COMPARISON OF GONAD DEVELOPMENT OF SHORT-FINNED EEL *Anguilla bicolor* REARED IN FRESHWATER AND SEAWATER

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INTRODUCTION

Figure 1. Short-finned Eel, *Anguilla bicolor*

Anguilla bicolor, also known as the short-finned eel, is a critically endangered species known for its remarkable ability to thrive across a wide range of salinities. This research **investigated the comparative effects of freshwater and seawater** environments on the morphological characteristics and gonadal condition of female broodstock. Effective broodstock management, including developing reproduction in captivity, is pivotal for the sustaining eel aquaculture. Understanding these environmental influences is crucial for optimizing breeding strategies and improving reproductive efficiency in aquaculture. This study provides insights into the physiological and anatomical adaptations of female broodstock in varying aquatic environments, aiming to enhance broodstock management practices.

MATERIALS AND METHODS

Ethical approval

This experiment was conducted per Universiti Malaysia Sabah's guidelines for animal care in scientific research.

Location

This experiment was conducted at the Aquaculture Research Center (ARC) of PT. Suri Tani Pemuka, Banyuwangi, Indonesia.

Rearing management

A. bicolor were sourced from coastal water of Pelabuhan Ratu, Indonesia and reared for a period of up to 2 years. Initial screening involved 1,500 potential eel broodstock. Selection was carried out using a morphometric approach (color shape, and size) to obtain 200 females. These selected females, with an average body weight of 2030 ± 476 g, were used for this study. The broodstock were evenly distributed and maintained in freshwater and seawater environments for four months, during which they were fed squid. Water quality parameters, including dissolved oxygen (DO), pH, and temperature, were closely monitored throughout the study period.

Data collection

- At the end of four month rearing period, a subset of female eels from both freshwater and seawater groups were randomly selected for morphological assessment, gonadal development, and visceral condition.
- All specimen were sacrificed using iced water immersion methods and dissected to determine the visceral and gonad condition.
- Before dissection, morphological features were observed and measurement including body weight (g), total length (cm), body round (cm) were done.

Figure 2. Research activity throughout the study

RESULTS

Morphological condition

The morphological characteristics of female *A. bicolor* after being reared for 4 months in freshwater and seawater showed **slight differences in skin color**. Eels reared in freshwater exhibited a yellow skin color, while those reared in seawater displayed a yellow skin color with a metallic hue at the base of the pectoral fin. There were no significant differences in the morphological features of the head, anus, and tail fin between the two groups (Figures 3 and 4).

Figure 3. Female *A. bicolor* after four months reared in freshwater.
(A) whole body, (B) head, (C) anus, (D) tail fin

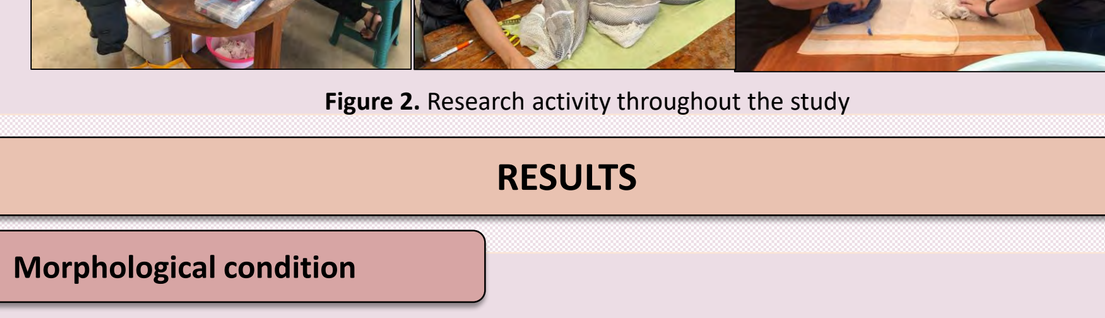

Figure 4. Female *A. bicolor* after four months reared in seawater.
(A) whole body, (B) head, (C) anus, (D) tail fin

The **freshwater-reared eels demonstrated significantly greater** body weight, length, and gonad size compared to the seawater-reared eels (Table 1), which resulted in a higher body index (Table 2). Both freshwater and seawater-reared eels exhibited excellent condition factors, with values of 1.86 and 1.67, respectively.

