Fish distribution in Ranggeh and Batang Air Stream, Tanjung Raya, Agam District, West Sumatra Province

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Abstract. Ranggeh and Batang Air Stream are two inlets of the entire channels of Lake Maninjau which are located on the southeast side of the lake with some different. Therefore, this study aims to assess fish distribution along Ranggeh and Batang Air Stream. Sampling was carried out in February, March, April and June 2019 at five stations in the Ranggeh Stream and three stations in the Batang Air Stream representing the upper section, middle section and lower section. The fish samples were caught using a scoop net and trap. Also, several parameters of water quality such as temperature, pH, dissolved oxygen, turbidity, conductivity, current, and discharge were measured \textit{in situ}. Fish were morphologically identified and measured followed by statistical analysis. A total of 11 fish species were found in Ranggeh Stream, namely Aplocheilus panchax, flower horn, Gobioperus brachypterus, Homaloptera gymnogaster, Namacheilus chrysolaimos, Oreochromis niloticus, Osteochilus vittatus, Poecilia reticulata, Puntius binotatus, Rasbora maninjau, and Tor sp. Furthermore, five fish species were found in Batang Air Stream namely Homaloptera gymnogaster, Namacheilus chrysolaimos, Oreochromis niloticus, Poecilia reticulata, and Rasbora maninjau. The highest number of fish species was found in the lower section of Ranggeh Stream. \textit{Homaloptera gymnogaster} is a species with a minimal habitat where only found in the upper part of both streams. Water temperature and dissolved oxygen were significantly different between the upper and lower part of Ranggeh Stream. It is recommended to conserve mainly the Ranggeh Stream due to its higher fish richness through restoration act along the stream and protect the upper section as habitat for protected fish species namely \textit{Homaloptera gymnogaster}.

Keywords: fish distribution, inlet, Lake Maninjau

1. Background
Ranggeh and Batang Air Stream are two of the entire inlets of Lake Maninjau which are located on the southeast side of the lake. Lake Maninjau, one of the natural lakes in West Sumatra, is geographically situated between 001\textdegree}26.63 "LS-0025'02.80" LS and 10000743.74'43.74 "BT-100016'22.48" East at an altitude of 461.5 m above sea level [1]. Lake Maninjau is included in the list of national priority lakes to be managed or revitalized due to high pressure on the lake ecosystem [2].

Many studies that have been carried out in the water of Lake Maninjau were mainly about water quality [3,4,5, 6] and biota [4, 7, 8, 9, 10, 11, 12], but information regarding the inlet is still minimal. So far, to the best author’s knowledge, we only found two publications related to Lake Maninjau inlets.
These studies had been conveyed information on fish species found only in the lower section of some lake inlets [10,12]. Information about fish distribution/community and their habitat in Ranggeh and Batang Air Stream has not been studied. Both of these streams are located on the same side of Lake Maninjau with some different physical characteristics. Based on the personal communication with physical limnology experts from Research Centre for Limnology (Ridwansyah I, oral communication, 26th December 2019), it is known that Ranggeh Stream is temporarily dry in the middle section whereas Batang Air Stream flows continuously from the upper to lower part. Therefore, this study aims to explore information related to the longitudinal distribution of fish species in the two streams and some of their environmental characteristics. The findings of this study are expected would be beneficial as a scientific base in formulating fish community management in inlets of Lake Maninjau.

