Diversity of riparian vegetation to support the life of ihan (Tor spp. and Neolissochilus spp.) in Bonandolok River, North Sumatra

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Abstract. The variety of riparian vegetation to support the life of ihan (Tor sp.) in the Bonandolok River in North Sumatra was studied. Ihan is an endemic species in Bonandolok that has been considered in the red list of species by the International Union for Conservation of Nature and Natural Resources (IUCN). Since ihan is almost extinct in its natural habitat, a research that relate to their habitat became crucial. Riparian vegetation plays an essential role in keeping ecosystem balance. Degradation of the riparian area not only triggers sedimentation but also change the microhabitat. It is thus vital to know the relation between the riparian vegetation and ihan. This research was conducted in April 2019 through the survey method at four stations (St. 1 the upstream, St. 2 upstream-middle part, St. 3 middle-downstream part, and St. 4 the downstream). The survey recorded a total of 51 plant species within 31 families. Tithonia diversifolia A. Grey was found as the most abundant species during the study (136 individuals). Station 2 was the station with the most species (23 species), and station with the most abundance of riparian vegetations was station 3 (262 individuals). The result of this study calls for the critical consideration supporting the efficiently riparian vegetation conservation as a habitat and food source of ihan in Bonandolok River.

Keywords: Bonandolok, ihan, North Sumatra, riparian vegetation.

1. Introduction
In North Sumatra, fishes of genera Tor and Neolissochilus are known as ihan or ikan batak. They are in the same family but different in genus and species [1]. Both are rare native freshwater species and almost identical. Ihan has a potential as a medicinal and fish consumption in North Sumatra. It has historical, cultural, and economic meaning among Batak society since it is used for offering in various religious ceremonies [2, 3]. Both Tor and Neolissochilus have such a high price in local market and they have a steep price compared to the other fish. The price of ihan can reach Rp 300.000,- per kg in North Sumatra area [4]. Genus Tor has a thick meat, a good taste, and rich in fish oil, while some
people claim that Neolissochilus has a rougher texture than Tor. Because of the high price and good
taste, people widely trap ihan in its natural habitat.

Ihan commonly live in upstream area with slow to heavy currents. They dwell in clean water
consisted of rock and pebbles on the bottom. These fishes usually come to the surface to prey on
flying insects during the moonlight in which this is the moment for anglers to fish ihan. Based on the
information from residents who lives around Tulas River near Lake Toba, ihan usually eat grains that
fall from the jabi-jabi tree, a kind of banyan tree from Moraceae family and grasshoppers [4]. The food
sources of these fishes are derived from riparian vegetation, molluscs, insects and any other
microbenthic species [2,5].

The riparian zone is a transition area between the terrestrial and the aquatic ecosystems. Many
processes related to the surface and subsurface flow are controlled by riparian vegetation. Vegetation
structures may affect the runoff pathways [6]. Plant is a vital component in the riparian zone. Riparian
vegetation is generally composed of forest trees, shrubs, herbs, and grasses. It maintains biodiversity
and ecological balance and has a significant role as a habitat and food provider for animals [7]. Beside
that, vegetation serves as a sink and a source of matter and energy. As a sink, plant reduces the power
of flowing water while it keeps and absorbs the particles from upland areas. As a source, the
vegetation produces debris from leaves and woods that become allochthonous (organic matter inputs)
sources of energy [8, 9]. It is an essential energy resource for organisms. The loss of riparian
vegetation can increase sunlight and sediment load into the stream and change the microhabitat [8].

This research aimed to study the composition of riparian vegetation and determine its relationship
with ihan existence in Bonandolok. The result of this study are expected to provide latest riparian
vegetation data in Bonandolok for aquatic resources management planning.

2. Methods
This study was conducted in Bonandolok River (figure 1) in April 2019 by using a simply stratified
random sampling. The study sites are categorized (stratified) into four zones, which are station 1
(upstream) (2° 38’ 21.8904” N; 98° 36’ 34.7868” E), station 2 (upstream middle part) (2° 38’ 25.3932”
N; 98° 36’ 42.3972” E), station 3 (downstream middle part) (2° 38’ 32.0784” N; 98° 36’ 49.122” E),
and station 4 (downstream) (2° 38’ 42.9288” N; 98° 36’ 53.3232” E). The four locations in each zone
were selected according to their position and location.

