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Analysis of Structure, the Composition of Vegetation, and Diversity of Epiphytes and Their Hosts

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Abstract: The tourist area of Kali Bak Kampung Harapan Sentani Jayapura Regency is one of the buffer zones for the Cycloop Mountains nature reserve which has the function of a rainwater catchment area and supply of drinking water for the people of Jayapura Regency and City, but currently, the tourist spot is experiencing intensive disturbances and threats. This condition is the reason for this study to be carried out to analyze epiphytic plant vegetation and their hosts in the Kali Bak tourism area, Harapan Village, East Sentani District, Jayapura Regency. The purpose of this study was conducted to determine the structure and composition of the vegetation as well as the diversity of epiphytes and their hosts at the Kali Bak tourist spot, Harapan Village, East Sentani District, Jayapura Regency. Data collection was carried out using transect methods, documentation methods, and plot methods. There are 25 observation plots with a plot size of 20 x 20 meters which are placed on the right and left of the transect line. The results showed that 5 families of 8 species were *Asplenium nidus* L., *Davallia trichomanoides* BL., *Dendrobium* sp, *Drynaria quercifolia* (L). J. sm., *Drynaria rigidula* (Sw.).Bedd., Microsorum sp, *Microsorum punctatum*, and *Nephrolepis falcata* (Cav.) C. Chr. As for the host tree species, 6 families were obtained consisting of 6 species including Alstonia scholaris (L.) R. Br., *Calophyllum inophyllum*, *Cycas rumphii* Miq., *Ficus virens* Aiton., *Gymnostoma papuana* Miq., *Intsia bijuga* (Colebr.) OK. The overall diversity index for epiphytic plants, which is 1.98, is moderate. The overall diversity index for host trees is 1.26 which is moderate.

Keywords: Diversity; Epiphytes; Host trees; Kali Bak

Introduction

Papua Province is an island with the largest tropical forest compared to other regions in Indonesia. According to Sri et al. (2007). Forest exploitation is a challenge for Papua at this time even though on the one hand this province has quite a high biodiversity. The forest area is very important for living things to interact in it. Like a house, the forest is seen as an important ecosystem that needs to be maintained, cared for, and preserved properly for the survival of the living things in it. Thus, forests need to be managed, utilized, and maintained as best as possible so that their functions are maintained sustainably (Alfasis et al, 2021). Forest is an important component for the living things in it because it is very unique where interactions occur between its constituent components. If one component is disrupted, it will have an impact on other things (Akas 2008).

Raunsay & Koirewoa (2021) explained that BBKSDA monitoring it showed that there had been disturbances and threats to the Cycloop CAP area. Threats that occur as a result of land conversion, encroachment, poaching, settlements, and roads. As a result of these threats, the resulting impacts are threats to ecological and hydrological functions such as landslides, sedimentation, flooding, and scarcity of water for consumption. Not only that, but this disturbance also has an impact on the loss of diversity of plant species, one of which is ferns. Ferns is a forest plant that has high diversity compared to other plants (Ekoyani, 2007 in Utin et al, 2014). Ferns usually live in terrestrial and epiphytes. Epiphytic plants are species

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that are attached to other trees in their growth. Based on Shofiana (2017) in Qur'ani et al (2019) most epiphytic plants live in single forms, but if they form colonies they grow and develop until they become hosts. Epiphytic plants usually grow abundantly in places with sufficient rainfall (Steenis, 1972 in Nawawi et al, 2014). Pteridophyta is an epiphytic plant that has an important role in forest ecosystems. Ferns have the important function of producing humus and covering the soil to prevent erosion (Rismunandar and Ekowati, 1991 in Utin et al, 2014). The purpose of this study was conducted to determine the structure and composition of the vegetation as well as the diversity of epiphytes and their hosts at the Kali Bak tourist spot, Harapan Sentani Village, Jayapura Regency.

The tourist area of Kali Bak Kampung Harapan is located in Kampung Harapan, East Sentani District, besides the tourist attractions of Kali Bak, there is also a waterfall tourist spot which is located 1 kilometer from the Kali Bak tourist area of Kampung Harapan. This tour is one of the buffer zones of the Cycloop Mountains nature reserve which has the function of a rainwater catchment area, a source of consumption water for the people in Jayapura Regency and City, and is useful for regulating water management, microclimate control, maintaining the supply of O_2 in the air, reducing emissions. CO_2 even helps keep the air temperature cool and serves as a source of germplasm and can also function as a means of education and tourism (Wesley, 2011). All of the above problems need to be balanced by conducting an analysis of the composition and structure of vegetation to determine the index of the diversity of epiphytic plant species and their hosts in the Kali Bak tourist area, Kampung Harapan Sentani, Jayapura Regency.

