

Study of Spermatophyte Diversity and Ethnobotany Potential in Buret Lake Tulungagung

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Abstract

Buret Lake is widely known as a tourist area and an environmental conservation park that has several types of animals and plants. Information about the diversity of Spermatophyte plants and their ethnobotany potency are not widely known. The research aims to reveal the Spermatophyte diversity, environmental conditions and ethnobotany potency in Buret Lake. The type of research is descriptive exploratory. The study was conducted in May until June 2024. The methods of this research were exploration, census and literature study. The data were collected by observation, identification and documentation. The results showed that the diversity of Spermatophyte was high with a total number of 147 species belong to 49 families were recorded. The environmental conditions range at air velocity 0.1 m/s, air temperature 28.6°C, soil temperature 28.6°C, and air humidity 84.2%. The ethnobotany potency of Spermatophyte were known to be used as food (44 species), traditional medicine (82 species), building materials (18 species), fiber and craft materials (8 species), firewood (9 species), animal feed (9 species), toxic materials (5 species) and ornamental plants (12 species). Information of Spermatophyte diversity will be very useful for the preservation of biodiversity and development of ethnobotany potency in the future.

Keywords: Buret Lake; Diversity; Ethnobotany; Spermatophyte

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INTRODUCTION

Indonesia Indonesia is a country with exceptionally high and diverse biological diversity. According to Retnowati and Rugayah (2019), Indonesia is home to approximately 31,750 plant species, making it one of the countries with the highest plant diversity in the world. These plant species grow in various habitats, both on land and in water. In Indonesia, flora can be found growing naturally in forests, mountains, hills, and around springs and lakes. This wealth of biodiversity further solidifies Indonesia's position as one of the countries with the highest biodiversity in the world (National Geographic Indonesia, 2019).

One example of Indonesia's biodiversity is the Buret Lake area. Buret Lake is an ecotourism site located in Buret Hamlet, Sawo Village, Campurdarat Subdistrict, Tulungagung Regency. Buret Lake has a total area of approximately 22.5 hectares, which includes 1.9 hectares of land, hills, cliffs, and the lake itself. The diameter of Buret Lake reaches 75 meters and is surrounded by dense forests with various types of vegetation (Ardiani, 2018). The lake is surrounded by diverse vegetation that forms a critical habitat for various species of wildlife. Therefore, Buret Lake serves as an important natural conservation area for flora and fauna. One of the most prominent animals in this area is the long-tailed macaque (*Macaca fascicularis*). According to Kartikasari *et al.* (2024), the long-tailed macaque population at Lake Buret numbers approximately 400 individuals spread across four areas, utilizing the surrounding vegetation as their primary food source.

According to research conducted by Pertiwi (2019), the formation of Lake Buret began with the efforts of Eyang Djigangdjaya, the figure who initiated the creation of Lake Buret, who held a ceremony to ward off disasters in Campurdarat District at that time. The ceremony resulted in a spring that continuously flows from the ground, eventually forming a lake. To this day, the ceremony is still

performed by the communities around Lake Buret and is known as Ulur-Ulur. In the Lake Buret area, there are several local beliefs that are still practiced today, and these beliefs help preserve biodiversity and the integrity of the ecosystem. Ecologically, ecotourism areas like Lake Buret play a crucial role in maintaining ecological balance. However, scientific documentation regarding plant diversity in small-scale ecotourism areas such as Lake Buret remains limited.

Geologically, Lake Buret is located in an area adjacent to limestone mountains. These conditions influence the spring water flowing from Lake Buret as well as the rock formations along the lake's shores, which have a high limestone content, giving them a yellowish hue. Nevertheless, the vegetation in the Lake Buret area appears to thrive. This vegetation serves as both a food source and a natural habitat for the fauna living around the lake, one of which is a troop of long-tailed macaques that have become an icon of the Lake Buret tourist area (Kartikasari *et al.*, 2024).

