



The Contribution of the Biota Diversity of Lake Toba to Indonesia's Biota Wealth

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Abstract: This study aims to analyze the contribution of the diversity of biota in the waters of Toba Lake to the richness of Indonesia's biota. Research is needed to analyze the diversity of Lake Toba water biota. In order to achieve this goal, data and information collected regarding the contribution of the diversity of Lake Toba waters to the richness of Indonesia's biota is used. Verification of the data and information obtained was carried out through literature study, document analysis, interviews and filling out questionnaires. The results showed that in the waters of the lake there are endemic fish species whose existence is currently almost extinct, namely Batak fish or "ihan" (*Neolissochillus thienemanni*) consisting of two species, namely: *Lissochilus sumatranus* and *Labeobarbus soro*. There are various types of aquatic plants such as various types of algae and water hyacinth. Apart from that, there are also various species of molluscs such as freshwater snails and clams as well as other aquatic animals such as frogs and eels. The aquatic biota of Lake Toba has an important role in maintaining the balance of the ecosystem and providing resources for the people around the lake and contributing to Indonesia's Biota Wealth.

Keywords: Aquatic Ecosystem; Biota Diversity; Indonesian Biotas; Lake Toba

Introduction

Lake Toba is the largest volcanic lake in Indonesia and also one of the largest lakes in the world. Located in the province of North Sumatra, this lake has a rich and unique diversity of aquatic biota (Sibarani, 2020). Here are some examples of aquatic biota that can be found in Lake Toba as much as Sigarantung fish (Tor tambra); Batak fish (*Osteochilus melanopleura*); Goldfish (*Cyprinus carpio*) (Murwantoko, 2009; Andriyono & Fitrani, 2021); Tilapia (*Oreochromis niloticus*) (Harahap & Humaizi, 2018; Marisa, Syahni, Hadiguna, & Nofialdi, 2023); Freshwater Shrimp (*Macrobrachium rosenbergii*) (Mayasari, Said, & Astuti, 2022). Apart from that, there are also various species of molluscs such as freshwater snails and clams as well as other aquatic animals such as frogs and eels.

The aquatic biota of Lake Toba has an important role in maintaining the balance of the ecosystem and providing resources for the people around the lake

(Latifah, Purwoko, Rambey, & Tarigan, 2018; Nurlaeni, Iskandar, & Junaedi, 2021), including as a source of protein and fishermen's livelihoods. It is important to preserve the lake and its aquatic ecosystems in order to ensure the sustainability of the diversity of Lake Toba's aquatic biota.

Diversity of lake water biota refers to the diversity of species of organisms that live in lake water ecosystems (Lindholm, Alahuhta, Heino, & Toivonen, 2020). Lake is a body of water that forms in a basin and generally has flowing or stagnant water (Yamazaki et al., 2019; Deemer, Stets, & Yackulic, 2020; Palacios-Fest, Duke, Young, Kirk, & Oviatt, 2022). The diversity of lake water biota is very important because it reflects the level of health of the lake ecosystem (Liew et al., 2020; Satya, Sulawesty, Yustiwati, & Widiyanto, 2020; Purba & Nurhayati, 2022). The following are several factors that affect the diversity of lake water biota:

The diversity of lake water biota is important to maintain the balance of lake ecosystems and provide

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economic and ecological benefits for humans (Usman, Zahri Harun, & AR Murniati, 2016). Good conservation and management efforts are needed to protect and maintain the diversity of lake biota in order to maintain the sustainability of the lake ecosystem and human welfare (Sihombing, Karlina, Garsetiasih, Rianti, & Sawitri, 2022).

The increasing pace of development, accompanied by the very fast increase in world population, has created various negative impacts on natural resources and the environment. Water ecosystems which are part of natural resources are also not immune from all the negative impacts caused by increased human activity in exploiting these natural resources and the environment. Many people think that the supply of fresh water on this planet is unlimited, and use water as if it will never run out. As we all know that approximately three-quarters of the earth's surface is covered with water. In terms of ecosystem, we can distinguish fresh water, sea water, and brackish water. Of the three aquatic ecosystems, seawater and brackish water are the largest, which is more than 97%.

