Population structure of bada (Rasbora maninjau Lumbantobing, Daniel N, 2014) caught using “lukah” in Batang Air Stream

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Abstract. Inlets of Lake Maninjau are the fishing area of bada (Rasbora maninjau), one of them is Batang Air Stream. Bada fishing intensively, which is not balanced with conservation efforts, causes the fish population to gradually decrease and even become rare. Bada fishing activities at this location using “lukah” (trap) has been carried out and owned from generation to generation. This study aims to determine the population structure of bada using “lukah” in Batang Air Streams based on conservation efforts. Fish sampling was carried out in March, April, and June 2019. Fish samples obtained from three “lukah”. The size structure (length and weight), growth patterns (length-weight relationship), the gonadal maturity stage (GMS), and the sex ratio of bada were measured in this study. The results showed that the length and weight of bada in March, April, and June were found with a range of lengths of size 12-127; 63-125; and 73-113mm and weight were 1.8-14; 1.9-13.6; and 3.1-11g, respectively. The value of $b$ ranged from 2.64 to 2.92. Isometric growth was found in March and April, which means the growth of length was balanced with the growth of the weight, and June is negative allometric. The highest frequency of GMS IV, which means the fish are ready to spawn, was found in March 2019. Therefore, during this survey period, it was might be a peak of the spawning period. High frequency ($\geq$50%) of mature bada was found at length 71.5-99.5 mm for females and 65.5-77.5 for males. It is shown that most of the bada in “lukah” was mature. The sex ratio between male and female fish is 1:1.

1. Introduction
Bada is a Rasbora fish that being popular food in Lake Maninjau, West Sumatra. Smoked fish of bada has become typical foods from Maninjau, which has being proposed as a geographical patent product. Bada fishing has been declined for many years because of water quality issues. The bada population has decreased over the year. In 2006-2007, the bada population was been reduced by 36.56%. In 2007-2008, it continued to decline at 39.71%. Moreover, the bada population decreased sharply to 80% in 2008-2017 [1]. Intensive fishing is considered to have contributed to the bada population decline in Lake Maninjau.

Bada migrates from the lake to the stream to spawn, while local people catch this fish using a kind of trap called "lukah". The stream is divided into some channels that become fish spawning areas where local people installed their "lukah". These channels have owned by individuals or groups.
Batang Air Stream is one of the Lake Maninjau inlets, which is the bada fishing area for local people. Bada fishing in the Batang Air Stream is managed by some (nine) communities that are hereditarily formed by ethnic groups (personal communication with fishers 2018/2019). "Lukah" is a local fishing gear which is a closed trap system. Water flow that comes out after "lukah" will be stagnant. Therefore, the spawning eggs will be trap in that small pool and perish.

This study aims to determine the population structure of bada using “lukah” in the Batang Air Stream, which consists of size structure (length and weight), length-weight relationship, and gonadal maturity stage for conservation efforts.

2. Methods
2.1. Study site
This research was conducted in the Batang Air Stream, which is one of Lake Maninjau inlets. The site was selected due to its function as the ada fishing area for local people. Batang Air stream is in Kanagarian (village) Sungai Batang, Tanjung Raya District, Agam Regency, West Sumatra (figure 1). Bada was caught by “lukah” (local fishing gears) which installed in the mouth of the stream (figures 2 and 3). Samples were analyzed at the laboratory of Research Center for Limnology, Indonesian Institute of Sciences (LIPI) Cibinong.

![Figure 1. Sampling location of bada fish in Batang Air Stream (Source: Dianto, 2019 unpublished) [2].](image1)

![Figure 2. Sketch of fishing gear “lukah” (Source: Samir, 2019 unpublished) [3].](image2)
2.2. Research focus
This paper to determine the size structure (length and weight), growth patterns (length-weight relationship), the gonadal maturity stage (GMS), and sex ratio of bada in its conservation efforts.

2.3. Data collection and analysis
A descriptive quantitative approach was used as a method of this research. Fish samples were caught by “lukah” (local fishing gear) in a day every month (March, April, and June 2018). Three “lukah” were installed from 12 p.m. to 6 a.m. on the next day (18 hours). Twenty-five percent of the total fish caught were preserved by 10% formaldehyde for further analysis. There were about 185 fish in March, 143 fishes in April, and 114 fishes were analyzed in this research. Total length and weight were measured by a ruler with an accuracy of 0.1 cm and a scale with a precision of 0.1 g. Sex ratio and Gonadal Maturity Stage (GMS) were analyzed morphologically [4]. Size at first maturity was estimated according to [5].