The abundance of vegetation in the Lake Buret area also serves to enhance the aesthetic value of the ecosystem landscape. Ecologically, natural vegetation plays several important roles, such as maintaining ecosystem stability through the hydrological system, minimizing soil erosion, and protecting the soil surface from the direct impact of rainfall. Dense vegetation growth can also help improve water infiltration and provide biodiversity as habitat and food sources for wildlife (Natan *et al.*, 2024). Plants conservation also contributes to maintaining environmental quality by producing clean air, supporting plant pollination processes, and preserving the natural habitats of various organisms. Thus, well-maintained vegetation can help mitigate the effects of climate change and reduce the risk of natural disasters. Therefore, the conservation of plant species in the Lake Buret area is crucial to maintaining ecosystem balance and the long-term sustainability of the ecotourism area.

One strategic effort in conservation involves conducting an inventory of plant species at Lake Buret. Currently, information regarding plant species at Lake Buret remains limited. Furthermore, there has been no comprehensive research specifically documenting the diversity of Spermatophyta and their utilization. Therefore, research on the diversity of Spermatophyta at Lake Buret is necessary to update and expand scientific information that can benefit both scientific advancement and the local community. Amboupe *et al.* (2019) state that ethnobotanical studies are important to enrich knowledge regarding the utilization of plant species and to provide information that can support communities in meeting their food, health, and daily living needs. Thus, this study aims to determine the diversity of Spermatophyta, environmental conditions, and ethnobotanical potential in the Lake Buret area.

MATERIALS AND METHODS

This study was conducted from May to June 2024 in the Lake Buret area, Sawo Village, Campurdarat Subdistrict, Tulungagung Regency, Indonesia (Figure 1), at coordinates 8°12'26"S and 111°50'16"E. This is a descriptive study, employing free-roaming, census, and literature review methods. Research data were collected through observation, identification, inventory, literature review, and documentation.

The free-roaming method involved traversing the Lake Buret area, which had been divided into stations (Figure 2), followed by recording all Spermatophyta species found at the study site. Each plant species encountered was documented and recorded using a tally sheet. Observations and documentation focused on the morphological characteristics of the plants, including leaves, stems, roots, flowers, and fruits, to support the species identification process.

Several measurements of abiotic factors were conducted to support the research activities. A soil tester (Ituin brand) was used to measure soil conditions, specifically soil pH, while a hygrometer was used to measure air humidity and air velocity. A Garmin eTrex 30x Global Positioning System (GPS) was used to determine the geographic coordinates of the research location. A smartphone camera was used to document plant species.

The identification process for Spermatophyta plants involved morphological observation of the species, referencing standard identification keys and relevant botanical literature. The identified species were then recorded and classified based on their taxonomic characteristics. If certain species were difficult to identify in the field, further identification was conducted at the Biology Laboratory of the Biology Education Program, Sayyid Ali Rahmatullah State Islamic University, Tulungagung.

The identified plant species were then organized into tables and described based on their morphological characteristics, taxonomic classification, and ethnobotanical uses. The research results are then presented in the form of tables and descriptive narratives to illustrate the diversity of Spermatophyta in the Buret Lake area.



Figure 1. Map of Buret Lake study area (modified from Google Earth, 2024)



Figure 2. Research stations at Buret Lake; 1) Location monument at the front entrance, 2) Lake water area, 3) Vegetation area, 4) Lake water area, 5) *Macaca fascicularis* habitat area, and 6) Vegetation area.

RESULTS

The results of the inventory conducted during the study showed that 147 species of Spermatophyta were recorded in the Buret Lake area, belonging to 108 genera and 49 families. The highest number of species was found in the families Fabaceae (15 species), Malvaceae (12 species), Moraceae (11 species), Euphorbiaceae (9 species), and Zingiberaceae (7 species). This indicates that these families have good adaptability to the environmental conditions in the Buret Lake ecosystem. Based on their life forms (habitus), the recorded plant species consisted of 76 tree species (51.7%), 24 shrub species (16.3%), 24 herb species (16.3%), 11 climber (liana) species (7.5%), 6 grass species (4.1%), and 6 palm species (4.1%). Of the 147 Spermatophyta species recorded in the Buret Lake area, 96 species (65.3%) were native species, 38 species (25.9%) were exotic species, and 13 species (8.8%) were classified as invasive species. The complete data is presented in Table 1. Detailed species data are available in the supplementary material.