![Figure 1. Bonandolok River and study location map (Source: RC Limnology internal data).](https://example.com/figure1.png)

Riparian vegetation data were collected from a line transect that set up in four stations using
purposive random sampling technique. In each station, 10 m line transects were installed along the
shoreline. Vegetation on either side of the transect line was recorded and photographed. In each station
we installed two transects. Thus, there were eight-line transects observed in four stations. Plant samples were preserved in 70% alcohol and dried in an oven at 70°C. Vegetation that is difficult to identify in the field was taken (the whole plant or some part of the plant) and brought into herbarium to be identified in the Research Center for Limnology or Research Center for Biology laboratories of the Indonesian Institute of Sciences (LIPI).

3. Results and Discussion
The result of this research consist of two findings: 1) the composition of riparian vegetation; 2) the amount of fish caught during the study. The total number of riparian vegetation in Bonandolok River was 50 species under 31 families. Compositae was the most abundant family.

Based on the result in Bonandolok, Compositae has seven species with 209 of total individual number from 917 total individual vegetation (table 1). The most abundant species from Compositae was kembang bulan or Mexican sunflower (*Tithonia diversifolia* A. Grey), with 136 individuals and it is found in all stations. Putri malu raksasa, namely giant sensitive tree (*Mimosa pigra* L.) was found in three locations, while rumput gajah or napier grass (*Pennisetum purpureum* Schumach) was found in two stations.

Compositae or Asteraceae family was the most abundant family with seven species during this study. The species from Compositae family that found in Bonandolok river were *Austroeupatorium inulifolium*, *Cosmos caudatus*, *Crassocephalum crepidiodes*, *Mikania micrantha*, *Sphaeranthus* sp., *T. diversifolia*, and one unidentified species. Compositae is not only the second-largest member among all of the vegetation in the world but also dominate the plant on Earth with more than 24,000-30,000 species spread almost all over the world and under every environmental condition [10]. In addition to that, it is believed that Compositae have a pseudoanthial heads with a specific pollen and pappus (a rudimentary sepals) structure, their fruit characteristics, and their range of chemical defenses. Compositae family also has a significant variability of morphology and anatomy of tissue composition of vegetative and generative structures [11].

