

Reproductive Aspects of Red Devil Fish (*Amphilophus citrinellus*) in Lake Batur Area, Bali

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Abstract. Red devil fish (*Amphilophus citrinellus*) has a rapid breeding nature, its presence a problem and detrimental to fish farmers. This study aims to examine the reproductive aspects of the fish, which can be seen from several aspects: sex ratio, gonad maturity level, gonad maturity index, and fecundity. The research method used is descriptive quantitative. Samples of red devil fish (*Amphilophus citrinellus*) were collected using purposive sampling at 3 sampling station locations. Sampling was conducted 3 times with intervals of every 2 weeks. Each sample collection consisted of 15 fish per station. The equipment used was a gill net with a mesh size of 2.5 inches, a net length of 100 m, and a net height of 1 m. The fish that are caught are then put into a coolbox and then observed. The research results indicate an imbalance in the sex ratio of the red devil fish population in Lake Batur. The male red devil fish population is larger than the female population. Based on the gonad maturity level (TKG), male red devil fish are most commonly at TKG III and II, with 20 individuals each, while females are dominated by TKG IV with 35 individuals. The average gonad maturity index (IKG) for male fish is 0.25 – 0.65, while for females, it is 1.58 – 2.32. The average fecundity of females ranges from 582 to 790 eggs.

Keywords: aspects of reproduction; Batur Lake; Red Devil Fish

I. INTRODUCTION

Lake Batur is one of the lakes located in the Kintamani District, Bali, with an area of 16,075 hectares, a water volume of 815.38 million cubic meters, and an average depth of 50.8 meters. It is classified as a volcanic lake because it was formed due to the eruption of Mount Batur. The local community utilizes Lake Batur for fish farming, agricultural activities, and tourism. The availability of fish resources in Lake Batur is relatively limited due to its characteristic as a volcanic lake, which leads to a low fish community. The introduction of new fish species generally occurs through fish introduction activities [10].

Fish introduction is the activity of introducing new fish species into a water body [9]. Fish introduced into a body of water can be done either intentionally or unintentionally [13]. The initial presence of introduced fish in Lake Batur is believed to have been caused by ornamental fish accidentally being released along with other fish seedlings during fish introduction activities, or intentionally released into the lake due to the declining popularity of the ornamental fish, reducing the community's interest in keeping them. Some of the introduced fish species in Lake Batur include flowerhorn cichlid (*Amphilophus trimaculatus*), convict cichlid (*Amatitlania nigrofasciata*),

Nile tilapia (*Oreochromis niloticus*), and red devil cichlid (*Amphilophus citrinellus*) [10].

The research by Adjie and Fatah (2015) in the Kedung Ombo Reservoir, Central Java, states that the red devil fish (*Amphilophus citrinellus*) has a small GSI (Gonado Somatic Index) value and is categorized as a species that spawns more than once a year. The highest GSI value for females was 5.40% in March, and for males, it was 1.64% in October, measured during the observation months of March, May, July, and October. Red devil fish with TKG IV (Gonad Maturation Stage IV) were most frequently found in March, with 33.33%, and TKG V was observed in every month of the study. Based on mature female gonads, fecundity in *Amphilophus citrinellus* ranged from 631 to 2,771 eggs.

The red devil fish is considered a pest because it preys on other fish but has no economic value in the market. Its rapid growth can be harmful and is considered a pest because it only preys on other species and does not provide significant economic benefits. It poses a threat to the lake's ecosystem [5]. Information on the reproductive aspects of the red devil fish (*Amphilophus citrinellus*) in Lake Batur is necessary for its management and control. Reproductive aspects are crucial in an organism's life cycle, and to understand the reproductive characteristics of fish, several

factors must be examined, such as the sex ratio, gonad maturity level, Gonad Maturity Index, and fecundity. This study is expected to provide a reference for controlling the red devil fish (*Amphilophus citrinellus*) population in Lake Batur.

II. METHODS

Research Period and Location

Sample collection was conducted from March to April 2024, consisting of three sampling locations, namely:

- Waters of the Songan Village area, located in Songan Village, which is a farming area with fish farming activities (floating net cages), residential settlements, and aquatic plants along the lake's edge. The substrate consists of sand and mud.
- Waters of the Toya Bungkah area, located in Toya Bungkah Village, which is a tourism area with fish farming activities (floating net cages) and a rocky, porous substrate.
- Waters of the Kedisan Village area, located in Kedisan Village, which is a residential area with farming, fish farming activities (floating net cages and fish capture), and a boat dock.