Table 1. Final weight and length measurements of *A. bicolor* reared in freshwater and seawater (mean±SD)

Parameter	Freshwater Eel	Seawater Eel
Final body weight (g)	2230±476.4[a]	1616±75.3[b]
Final length (cm)	88±4.3[a]	82.5±1.3[a]
Final Body Round (cm)	24±2.3[a]	19.7±0.5[b]
Visceral weight (g)	216±75.8[a]	101.7±1.1[b]
Gonad weight (g)	93.7±39.2[a]	42.9±2.4[b]
Liver weight (g)	44.2±13.8[a]	24.3±4[b]

Table 2. Comparison of body index measurement for *A. bicolor* reared in freshwater and seawater (mean±SD)

Parameter	Freshwater Eel	Seawater Eel
Gut-somatic Index (ID) (%)	9.46±1.57[a]	6.3±0.23[b]
Gonad Somatic Index (GSI) (%)	4.13±1.15[a]	2.66±0.27[b]
Hepatosomatic index (IL) (%)	1.97±0.32[a]	1.50±0.17[b]

Visceral and gonad condition

The visceral condition of *A. bicolor* reared in **freshwater showed higher fat content**, larger gonads, and a bigger liver compared to seawater-reared eels (Figures 5 and 6).

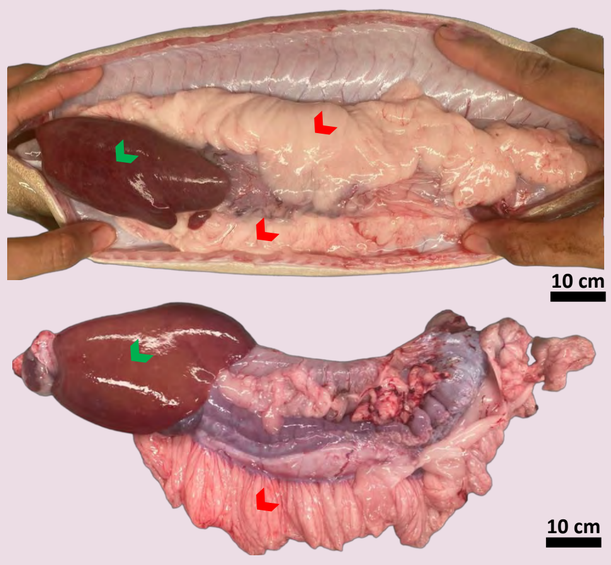

Figure 5. Visceral condition of *A. bicolor* reared in freshwater. The red arrow indicates the gonad position, and the green arrow indicates the liver condition

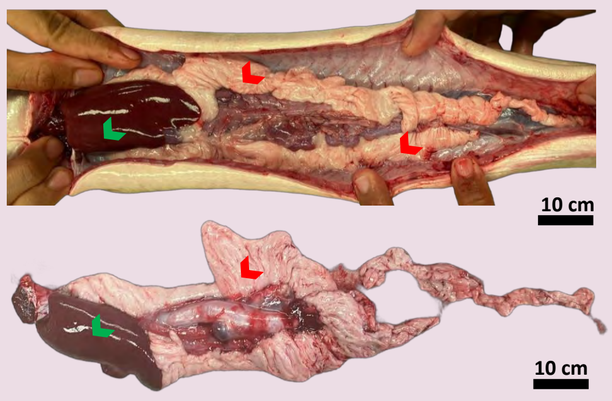

Figure 6. Visceral condition of *A. bicolor* reared in seawater. The red arrow indicates the gonad position, and the green arrow indicates the liver condition

Microscopic observations of the gonads of *A. bicolor* reared in freshwater and seawater are shown in Figure 7. **Freshwater eel gonads were more oily**, but there was no significant difference in egg size between the two groups, with eggs measuring 0.21±0.03 mm for freshwater-reared eels and 0.21±0.04 mm for seawater-reared eels.