Environmental conditions around Buret Lake, researchers tested abiotic factors including air velocity, air temperature, soil pH, and humidity (Table 2). From these measurements, the air speed was 0.1 m/s, air temperature was 28.6°C, soil pH was 7, and humidity was 84.2% (Table 2).

Table 1. Summary of spermatophyta diversity, family composition, life forms, and species status in the Buret lake

Category	Description	Total Species	Percentage	Category	Description	Total Species	Percentage
Families	Fabaceae	15	10.2%	Families	Burseraceae	1	0.7%
	Malvaceae	12	8.2%		Capparaceae	1	0.7%
	Moraceae	11	7.5%		Caricaceae	1	0.7%
	Euphorbiaceae	9	6.1%		Clusiaceae	1	0.7%
	Zingiberaceae	7	4.8%		Cycadaceae	1	0.7%
	Araceae	6	4.1%		Dioscoreaceae	1	0.7%
	Poaceae	6	4.1%		Elaeocarpaceae	1	0.7%
	Arecaceae	5	3.4%		Gnetaceae	1	0.7%
	Asteraceae	5	3.4%		Laxmanniaceae	1	0.7%
	Myrtaceae	5	3.4%		Lecythidaceae	1	0.7%
Families	Phyllanthaceae	5	3.4%	Magnoliaceae	1	0.7%	
	Rubiaceae	5	3.4%	Muntingiaceae	1	0.7%	
	Meliaceae	4	2.7%	Musaceae	1	0.7%	
	Sapindaceae	4	2.7%	Oxalidaceae	1	0.7%	
	Anacardiaceae	3	2.0%	Pandanaceae	1	0.7%	
	Lauraceae	3	2.0%	Rutaceae	1	0.7%	
	Salicaceae	3	2.0%	Thymelaeaceae	1	0.7%	
	Verbenaceae	3	2.0%	Urticaceae	1	0.7%	
	Acanthaceae	2	1.4%	Vitaceae	1	0.7%	
	Annonaceae	2	1.4%				
Lamiaceae	2	1.4%	Habitus	Trees	76	51.7%	
Menispermaceae	2	1.4%		Shrubs	24	16.3%	
Piperaceae	2	1.4%		Herbs	24	16.3%	
Sapotaceae	2	1.4%		Climbers	11	7.5%	
Solanaceae	2	1.4%		Grasses	6	4.1%	
Achariaceae	1	0.7%		Palms	6	4.1%	
Amaranthaceae	1	0.7%	Spesies status	Native species	96	65.3%	
Apocynaceae	1	0.7%		Exotic species	38	25.9%	
				Invasive species	13	8.8%	

Table 2. Environmental parameters in Buret Lake

Parameter	Measurement
Air Velocity	0,1 m/s
Air Temperature	28,6 °C
Soil pH	7
Humidity	84,2 %

The results of Spermatophyta research in Telaga Buret show that out of 147 species there are 140 species that have ethnobotanical potential. The existing Spermatophyta species are grouped into 8 categories based on their ethnobotanical potential, namely as foodstuffs, traditional medicinal materials, building materials, fiber and craft materials, firewood materials, animal feed materials, toxic materials, and ornamental plants (Table 3).