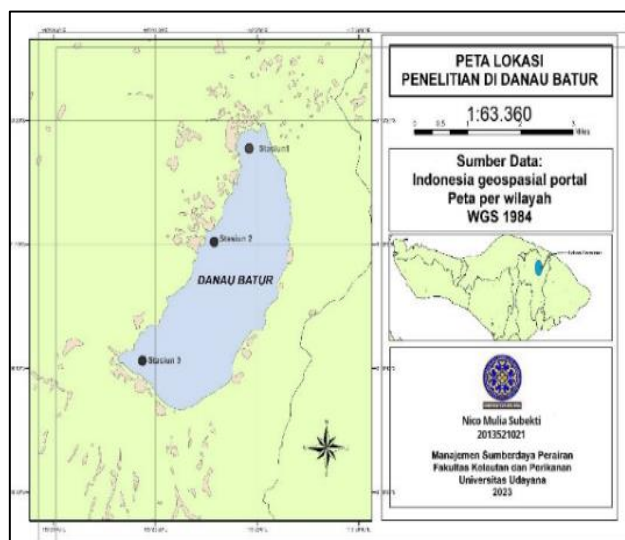


Fig. 1. Location

Data Sampling Method

The method used in this study is descriptive quantitative. Descriptive methods are used to provide an overview of an object being studied through collected data or samples. The quantitative method is used to collect data using research instruments, with data analysis being statistical in nature on a particular object or sample [11].

Sampling of red devil fish (*Amphilophus citrinellus*) was conducted using the purposive sampling method at three sampling station locations. The sampling was repeated three times with a two-week interval between each sampling. The equipment used was a gillnet with a mesh size of 2.5 inches, a net length of 100 meters, and a net height of 1 meter. Each sample collection consisted of 15 fish per station. The purposive sampling method is a sampling technique based on specific considerations [4].

Data Analysis

Measurement of Total Length, Body Depth, and Weight of Red Devil Fish Samples

The total length, body depth, and weight of the red devil fish samples were measured. The length of the fish measured is the total length (TL). The length was measured using a ruler with a precision of 1 mm. The fish were weighed using a digital scale with a precision of 0.01 grams.

Dissection of Samples

The dissection of the red devil fish's gonads (*Amphilophus citrinellus*) was carried out on-site around Lake Batur, following this procedure:

- The red devil fish sample, after being weighed, was dissected. The dissection was performed from the anus to the ventral part of the fish.
- After the dissection, the gonads found were differentiated between male and female fish gonads.
- The gonads were weighed using a digital scale to measure the total weight.
- The morphological observation of the gonad maturity level (GML) was conducted on both male and female fish gonads.
- For female fish with gonads classified as GML III and IV, fecundity observation and analysis were performed.

Observation of Gonad Maturity Level

The gonad maturity level (GML) is the stage of gonad development before and after the fish spawns. Table 1 shows the morphological characteristics of gonad maturity levels in determining the gonad maturity group (GML) of the red devil fish.

Fecundity Observation

The fecundity of the fish was determined using the gravimetric method. This method is based on the total gonad weight and the weight of the gonad sample, which is divided into 3 sub-samples of the gonads and weighed. Each sub-sample was weighed with an accuracy of 0.01 grams, and the number of eggs in each sub-gonad sample was counted. Fecundity was calculated using the gravimetric method with the formula [3]:

$$F = \frac{G}{Q} \times N$$

F = Total Fecundity

G = Gonad Weight (g)

Q = Gonad Sample Weight (g)

N = Number of eggs per sub-gonad (eggs)

Sex Ratio Observation

The sex ratio, based on the number of male and female red devil fish caught, was calculated using the following formula (Omar et al, 2015):

$$NK = \frac{J}{B}$$

NK = Sex ratio

J = Number of male fish

B = Number of female fish

Gonad Maturity Index Observation

According to Adebiyi (2013), the gonad maturity index can be measured by comparing the weight of the gonads to the body weight of the fish. The formula for the gonad maturity index is:

$$IKG = \frac{BG}{BI} \times 100$$

IKG = Gonad Maturity Index

BG = Gonad Weight (g)