The total amount of water found on planet Earth is about 1.4 billion cubic kilometers. Of this amount, the volume of fresh water is only around 36 million cubic kilometers or only about 2.6%. Most of the volume of fresh water is in the form of polar ice, glaciers in the mountains, groundwater and water in the atmosphere, so that from the calculations of experts there is only around 34,000 cubic kilometers available which can be utilized directly by humans and other living things. All water on earth is contained in a hydrologic cycle, which is a process of circulating water from the earth to the atmosphere and vice versa.

When compared to terrestrial and marine ecosystems, the area of freshwater ecosystems, such as rivers and lakes, is very small. But this small ecosystem is the habitat for most of the species that exist on earth. In freshwater ecosystems live 10% more species when compared to those found on land. As much as 12% of all fauna found on earth, including 41% of all identified fish species, live in freshwater ecosystems which cover only about 1% of the total surface area of the earth.

An equally important potential hazard that threatens native species in the Lake Toba ecosystem is the entry of newcomer species which are referred to as exotic species, either intentionally or unintentionally. Although introduced species are not the result of pollution, these exotic species can be classified as pollutants that threaten the life of native species. It often happens that exotic species prey on native species or compete with native species for food and places to breed. It may even happen that an exotic species introduces a new disease that could endanger all life in that aquatic ecosystem. Fish that are supplied

unnaturally in Lake Toba can increase the species and population of fish, but because these fish are not part of a food chain that has been formed naturally for a long time, the life of fish and other biota in the lake is disrupted.

The loss of Batak fish from the waters of Lake Toba can occur as a result of changes in various environmental factors or also as a result of the intervention of many fish that are introduced into the lake. Another danger that needs to be considered is that the pollution of Lake Toba since the community started cultivating fish in floating net cages (*Keramba Jaring Apung, Kejagung*). When corn maize was only owned by local people, pollution was not much heard, but when companies and large-scale floating net cage entrepreneurs entered, it began to be seen how dangerous corn cultivation is if it exceeds the carrying capacity of the environment. The terrible danger of corn is the eutrophication of the lake. Fertilization occurs due to the remains of the feed. The remains of the feed serve as fertilizer which is a source of food for plants in Lake Toba.

The enrichment of the lake causes phytoplankton to grow uncontrollably (blooming). When there is blooming plankton, then when the plankton dies it undergoes a process of decay. This decomposition process requires oxygen. Because the plankton decomposition process requires oxygen, there is competition for oxygen between the decomposition of plankton and the need for oxygen with the fish in the lake. No wonder, if all of a sudden many fish die.

So, if there is an interview with the Head of the Fisheries Service in the media, those who do not have a background in fisheries or biology often indiscriminately mention the causes of the sudden death of large numbers of fish. The impact of the presence of corn that exceeds the carrying capacity besides causing blooming is the booming of water hyacinth plants (*Eicornia* sp) and moss plants. According to my observations around Lake Toba, fishermen say when they throw their nets into the lake the nets float on the moss. That is one proof of the uncontrolled growth of moss plants in Lake Toba. If this is not resolved, then there is a possibility that ships passing through Lake Toba will get stuck in moss. Indeed, the growth of this moss can also be caused by the ecosystem of Lake Toba which has been damaged. Therefore, this study aims to analyze the contribution of the diversity of biota in the waters of Lake Toba to the richness of Indonesia's biota.

Method

The implementation of the research was carried out through the study of scientific data and information related to the Contribution of the Biota Diversity of Lake Toba to Indonesia's Biota Wealth. The data and

information collected is the Contribution of Biota Diversity in the Lake Toba Waters to Indonesia's Biota Wealth. Verification of the data and information obtained was carried out through literature study, document analysis, interviews and filling out questionnaires. Interviews were conducted based on a list of questions for filling out the questionnaire. The selection of respondents was carried out using a purposive sample selection method. The selection of respondents was based on the consideration that respondents understood the Contribution of Lake Toba's Aquatic Biota Diversity to Indonesia's Biota Wealth. The data and information obtained were compiled and synthesized descriptively. The results of the synthesis were discussed with several experts according to their areas of expertise through meetings and discussions. In addition, the utilization of the results of previous research both in journals and books greatly supports researchers in their efforts to analyze the Contribution of Lake Toba's Aquatic Biota Diversity to Indonesia's Biota Wealth.

