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Breeding and embryonic development of angelfish (*Pterophyllum scalare*)

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Abstract
This study investigated the breeding behavior, embryonic development, and physicochemical parameters of *Pterophyllum scalare*, commonly known as the angelfish. Breeding trials were conducted over a six-month period at the Meghalaya State Fisheries Research and Training Institute, Mawpun from July to December 2023. Physicochemical analyses of the breeding and broodstock tanks showed variations in temperature (26-28 °C), pH (6.2-7.2), dissolved oxygen (4-5 ppm), hardness (120-146 ppm), and alkalinity (126-154 ppm). Morphometric analysis revealed male angelfish measuring 15 cm in length and 18 g in weight, while females measured 13 cm and 15 g, respectively. The fertilization rate was 85%, with a hatching rate of 60% and a survival rate of 35%. Embryonic development stages were meticulously observed, documenting key milestones such as the first cleavage completed within 35 minutes, progressing through stages including 2-cell, 4-cell, 8-cell, 16-cell, blastula, dome, gastrula, segmentation, and hatchling emergence at 72 hours post-fertilization. This comprehensive study provides valuable insights into the reproductive biology and early life stages of *Pterophyllum scalare*, essential for its aquaculture and conservation management.

Keywords: Breeding, angelfish, *Pterophyllum scalare*, embryonic development

1. Introduction
The freshwater angelfish (*Pterophyllum scalare*) is a popular ornamental fish known for its striking appearance and peaceful nature. Originating from South America, it is widely kept in aquariums due to its attractive colors, moderate size, and fascinating behavior. The present study aims to explore the breeding pattern and embryonic development of *Pterophyllum scalare*. Specific objectives include studying physicochemical parameters, assessing fertilization and hatching rates, and fabricating an aquarium suitable for the species. By understanding the reproductive biology of the fish, this study seeks to contribute to the knowledge base of ornamental fishkeeping and improve breeding practices for this species.

2. Materials and Methods
The study focused on the breeding of angelfish in specially fabricated aquariums. The aquariums, measuring 24 x 17 x 17 inches, were constructed using 8mm glass, silicone adhesive applied with a silicone gun, and secured with masking tape during assembly. After construction, the aquariums underwent a curing period to ensure the integrity of seals and were inspected for leaks.
To maintain water quality, potassium permanganate (KMnO4) was used for disinfection before filling with water. Water quality parameters such as temperature, pH, dissolved oxygen, hardness, and alkalinity were closely monitored throughout the experiment. A 30-liter breeding tank was set up with a temperature-regulating thermostat and an aerator to support oxygenation. Additionally, a glass piece was placed at a 45° angle to serve as a spawning site.
Broodstock management spanned 21 days, during which water parameters were rigorously analyzed using standard methods to ensure optimal conditions for fish health and reproduction. The study also involved identifying the sex of the fish to select breeding pairs based on physical characteristics like abdomen shape and papilla appearance. Upon transferring brooders into the breeding tank, spawning behaviors were observed, including egg deposition and fertilization. Embryonic development was studied through microscopic observation and documentation of various developmental stages from spawning to hatching.

Throughout the study, meticulous attention was given to aquarium fabrication, water quality management, broodstock selection, spawning behaviors, and embryonic development, facilitated by specialized instruments such as thermostats, aerators, and chemical treatments like potassium permanganate for disinfection.

3. Results and Discussion

3.1 Water quality parameters

Throughout the breeding trail, key water quality parameters were diligently monitored and recorded, particularly during the management of the broodstock. These parameters, including Temperature, pH, Dissolved Oxygen, Nitrate, Hardness, and Alkalinity, were observed at regular intervals from August to September. The recorded data reveals fluctuations and trends in these parameters over time. For instance, the temperature ranged from 26 °C to 28 °C, with variations observed across the different dates. Similarly, pH levels showed variations between 6.2 and 7.2, indicating changes in acidity or alkalinity. Dissolved oxygen levels ranged from 4 to 5 ppm, suggesting adequate oxygenation throughout the period. Notably, hardness and alkalinity levels also fluctuated, with hardness ranging from 120 to 146 ppm and alkalinity ranging from 126 to 154 ppm. These recorded values provide valuable insights into the stability and suitability of the water conditions for effective broodstock management during the breeding period. Such meticulous monitoring ensures optimal conditions for the successful breeding and rearing of aquatic species.