BI = Body Weight of Fish (g)

TABLE 1
GONAD MATURITY LEVELS OF RED DEVIL FISH

TKG	Male	Female
I (Immature)	The testes are empty, transparent, and elongated like a thread extending towards the front of the body cavity, with the tip of the testes thread not visible.	The ovaries are still empty, transparent, and shaped like a thread, shorter than the male testes, with the tip of the ovarian thread visible.
II (Developing)	The testes are larger, with a clear reddish coloration, and some parts are still transparent.	The ovaries are larger, with a darker yellowish coloration, and the eggs are not yet clearly visible to the naked eye.
III (Mature)	The testes are becoming larger and more defined, with a reddish-white coloration indicating the beginning of sperm cell formation.	The ovaries are yellow, with egg granules starting to be visible to the naked eye. The eggs appear not to have fully filled the tissue and are not easily separable (they are attached to the ovarian tissue).
IV (Ripe)	The testes continue to grow larger and become fully developed, with a solid, elongated shape and a more pronounced white coloration compared to the previous stage.	The ovaries continue to grow larger and appear full, filled with eggs, occupying ½ to ⅔ of the abdominal cavity. The eggs are yellow and easily separable.
V (Spent)	The posterior part of the testes (near the anus) is shriveled and empty, while the anterior part (towards the front) is still filled.	The ovaries are shriveled in the posterior part (near the anus), while the anterior part still contains eggs, which are yellowish in color. The tissue without eggs is visible.

III. RESULTS AND DISCUSSION

Total Length, Body Depth, and Weight of Red Devil Fish

During the study, 150 red devil fish samples were collected, consisting of 85 males and 65 females. The average total length of male and female fish was highest at station 3, with a value of 15.8 cm, and lowest at station 2, with a value of 15.4 cm. The highest average body depth was found at stations 1 and 2, with a value of 5.8 cm, while the lowest was at station 3, with a value of 5.7 cm. The highest average weight was recorded at station 3, at 77.5 grams, and the lowest at station 1, at 70.6 grams.

TABLE 2
MORPHOLOGY OF GONAD MATURITY LEVELS OF RED DEVIL FISH IN LAKE BATUR

Morphometric		Station 1	Station 2	Station 3
Body Depth (cm)	Average	15.6	15.4	15.8
	Min	12.2	9.5	13
	Max	18	19	13
	SD	1.2	1.9	1.6
Total Length (cm)	Average	5.8	5.8	5.7
	Min	3.6	3.4	3
	Max	7	7	7
	SD	0.7	0.8	0.7
Wight (gr)	Average	70.6	71.5	77.5
	Min	26	17	51
	Max	116	107	140
	SD	13.7	22.2	19.3

Sex Ratio

The sex ratio of red devil fish in Lake Batur showed varying results in each sampling. Based on the research

conducted, the results indicate an imbalanced sex ratio between males and females. The sex ratio at station 1 had the lowest value of 1.2, with a percentage of 54% male : 46% female. At station 2, the sex ratio was 1.3, with a percentage of 56% male : 44% female. At station 3, the highest sex ratio value was 1.5, with a percentage of 60% male : 40% female. According to previous studies, the red devil or oscar fish in Lake Batur had an imbalanced sex ratio of 1.73, dominated by males [12].

TABLE 3
SEX RATIO

Station	Male	Famale	Sex Ratio
1	27	23	1.2
2	28	22	1.3
3	30	20	1.5
Total	85	65	1.3