The research procedures are presented as follows:



Figure 1. Research Procedure

Result and Discussion

Lake Toba Biota Diversity

1. Phytoplankton

The size of plankton organisms is microscopic and lives floating in the waters and has a weak ability to move and is influenced by the movement of water masses. Generally, this microscopic plankton consists of plants and animals. The group of plants is called phytoplankton and the group of animals is called zooplankton (Odum EP 1996). The classification of plankton is generally based on 3 parts, the first part is based on size called netplankton, the second part is based on its habitat, namely haliplankton and limnoplankton, and the third part is based on the life cycle, namely holoplankton and meroplankton. By (JS 1982) classified plankton based on their size, namely ultraplankton (<2 μ m), nanoplankton (2-20 μ m), microplankton (20-200 μ m), macroplankton (0.2-2mm), and megaplankton (>2mm). Phytoplankton is an aquatic biota that plays an important role in maintaining a balanced inland water ecosystem.

Phytoplankton are organisms that are able to photosynthesize, so that they become primary producers which play an important role in influencing

water productivity. Thus, sustainable management of aquatic resources requires a more accurate evaluation of the condition of abundance and productivity of phytoplankton. To measure the productivity of phytoplankton can be done by measuring the chlorophyll content and the abundance of cells.

Although these two measurements cannot fully represent the condition of the level of productivity of phytoplankton (Chrissada T 2011). Phytoplankton in freshwater ecosystems are primary producers, which make them food for other ecosystems such as fish. The condition of this phytoplankton is the basis for the level of the food chain which is able to neutralize the health of the aquatic environment. Any disruption to phytoplankton will affect other aquatic communities. Water quality greatly determines the composition of phytoplankton, therefore there are certain algae that function as a measure of water eutrophication.

The acidity factor (pH) of the waters will affect the abundance of phytoplankton. The general composition of phytoplankton is divided into diatoms (class Bacillariophyceae), dinoflagellates, coccolithopore and other golden brown algae (class Heptophyceae), blue green algae (class cyanophyceae also called cyanobacteria), green algae (class chlorophyceae) and Flagellata Cryptomonas (class Cryptophyceae) (JS 1982). The different body sizes and cell shapes of the phytoplankton result in a varied composition of the phytoplankton and can be used as an identifier for the state of a particular aquatic environment. Arteaga, Boss, Behrenfeld, Westberry, & Sarmiento (2020) explained that changes in water conditions caused by changing seasons and conditions for the availability of nutrients can cause variations in the rate of division of phytoplankton. This results in differences in primary productivity between geographic areas with one another. In addition, Baggio, Chavas, Di Falco, Hertig, & Pomati (2020) describes that natural factors and anthropogenic conditions affect environmental factors which in turn have an impact on the abundance of phytoplankton and the turnover of phytoplankton in the waters. There is a relationship between phytoplankton diversity and water quality, where alkalinity and dissolved organic matter (BOT) affect phytoplankton diversity (Amorim & Moura, 2021).

2. Fish

Based on various publications, there were 18 recorded fish communities in Lake Toba (Soerjani, M. et al. n.d.), while 13 species were found (Kartamihardja and Sarnita 2008a) and several new introduced fish (Table 1.6). Introduced species such as tilapia and goldfish were introduced to Lake Toba in 1940 and 1937 respectively. Currently, the most abundant fish is bilih fish, which is an introduced fish and comes from Lake

Singkarak. This fish was first stocked in 2003 by the Ministry of Maritime Affairs and Fisheries. This introduction was carried out as an effort to restore fish populations due to a crisis in native fish populations, such as a decrease in the abundance of pora-pora fish (*Puntius binotatus*) as a result of decreasing environmental quality and the biological impact of stocking other introduced fish such as tilapia.