Figure 3. Bada (Rasbora maninjau) (a) fish samples were obtained using “lukah” (b) in Batang Air Stream (Source: Nasution, 2019) [6].

3. Results and Discussion
3.1. Fish size structure
3.1.1. Length size structure
The length of the bada range in March, April, and June between 65 to 127; 63 to 125; and 73 to 113, respectively (figure 4). The highest frequency of length midclass in March was 77.5 mm (30%), April was 77.5 mm (26.5%), and June was 83.5 mm (25%). The length and size of fish which caught in “lukah” have shown that they were ready to spawn.

Figure 4. Length size structure of bada fish in March, April, and June in Batang Air Stream.
3.1.2. Weight size structure
The weight of bada in March, April, and June is 1.8-14.0 g; 1.9-13.6 g; and 3.1-11.0 g, respectively (figure 5). Moreover, 3.55 g is the most dominant in this observation. The dominant frequency of middle-class weight in April is 3.55 g (40.0%), which is the highest. While in March and June are 3.55 g (37.0%) and 4.75 g (35%). The weight of fish caught in the size of fish that are ready to spawn.

![Figure 5](image_url)

**Figure 5.** Weight size structure of bada in March, April, and June 2019 in Batang Air Stream.

3.2. Length-weight relationship
Table 1 presents the length-weight relationship equation and the growth pattern of bada corresponding to the time of the survey. T-test ($\alpha=0.05$) results on the regression coefficient value ($b$) show the value of $b<3$ and $b=3$ [7]. The value of $b$ ranged from 2.64 to 2.92 (figure 6). Generally, isometric growth was found in March and April 2019, which means the growth of length was balanced with the growth of the weight. A change from isometric to negative allometric growth was found in June 2019, where the growth of length was faster than the growth of weight.

| Month | Length-weight relationship model | Growth pattern |
|-------|----------------------------------|----------------|
| March-♀ | $W = 1E-05L^{2.83}$ ($R^2= 0.89$; n=105) | Isometric |
| March-♂ | $W = 2E-05L^{2.72}$ ($R^2= 0.76$; n=80) | Isometric |
| April-♀ | $W = 1E-05L^{2.92}$ ($R^2= 0.94$; n=81) | Isometric |
| April-♂ | $W = 4E-05L^{2.64}$ ($R^2= 0.79$; n=62) | Allometric (-) |
| June-♀ | $W = 2E-05L^{2.74}$ ($R^2= 0.94$; n=60) | Allometric (-) |
| June-♂ | $W = 2E-05x^{2.74}$ ($R^2= 0.93$; n=54) | Allometric (-) |

In this study, one presumably factor that affects the higher $b$ value in March April was the more significant proportion of mature fish (GMS IV) during this period (figure 7). For instance, it is reported that the weight of mature gonad of *Rasbora argyrotaenia* in Central Java ranged from 4.5% to 44% total weight [8].

The environmental condition often influences to fish growth pattern. The length-weight relationship will slightly deviate from the cubic law ($b \neq 3$) [9]. At the time of sampling in March, the weather conditions were rainy. While in June, the dry conditions were supported by the decreasing value of the quality parameters (TSD and conductivity) (table 2). Biologically the value of $b$ relates to the condition of the fish, while the status of the fish depends on the food, age, sex, and maturity of the gonads [10].
Figure 6. Length-weight relationship of female and male bada in March, April, and June in Batang Air Stream.

Table 2. Water quality of Batang Air Stream.

| Month | Temperature (°C) | pH | DO (mg/L) | Conductivity (µS/cm) | TDS (mg/L) |
|-------|-----------------|----|-----------|----------------------|------------|
| March | 27.2            | 8.5| 5.5       | 0.124                | 77.4       |
| April | 24.8            | 7.7| 7.9       | 0.110                | 53.7       |
| June  | 25.7            | 8.0| 6.4       | 0.055                | 38.0       |

(Source: Sudarso et al., 2019) [11].