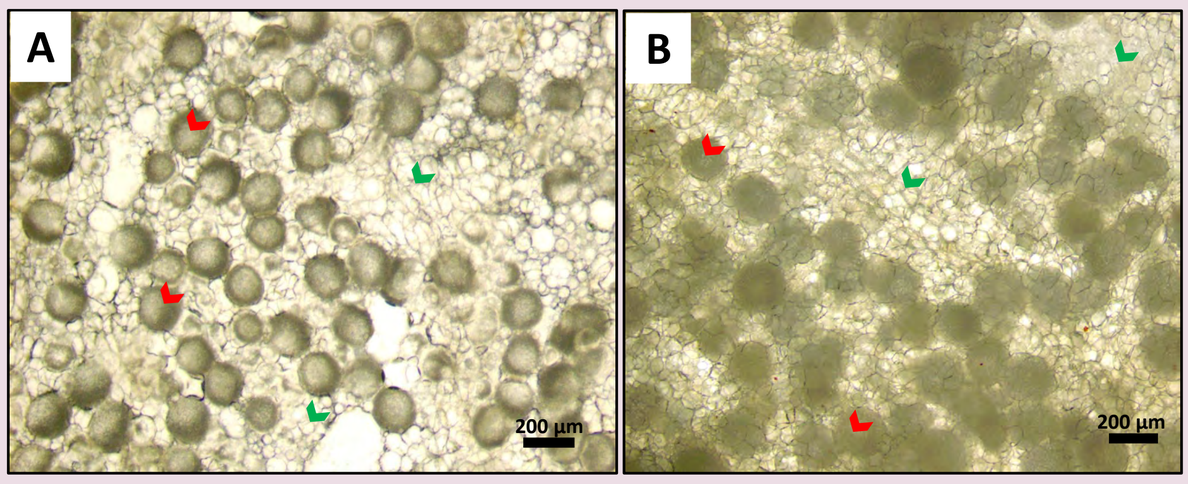

Figure 7. Gonad condition under a microscope (40x magnification). Scale: 200 µm. The red arrow indicates oocytes, and the green arrow indicates oil.
(A) freshwater-reared eel, (B) seawater-reared eel.

DISCUSSIONS

- Female *A. bicolor* reared in freshwater exhibit greater body size and visceral indicators, including larger gonads and livers.
- This aligns with previous research indicating that eels develop their gonads during migration to freshwater, with gonad maturation and spawning occurring in the sea with higher salinity (>30 ppt). (Tesch, 1997; Haryani *et al.*, 2021)
- The freshwater environment may favor the development of female eel.
- Gonadal development in female eels is influenced by body size and age, with larger gonads supporting reproductive requirements. (Yoshikawa, 1995; Gong *et al.*, 2017)
- Eels accumulate fat in both muscle and liver during their growth process, where the liver plays a significant role in producing vitellogenin (VTG), essential for the gonad development. Energy, notably in the form of fat, is then transferred from both muscle and liver to the gonad to support the reproductive process. The liver's active participation in depositing oil droplets and yolk precursors in eggs could contribute to the observed increase in liver size and hepatosomatic index (HSI) during silvering in female eels (Han *et al.*, 2001)

CONCLUSION

In conclusion, this study demonstrated that freshwater-reared eels have more gonads, suggesting that broodstock management in freshwater may be beneficial for breeding purpose. Further research on the spawning response and peak ovulation time in both groups should be conducted.

ACKNOWLEDGEMENTS

The authors would like to thank the staffs of Aquaculture Research Centre of PT Suri Tani Pemuka, Banyuwangi, Indonesia and Universiti Malaysia Sabah for the undivided support and technical assistance throughout the research. This research was funded by a collaboration research project between JAPFA Ltd. and Universiti Malaysia Sabah.

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