Biodiversity of Rambut Cave Sale Central Java

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Abstract. Rembang zone karst area stretches from Central Java to Madura Islands. This area is the most significant water or groundwater basin (CAT) area in Rembang Regency, often known as Watuputih Mountains or Karst Area. Watuputih Groundwater Basin is a karst area that is characterized by the formation of several caves. Rambut Cave is one of the caves in Watuputih area located to the east of Watuputih with coordinate's point -6.8783, 111.5534. There are seven types of flora found in the Rambut Cave, namely Horseshoe Bats, Bent-Wing Bats, Ants, Geckos and Crickets, Forest Grasshoppers, and Snails. While the flora was found, there are six types of Bauhinia scandens, Suweg, Mahogany, Drypetes littoralis, Yellow Palm, and Teak trees. The study results obtained the Flora Diversity Index Value \( H' = 0.687 \), which belongs to the low category, and the value of Fauna Diversity Index \( H' = 1.414 \), which belongs to the medium category.

1. Introduction
Karst area is a landscape area that occurs due to natural processes, namely dissolution. Most of the dissolving process occurs in easily dissolved rocks such as carbonate rocks. The cave is one of the characteristics of karst morphology. Suprianto and Labib [1] state that the appearance of the endokarst, especially the cave, is protected from human activity because humans rarely enter natural caves. Much geological history is still preserved in the cave.

Bottrell et al. [2] define karst as a field with characteristic hydrological conditions due to easily dissolved rocks and well-developed secondary porosity. Karst has a strategic function as a storage for enormous water reserves under the surface of the karst landscape with its distinctive surface and subsurface relief characteristics. The karst landscape can be seen through the conical limestone hills, the emergence of springs in rock fractures, and the flow of underground rivers with cave passages.

White et al. [3] and Ferreira et al. [4] states that caves are natural underground cavities, including entrances, passages, and rooms that human explorers can trace. The organisms in the cave are classified into terrestrial and aquatic organisms. Terrestrial organisms are categorized into trogloxene, troglobite, and troglophilic. Aquatic organisms are categorized into stygogenic, stygobite, and stygophilic.

The karst cave ecosystem is one of the most vulnerable ecosystems to environmental changes on earth. More than 50% of the Microchiroptera and 20% of the Megachiroptera live in caves. As cave dwellers, bats have a vital role in the ecosystem in the cave. However, until now, the cave area was not spared from potentially damaging exploitation efforts cave function, both as a natural habitat of bats and a regulator of the hydrological cycle. Apart from the cave ecosystem, which is the place for various organisms' adaptation and evolution processes [5].
Rambut cave is located in Dukuh Sawah, Gading Village, Sale District, Rembang Regency, Central Java. It belongs to the Watuputih karst area, about 300 m from the tourist area of Sumber Semen Springs. Because it is close to Wana Wisata Sumber Semen Ecotourism, the site of Rambut Cave is more often used as a tourist attraction by tourists. Nevertheless, scientific information related to the potential biodiversity of Rambut Cave has never been studied. Therefore, this research is expected to reveal the potential of biodiversity contained in Rambut Cave. This study aims to determine the diversity of fauna and flora of The Rambut Cave in Sale, Rembang, Central Java.

2. Methodology
The research was located in The Rambut Cave of Sale District, Rembang Regency, in October 2020. Research method using descriptive research. This research data consists of primary data and secondary data. Primary data collection is done through direct observations and interviews with Perhutani. Secondary data is collected from various literature studies, report books, journals, research results, and other supporting data related to the research being conducted.

Figure 1. Research location map.

Materials and Tools needed in this research are GPS, cameras, measuring instruments, inventory data, stationery, counting tools, a set of computers with ArcMap 10.1 software, machetes, and other supporting tools. The data obtained will be analyzed using the Shannon-Wiener Diversity Index formula to determine the level of diversity and the average index to represent the total number of individuals scattered in each species obtained as follows:

\[ H' = -\sum pi \ln pi \]  

Description:
- \( H' \) = diversity Index of Shannon Wiener
- \( Pi \) = proportion of species to 1 in the total sample
- \( Ni \) = number of individuals of all types
- \( N \) = the total Number of individuals of all types

Criteria for diversity of types is determined as follows:
- \( H' < 1 \) = diversity is kind of low,
- \( 1 < H' < 3 \) = the diversity of types of being.
Data that has been collected, then tabulated, processed and analyzed descriptively qualitative. Analysis of the data includes the index of species diversity [6].

3. Result and discussion

Rembang Regency is administratively bordered by the Java Sea to the north, Tuban Regency, East Java Province in the east, Pati Regency in the west, and Blora Regency in the south. The position of Rembang Regency is flanked by the Java Sea to the north and the North Kendeng Mountains to the south. The topography of this district varies from coastal areas, lowlands, and mountains with soil types consisting of mediteral, grumosol, alluvial, andosol, and regosol content.

The Rembang Zone Karst area stretches from Central Java to the Madura Islands. This area is the largest water recharge area or groundwater basin (CAT) in Rembang Regency, often known as the Watuputih Mountains or Karst Area. As a groundwater basin or CAT (Cekungan Air Tanah), the Kendeng Mountains area is an area that needs attention in the context of protection and conservation. The Watuputih CAT area is the primary controller in supplying water resources around the Watuputih Mountains area. The Watuputih CAT area as a protected geological area in Perda No. 14 of 2011 concerning RTRW of Rembang Regency must be the basis for providing protection and carrying out further management so that functions are maintained that the risk of losing water resources can be avoided in the future. The Watuputih Groundwater Basin is a karst area characterized by the formation of several caves. Rambut Cave is one of the caves included in the Watuputih area. Rambut Cave is located east of Watuputih with coordinates -6.8783; 111.5534.