3.3. The gonadal maturity stage (GMS)
Gonadal maturity stage (GMS) is one of the basic knowledge of the biology of fish reproduction such as butini (Glossogobius matanensis). Gonad maturity is one part of reproduction before spawning [10]. Gonadal maturity can be used as a predictor of the reproductive status of fish, determining the size and age at the first time the gonad is matured, proportion or amount reproductively mature.
population, and understanding of the reproductive cycle of a population or species. Fish that live in the tropics tend to have long spawning periods, usually during high rainfall and flooding [12]. It is supported that fish spawning in the rainy season due to environmental factors such as temperature stimulus, changes in water chemistry, and water flow [13]. These factors directly influence or stimulates fish to spawn. The highest frequency of GMS IV, which means the fish are ready to spawn, was found in March 2019 (figure 7). Therefore during this survey period, it was might be a peak of the spawning period.

![Figure 7](image7.png)

**Figure 7.** Gonadal maturity stage (GMS) of bada caught using "lukah" in Batang Air Stream.

Furthermore, high frequency (≥50%) of mature bada was found at length 71.5 - 99.5 mm for females and 65.5 - 77.5 mm for males. Compared to the length-frequency distribution (figure 8), it is shown that most of the bada in “lukah” was mature.

![Figure 8](image8.png)

**Figure 8.** Percentage of mature bada by length.
Bada fish is a type of fish total spawner so that it can produce juvenile simultaneously. There are two stages of fish gonad development, namely the stage of gonad development into sexually mature and the stage of gamete maturation. Bada fish is classified as a true bony fish (Teleostei), it usually has a pair of ovaries that are elongated and are found in the abdominal cavity [14].

### 3.4. Sex ratio

The sex ratio analysis result of male and female bada in the Batang Air Stream shows balance with a ratio of 1.0:1.0. Fish sex ratio which close to 1:1 is an ideal proportion [14,15]. Moreover, it is stated that to maintain the fish population, the ratio of male and female fish should be in balance [16]. This condition would maintain fish species from extinction.

The sex ratio could be used as indicators of fish recruitment. The closer to the ideal ratio, the greater chances of successful recruitment. Recruitment potential will increase if the sex ratio of male and female fish reaches an ideal 1:1 ratio. This perfect ratio will also increase the chance of spawning fish pairs. Djumanto et al [17] the reproductive biology of Rasbora lateristriata, find that the sex ratio of the spawning fish was 1:1. Nevertheless, this ratio was biased because, during spawning and gamete releasing, each female would be accompanied by 1 to 2 males.

The sex ratio is influenced by the spawning behavior of each species of fish. Gray and Mc Kinnon [18] stated in fish groups from the Telmatherinidae family, such as Tominanga sp. and Tominanga sarasinorum, each pair of fish consists of 3-7 male fish and one female fish. One female fish with one or two male fish will do the spawning process. The sex ratio in bonti-bonti (Paratherina striata) is 1.0: 0.9 [18]. Furthermore, it was said that fights often fought for females by other males (sneak/sneaker). The sneak male besides causing competition is suspected of carrying out cannibal actions against the same fish eggs. Nasution [19] also stated that egg cannibalism activity occurs in T. sarasinorum and T. celebensis fish.

The existence of competition and egg cannibalism activity allegedly related to the imbalance of sex ratio between male fish and female fish where the portion of male fish is higher than female fish. It will minimize the potential for new fish additions.

### 4. Conclusion and Suggestions

#### 4.1. Conclusion

The average size of length and weight of bada in March, April, and June were found 82.92 mm; 85.77 mm; and 90.77 mm and 4.11 g; 4.77 g; and 5.59 g, respectively. The value of $b$ ranged from 2.64 to 2.92. Isometric growth was found in March and April, which means the growth of weight was balanced with the growth of the weight, and June is negative allometric. The highest frequency of GMS IV, which means the fish are ready to spawn, was found in March 2019. Therefore during this survey period, it was might be a peak of the spawning period. High frequency (≥50%) of mature bada was found at length 71.5-99.5 mm for females and 65.5-77.5 mm for males. It is shown that most of the bada in “lukah” was mature. The sex ratio between male and female fish is 1:1.

#### 4.2. Suggestions

Understanding of conservation needs to be done so that bada populations can be sustainable. To keep the fish resource population sustainable, early efforts are requiring to find a form of management by making management arrangements to prevent overfishing. The types of management of bada resources in the Batang Air Stream are restrictions on the exploitation season, limiting the number of attempts and catches.

### 5. References

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