Table 1: Physico-chemical parameters

Parameters	7th August	14th August	22nd August	29th August	5th September
Temperature (°c)	28	27	28	28	26
pH (ppm)	7.0	6.8	7.2	7.2	6.2
Dissolved oxygen (ppm)	4	5	4	4	5
Hardness(ppm)	120	126	130	125	146
Alkalinity (ppm)	154	128	150	140	126

3.2 Biometric index

Biometric indices were assessed for male and female *Pterophyllum scalare*, providing valuable insights into their physical characteristics. Table 2 presents morphometric analysis data, indicating notable differences in various parameters between males and females. For instance, male angelfish exhibited larger measurements across parameters such as total length, standard length, caudal peduncle length, dorsal fin base, and anal fin base compared to females. Similarly, measurements of body depth, post orbital length, eye diameter, head length, snout length, and length of upper jaws were generally greater in males. Table 3 provides meristic counts, revealing the specific anatomical features of P. scalare. Notably, males typically exhibited higher counts in parameters such as dorsal spine and soft dorsal spine compared to females. Additionally, lateral bands and the scale of the lateral line were consistent across genders. Table 4 further emphasizes the biometric differences between male and female angelfish, with males generally displaying larger lengths and weights compared to females. These comprehensive biometric assessments provide crucial data for understanding the physical characteristics and variations within *P. scalare* populations, aiding in their management and breeding programs.

Table 2: Morphometric analysis of the male and female *Pterophyllum scalare*

Parameters	Male (cm)	Female (cm)
Total Length	15	13
Standard Length	7	6
Caudal peduncle length	6.7	6.5
Dorsal fin base	6.5	6.2
Pre-dorsal fin base	5	5
Anal fin base	6	5.8
Body depth	5.5	5.3
Post orbital length	3.5	3.4
Eye diameter	1.8	1.8
Head Length	2.5	2.4
Snout Length	1	1
Length of upper jaws	1	1

Table 3: Meristic counts of *Pterophyllum scalare*

Meristic character	Numbers
Dorsal spine	11
Soft dorsal spine	9
Lateral bands	4
Scale of lateral line	26

Table 4: Length and Weight of the fish

Parameters	Male	Female
Length	15 cm	13 cm
Weight	18 g	15 g

3.3 Spawning behavior

As spawning substrate, a clear, long piece of glass measuring 15 by 2.5 inches was positioned 45 degrees from the tank's floor. The pair begins cleaning the spawning site using their mouths to bite and scrub the surface of the glass. After few false passes at the site, the female passes over the site and deposits eggs, which adhere to the surface. The male makes alternate passes and release spermatozoa, fertilizing the eggs. Continual movement of the angles over the eggs after the spawning serves the purpose of creating the circulation through fanning movement of the pectoral fins

3.4 Fertilization rate, hatching rate and survival rate

Following the breeding process, crucial parameters such as fertilization rate, hatching rate, and survival rate were meticulously observed to evaluate the success of the breeding program. The data presented in Table 5 provides insights into these key metrics for *Pterophyllum scalare*. The fertilization rate, indicating the percentage of eggs successfully fertilized, was recorded at 85%, suggesting a high level of reproductive success during breeding. Subsequently, the hatching rate, representing the percentage of fertilized eggs that successfully hatched, was observed to be 60%, indicating a moderate success rate in the development of viable offspring. Finally, the survival rate, reflecting the percentage of hatched larvae that successfully survived to a certain stage, was noted at 35%, indicating challenges in maintaining larval survival beyond hatching. These observations highlight both successes

and potential areas for improvement in the breeding and rearing protocols for *P. scalare*, contributing valuable data for refining future breeding strategies and enhancing overall breeding program effectiveness.

Table 5: Fertilization rate, hatching rate and survival rate

Species	Fertilization rate (%)	Hatching rate (%)	Survival rate (%)
Pterophyllum scalare	85	60	35

3.5 Stages of embryonic development

The embryonic development stages of *Pterophyllum scalare* were meticulously examined using a binocular microscope. The process began with the deposition of small, round, translucent fish eggs, which were observed to turn white if infertile. The progression of embryonic development was carefully documented, starting with the completion of the first cleavage within 35 minutes' post-fertilization. Subsequently, the embryos progressed through stages such as the 2-cell, 4-cell, 8-cell, 16-cell, and 32-cell stages within specific timeframes. The blastula stage was reached between 3.30 to 6.00 hours' post-fertilization, followed by the dome stage between 7 to 10.30 hours. Gastrulation occurred between 10 to 26 hours, marking a critical phase in embryonic development. Subsequently, segmentation was observed between 26 to 60 hours' post-fertilization, leading to the formation of distinct somites. Finally, hatchling occurred approximately 72 hours' post-fertilization, completing the embryonic development process. These detailed observations provide valuable insights into the temporal dynamics of *P. scalare* embryonic development, aiding in understanding the species' reproductive biology and informing breeding and conservation efforts.