2. Methods
The sampling was carried out in the Ranggeh Stream (SR) from February to April and June 2019 and the Batang Air Stream (SBA) from March to April and June 2019. Sampling stations in each stream were purposively determined to represent the upper section, middle section, and lower section with different conditions (table 1 and figure 1). Five sampling stations were in the Ranggeh (SR1-SR5) and three sampling stations in the Batang Air (SBA1-SBA3). Fish were caught directly using a 30 cm diameter scoop net with a mesh size of 0.2 mm. It was operated by combing the right, left, and middle part of the stream along 10-50 m. Besides, traps were also operated at stations SR 4, SR 5, and SBA 3.

| No | Station | Description |
|----|---------|-------------|
| **Ranggeh Stream** | | |
| 1 | SR 1 | Station 1 is in the upper section. The substrates are dominated by sand and rocks with more giant rocks found towards the top part. The surrounding land consists of bushes, forests, and rice fields. The channel width is 280 cm. |
| 2 | SR 2 | Station 2 is still in the upper section. The substrates are composed of sand and rocks. The surrounding land is dominated by rice fields. The banks of the stream are overgrown by shrubs and trees. The channel width is 290 cm. |
| 3 | SR 3 | Station 3 represents the middle section of the stream. The location is surrounded by rice fields, settlements, and near the road. |
| 4 | SR 4 | Station 4 represents the lower section. The station is surrounded by rice fields. There is an edge mounted on a wire gabion due to frequent landslides. The substrates are dominated by gravel and sand, and rocks are rarely found. At the banks of the stream, there are some quite large trees. The channel width is 200 cm. |
| 5 | SR 5 | Station 5 is located in the lower section of the stream. It is approximately 50 m from Lake Maninjau. The substrates are dominated by sand and gravel. |
| **Batang Air Stream** | | |
| 1 | SBA 1 | Station 1 is the upper section, with rocky and sandy substrates. The surrounding land is in the form of rice fields and plantations. The banks of the stream are overgrown with shrubs and trees. |
Station 2 is the lower section which is located between rice fields. The substrates are gravel and rocky, overgrown with bushes.

Station 3 is in the mouth of the stream directly adjacent to the lake. The edges are overgrown with more dense trees, so they look shady. The substrates are sand and gravel, with tree roots in the middle of the stream. Fishers divide the stream into some small channels and install specific fish traps at a channel mouth to trap bada (*Rasbora* spp.).

The caught fish were separated based on species followed by measurement on total length [13] to the nearest 0.1 cm and wet weight [14] to the nearest 0.1 g. Fish size data were descriptively presented.

Some fish were taken to be preserved in a 10% formalin solution [15] for further analysis in the laboratory. In the laboratory, fish samples were rinsed and cleaned from formalin solution, then stored in 70% alcohol solution [15]. Furthermore, fish samples were morphologically identified by referring to Kottelat et al. [16] and Kottelat [17] at the Fish Laboratory, Zoology Division, Research Centre for Biology, LIPI. The conservation status of each fish species was accessed on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species website.

Some water quality parameters were measured *in situ* using the Water Quality Checker (WQC Horiba U-50). The parameters were water temperature (°C), dissolved oxygen (mgL⁻¹), turbidity (NTU), conductivity (mScm⁻¹), and pH (1-14). Also, water current was measured using a current meter (Tamaya UC-20). Furthermore, the mean difference of the water quality parameters were statistically tested using Variance Analysis (ANOVA) in SPSS 15.0 software package.
3. Results

3.1. Water quality

The following table 1 and table 2 present the values of several water quality parameters in Ranggeh Stream (SR) and Batang Air Stream (SBA). Field observations at SR 3 showed that this station was dry in March and April. Therefore, the water quality parameters at this station were not statistically tested. Furthermore, a statistical test was also not applied to water quality parameters in Batang Air Stream due to the lack of data.