Method

This study was conducted for 5 months, from January to May 2022 in the Kali Bak tourism area, Kampung Harapan, Jayapura Regency (Figure 1). Data collection was carried out using transect methods, documentation methods, and plot methods. There are 25 observation plots with a plot size of 20 x 20 meters which are placed on the right and left of the transect line.

According to Indriyanto (2006) in Raunsay (2014) data on the structure and composition of vegetation was obtained through vegetation analysis. The parameters measured are DR, KR and FR, and IVI (Indriyanto, 2008 in Wiryono et al, 2021).

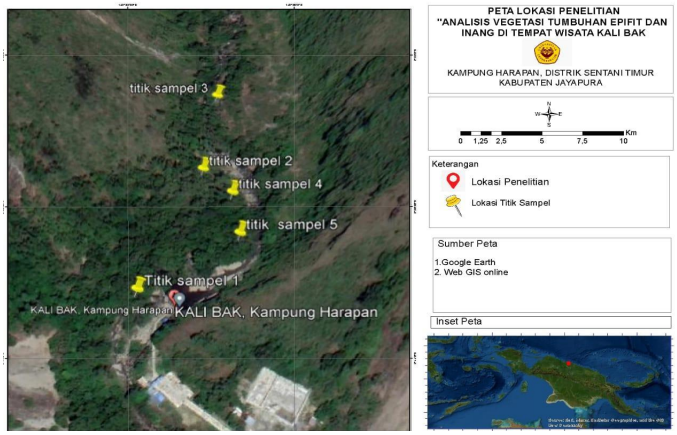

Figure 1. Research location map

The data is analyzed as follows:

The data is analyzed as follows:
Significant Value Index (INP)

$$INP = Kr + Dr + Fr \quad (1)$$

Relative Density (RD)

$$RD = \frac{\text{Density of a kind}}{\text{Density of all types}} \times 100\% \quad (2)$$

Frequency (F)

$$F = \frac{\text{Number of plots found a type}}{\text{The total number of plots}} \quad (3)$$

Relative Frequency (RF)

$$RF = \frac{\text{Frequency of a type}}{\text{Frequency of all types}} \times 100\% \quad (4)$$

Dominance (D)

$$D = \frac{\text{The basic area of a type}}{\text{Total sample area}} \quad (5)$$

Dominance Relatif (DR)

$$DR = \frac{\text{The dominance of a kind}}{\text{Dominance of all kinds}} \times 100\% \quad (6)$$

Species diversity is known by using the Shannon–Wiener diversity index (Cox 1976) with the following equation:

$$H' = -\sum_{i=1}^{S} (pi)(\ln \ln pi) \quad (7)$$

Species diversity is known by using the Shannon–Wiener diversity index (Michael, 1995) with the following equation:

$$H' = -\sum_{i=1}^{s} (pi)(ln\ ln\ pi) \quad (8)$$

Result and Discussion

Epiphytic species

Species of epiphytes found in Kali Tourism Area, Bak, Kampung Harapan. The results of data collection show that the tourist area of Kali Bak Kampung Harapan Sentani, Jayapura Regency has 8 species of epiphytic plants as shown in Table 1. The results of the study at the Kali Bak tourist spot in Harapan Sentani Village, Jayapura Regency, showed that there were 44 individuals consisting of 8 plant species in the 5 families. The following results show that the structures and compositions vary with different characteristics (Table 2).

