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Species Diversity and Cave-Bat Conservation Efforts in Aoma Village, Wolasi District -Southeast Sulawesi

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Abstract

Indonesia a tropical country that remains warm all year, has the largest biodiversity. This study aims to determine the diversity of bats of the order Microchiroptera in Rau Cave, Wolasi, Conservation (Protected) Forest area, around Aoma Village, South Konawe Regency. Data collection was carried out using a mist net measuring 6 x 2 meters which were stretched in front of the mouth of the cave at 16.00 before the bats came out looking for food and harvested at 06.00-0.700. The trapped bats were identified using the Sulawesi Bat and its role in the health sector, and other relevant references. The results showed that there were 26 trapped bats consisting of 5 species, namely *Rhinolopus arcuatus* (Prok Bruk Sulawesi), *Hipposideros ater* (Barong gauld), *Dobsonia viridis* (Kubu Hijau), *Miniopterus australis* (Tomosu australi) and *Hipposideros dinops* (Barong horsfield). The species found consisted of 2 families, namely the families Rhinolopidae and Hipposideridae, and consisted of 2 genera, namely the genera of Dobsonia and Miniopterus. The diversity index shows a value (H') = 0.986, which indicates a low category in diversity and a Margalef wealth index (R) of 0.26. It is necessary to conserve plant species both for eating insects and for food sources for Microchiroptera bats in their feeding ground.

Keywords: Rau Wolasi cave, bat sub-order Microchiroptera, diversity

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INTRODUCTION

Indonesia has a fairly high diversity of bat species, there are about 205 bat species, or about 20% of the total number of known species in the world, consisting of 72 species of fruit-eating bats (Frugifora) and 133 species of insectivorous bats (Insectifora) [1]. Bats have an important role, including being a pollinating agent for flowers of forest and agricultural plants, and as a disperser of plant seeds. The Microchiroptera sub-order has a function as insect pest control because this sub-order is the main predator for insects, according to [1], a bat can consume 600 insects in one hour so it can control insect pest populations that cause damage to crops. forestry, and the human environment. Conversely, bats are also a natural reservoir of several potential viruses against zoonotic diseases [2] The bat population is currently experiencing a decline that has occurred almost all over the world [3].

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Some of the bat species even have been declared almost extinct. The main causes of declining populations and even extinction of bats are habitat degradation, forest fires either due to human intervention or naturally, illegal logging, and stone mining. This can change the compositional structure of its natural habitat so that the impact can affect the abundance of bat species [4]. Therefore it is necessary to seek protection or conservation measures to maintain these species. According to [5], protecting the preservation of bat species can be done by paying attention to three things, namely the availability of food, habitat protection, and protection against predator threats. Bats from the Microchiroptera order are very adapted to dense and natural forest conditions as a place to find food so degradation or other forest disturbances greatly affect the existence of bats.

Bats are Trogloxene animals, namely animals nesting in caves but looking for food outside the cave [1], [6]. As troglodyte animals, bats have an important role in the energy circulation in the cave because they produce guano which is a source of energy for small animals [7]. Forest destruction greatly affects the availability of water in the cave through the system of fissures causing microclimatic climatic conditions to change in the cave thereby affecting the decomposition and development of organisms that are important as the main energy source in the cave. High rates of deforestation will reduce the area of bat habitat in a forest. Loss of habitat will result in a decrease in the bat population thereby affecting the diversity of bat species. One of the steps that can be taken to protect bats is to ensure that bats are safe from predators, both natural predators and humans. The threat to the existence of bats is humans due to land conversion [8] and hunting for consumption and the existence of myths that believe some parts of the body of bats are medicinal. In addition, people and even the world still consider bats as plant pests. Lack of knowledge about the role of bats in forest ecosystems and the environment results in disturbances and threats to the preservation of bat species.

Rau Cave in Aoma Village is one of several karst caves in Wolasi District, South Konawe Regency which is inhabited by bats of the Microchiroptera suborder. The karst area is experiencing a lot of pressure, including land conversion and limestone or limestone mining. Stone mining activities and land conversion have an impact on habitat conditions and the availability of bat food. Given the important role of bats for ecosystems and humans and also the increasing threat to bats, current information is needed regarding the existence and diversity of bat species in these locations.