| No | Family       | No | Species                                      | Total |
|----|--------------|----|---------------------------------------------|-------|
| 1  | Acanthaceae  | 1  | *Strobilanthes crispa* Blume               | 30    |
| 2  | Araceae      | 2  | Colocasia esculenta L.                     | 8     |
| 3  | Arecaleae    | 3  | *Arenga pinnata* (Wurmb) Merr.             | 4     |
| 4  | Aquifoliaceae| 4  | *Ilex cymosa* Blume                        | 1     |
| 5  | Capparaceae  | 5  | *Sieruela rutidosperma* (DC.) Roalson & J.C.Hall. | 1     |
| 6  | Caricaceae   | 6  | *Carica papaya* L.                         | 2     |
| 7  | Commelinaceae| 7  | *Commelina* sp.                            | 1     |
| 8  | Compositae   | 8  | *Austroeupatorium inulifolium* (Kunth) R. M. King & H. Rob. | 3     |
| 9  |              | 10 | *Cosmos caudatus* Kunth.                   | 45    |
| 11 |              | 11 | *Crassocephalum crepidiodes* (Benth.) S. Moore | 18    |
| 12 |              | 12 | *Mikania micrantha* Kunth.                 | 5     |
| 13 |              | 13 | *Sphaeranthus* sp.                         | 1     |
| 14 |              | 14 | *Tithonia diversifolia* A. Grey            | 136   |
| 9  | Convolvulaceae| 15 | *Ipomoea* sp.                              | 1     |
| 10 | Cyperaceae   | 16 | *Cyperus iria* L.                          | 1     |
| 11 | Davalliacae  | 17 | *Cyperus rotundus* L.                      | 50    |
| 12 | Dryopteridaceae| 18 | *Davallia solida* (G. Forst.) Sw.          | 1     |
| 13 |              | 19 | *Polystichum* sp.                          | 7     |
| No | Family          | No     | Species                                             | Total |
|----|----------------|--------|-----------------------------------------------------|-------|
| 13 | Elaeagnaceae   | 20     | *Elaeagnus* sp.                                     | 1     |
| 14 | Euphorbiaceae  | 21     | *Aleurites moluccanus* (L.) Willd.                  | 6     |
| 15 | Lamiaceae      | 22     | *Hyptis capitata* Jacq.                             | 3     |
| 16 | Leguminosae    | 23     | *Crotalaria pallida* Aiton                         | 30    |
|    |                | 24     | *Mimosa pigra* L.                                   | 1     |
|    |                | 25     | *Mimosa pudica* L.                                  | 10    |
| 17 | Malvaceae      | 26     | *Ceiba pentandra* (L.) Gaertn.                      | 1     |
|    |                | 27     | *Sida rhombifolia* L.                               | 5     |
|    |                | 28     | *Urena lobata* L.                                   | 1     |
| 18 | Meliaceae      | 29     | *Azadirachta indica* A. Juss                        | 1     |
|    |                | 30     | *Toona sinensis* (Juss.) M. Roem                    | 15    |
| 19 | Menispermacae  | 31     | *Pericampylus* sp.                                  | 3     |
| 20 | Moraceae       | 32     | *Artocarpus heterophyllus* Lamk.                    | 1     |
|    |                | 33     | *Ficus benjamina* L.                                | 5     |
| 21 | Musaceae       | 34     | *Musa* sp.                                         | 11    |
| 22 | Myrtaceae      | 35     | *Psidium guajava* L.                                | 1     |
| 23 | Orchidaceae    | 36     | *Spathoglottis* sp.                                | 1     |
| 24 | Piperaceae     | 37     | *Piper betle* L.                                    | 3     |
| 25 | Poaceae        | 38     | *Bothriochloa bladhii* (Retz.) S. T. Blake          | 70    |
|    |                | 39     | *Oplismenus compositus* (L.) P. Beauv.              | 51    |
|    |                | 40     | *Oryza sativa* L.                                   | 3     |
|    |                | 41     | *Pennisetum purpureum* Schumach.                    | 76    |
| 26 | Polipodiaceae  | 42     | -                                                   | 11    |
|    |                | 43     | -                                                   | 4     |
|    |                | 44     | -                                                   | 2     |
| 27 | Polygonaceae   | 45     | *Persicaria barbata* (L.) H. Hara                   | 15    |
| 28 | Pontederiaceae | 46     | *Eichhornia crassipes* (Mart.) Solms.               | 100   |
| 29 | Thelypteridaceae| 47    | *Amphineuron* sp.                                   | 16    |
| 30 | Verbenaceae    | 48     | *Lantana camara* L.                                 | 2     |
|    |                | 49     | *Stachytarpheta jamaicensis* (L.) Vahl.             | 65    |
| 31 | Zingiberaceae  | 50     | -                                                   | 9     |
|    |                |        | **Total**                                           | **919**|

Kembang bulan or mexican sunflower (*T. diversifolia*) (figure 2) is adaptable to live in 2-1,000 m above sea level and suitable to stay in less fertile land [12], as bushes or weeds in disturbed areas, abandoned and wastelands along the roadsides, mountain slopes, waterways and around farmland like the riparian area in Bonandolok. Most of riparian zones in Bonandolok were rice field areas, except at around station 1 (figure 2). *T. diversifolia* has a high biomass production, around 9-11 t/ha during dry season and 14-18 t/ha during wet season [13]. It even can produce biomass around 5.6-8.1 t/ha/year in twice pruning [12], so it is potential as a source of green manure, mulch, or compost to improve soil quality. It contains 3.50-4.00% N, 0.35-0.38% P, 3.50-4.10% K, 0.59% Ca, and 0.27% Mg [13].