Table 1. Epiphytic plants found in the tourism area of Kali Bak Kampung Harapan

Epiphyte Type	Local name	Family
Asplenium nidus L.	Paku sarang burung	Aspleniaceae
Davallia trichomanoides BL.	Paku kaki tupai	Davalliaceae
Dendrobium sp	Anggrek	Orchidaceae
Drynaria quercifolia (L) J. sm.	Daun kepala tupai	Polypodiaceae
Drynaria rigidula (Sw.) Bedd.	Daun kepala tupai	Polypodiaceae
Microsorum sp	-	Polypodiaceae
Microsorum punctatum (L.) Couple.	Paku bintik	Polypodiaceae
Nephrolepis falcata (Cav.) C. Chr.	Paku pedang	Dryopteridaceae

Table 2. KR, FR, and IVI Epiphytic growth

Species	Family	RD (%)	FR (%)	IVI (%)
Asplenium nidus L.	Aspleniaceae	22.73	32.26	54.99
Davallia trichomanoides BL.	Davalliaceae	18.18	12.90	31.09
Dendrobium sp.	Orchidaceae	9.09	22.58	31.67
Drynaria quercifolia (L) J. sm.	Polypodiaceae	13.64	3.23	16.86
Drynaria rigidula (Sw.) Bedd.	Polypodiaceae	4.55	3.23	7.77
Microsorum sp	Polypodiaceae	9.09	9.68	18.77
Microsorum punctatum (L.) Couple.	Polypodiaceae	9.09	6.45	15.54
Nephrolepis falcata (Cav.) C. Chr.	Dryopteridaceae	13.64	9.68	23.31
Number		100	100	200

In a study conducted at the Kali Bak tourist spot in Kampung Harapan, it was found that the most common species, *Asplenium nidus* from the Aspleniaceae family, was 10 individuals, while the rare species, *Drynaria rigidula* from the Polypodiaceae family, was 2 individuals. The density value of a species shows the number of individuals of that species in a certain area, thus the number can describe the number of species at the study site, although the density value does not describe the distribution and pattern. *A. nidus* species is the type with the highest density and frequency. It is concluded as a species with a wide distribution and density in all research sites. The highest IVI was owned by the Asplenium nidus species, namely 54.99%. The magnitude of IVI indicates that the role of this species in the community is very dominant.

Vegetation composition is the composition and number of individuals in the plant community. Climate and soil conditions in the habitat can affect the structure and composition of vegetation (Naharuddin, 2017). Species composition is a variable to determine the successional stages that temporarily occur in disturbed communities. If the composition is close to the initial state, it may be interpreted that the community is close to recovering. Vegetation in space includes various individuals that form stands both horizontally and vertically. Horizontally it shows the distribution of individuals in their habitat, while the vertical distribution of trees can be said to be the canopy layer.

The results of the study showed that there were 8 species of epiphytic plants from 5 families with a total of 44 individual epiphytic plants. The number of species found and the area of the plot can affect the value of the relative density (Wiryono et al., 2021). The number of Asplenium nidus consists of 10 individuals and is more dominant in all plots which reach 95%. The FR value of a species is the sum of the frequency of that species from the frequencies of all species. The frequency of species in a habitat indicates the presence of organisms in that habitat. Table 2 shows FR values ranging from 3.23%-32.26%. Asplenium nidus had the highest FR value of 32.26% and the highest FR value of 22.73%.

The species that have the highest frequency values indicate that there is a greater distribution of species in several plots than species with lower frequency values (Paga et al., 2020 in Raunsay & Koirewoa, 2021). Distribution patterns and species density values have an influence on the frequency of these species (Greig-Smith, 1983 in Raunsay & Koirewoa, (2021). Usually, the species that have the highest value are very linear with a high level of density as well as environmental factors, which in a broad sense some plant species in tropical rain forests adapt to situations under the canopy, in the middle, and above the canopy with different light intensities. In this study, the species that had the highest density and frequency belonging to Asplenium nidus at the plant was included in the species group with the best adaptability to its environmental conditions. Dominant IVI was found in *Asplenium nidus* (54.99%), *Dendrobium*

sp (31.67%), *Davallia trichomanoides* (31.09%), and *Nephrolepis falcata* (23.31%).

The magnitude of the IVI shows the role of the species in the community. Asplenium nidus and *Dendrobium* sp are the two most dominant species in the Kali Bak tourist area of Kampung Harapan. Species that have a dominant role in the community will have a high IVI (Muller-Dombois & Ellenberg, 1974 in Natalia 2019). In Figure 19 it can be seen that Asplenium nidus has the highest IVI and role compared to other types. This condition indicates that this species has a high ability to adapt to its environment and can compete with other species.