The fish species *Neolissochilus* (*Lissochilus*) *thienemanni* (Figure 1.14) is known to only be found in Lake Toba (Kottelat, A.J. Whitten, and S. Wirjoatmodjo

1993). Thus, this fish is an endemic fish, but its existence is unknown. According to (Suwelo, Supangat, and C. Yunita 1986), the fish species *Lissochilus* sp., is a rare fish that is only found in Lake Toba. The author suspects that there is a possibility that this species of *N. thienemanni* is a Batak fish or what is known to the public as *ihan*. However, based on information (Kottelat et al. 1993) the important value fish for the Batak people for traditional ceremonies is *Tor* (*Labeobarbus*) *soro* which is also found in sacred ponds in Kuningan, West Java.

Tabel 1. Distribution of Endemic and Rare Fish Species in Lake Toba

Local Name	Latin name	Soerjani et al 1979	Kartamihardja, 1987
Mujair, Jahir	<i>Oreochromis mossambicus</i>	+	+
Mas	<i>Cyprinus carpio</i>	+	+
Lele, Sibahut	<i>Clarias batrachus</i>	+	+
	<i>C. nieuhofi</i>	+	-
Batak, Jurung, Ihan*	<i>Labeobarbus soro</i>	+	-
	<i>Neolissochilus thienemanni</i>	-	-
Bulan-bulan, Asak	<i>Osteochillus hasselti</i>	+	+
Pora-pora, undalap	<i>Puntius binotatus</i>	+	+
Paitan	<i>P. gonionotus</i>	-	+
	<i>P. javanicus</i>	+	-
Harunting	<i>Ophiocephalus striatus</i>	+	+
	<i>O. micropeltes</i>	-	+
Itok	<i>Channa gachua</i>	+	-
Kalui	<i>Osphronemus goramy</i>	+	+
Sepat	<i>Trichogaster trichopterus</i>	+	+
Insor	<i>Nemachilus fasciatus</i>	+	+
Siburicak; Mangiring	<i>Rasbora jacobsoni</i>	+	+
Ikan bunting	<i>Lebistes reticulatus</i>	+	+
Kepala timah	<i>Aplocheilus panchax</i>	+	-
Nila [c]	<i>Oreochromis niloticus</i>	-	-
Bilih [d]	<i>Mystacoleucus padangensis</i>	-	-
Betutu [e]	<i>Oxyeleotris marmorata</i>	-	-



Figure 1. Fish *Neolissochilus Thienemanni*

Plant Based on observations (Kartamihardja 1987) there are 14 types of aquatic plants found in the waters of Lake Toba, consisting of sinking types with roots at the bottom, sticking roots at the bottom, and floating types (Table 2).

Table 2. The types of aquatic plants found in the waters of Lake Toba

Genus	Sifat
<i>Potamogeton</i>	tenggelam, berakar di dasar
<i>Myriophyllum</i>	tenggelam, berakar di dasar
<i>Najas</i>	tenggelam, berakar di dasar
<i>Ceratophyllum</i>	tenggelam, berakar di dasar
<i>Utricularia</i>	tenggelam, berakar di dasar
<i>Hydrilla</i>	tenggelam, berakar di dasar
<i>Nitella</i>	tenggelam, berakar di dasar
<i>Chara</i>	tenggelam, berakar di dasar
<i>Nymphaea</i>	mencuat, berakar di dasar
<i>Nelumbium</i>	mencuat, berakar di dasar
<i>Eichornia</i>	mengapung
<i>Azolla</i>	mengapung
<i>Lemna</i>	mengapung
<i>Spirodella</i>	mengapung

Phytoplankton is an organism that has an important role in the waters because it has chlorophyll which can help the process of photosynthesis. Water

products that act as consumers such as zooplankton followed by other aquatic organisms form a food chain (Barus 2004). Phytoplankton can be found in fresh and marine waters. Phytoplankton are found in waters with high nutrient content (nitrate and phosphate). High nutrient content is influenced by various human activities around water bodies which can produce waste.