Giant sensitive tree (*M. pigra*) is considered as an invasive woody weed that threat agriculture and wetlands areas around South East Asia and Australia [14, 15]. It is listed in the Global Invasive Species Database as one of the One Hundred of the World’s Worst Invasive Alien Species [16]. *M. pigra* reduce the biodiversity and impact negatively by competing with native species, deter mustering of livestock, and preventing water access for humans and cattle. It is also adaptable and formed dense understories in swamps, shade native tree seedlings, floodplain, swamps, shallow dams, dried riverbeds, riparian zones (banks of watercourses) and change the community.
Rumput gajah or napier grass (*P. purpureum*) is one of alternatives in forage since it has high productivity and quality [17]. Napier grass included in grass kind (Poaceae) family. It is a cosmopolitan plant and one of the pioneer vegetation that quickly grow and live in an open area with full tolerance to any environmental condition. As a pioneer plant, it can reproduce both in vegetative and generative ways [18]. Although it comes from tropical Africa, napier grass grows naturally throughout South East Asia, which has rainfall of more than 1,000 mm/year and does not has long summer period [17]. It is easy to find napier grass in Bonandolok since the area of Bonandolok has been dominated by rice field area so there are some open areas which have only a few canopy trees (figure 3).

![Figure 2. *T. diversifolia* and its habitat condition.](image)

The number of riparian vegetation recorded at station 3 was 262 individuals, which become the most abundant vegetation among four stations. Yet, station 3 has only 16 species, while station 2 has 23 species. However, station 2 was the station that has the least galore vegetation, with only 173 individuals (table 2). Station 3 is the confluence of two tributaries with medium current (3.25 m/s), 9.2
m in width, and 50.1 cm in depth average with many boulders. This area has many trees that make station 3 as the shadiest area of all stations. In station 3, there were two banyan trees (F. benyamina) which have a diameter around 2 cm and a member or neem tree (A. indica) which has a diameter around 41 cm. This station is also close enough to the villager's residential and rice field area, and it is only 362 m to the lakeshore. Based on sediment analysis data, sediments on station 3 was dominated by blackish white sands (98%), while clay and dust were only 1% each that indicate clear waters. It is also supported by measuring water quality data (table 3). Sand substrate also makes it easier for plant seeds or shoot to attach and grow among soils and sands.

Table 2. Station and Species Abundance.

| Station No. | Species                              | Amount |
|-------------|--------------------------------------|--------|
| 1           | Aleurites moluccanus (L.) Willd.      | 5      |
| 2           | Piper betle L.                        | 3      |
| 3           | Arenga pinnata (Wurmb) Merr.         | 4      |
| 4           |                                      | 10     |
| 5           | Amphineuron sp.                      | 15     |
| 6           | Davallia solida (G.Forst.)Sw.        | 1      |
| 7           | Polystichum sp.                      | 7      |
| 8           | Colocasia esculenta L.               | 5      |
| 9           | Tithonia diversifolia A. Grey        | 50     |
| 10          | Ficus benjamina L.                    | 3      |
| 11          | Musa sp.                             | 3      |
| 12          | Oplismenus compositus (L.) P.Beauv.   | 50     |
| 13          | Toona sinensis (Juss.) M.Roem         | 15     |
| 14          | Crassocephalum crepidiodes (Benth.) S. Moore | 10     |
| 15          | Mikania micrantha Kunth.             | 5      |
| 16          | Persicaria barbata (L.) H.Hara       | 15     |
| 17          | Strobilanthes crispa Blume           | 30     |
| 2           | Stachytarpheta jamaicensis (L.) Vahl. | 4      |
| 2           | Crassocephalum crepidiodes (Benth.) S. Moore | 5      |
| 3           | Colocasia esculenta L.               | 1      |
| 4           | Musa sp.                             | 8      |
| 5           | Aleurites moluccanus (L.) Willd.      | 1      |
| 6           | Artocarpus heterophyllus Lamk.       | 1      |
| 7           | Oplismenus compositus (L.) P. Beauv.  | 1      |
| 8           | Tithonia diversifolia A. Grey        | 50     |
| 9           | Crotalaria pallida Aiton             | 30     |
| 10          | Mimosa pigra L.                      | 2      |
| 11          | Ceiba pentandra (L.) Gaertn.         | 1      |
| 12          | Cyperus rotundus L.                  | 50     |
| 13          | Austroeuripatorium inulifolium (Kunth) R.M. King & H.Rob. | 3 |
| 14          | -                                    | 2      |
| 15          | Amphineuron sp.                      | 1      |
| Station No. | Species | Amount | Total |
|------------|---------|--------|-------|
| 16         | -       | 1      |       |
| 17         | *Lantana camara* L. | 2      |       |
| 18         | *Mimosa pudica* L.  | 5      |       |
| 19         | *Ilex cymosa* Blume | 1      |       |
| 20         | *Psidium guajava* L. | 1      |       |
| 21         | -       | 1      |       |
| 22         | *Spathoglottis* sp. | 1      |       |
| 23         | *Elaeagnus* sp.     | 1      |       |

