured Wader fish are kept in a pond measuring 2x3 meters. Several things that must be considered in moving fish from nature to be kept in a controlled pond are:

- Engineering the environment: the maintenance pond is given a water flow (the water should not be stagnant), because Wader fish are often found in waters that have currents.
- Knowing eating habits: surgery is performed on the digestive tract to obtain samples of stomach contents, then analyzed for the identification of microscopic and macroscopic food organisms (Hedianto et al., 2016).
- Engineering feed: a trial is carried out on the provision of pellets / factory-made fish feed with different protein compositions.
- Engineering spawning: a substrate is provided in the spawning pond (stones, coconut fiber, grass, raffia).
- Maintain Wader fish until they reach gonad maturity in both males and females.

Habitat of Wader Fish (Puntius binotatus)

The two-spotted Wader fish is usually found with other Wader species in tropical areas from the coast to areas with an altitude of 2,000 meters above sea level with a pH range of 6 - 6.5 and a water temperature of 240 - 260 °C. The two-spotted Wader likes shallow ditch water, rivers and even lakes with clear water (Robert, 1989 in Rahmawati, 2006). The Wader fish caught from the Umbulan spring are kept in a new place in the form of a pond measuring 2x3 meters as shown in Figure 4.

Figure 4. Pond Engineering and Feed

From the results of the analysis of the identification of organisms of the type of Wader fish food microscopically, it was obtained that the Wader fish is classified as a herbivorous fish or a type of fish whose food comes from plants, because the results of the analysis of the digestive tract dissection obtained only the type of phytoplankton in the stomach of the Wader fish. The types of phytoplankton identified

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are as shown in Figure 5 below:

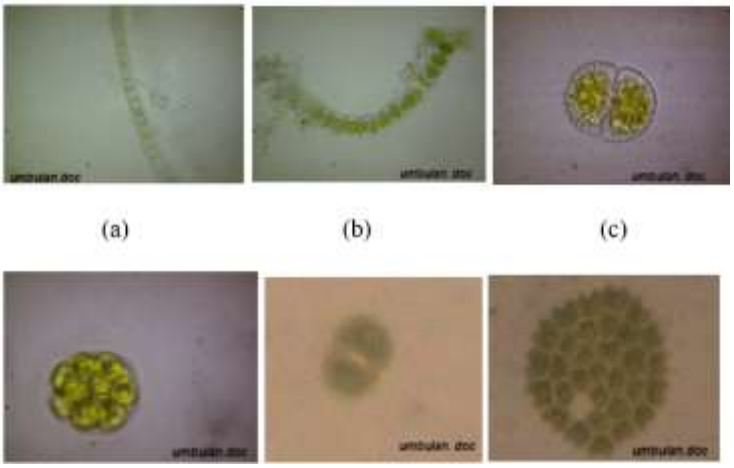

Figure 5. Types Of Phytoplankton Found in the Stomach of the Wader Fish

(a). *Melosira sp.* (b). *Mycrospora sp.* (c). *Cosmarium sp.* (d). *Pandorina sp.*

(e). *Chroococcus sp.* (f). *Pediastrum sp.*

Reproduction of Wader Fish (Puntius binotatus)

Reproduction is the ability of an individual to produce offspring as an effort to preserve its species or group (Fujaya, 2004). In studying the fish reproductive system, we must first be able to distinguish the types of fish based on their gender. Male Cakul Wader fish have a slimmer body shape than female Cakul Wader fish. The characteristics of male Cakul Wader fish are that they will release sperm when their stomachs are pressed, while female Cakul Wader fish will release eggs. The characteristics of the female Wader Cakul fish are wide and have no protrusions and have three holes, while the male Wader Cakul fish have protruding, pointed and have two holes (Figures 6 and 7).

Figure 6. (A) Morphology Of Male Wader Fish, (B). Sperm Comes Out When the Stomach is Pressed

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Figure 7. (A) Morphology of Female Wader Fish. (B). Eggs Come Out When the Stomach is Pressed

Laboratory and Mass Scale Seed Production

Iskandar et al. (2023), spawning is one part of reproduction which is a link in the life cycle that determines the survival of the species. Fish, like other organisms, must be able to adapt to their environment in order to survive. The survival process is the ability to reproduce rapidly during their life and increase the number of offspring (Prayitno & Ayu, 2018).

At this stage, Wader fish that have been domesticated (tame) will be tested for spawning both naturally and artificially. In this laboratory scale production, it is still limited to research. The factors observed are the success rate of spawning, egg hatching power, fish survival and economically unprofitable.

The process of spawning Wader Cakul fish begins with preparing the aquarium, filling the water and providing substrate and without substrate. The aquarium is set in such a way that it resembles the conditions of Wader fish found in nature. Wader fish are often found in flowing waters, so in this spawning process, the aquarium is given a continuous flow by implementing a circulation system.