Table 3. Grouping of Spermatophyta in Telaga Buret based on its ethnobotanical potential

Ethnobotanical Grouping	Total	
	Species	Family
Foodstuffs	44	26
Traditional Medicinal Materials	82	31
Building Materials	18	11
Fiber and Craft Materials	8	7
Firewood Materials	9	4
Animal Feed Materials	9	5
Toxic Materials	5	5
Ornamental Plants	12	11

DISCUSSION

The large number of identified spermatophyte species indicates a fairly high level of plant diversity in Lake Buret. The high number of plant families found in Lake Buret suggests that the ecosystem there provides a variety of habitat conditions that support the growth of diverse plant

species. This is also supported by the view of Kent and Coker (1992), who state that a high number of families and genera in a given area reflects a complex vegetation structure and indicates that the ecosystem is relatively stable. These conditions are likely influenced by the environmental characteristics of Lake Buret, which still possesses fairly good vegetation cover and an abundant water supply. These environmental factors play a crucial role in supporting the growth and survival of various Spermatophyta plant species in Buret Lake.

Among the Spermatophyta found, tree species dominate. Ecologically, trees play a vital role in maintaining ecosystem stability, such as providing habitats for various organisms, regulating nutrient cycles, and controlling the microclimate of an area (Odum, 1993). The dominance of tree vegetation around Lake Buret also helps maintain environmental humidity and reduce soil erosion in the surrounding area. These conditions are vital for preserving the lake's ecological functions as a water source and as a habitat for various living organisms.

Based on their status, the majority of the plants found are native species. The dominance of native species indicates that the Lake Buret ecosystem still maintains a relatively natural vegetation structure. Native plants play an important ecological role because they have naturally adapted to local environmental conditions and contribute significantly to ecosystem stability. Additionally, natural vegetation can act as an air pollutant filter and plays a crucial role in carbon sequestration, which contributes to climate change mitigation (Shackleton *et al.*, 2019).

Environmental factors play a crucial role in determining plant growth and distribution within an ecosystem. Wind plays a role in the dispersal of spores and can influence the spread of plant diseases. However, excessively strong winds can increase the rate of evaporation and affect the diffusion of CO₂ and H₂O through the stomata (Grace, 1988). According to Grace (1988), the optimal airspeed for plant growth ranges from 0.5–0.7 m/s. However, the airspeed measured in the Lake Buret area was 0.1 m/s, which is lower than this optimal range. This relatively low wind speed is likely influenced by dense vegetation and the sheltered environmental conditions around the lake. Although below optimal range, these conditions can still support plant growth, as evidenced by the presence of dense and widespread vegetation around the lake area.

Air temperature in the Buret Lake area was recorded at 28.6 °C. Changes in temperature can trigger an increase in the rate of photosynthesis. According to Salisbury and Ros (1995), plants can only grow well at an optimal ambient temperature. If it is at the minimum or maximum temperature, the growth of the plant will be disrupted.

According to Kartikasari *et al.* (2023), one indicator of soil fertility is influenced by pH. This is because plants can grow well in the pH range between 5.5–7.5. If the pH acidity level is higher, it will affect plant growth (Rina, 2015). This is in line with the pH measurement in Buret Lake so that it has an impact on its abundant biodiversity. The fourth abiotic factor is air humidity. Air humidity is affected by certain factors including temperature, wind movement, vegetation, quality and quantity of irradiation, air pressure, and the presence of water in a place (Soegijono, 1999). The optimal air humidity for plant growth ranges from 40–85%. From the measurement results, the air humidity in the Buret Lake area is 84.2%. Air humidity lower than 40% can result in inhibition of photosynthesis rate and plant growth. While relative air humidity above 85% can cause malfunctions in stomata, which can result in water stress in plants (Carvalho *et al.*, 2015). Air temperature and humidity are two factors that can influence plant growth to create optimal environmental conditions for plants. The growth process in plants can increase if the surrounding temperature increases and humidity levels decrease (Kartikasari *et al.*, 2023). At relatively low air humidity can cause the evaporation rate on the leaves to increase, so that plants will lose a lot of water. This will be able to stop the photosynthesis process, because the stomata on the leaves are closed and no more CO₂ can be absorbed (Ryu *et al.*, 2014).