Table 5: Stages of embryonic development of *Pterophyllum scalare*

Developmental stages	Zygote	Hours post-fertilization
1-cell		**0.00**
2-cell	Cleavage	1.30
4-cell		2.00
8-cell		2.20
16-cell		3.00
32-cell		3.30
64-cell	Blastula	6.00
Dome		10.30
Epiboly	Gastrula	24
Bud		26
Somite	Segmentation	60
Hatchling		72

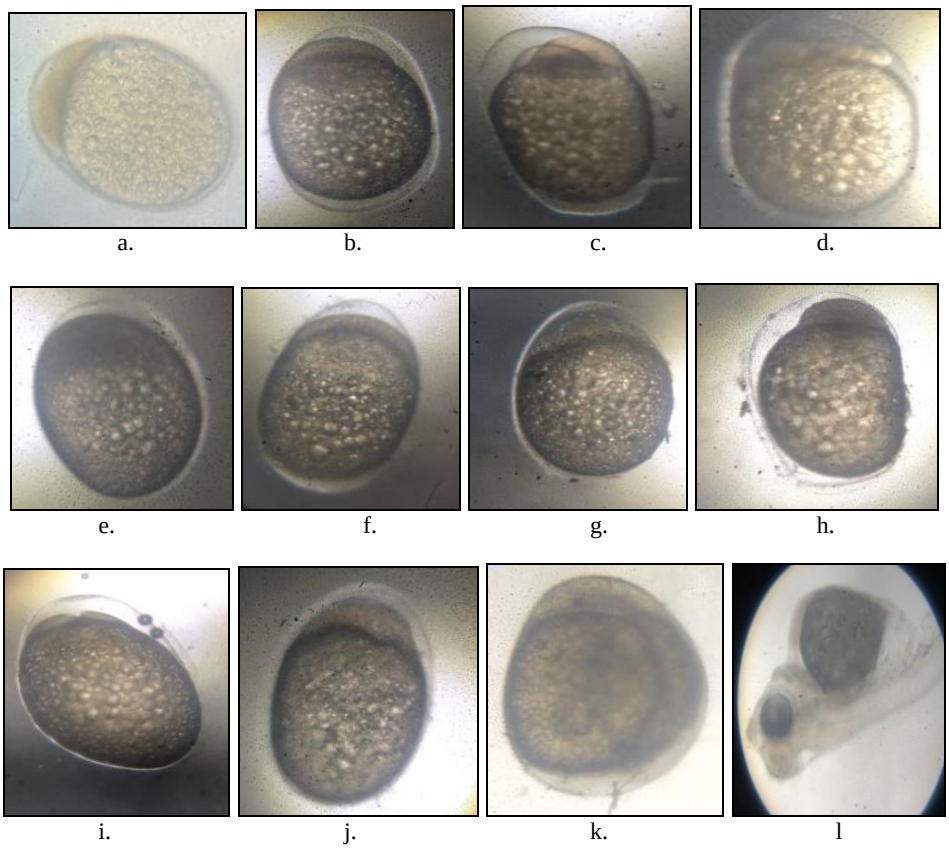

Fig 1: Embryonic stage of *P. scalare* A) 1-cell stage, B) 2-cell-stage, C) 4-cell stage, D) 8-cell stage E) 16-cell-stage, F) 32-cell-stage, G) 64-cell-stage, H) Dome-stage, I) Epiboly-stage, J) Bud-stage, K) Somite-stage, L) Hatchling-stage.

4. Conclusion

The study showcases successful captive breeding of angelfish (*Pterophyllum scalare)* without hormone intervention, with stable water quality parameters supporting embryonic development. Despite variations in water temperature and pH, the breeding achieved high fertilization, hatching, and survival rates. While challenges like brooder immaturity and limited space impacted egg production, the study underscores the potential of captive breeding to conserve species and reduce reliance on wild populations.

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