In this laboratory scale Wader fish spawning, various types of substrates are used. The parent Wader Cakul fish are inserted according to the treatment of the spawning pair. At this time, the behavior of the fish is observed during spawning. The process of observing spawning behavior is very important, because spawning behavior is the beginning of how the reproductive properties of fish are known. Spawning behavior is an activity that is directly related to the production of new individuals. Such behavior is sometimes quite simple, but in many species the spawning behavior can be very complex and include spectacular displays and movements. Based on this, the spawning behavior of fish is divided into three, namely behavior in the pre-spawning phase, fish behavior in the spawning phase and fish behavior in the post-spawning phase.

Both male and female parents are placed in an aquarium measuring 40 x 30 x 30 cm^3 with a ratio of male and female parents of 1.5-2: 1. This ratio is based on the weight of the parent; the weight of the female parent is greater than the weight of the male parent. As with fish from the genus Puntius, the ratio of the number of male and female parents used in spawning is using a weight ratio, namely the ratio of the weight of the number of male parents: female parents are 1: 1. So if the weight of the female parent is 12 grams, it requires a male weight of 12 grams as well. While the average weight of the male parent ranges from 6-8 grams / tail. Based on the results of observations, it was found that spawning took place at night, precisely at 17.00 to 22.45. The spawning process begins with the male parent introducing / matching between the male parent and the female parent. The male parent and the female parent chase each other in the aquarium. This process is called the introduction / matching process. Once matched, the male parent wraps around the female's body and rubs his body against the female's stomach, and runs around the substrate. The spawning period is approximately 6-7 hours. Wader fish release their eggs gradually, namely 4-5 times during the spawning process.

Wader fish require a substrate for their spawning. This is because in the treatment experiment in an aquarium without a substrate, it was found that the Wader fish parents did not spawn. While in an aquarium that used a substrate, namely coconut fiber substrate, it was found that the Wader parents spawned as indicated by the release of eggs. In general, the substrate is used as a medium for attaching eggs. However, in the Wader fish spawning process, the eggs produced by the use of coconut fiber substrate can actually be used as a medium for stimulating spawning.

The number of eggs produced by the female Wader parent varies, depending on the weight of the parent. The greater the weight of the female parent, the greater the number of eggs produced. According to Iswahyudi (2013), the average fecundity of Wader Cakul fish eggs is 5,156 eggs as shown in Table 1. Meanwhile, according to Rahmawati (2006), the fecundity of benteur fish in open waters is 2588 eggs.

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Table 1. Fecundity of Wader Broodstock (*Puntius binotatus*)

No	TL (cm)	SL (cm)	HL (cm)	Total Gonad Weight (g)	Gonad Partial Weight (g)	Partial Eggs Amount	Total Eggs Amount
1.	10,80	8,60	1,80	1,98	0,16	366	4529
2.	11,20	9,30	1,80	2,51	0,15	467	7814
3.	10,60	8,50	1,80	1,98	0,09	163	3586
4.	10,30	8,30	2,00	2,02	0,08	167	4216
5.	10,70	8,80	1,80	2,05	0,06	165	5637
Average	10,72	8,70	1,84	2,11	0,11	265	5156

Wader Cakul fish eggs hatch 24 hours after fertilization and become larvae. Signs of fertilization are the formation of a perivitelline space due to water absorption after the eggs are released and touch the water, causing the eggs to swell. Fertilization is the event of the fusion of egg cells and sperm to form a zygote. Cell development occurs after fertilization from the zygote stage to the hatching stage. The fertilization process is the first step in embryo development, where the fusion between the sperm and egg produces a zygote, which is the basis for further embryo growth (Bensam, 1989). Egg cell activation, triggered by increased intracellular calcium levels, has an important role in initiating and supporting the subsequent process of embryo development (Coward et al., 2002). After fertilization, the egg enters a series of developmental stages, namely cleavage, blastula, gastrula, and neurula, all of which are important in forming the more complex structure of the embryo, with hatching as the final stage (Masoudi et al., 2018). The time taken for each of these stages can vary, but in general, important milestones in embryo development occur within hours of fertilization. After hatching, larvae emerge about 24 hours after fertilization, ready to start their life in the aquatic environment (Bensam, 1989; Masoudi et al., 2018).