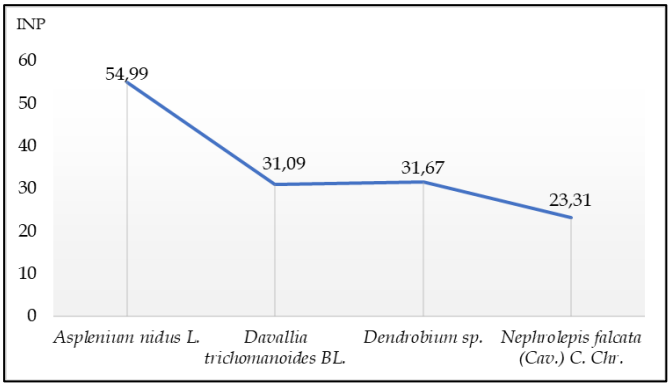

Figure 2. The highest IVI of epiphytes

Description of Epiphytic Plant Species

Epiphytic plants in the Kali Bak tourist area, Harapan Sentani village, Jayapura Regency can be described as follows:

1. *Asplenium nidus* L.

Herbal addiction. Terrestrial and epiphytic having brownish roots. The stem is not clearly visible because the leaves sit tightly. The leaves are lanceolate, single type, the tip is tapered and the veins protrude on the upper surface, the leaf surface is smooth and green. The sporangium is like a brown line on all the veins that are under the leaf.

Figure 3. *Asplenium nidus* L

2. *Microsorum* sp

Microsorum sp is an epiphytic fern that has fibrous roots. The color of the leaves is green, single-leaf, and lanceolate in shape, the edges of the leaves are flat and the tips of the leaves are tapered. Leaf stalks straight up. And the spores are located under the leaves.

Figure 4. *Microsorum* sp

3. *Microsorum* sp

Microsorum sp is an epiphytic fern that has fibrous roots. The color of the leaves is green, single-leaf, and lanceolate in shape, the edges of the leaves are flat and the tips of the leaves are tapered. Leaf stalks straight up and the spores are located under the leaves.

Figure 5. *Drynariaaquercifoliaa* (L) J. Sm.

4. *Davallia trichomanoides* Bl.

Davallia trichomanoides Bl. is an epiphytic species attached to tree trunks and other plants. It has fibrous roots with rhizomes that spread lengthwise, with the upper side being scaly and tightly arranged and red-

brown in color. The petioles are long and bright brown on the front side and black on the back. Triangular double pinnate leaves with a tapered tip and blunt base, jagged edges, slim texture, and green in color. Spores are found at the tips of the leaflets.

Figure 6. *Davallia trichomanoides* BL.

5. *Nephrolepis falcataa* (Cav.) C. Chr.

Nephrolepis falcataa (Cav.). C. Chr. is an epiphytic fern plant, with alternating leaf arrangements, serrated edges, and pointed ends. Stems are slightly brownish green, scales are brownish green, and chocolate Sorus.

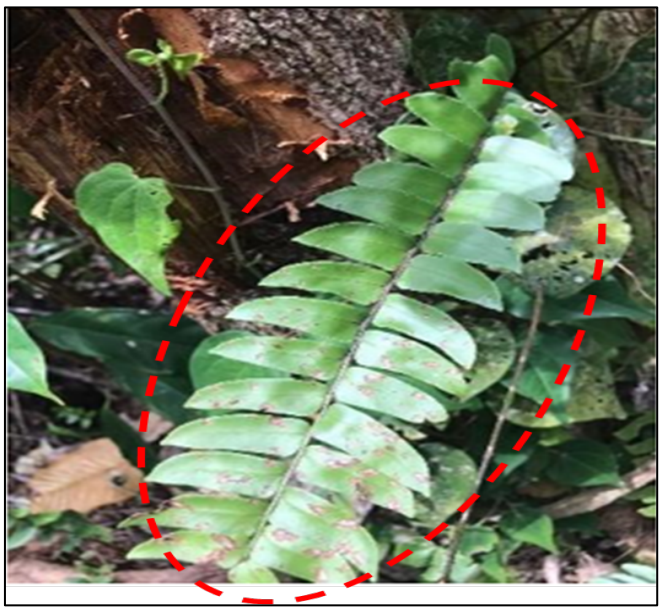

Figure 7. *Nephrolepis falcata* (Cav.) C. Chr.

6. *Microsorum punctatum* (L.) Couple.

Rhizomes are erect, short, single, lanceolate, rather fleshy, with a light green color, with wavy flat leaf edges, pointed base, pointed tip, and bright green smooth leaf surface. The sorus is found in the center of the leaf to the tip of a small round sorus.