METHODS

Data Collection

This research was conducted in Rau Cave, Aoma Village, Wolasi District, South Konawe Regency, Southeast Sulawesi Province, which is located at an altitude of approximately 400 meters above sea level. Identification of bat specimens was carried out directly at the research location. Mist net installation is done before 17.00. Bats that were caught were subjected to morphological measurements and identification processes. According to [9] in identifying bat species, the body parts that are measured include the tail (E), which is measured from the tip of the tail excluding fur or long hair that extends beyond the tail, and hind legs (KB), namely from heel to toe. the longest excluding the claws, Ear Length (T) which is measured from the outside that is open to the tip, and the Forearm (LB) which is from the outside of the elbow to the outside of the wrist on the curved wings. To see the identity of each species, weight (B), head and body length (KT) were also measured, which were measured from the anus to in front of the nose, the length of the third and fifth fingers, and looked at the species' sex and age (adult or child). Morphological measurements, to ensure species identification, observations were also made of the arrangement of bat teeth [4]. After the measurements were taken, the identified bats were tagged and then released again.

Data Analysis

Data analysis used in this study uses the following equations:

Bat Species Diversity Index

The species diversity index used is the Shannon - Winner diversity index [10].

$$H' = -\Sigma \frac{ni}{N} \; X \; ln \frac{ni}{N}$$

Information:
H = Shannon- Wiener diversity index
nii = number of individuals of the i-th species
N = number of individuals of all species

Shanon Wiener Index Value:
Value with < 1 low diversity, low number distribution of each species, and low community stability. 1 – 3 moderate diversity moderate individual distribution, community stability >3 high diversity, high distribution of the number of individuals of each species, and high individual community stability.

The range of diversity index shows the diversity of species in a community and also shows the balance in the distribution of the number of individuals of each species. The diversity index value is used to determine the evenness index value of the species using the Shannon-Winner Evenness Index formula [10].

$$E = \frac{H'}{InS}$$

Information:
E = Shannon Evennes tightness index
H = Shannon Wienner diversity index
S = Number of species

Species Richness Index
The Margalef richness index (R) is a calculation of the species richness of a community, where the magnitude of this value is influenced by the number of species and the number of individuals in the area. Based on [11] the magnitude of R <3.5 indicates low richness, R= 3.5-5 indicates moderate species richness and R> 5 indicates high species richness. Species richness was measured using the Margalef formula [12].

$$R = \frac{S-1}{In\,(N)}$$

Information:
R = Margalef species richness index
S = Number of species
N = total number of individuals

RESULTS AND DISCUSSION

Research Results

Species and number of individuals
The results showed that in Rau Cave in Aoma Village, Wolasi District, 15 individual bats were found consisting of 5 species from 3 families and 2 genera. The research data are presented in the following table.

Table 1. Bat Species of the Sub Order Microchiroptera found in Rau Cave, South Konawe Regency.

No	Species Name	Latin name	Family	amount individual (n)
1	Prok Bruk Sulawesi	*Rhinolopus arcuatus*	Rhinolopidae	8
2	Barong gauld	*Hipposideros ater*	Hipposideridae	7
3	Kubu hijau	*Dobsonia viridis*	Dobsonia	6
4	Tomosu australi	*Miniopterus australis*	Miniopterus	3
5	Barong horsfield	*Hipposideros dinops*	Hipposideridae	2
Total				26

Table 2. Diversity index and species richness index of bats in Rau Cave, Konawe Selatan District

Index type	Mark
Diversity Index (H')	0,986
Margalef Wealth Index (R)	0,26

Table 3. Plant species found around Rau Cave as a food source for insects

No	Local Name	Scientific name
1	Ruruhi	*Syzygium subglauca*
2.	Jambu-jambu	*Gardenia anisophylla*
3.	Rau	*Dracontomelsa mangiferum BL*
4.	Melinjo	*Gnetum gnenemon*
5.	Ketapang	*Terminalia catapa*
6.	Matoa	*Pometia piñata*

Index of Diversity, Evenness, and Species Richness

Index of diversity, evenness, and species richness of bats of the Sub Order Microchiroptera in Rau Cave. The results of the analysis obtained can be seen in Table 2.