![Figure 2. Types of flora in Rambut Cave.](image)

### Table 1. Biodiversity of flora in Rambut Caves.

| No. | Species Name       | pi     | ln     | index | Stratification Distance (m) |
|-----|--------------------|--------|--------|-------|-----------------------------|
| 1   | Teak               | 0.817661 | -0.20131 | 0.16  | 150 - 200                  |
| 2   | *Bauhinia scandens*| 0.070319 | -2.65471 | 0.18  | 0 - 50                     |
| 3   | *Drypetes littoralis*| 0.020442 | -3.89019 | 0.08  | 100 - 150                  |
| 4   | Mahogany           | 0.081766 | -2.50389 | 0.20  | 100 - 150                  |
| 5   | Suweg              | 0.004088 | -5.49962 | 0.022 | 50 - 100                   |
| 6   | Yellow Palm        | 0.005724 | -5.16315 | 0.029 | 100 - 150                  |
|    | **Total**          |        |        | **0.687** |                       |

The diversity of Flora in Rambut Cave is presented in Table 1 and Figure 2. There are six types of flora found in The Rambut Cave with different distance stratification. At a distance of 0-50 meters dominated by Bauhinia scandens. At a distance of 50-100 meters was found flora Suweg. While at a distance of 100-150 meters dominated by Mahogany, Drypetes littoralis, Yellow Palm, and Teak trees.
found at 150-200 meters from the Rambut Cave. The value of the diversity index (H') of each flora is presented in Table 1.

![Diagram showing the biodiversity of fauna in Rambut Cave]

**Figure 3.** Types of fauna in Rambut Cave.

**Table 2.** Biodiversity of fauna in the Rambut Caves.

| No. | Species Name      | pi     | ln     | index | Stratification Distance (m) |
|-----|-------------------|--------|--------|-------|----------------------------|
| 1   | Horseshoe Bats    | 0.353646 | -1.03946 | 0.368 | 0 - 50                      |
| 2   | Bent-wing Bats    | 0.246753 | -1.39937 | 0.345 | 0 - 50                      |
| 3   | Ants              | 0.2997  | -1.20497 | 0.361 | 0 - 50                      |
| 4   | Forest Grasshopper| 0.04995 | -2.99673 | 0.149 | 100 – 150                  |
| 5   | Crickets          | 0.02997 | -3.50756 | 0.105 | 50 - 100                   |
| 6   | Snail             | 0.017982 | -4.01838 | 0.072 | 100 - 150                  |
| 7   | Gecko             | 0.001998 | -6.21561 | 0.0124 | 0 - 50                      |
|     | **Total**         |        |        |       | **1.414**                  |

The diversity of Fauna in Rambut Cave is presented in Table 2 and Figure 3. There are seven types of fauna found in The Rambut Cave with different distance stratification. At a 0-50 meters’ distance, four types of Horseshoe Bats, Bent-wing Bats, Ants, and Geckos were found. Crickets dominate a distance of 50-100 meters. While at a distance of 100-150 meters is dominated by Forest Grasshopper and Snails. The value of the diversity index (H') of each fauna is presented in Table 2.

Rambut Cave is a horizontal cave with the mouth of a cave located around the Wana Wisata Sumber Semen. The environmental condition around the mouth of the cave is overgrown with Teak Trees. The cavernous passageway is relatively steep with a large hallway size. At the end of the cave hallway, a pool of water with a stream of water enters the cave. This water flow is out of the line of layering limestone [7].
Figure 4. Mouth of the Rambut Cave.

This Rambut Cave has an underground stream inside. The shape of the cave mouth of the site resembles a break or depression on the ground that is then connected to the underground flow and forms a horizontal cave structure. The distance between the mouth of the caves and the base of the caves vertically is approximately 7 meters deep, and the length of the caves horizontally is not yet known. The cave tunnel is relatively steep with a large hallway size.

Figure 5. Estimated structure of the Rambut Cave [7].

This site is located in Perhutani land and is close to residential areas with poor road infrastructure. Access to this site can be reached by motorbike (trail) and on foot. This site has a high level of difficulty and danger due to the vertical structure of the cave mouth and the steep passageway so that it cannot be explored without using adequate equipment. There are not too many ornaments in the cave site to be categorized as low.

The environment around the cave site, which is more than 150 meters away, is overgrown with Teak trees. It makes the type of vegetation in the environment around the cave to be homogeneous. Because it is close to the Wana Wisata Sumber Semen area, the Rambut cave site is more often used as a tourist attraction. There was no living vegetation in the cave.

Rambut Cave has a high biospeological category because of the large number of living things that live in it, especially bats. According to Altringham [8], cave conditions far from noise, dark, humid and stable temperatures are suitable for bats to rest and reproduce. The bats can protect from predators,
prevent evaporation, maintain body temperature, and breed safely with these conditions. Tristiani et al. [9] and Campbell et al. [10] stated that the environmental conditions of the cave significantly affect the diversity of fauna in the cave ecosystem because the presence of organisms follows instincts and the efficient use of energy to utilize the available prey area.

4. Conclusion
There are seven types of flora found in the Rambut Cave, namely horseshoe bats, bent-wing bats, ants, geckos and crickets, forest grasshoppers, and snails. While there are six types of flora found, namely Bauhinia scandens, Suweg, Mahogany, Drypetes littoralis, Yellow Palm, and Teak trees. The study results get the Flora Diversity Index Value $H' = 0.687$, which is included in the low category, and the Fauna Diversity Value $H' = 1.414$, which is included in the medium category.

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