| Parameters                  | Location | Min   | Max   | Mean±SD       |
|-----------------------------|----------|-------|-------|---------------|
| Temperature (°C)            | SR 1     | 21    | 21.75 | 21.46±0.33*   |
|                             | SR 2     | 21    | 26    | 23.57±2.16*   |
|                             | SR 3     | 21    | 25.44 |               |
|                             | SR 4     | 26.3  | 28.3  | 27.23±0.86**  |
|                             | SR 5     | 26.29 | 29.2  | 27.85±1.42**  |
| Dissolved oxygen (mgL⁻¹)   | SR 1     | 7.13  | 8.57  | 8.09±0.66*    |
|                             | SR 2     | 6.85  | 8.18  | 7.84±0.66*    |
|                             | SR 3     | 6.82  | 8.15  |               |
|                             | SR 4     | 4.68  | 7.49  | 6.08±1.18**   |
|                             | SR 5     | 5.09  | 6.64  | 6.08±0.68**   |
| Current (ms⁻¹)              | SR 1     | 0.48  | 4.10  | 2.12±1.87     |
|                             | SR 2     | 0.20  | 0.88  | 0.55±0.38     |
|                             | SR 3     | 0.16  | 0.35  |               |
|                             | SR 4     | 0.08  | 1.28  | 0.48±0.56     |
|                             | SR 5     | 0.05  | 1.28  | 0.60±0.56     |
| Discharge (m³s⁻¹)           | SR 1     | 0.007 | 0.368 | 0.172±0.148   |
|                             | SR 2     | 0.002 | 0.116 | 0.055±0.050   |
|                             | SR 3     | 0.006 | 0.031 |               |
|                             | SR 4     | 0.001 | 0.061 | 0.020±0.027   |
|                             | SR 5     | 0.002 | 0.100 | 0.033±0.046   |
| Conductivity (mScm⁻¹)       | SR 1     | 0.058 | 0.114 | 0.08±0.03     |
|                             | SR 2     | 0.058 | 0.122 | 0.09±0.03     |
|                             | SR 3     | 0.054 | 0.062 |               |
|                             | SR 4     | 0.069 | 0.185 | 0.13±0.06     |
|                             | SR 5     | 0.071 | 0.187 | 0.13±0.06     |
| pH                          | SR 1     | 7.68  | 8.57  |               |
|                             | SR 2     | 7.53  | 8.57  |               |
|                             | SR 3     | 7.62  | 8.57  |               |
|                             | SR 4     | 7.03  | 7.32  |               |
|                             | SR 5     | 7.27  | 7.61  |               |

*: * is group 1 and ** is group 2 (the mean difference within a group is not significant)
*: * and ** are significantly different
Table 3. Water quality of Batang Air Stream

| Parameters                | Batang Air |
|---------------------------|------------|
|                          | SBA 1      | SBA 2      | SBA 3      |
| Temperature (°C)          | 22.2–23.6  | 23.3–26.37 | 24.8–27.2  |
| Dissolved Oxygen (mgL⁻¹)  | 6.22–8.51  | 6.25–8.23  | 5.47–7.93  |
| Current (ms⁻¹)            | 0.22–0.28  | 0.19–0.88  | 0.20–0.76  |
| Discharge (m³s⁻¹)         | 0.010–0.106 | 0.005–0.072 | 0.016      |
| Turbidity (NTU)           | 3.79–19.8  | 39.5–44.2  | 13.2–28.9  |
| Conductivity (mScm⁻¹)     | 0.08–0.14  | 0.06–0.11  | 0.06–0.12  |
| pH                        | 8.14–8.48  | 7.47–8.23  | 7.98–8.13  |