Vegetation as a Food Source for Insects

Insects are the main source of food for bats of the Microchirptera sub-order, so the presence of insect food plants greatly influences the existence of these bats. Most insects are plant-eating organisms, but of a large number of plants, not all of them can be eaten by insects, there are several plant species that insects like the most. Based on the data obtained, there are several plant species as a food source for insects. This can be seen in Table 3.

From Table 1 it appears that there are 5 species of the Microchiroptera sub-order found in Rau Cave, this shows that the number of bat species that inhabit the cave is very low. According to [13] found 19 species of the Microchiroptera suborder were in Way Canguk, Bukit Barisan Selatan National Park, but this is still a higher area.

Bats play an important role in the ecological system because they play a role in dispersing plant seeds. It [15] suggested that Macrochiroptera have an important role in forest ecosystems, namely as a seed disperser for tropical forest plants. This is evidenced by the known eating behavior of bats on trees and dropping leftover food onto the ground and supported by the ability to fly long distances causing seed dispersion. seeds too far. A finding [16] in [17] states that seeds eaten by bats have a higher germination rate compared to germination naturally or directly without the help of bats while during the pollination process bats play a role in carrying pollen around their mouths to other flowers which visited them. Compared to the results of research by [14] who only found 3 species of bats in Groda Cave, the Gunung Sewu karst.

Furthermore, Microchiropter plays an important role as a pest controller that can cause damage and loss in plantations, agriculture, and forests. This was proven by [18] in Malagasy who found that several species of Microchiroptera inhabiting caves ate insects of the orders Isoptera, Hymenoptera, Coleoptera, Lepidoptera, Orthoptera, Hemiptera, and Homoptera, which are plant pests.

The ability of bats to catch insects helps maintain the balance of the ecosystem, namely by controlling insect pest populations by eating them. Bats are capable of eating up to 600 individual insects in one hour [1]. Microchiroptera bats need energy to fly and have a short digestive system that causes bats to eat more often.

Species of Bats in Rau Cave, Aoma Village, Wolasi District, Konawe Selatan District

Five species of sub-order Microhiroptera bats were found: Rhinolopus arcuatus, Hipposideros ater, Dobsonia viridis, Miniopterus australis, Hipposideros dinops, the highest number of species was Rhinolopus arcuatus with 8 individuals and the lowest was Hipposideros dinops with 2 individuals. The species found are described as follows.

Rhinolopus arcuatus

Bats of this species are small to medium in size. Body color ranges from yellow, light brown, and dark brown to black. The nostrils are complex in shape and have their characteristics for each species, so they are often the difference between species. The antitragus is round and tapered at the end, while the tragus is round. The size of the

wings is wide, but aerodynamic, making it possible to move in an environment with dense vegetation. Bats of this tribe catch insects that are on the leaves to the ground surface or grabbed while flying, then eat them when perched in caves, tree holes, and branches. Live alone or in large groups. Like forest to open areas [19].

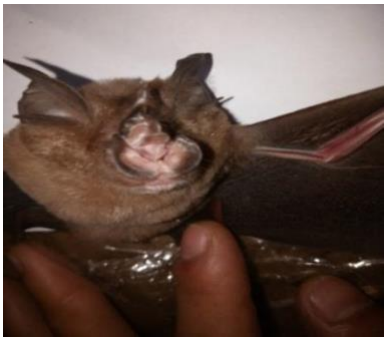

Figure 1. Rhinolopus arcuatus species

Hipposideros ater

Hipposideros ater Templeton, 1848 is a medium-sized species of the Hipposideridae tribe with a forearm length between 36.2 - 43 mm [1]. The hair color on the whole body is gray with a black base.

This bat has special features in that the face has a nose that does not have additional lateral skin folds and does not have a disc-like structure. The nostrils are pink in color, the shape of the ears is round and the septum in the nasal cavities is bulging at the base.