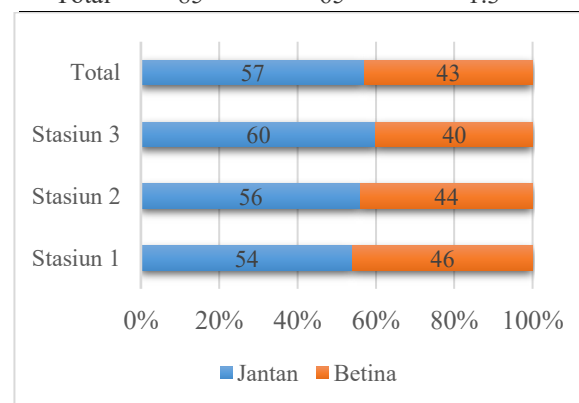


Fig 2. Gender Percentage of Red Devil Fish in Lake Batur

Gonad Maturity Level

The red devil fish in Lake Batur exhibit a complete range of gonad maturity levels, from GML I to GML V. Female red devil fish at GML I were not found at any of the research locations. GML IV in females dominated across all research stations. GML IV is a gonad maturity level indicating that the fish are ready to spawn. The presence of GML IV in female red devil fish found at each station suggests that the red devil fish have the ability to reproduce throughout the year.

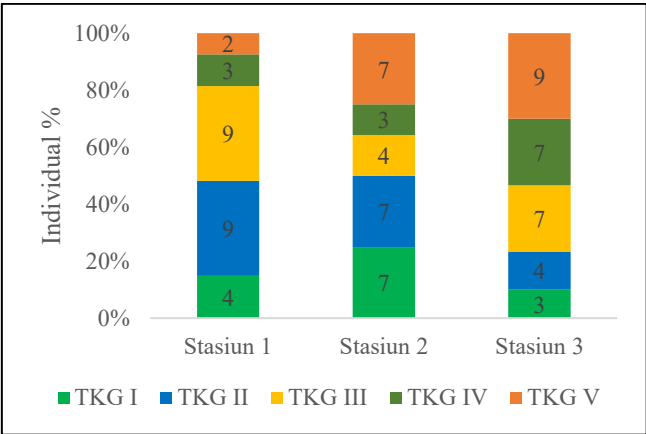


Fig 3. Gonad Maturity Levels of Male Red Devil Fish in Lake Batur

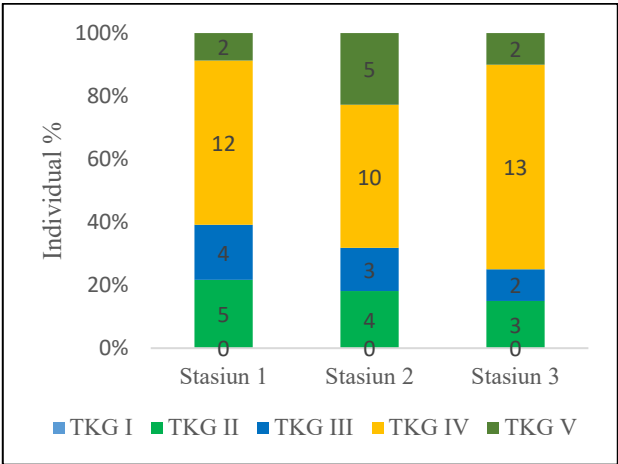


Fig 4. Gonad Maturity Levels of Female Red Devil Fish in Lake Batur

Based on the research by Sukmayanti et al. [12], the gonad maturity levels (GML I-V) of red devil fish in Lake Batur show diversity. This is supported by the statement of Purnamaningtyas and Tjahjo [8], who noted that red devil fish can spawn and lay eggs throughout the year, regardless of the season. Furthermore, according to research by Adjie and Fatah [2], red devil fish are capable of spawning throughout the seasons, with the peak spawning period suspected to occur between December and March, at GML IV. Based on the morphology of the gonad maturity levels of red devil fish found in Lake Batur, the results are presented in Table 4, as follows.

TABLE 4 MORPHOLOGY OF GONAD MATURITY LEVELS OF RED DEVIL FISH IN LAKE BATUR		
TKG	Documentation	
	Male	Female
TKG I		Not found.
TKG II		
TKG III		
TKG IV		
TKG V		

IV.CONCLUSION

The sex ratio of red devil fish in Lake Batur is imbalanced, with station 1 showing the closest value to a balanced sex ratio. More male red devil fish were found compared to female red devil fish. Based on the gonad maturity levels (GML) and the number of red devil fish found, male red devil fish were dominated by GML II and GML III, with 20 individuals in each category, while female red devil fish were dominated by GML IV, with 35 individuals. The GML index for male red devil fish ranged from 0.25 to 0.65, while the IKG for female red devil fish ranged from 1.58 to 2.32. The average fecundity ranged from 582 to 790 eggs.

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