Water temperature in the upper section of Ranggeh Stream (SR 1 and SR 2) was cooler with an average temperature of 21.46 and 23.57 °C, compared to temperatures in the lower section (SR 4 and SR 5) with an average temperature of 27.23 and 27.85 °C (α = 0.05). Ward [18] states that generally, the temperature in flowing water systems increases from upstream to downstream. A similar trend was also found in the Batang Air Stream, but the water temperature in the mouth of Batang Air was lower by the range of 24.8–27.2 °C. Riparian vegetation at this location is very shady, thereby reducing intensity of sunlight entering the water. Many factors affect water temperature characteristics, especially hydrological factors such as water sources, groundwater contributions, current, and discharge. However, other factors such as vegetation cover that affect direct exposure to sunlight also influence the temperature of flowing waters, especially in the tropics [18]. Also, the average of dissolved oxygen in the upper section of Ranggeh Stream was higher (8.09 and 7.84 mgL⁻¹) than in the lower part which was 6.08 mgL⁻¹ (α = 0.05). The same trend in the dissolved oxygen concentration was also found at Batang Air Stream. The conductivity values at all locations in the Ranggeh Stream were not significantly different (α = 0.05) with an average ranging from 0.08 to 0.13 mScm⁻¹, while the conductivity in Batang Stream ranged from 0.06 to 0.14 mScm⁻¹. Other parameters like current, discharge, and turbidity showed a high variance. Hence, statistical test was not conducted although the flow in the upstream of Ranggeh Stream tends to be higher. A high turbidity in Ranggeh Stream was recorded in June. Based on information from the local community, it was suspected that this was due to the activity of plowing the fields by farmers around the SR 3 station. However, this condition did not last long because the next day, the water visually appeared clear again.

3.2. Fish distribution

A total of 11 species were collected along Ranggeh Stream from upper to lower section and five species in Batang Air Stream as presented in table 4 below:

Table 4. Fish Distribution

| No | Family     | Species                          | Local name          | Conservation Status | Rangege 1 | Rangege 2 | Rangege 3 | Batang Air 1 | Batang Air 2 | Batang Air 3 |
|----|------------|----------------------------------|---------------------|---------------------|-----------|-----------|-----------|--------------|--------------|--------------|
| 1  | Aplocheilidae | Aplocheilus panchax           | LC                  | LC                  | √         |           |           |              |              |              |
| 2  | Balitoridae  | Homaloptera gymnogaster       | NE                  | LC                  | √         |           |           |              |              |              |
| 3  | Cichlidae    | Oreochromis niloticus          | LC                  | LC                  | √         |           |           |              |              |              |
| 4  | Cyprinidae   | Barbodes binotatus            | Supareh             | LC                  | √         |           |           |              |              |              |
No | Family | Species | Local name | Conservatio n Status | Ranggeh | Batang Air |
---|---|---|---|---|---|---|
5 | Osteochilus | vittatus | Asang | LC [22] | SR/1 | SBA/2 |
6 | Rasbora | maninjau | Bada | NE | SR/2 | SBA/2 |
7 | Tor sp. | | Gariang | | SR/3 | SBA/3 |
8 | Gobiidae | Gobiopterus | brachypterus | | | |
9 | Nemacheilidae | Nemacheilus | chrysolaimos | | | |
10 | Poeciliidae | Poecilia | reticulata | | | |
11 | Artificial hybrid | | | | | |

Subsequently, a t-test has been carried out to examine the length difference of the dominant species, *H. gymnogaster, N. chrysolaimos,* and *R. maninjau,* between the two streams. The results showed that at a 95% confidence level, the size of *H. gymnogaster* and *N. chrysolaimos* in the Ranggeh and Batang...
Air Stream was not significantly different, whereas the length of *R. maninjau* in Ranggeh Stream was substantially larger than in Batang Air Stream.

4. Discussion

The number of fish species found in the lower section of both Ranggeh and Batang Air Stream was higher than in the upper part. These results follow the earlier patterns summarized by Tejerina-Garro et al. [24] where the previous studies also showed that the species richness would be higher in the lower section compared to the upper part of running waters due to increase of habitat size, habitat diversity, or both. Furthermore, Das et al. [25] also summarized that the variety of fish species in a riverine ecosystem is determined by the interaction of many ecological variables such as hydrology, water quality, morphology, and others. The dominant factor determining the fish species richness will differ between ecosystems or locations. For example, fish diversity of rivers in India is determined by the surface area of the basin, the availability of habitat which is a function of discharge and sediment input [25]. Moreover, Suvarnaraksha et al. [26] also revealed that the pattern of fish distribution in the Ping-Wang River basin, Thailand is more determined by geomorphological parameters, especially altitude rather than physicochemical parameters.