Figure 2. Barong Gauld (*Hipposideros ater*)

Distribution: Sumatra, Kalimantan, Java, Lombok, Sulawesi, Maluku, West Papua, Papua New Guinea, Solomon Islands, Australia, Philippines, and Vietnam [1].

Dobsonia viridis

There are 9 species of this bat throughout Indonesia, and 4 species were reported in Sulawesi, namely: *Dobsonia crenulata*, *D. exoleta*, *D. minor* and *D. viridis*. The characteristics of this bat are that the hair on the back does not grow, and the wing membrane looks connected on the back. The length of the forearm is an identification feature of the genus Dobsonia [1].

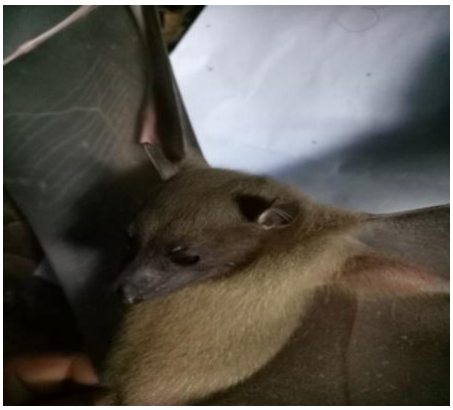

Figure 3. Kubu Halmahera (*Dobsonia viridis)*

Myotis australis

There are 11 species of this species throughout the world, 9 species of which are found in Indonesia and 7 species found on the island of Sulawesi. The characteristics possessed by this species are the size of the last joint of the third finger 3 times the length of the first finger bone, and short rounded ears with folds back. Short blunt tragus curved slightly forward [1].

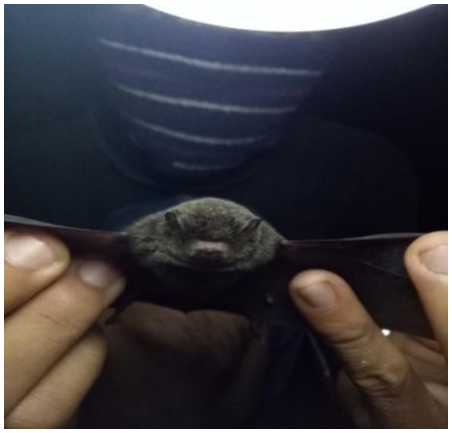

Figure 4. Tomosu australi (*Myotis australis)*

Hipposideros dinops

There are 3 genera throughout Indonesia, namely Aselliscus, Coelops, and Hipposideros consisting of 26 species. In the Sulawesi Islands, only 1 genus (Hipposideros) is found and consists of 7 species [1]. The characteristics possessed by these bats

are a complex nose, the anterior (front) shaped like a horseshoe, the middle part of the flesh in the form of a pillow, and the posterior (back) in the form of a structure like a bulkhead bag, has no tragus, only 2 toes II-IV.

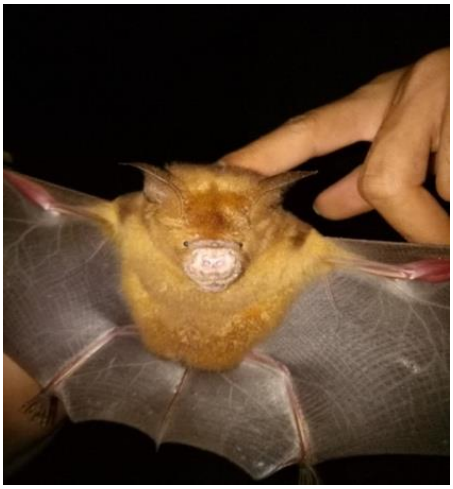

Figure 5. Barong horsfield (*Hipposideros dinops)*

Species Diversity Index of Bats in Rau Cave

Based on the analysis table of bat diversity index in Rau Cave in Aoma Village, Wolasi District, South Konawe Regency (Table 4), which is equal to 0.986 or less than 1 (<1) This indicates that bat species diversity is low, this is following Wiener's Shannon diversity index criteria. which states that if H'< 1 the diversity is low, the distribution of the number of individuals of each species is low, and the stability of the community is also low.