Station 3 has both shades and open areas. The shades area were dominated by some species of shrubs such as kenikir or wild cosmos (*C. caudatus*), mexican sunflower, and giant sensitive tree; and canopy trees such as banyan and neem, while the open area were dominated by some species of
grasses such as forest blue-grass (*B. bladhii*) and napier grass. The grass may appear as dominant vegetation in the area getting high sunlight penetration [19].

Station 1 was the inlet of Bonandolok River, 950 m distance to the shore of Lake Toba, and naturally conserved by the villagers who believe that the upstream part of the Bonandolok river is a sacred place so that they protect that area. Some regulations are obeyed by people, such as throwing garbage is forbidden in the water; fishing at the specific time and asking permission to the spirit through a ceremony which made the fishing process difficult to be done. There was an urban legend among the villagers that sacred the upstream area of Bonandolok river so they must take care of it. It makes station 1 is still intact and has magnificent natural scenery.

In contrast, station 4 was the outlet of Bonandolok River and the closest area to villager residencies and rice fields and is located on the shore of Lake Toba. It has the least abundant species (only 14 species). However, it has 253 individuals of vegetations, which means this area is fertile enough for plants to grow.

| No. | Parameters                          | Station 1 | Station 2 | Station 3 | Station 4 |
|-----|------------------------------------|-----------|-----------|-----------|-----------|
| 1.  | Temperature (°C)                   | 20.3      | 21.3      | 21.9      | 29        |
| 2.  | Watercolor                         | Brownish, clear | Brownish, clear | Brownish, clear | Brownish, clear and there were some algae populations |
| 3.  | Dissolved Oxygen (DO) (mg/L)       | 8.61      | 8.34      | 8.43      | 7.2       |
| 4.  | Conductivity (mS/cm)               | 0.023     | 0.025     | 0.023     | 0.1518    |
| 5.  | Total Dissolved Solid (TDS) (mg/L) | 16.25     | 16.9      | 16.7375   | 91.46     |
| 6.  | Salinity (ppt)                     | 0.01      | 0.01      | 0.01      | 0.062     |
| 7.  | pH                                 | 6.9       | 6.8       | 6.7       | 8.2       |
| 8.  | ORP (mV)                           | 47        | 56        | 60.9      | 45.7      |

According to Larashati *et al* [20], ihan species obtained from Bonan Dolok River consist of *Neolissochilus sumatranus* and *Tor douronensis* (figure 4). The two genera are omnivores and usually eat plant matter, fallen fruits from riparian vegetation, and insects [5, 21]. Moreover, *Neolissochilus* and *Tor* favor eating forest fruits and seeds such as from *Dysoxylon angustifolium*, *Aglaia saicifolia*, and *Parkia javanica*. The anglers usually use one of them as the bait for Neolissochilus or Tor. The gut contents of *N. soroides* of Gombak River in Malaysia showed unidentified plant material, insects, crustacea [22].

This study was not included about ihan’s gut content analysis, so the food habits of ihan in Bonandolok River have not been determined. Some of the riparian vegetation could function as the
primary source of food or shelter since some roots of big trees can grow through the soil and appear on the bottom of the river.

![Figure 4. A: Neolissochilus sumatranus; B: Tor douronensis.](image)

### 4. Conclusion
Bonandolok river has 50 riparian vegetation species within 31 families. Compositae is the family found as the most abundant. One of the Compositae species is *T. diversifolia* with 136 individuals. Station 3 was the station with the highest vegetation population (262 individuals), while the station with the highest number of vegetation species was station 2 (23 species). Further analysis like gut content, food web study, and habitat assessment are required in the next research.

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