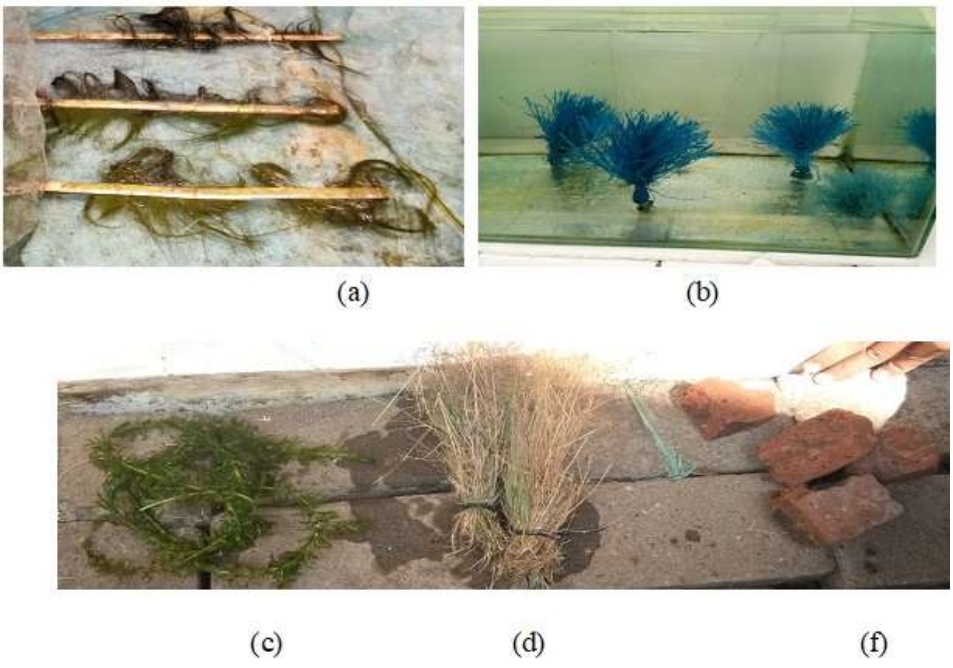

Figure 8. (A) Palm Fiber Substrate, (B). Raffia Rope Substrate, (C) Hydrilla Plants, (D) Plant Roots, (F). Brick

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The development of Wader Cakul fish eggs (*Puntius binotatus*) according to Iswahyudi (2013), goes through several phases, namely: cleavage stage, morula stage, blastula stage, gastrula stage, organogenesis and hatching. The cleavage stage starts from the first mitosis division to the fifth division. The characteristics of fertilized Wader fish eggs are clear while unfertilized fish eggs are white. One hour after fertilization, the eggs undergo the first division, namely the formation of 2 blastomeres of the same size (Figure 9a). The second division occurs at one hour and 15 minutes producing four blastomeres in Wader Cakul fish eggs (Figure 9b). The third division in Cakul Wader fish eggs produces eight blastomeres which occurs 2 hours after fertilization (Figure 9c). 16 blastomeres are produced by Cakul Wader fish eggs in the fourth division which occurs two hours and fifteen minutes after fertilization (Figure 9d). The morula stage begins with the fifth division which produces 32 blastomeres and then becomes many cells. Cakul Wader fish eggs experience this phase two hours and twenty-three minutes after fertilization (Figure 9e). The blastula stage in Cakul Wader fish eggs occurs 6 hours (Figure 9f). This stage is marked by blastomeres that begin to cover the yolk (yolk invation). The Gastrula stage in Cakul Wader fish eggs begins 7 hours after fertilization (Figure g) and ends 8 hours (Figure 9h). The organogenesis stage of Cakul Wader fish eggs begins 9 hours after fertilization (Figure 9i) until 21 hours (Figure 9v). Hatching of Cakul Wader fish eggs occurs 24 hours after fertilization and becomes larvae (Figure 9w).

Figure 9. Development of Cakul Wader Fish Eggs at Ph 8, Temperature 28oc (Iswahyudi, 2013)

Caring for fish larvae after hatching is a complicated and very critical process. The success of seed maintenance depends on the availability of feed that can be consumed by the seeds according to the size of the mouth. The unavailability of suitable feed in terms of quality and quantity will inhibit additional respiratory organs, thereby increasing seed mortality. Wader Cakul fish that have hatched are cared for by siphoning or cleaning the aquarium if there is dirt in it. Fish larvae are not fed until they are 3 days old after hatching because they still have egg yolk as a food reserve in their bodies. On the fourth day, Wader fish larvae begin to be given appropriate feed. Food for Wader Cakul fish larvae is given boiled egg yolk or

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plankton and adjusted to the mouth opening of the Wader fish ad libitum twice a day. Boiled egg yolk is given until the fish are one week old. Furthermore, the Wader Cakul fish are moved to the nursery pond and given fine pellet feed. The water temperature is maintained at 28-30 °C and pH 7-8 (Figure 9).