Based on the analysis of the evenness index of the Rau Cave bat species in Aoma Village, it was 0.1972. This index value is very low in expressing evenness in a bat community in the Rau cave, this is by the statement (Ludwig and Reynolds, 1988) E < 0.4 low evenness. The smaller the evenness index (E), the smaller the evenness of a population, which indicates that the distribution of the number of individuals is not the same and there is a tendency for dominance of the existing species to occur. The greater the evenness index value, the population shows high evenness which indicates that there is no domination between existing species.

The bat species richness index in this study was 0.26. The index value is very low in expressing the species richness index. This is consistent with the statement [20] stating that a community where the value of wealth is influenced by the number of species and the number of individuals in the area. Based on [14] the amount of R <3.5 indicates low wealth R = 3.5-5 indicates moderate species richness and R> 5 indicates high species richness.

Bat Conservation Efforts in Rau Cave, Aoma Village, Wolasi District, Konawe Selatan Regency

Conservation of Insect Food Source Plants Around Rau Cave

In general, plant conservation is carried out using the in-situ conservation method [21], which is a method used to preserve the diversity of plant and animal species and their ecosystems carried out in their natural habitat, and ex-situ conservation (outside their natural habitat), which is a conservation method. used to conserve species outside their natural habitat [22].

Based on the results of an inventory of plant sources of insect food around Rau Cave, it was found that almost all plant species from various stages of growth were eaten by insects. However, of all the plant species in the study area, several plant species are most favored by insects, namely: Ruruhi (*Syzygium subglauca*), Guava (*Gardenia anisophylla*), Rau (*Dracontomelsa mangiferum* BL), Melinjo (*Gnetum gnemon*), Ketapang (*Terminalia catapa*), Matoa (*Pometia piñata*). This is following the opinion [23] which states that almost 50% of insects are plant eaters or phytophagous. Insects are attracted to plants, either for food or as shelter. The parts of the plant that insects like are the leaves, stalks, and stems of plants. Some parts of the plant can be used by insects to take shelter or to make cocoons (nests to lay eggs). The appropriate conservation method for preserving the diversity of plants around Rau Cave, Aoma Village, is in-situ conservation. plants around the cave.

Bats belonging to the Suborder Microchiroptera generally prey on insects, although some also prey on fish, frogs, lizards, small rats, bloodsuckers, and cannibals. Insects that fall prey to bats belonging to the Suborder Microchiroptera in the Karst region of Tuban in previous studies are all pests for crops. These insects are members of the Order Lepidoptera (*butterfly nation*), Order Coleoptera (*beetle nation*), Order Hymenoptera (*ants nation*), Order Isoptera (*termite nation*), Order Hemiptera (ladybug nation), Order Trichoptera, Order Diptera (*mosquito nation*)) Order Odonata (*dragonfly nation*) and Order Blattaria, as well as the Arhacnida Order (*spider nation*), and the

species *Stygophrynus damermani* outside insects. The insect order is the main food source for bats from the Microchiroptera order. This is evidenced by the results of research by [3] which states that several species of insects from the Microchiroptera suborder eat insects belonging to the orders Lepidoptera, Coleoptera, Hymenoptera, Orthoptera, and Neuroptera in several karst areas in Central Java.

CONCLUSION

Based on the results of research on the diversity of cave bat species (Microchiroptera) which was conducted in Aoma Village, Wolasi District, South Konawe Regency, it can be concluded as follows: 5 species of sub-order Microchiroptera bats were found, namely, Rhinolopus arcuatus, Hipposideros ater, Dobsonia viridis, Myotis australis, and Hyposideros dinops, which consisted of three families and two genera. The bat species diversity index found in Rau Cave is 0.986 in the low category. Efforts to maintain the diversity of bat species of the Microchiroptera suborder in Rau Cave can be carried out by in-situ conservation of plant species as sources of insect food.

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