Subsequently, ethnobotanical studies were conducted to examine the interactions between humans and plants, particularly regarding how plants are utilized by local communities. Ethnobotanical studies are important because they can expand knowledge about plant utilization and provide useful information for communities in meeting their food, health, and other livelihood needs (Amboupe *et al.*, 2019). Research on the potential of local plants can also contribute to supporting food security and preserving local culture. This is in line with a study conducted by Rahayu *et al.* (2024), which states that local plants can be categorized and classified based on their nutritional functions, such as sources of energy, vitamins, and fiber. In addition to being classified as food sources, plants in the Buret Lake area are also grouped into several categories related to daily life. Recent studies indicate that many plants used as spices also have pharmacological functions, such as antioxidant and antimicrobial properties, thus playing a dual role as both food and health resources (Asfaw *et al.*, 2023).

Hidayat *et al.* (2010) classified food crops into three categories: carbohydrate-producing plants, vegetables, and fruits. In the Buret Lake area, there are four types of carbohydrate-producing plants in the form of tubers. In addition, there are four types of plants that can be used as vegetables. A total of 26 types of fruit plants were also found and can be utilized.

In addition to the three categories mentioned above, plants in the Buret Lake area are also utilized for their seeds, as well as for spices and flavoring agents in cooking. There are eight plant species whose seeds are used. Spermatophyta species in the Buret Lake area that are used as traditional medicine constitute the largest group, totaling 82 species. The plant parts used for medicinal purposes are highly diverse, including tubers, leaves, sap, fruits, and seeds, indicating that many parts of these plants have potential in traditional healing practices. This finding demonstrates that medicinal plants still have strong potential for use and remain relevant in modern healthcare systems, especially in developing countries (Rahayu *et al.*, 2024).

Besides being used as medicine, several Spermatophyta species found in the Buret Lake area are also utilized as construction materials. A total of 18 species are known to produce usable timber. These species generally produce strong and durable wood, making them suitable for construction purposes. In addition, several plant species in the Buret Lake area are also used as sources of fiber and materials for handicrafts, while seven other species are commonly used to make handicrafts and household tools. The utilization of these plants also contributes significantly to improving local economic sustainability (Santana *et al.*, 2024).

Besides being used for construction and crafts, some tree species are also used as firewood by local communities. In the Buret Lake area, nine species are commonly used as firewood. In addition to human use, several Spermatophyta species are also utilized as livestock feed, with a total of nine species used for this purpose. These plants provide important nutritional sources for livestock raised by local communities. Studies show that wild and local plants play an important role as alternative nutritional sources for livestock, especially in areas with limited access to commercial feed (Asfaw *et al.*, 2023).

In addition to their functional value, several Spermatophyta species in the Buret Lake area also have aesthetic value as ornamental plants, with around 12 species identified. On the other hand, some plant species in the Buret Lake area are known to contain toxic compounds. Five species fall into this category, such as *kluwak* (*Pangium edule*). According to Irsyad *et al.* (2013), *kluwak* leaves contain high levels of cyanide and are traditionally used as fish poison, while the *gadung* plant produces toxic sap that can be used to trap birds. Recent studies indicate that toxic plants are often utilized traditionally with proper local knowledge, for example as fish poison or as food ingredients after detoxification processes (Rahayu *et al.*, 2024).

CONCLUSION

Based on the inventory of Spermatophyta plants found in Buret Lake, 147 species of Spermatophyta were recorded belonging to 108 genera and 49 families. In addition to their important ecological roles, many plant species found in the Buret Lake area also have significant ethnobotanical value. These findings can provide useful information and help improve local community understanding regarding the use of plants as sources of food, traditional medicine, building materials, handicraft materials, livestock feed, firewood, and ornamental plants. Therefore, conservation efforts and sustainable vegetation management in the Buret Lake area are highly necessary to preserve plant diversity, control invasive species, and maintain the ecological integrity of the ecosystem.

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CONFLICT OF INTEREST

The authors declare there is no conflict of interest to disclose.

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Supplementary file: [Complete list of Spermatophyta species in Buret Lake](#)