The laboratory-scale seed production trial activity has been ongoing since 2018. In 2019, this domestication technology began to be introduced to fish farmers in East Java. This technology transfer aims to disseminate and introduce the Wader fish species to farmers in order to develop wild fish species into cultivated species. Mass-scale production is carried out after laboratory-scale production has been successfully carried out. The success rate of laboratory-scale production such as spawning rates, egg hatching and seed survival, so that it can produce seeds in large quantities as a basis for mass-scale seed production. This mass-scale production is more directed at commercially oriented production, because at this scale it has included profitable economic aspects. Mass-scale seed production began in mid-2020. This mass-scale seed production was carried out at the Umbulan PBAT UPT to meet the needs of Wader fish by the Ministry of Marine Affairs and Fisheries and the East Java Provincial Marine and Fisheries Service in restocking activities to nature. The production of Wader Cakul fish seeds (*Puntius binotatus*) is carried out in larger containers/ponds starting from the spawning process, larval maintenance, nursery to enlargement. Things that need to be considered in the mass production of Wader fish seeds include (1) Readiness of applied technology, namely mastery of Wader fish domestication technology and (2) Readiness of Wader fish broodstock. Readiness of facilities and infrastructure for spawning and rearing Wader fish.

Previous studies have shown that stocking density affects the growth rate of *Puntius binotatus*, with lower densities resulting in higher growth and survival rates (Prasetyo et al., 2019). However, environmental quality remains an important factor to ensure the health of domesticated fish (Lim et al., 2013). To improve the success of *Puntius binotatus* domestication, further research is needed that focuses on optimizing culture conditions, including stocking density, water quality management, and feed management to approach natural conditions.

Domestication of freshwater fish, including wader (*Puntius binotatus*), has become an important focus in aquaculture diversification and biodiversity conservation. As local species that have ecological and economic value, domestication of these fish aims not only to increase productivity, but also ensure the sustainability of freshwater fish resources. An integrated approach, including breeding techniques, environmental management and innovative technologies, is key to an effective domestication process.

One technique that supports successful domestication is the use of hormones to trigger reproduction. Research by (Iskandar et al., 2023) inferred that in *Puntius orphoides* showed that the hormone Pregnant Mare Serum Gonadotropin (PMSG) significantly accelerated gonadal maturation, thereby increasing spawning efficiency. In addition, the application of controlled environments, such as artificial ponds with stable environmental parameters, was shown to improve the adaptation and growth of Rasbora sp. fish, which showed similar potential in *Puntius binotatus* species (Suryani et al., 2022).

Another important factor is managing the growth rate and survival of the fish during the domestication process. Appropriate feeding strategies, such as the use of pelleted feed and Tubifex, have been shown to provide similar growth results in *Puntius orphoides* (Setyaningrum & Nuryanto, 2006). This combination can be applied to support wader growth in the domestic environment. In addition, water quality management, including pH, dissolved oxygen (DO), and temperature, is key to maintaining fish health and survival in closed systems (Suryani et al., 2022).

Technological advancements have also contributed greatly to supporting domestication. Modern aquaculture systems, such as Recirculating Aquaculture Systems (RAS) and aquaponics, have been explored to improve water use efficiency and reduce environmental impact (Bandyopadhyay, 2022). This technology allows for more precise environmental management, making it adaptable for species such as wader that require specific environmental conditions for optimal growth.

Although the progress has been made, challenges in freshwater fish domestication remain, including maintaining genetic diversity and minimizing the environmental impact of intensive aquaculture.

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Therefore, the development of sustainable domestication strategies, which integrate breeding techniques, environmental management and technological innovations, is critical to the long-term success of this endeavor.

Conclusion

Domestication not only prevents extinction but also holds great potential for fisheries. This process aims to increase productivity, control life cycles, and ensure the year-round availability of Wader fish for both consumption and conservation. Ecologically, domestication activities are to conduct an inventory and collect wild fish in nature to then be moved into a controlled container/place. At this stage, what needs to be considered is the factor of Wader fish mortality due to differences in previous containers in nature which are then only limited to ponds of a certain size. Things that must be prepared for domesticated fish are by studying the biological characteristics of Wader fish (morphology, habitat and distribution) and studying the reproductive characteristics of Wader fish (male and female characteristics, gonad maturity characteristics, fecundity).

Several things that must be considered in moving fish from nature to be kept in controlled ponds are (1) Engineering the environment: done by engineering the maintenance container environment so that it has water quality that can be accepted by wild species to be domesticated (2) Knowing eating habits: surgery is performed on the digestive tract to obtain samples of stomach contents, then analyzed for identification of microscopic and macroscopic food organisms (3) Feed engineering: a trial of providing factory-made fish pellets/feed with different protein compositions is carried out. This is done to ensure that the fish can continue to grow by engineering the feed so that quantitatively and qualitatively it can support somatic growth and encourage generative growth and engineer the environment and hormones that affect the vitellogenesis process and ovulation process; (4) Spawning engineering: substrates are provided in the spawning pond (stones, coconut fibers, grass, raffia) (5) Maintaining Wader fish until they reach gonad maturity in both males and females.

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