Water quality parameters affect aquatic life either directly or indirectly, for example, the temperature. As stated by Dallas [27] that all aquatic organisms have an optimum temperature range that supports growth, reproduction, and fitness of biota. Rashid et al. [28] showed that the essential water quality parameters to the distribution of fish species in Sungai Pahang, Malaysia were pH, temperature, conductivity, and phosphate. According to EPA [29], range of pH for freshwater aquatic life is 6.5–9. Furthermore, the pH range which is not directly lethal to fish is 5 to 9 [30]. As summarized in [31] from Behar, the conductivity of most streams ranged between 50 to 1500 μScm⁻¹ and freshwater streams with conductivity 150 to 500 μScm⁻¹ are correctly supported various aquatic life. The Dissolved Oxygen ranged between 4 to 7 mgL⁻¹ is suitable for many aquatic animals, and 7 to 11 mgL⁻¹ is an optimal concentration for most stream fish. Thus, based on the values of some measured water quality parameters, Ranggeh and Batang Air streams ideally support the fish life.

Species richness found in the lower section of Ranggeh Stream is higher than in the lower section of Batang Air Stream. The larger size of the mouth of Ranggeh stream may contribute to the higher species richness, as stated earlier that the Batang Air Stream's flow has been divided into a small channel with a particular trap in place to catch bada.

Four species are in the Least Concern category of the IUCN Redlist, namely *A. panchax, O. niloticus, B. binotatus,* and *O. Vittatus* while one species is Data Deficient viz. *G. brachypterus.* Although they are widespread and the population is relatively stable as reported, some threats are found locally such as overfishing and habitat degradation. Therefore, monitoring of the fish population and further taxonomy study of some species are needed for wild population management. *Barbodes binotatus, O. vittatus,* and *Tor* sp. are commonly found in the lower section of inlets and lake waters of Maninjau and they are widely distributed in Indonesian freshwater [4, 10], while *H. gymnogaster* is a species which occupies minimal habitat, *Homaloptera gymnogaster* was only found in the upper habitat with cooler water temperature, higher dissolved oxygen, and relatively greater current. As reported by Lubis et al. [32] that this species is usually found in rocky forest streams with fast flow, high dissolved oxygen, water temperatures of 21°–25.5°C, and pH 6.5–7.5.

Most of the fish in these streams are native fish species. For management or conservation purposes, further study is needed to determine the most critical ecological parameters affecting the distribution of fish species in Lake Maninjau inlets, by examining more comprehensive parameters with more replications. *Homaloptera gymnogaster* lives in relatively pristine habitat and therefore it could be used as indicator species for upstream habitat in its distribution range. Based on the current results of this limited survey, we would recommend to protect the upper section of Ranggeh and Batang Air Stream because they are essential habitat for *H. gymnogaster.* *Homaloptera* is one of the Indonesian native fishes and some species within the genus have minimal geographical distribution. *Homaloptera gymnogaster* is a rare species and has been categorized as one of protected fishes by Government.
Ordinance of the Republic of Indonesia no. 7, 1999. Suwelo et al [33] have stated that *H. gymnogaster* is a rare species which lives in unprotected area in Maninjau and until today the habitat has not been conserved yet.

### 5. Conclusions

Eleven and five species of fish were collected along Ranggeh Stream and Batang Air stream, respectively. The number of fish found in the lower section of both streams was higher than in the upper part. *Homaloptera gymnogaster* is a rare species with a minimal distribution where only found in the top of both streams with lower water temperature, higher dissolved oxygen, and faster current. Conservation acts through stream restoration and protection are recommended mainly in the upper section of Ranggeh Stream due to its higher fish richness. Further bioecological study on *Homaloptera gymnogaster* is needed for the management of this species in the future.

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