Lake Toba is a water area that is widely used by the local community for various needs, such as fish farming, docks, agriculture, water tourism. The activities carried out by the people living around and on Lake Toba can affect the quality of the water in Lake Toba and in turn affect the life of the phytoplankton contained in it, both in terms of the number of species and their abundance. In this regard, the diversity and abundance of phytoplankton can directly or indirectly indicate the quality of water in Lake Toba. Phytoplankton from the Chlorophyta phylum in the Chlorophyceae class and the Bacillariophyta phylum in the Bacillariophyceae class dominate the number of phytoplankton species. Classes Chlorophyceae and Bacillariophyceae are classes of phytoplankton that are able to adapt to a photosynthetic environment in the form of oxygen and carbohydrates, which are the main source of nutrition for groups of organisms quickly, have varied types and can carry out rapid reproduction processes. According to (Odum 1998), the Bacillariophyceae (Diatom) class has good adaptability to the environment so that it can survive extreme environmental conditions, is cosmopolitan, and has high reproductive power. (Nybakken 2005) stated that the phytoplankton from the Bacillariophyceae (Diatom) class had a very fast response to the addition of nutrients in the waters. Furthermore (Praseno and Sugestingsih 2000) added that the response shown by this organism when there is an increase in nutrient concentrations in a waters is that it will carry out the reproductive process three times in 24 hours.

Conclusion

As the largest lake in Indonesia which is located on the northern part of Sumatra Island and the Bukit Barisan mountains with an altitude of 905 above sea level, Lake Toba is called the second deepest lake in the world after Lake Victoria in Africa and the largest in Southeast Asia with an area of 1,124 km², volume of water 256.2x10⁹ m³, and a depth of ± 450 m and an average depth of 228 m (Lukman and Ridwansyah 2010), the length of the lake is 100 km and the width of the lake is 30 km. In the middle of the lake there is an island formed from a volcanic earthquake named Samosir Island which has an area of 1,145 km² which is almost the same area as Singapore. Lake Toba became the 10 priority tourism destinations determined based on

Cabinet Secretariat Letter Number B652/Seskab/Maritim/2015 dated 6 November 2015. In the waters of this lake there are various types of fish, both endemic (native) fish and fish introduced to these waters which are cultivation products (stocking, kertamba and floating nets). The type of fish which is an endemic fish whose existence is currently almost extinct is the Batak fish or "ihan" (*Neolissochillus thienemanni*) consisting of two species, namely: *Lissochilus sumatranus* and *Labeobarbus soro*. This type of fish is based on the criteria of the IUCN (International Union for the Conservation of Nature) have been classified as endangered (endangered). This type of fish was once often served as a special dish for various traditional party events for the local community, but now it is very difficult for people living around the lake to found the fish. In the waters of this lake there is also an endemic mussel known as Toba Remis (*Corbicula tobae*). While various other types of fish that are natural or cultivated which are not endemic, for example are carp, mujair, tilapia, tawes, catfish, cork and so on. From several research results in Lake Toba, 14 species of fish were found, of which the most frequently found are mujahir fish (*Tilapia mossambica*), tin head fish (*Aplocheilus panchax*), thousand fish (*Lebistes reticulates*), gourami fish (*Osphronemus goramy*), Sepat fish (*Trichogaster trichopterus*), snakehead fish (*Channa striata*), catfish (*Clarias batrachus*), goldfish (*Cyprinus carpio*), and tilapia. In the waters of Lake Toba there are also various types of aquatic plants such as various types of algae and water hyacinth. The existence of this water hyacinth plant is currently very worrying in terms of its development, growth and spread. The total surface area of the lake covered with water hyacinth has reached 381.8 hectares, covering approximately 23 sub-districts in three districts namely North Tapanuli, Toba Samosir and Simalungun. The most severe conditions are in the waters of the lake which is included in the Simalungun district. Apart from that, there are also various species of molluscs such as freshwater snails and clams as well as other aquatic animals such as frogs and eels. The aquatic biota of Lake Toba has an important role in maintaining the balance of the ecosystem and providing resources for the people around the lake, including as a source of protein and fishermen's livelihoods. It is important to preserve the lake and its aquatic ecosystems in order to ensure the sustainability of the diversity of Lake Toba's aquatic biota. Diversity of lake water biota refers to the diversity of species of organisms that live in lake water ecosystems.

Author Contributions

Purba, I.R.: is responsible for envisioning, developing, collecting, and analyzing data, as well as writing publications.
Nurhayati.: data gathering, analysis, and paper editing.

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Conflicts of Interest

The authors declare no conflict of interest.

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