Figure 8. *Microsorum punctatum* (L.) Couple.

7. *Drynaria arigidulaa* (Sw.). Bedd.

This species has supporting leaves with a length of ± 25 cm which are small and numerous. This species has both fertile and sterile leaves. Fertile leaves up to 1.5 m long with pinnate leaflets.

Figure 9. *Drynaria rigidula* (Sw.) Bedd.

8. *Dendrobium* sp.

Dendrobium sp herbaceous stature lives as an epiphyte. Has fibrous roots with rhizomes, and large stems, and contains food reserves. The shape is round, the direction of development of the stem is perpendicular, where a monopodial branching system and also the form of a segmented stem, a single fleshy leaf consisting of a vagina and lamina, the structure of leaf development is not parallel/the role of alternating leaves, leaf length 10.8-11.7 cm, width, 6 centimeters, the shape of the leaves, are oblong/oval. Tuberous stems. At the time of observation, no flowers were found.

Figure 10. *Dendrobium* sp.

Types of trees found in the Kali Bak Kampung Harapan area

Based on identification observations that have been carried out at the Kali Bak tourist spot in Harapan Sentani Village, Jayapura Regency, several plant species have been found that become hosts for epiphytes.

Table 3. Host tree species

Tree Type	Local name	Family
Alstonia scholaris (L.) R. Br.	Pulai	Apocynaceae
Calophyllum inophyllum L.	Bintangur	Clusiaceae
Gymnostoma papuana Miq.	Cemara gunung	Casuarinacea
Cycas rumphii Miq.	Pakis haji	Cycadaceae
Intsia bijuga (Colebr.) O.K.	Kayu besi	Fabaceae
Ficus virens Aiton.	Beringin putih	Moraceae

In a study conducted at the Kali Bak tourist spot in Kampung Harapan, it was found that the most common species was *Gymnostoma papuana* from the Casuarinaceae family, while the rare species was *Cycas rumphii* from the Cycadaceae family.

The results of the study at the Kali Bak tourist spot in Harapan Sentani Village, Jayapura Regency, showed that there were 38 individual trees with 6 species of epiphytic plants consisting of 6 families (Table 3). The data shows the composition and structure of plants with varying values for each species due to the different characteristics of each tree. Host tree species, relative density, relative frequency, relative dominance, and important value index in the Kali Bak Kampung Harapan tourism area.

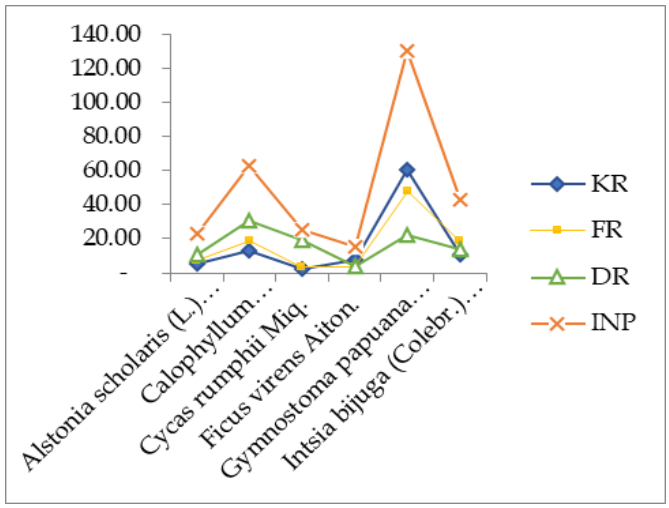

Figure 11. RD, RF, RDo, and IVI host trees

In a study conducted at the Kali Bak tourist spot in Kampung Harapan, it was found that the most common species, *Gymnostoma papuana* from the Casuarinaceae family, was 13 individuals, while the rare species, Cycas rumphii from the Cycadaceae family, was 1 individual.

The highest relative density was 60.53% from *Gymnostoma papuana*, followed by *Calophyllum inophyllum* at 13.16% and *Alstonia scholaris* at 5.26%. The difference in the densities of each species is influenced by their reproductive abilities, distribution, and efforts to adapt to the environment. The density value of a species shows the number of individuals in a certain unit area, thus the density value can describe the number of these species in the study area. The highest frequency value was obtained for the type of *Gymnostoma papuana* of 48.15%. *Gymnostoma papuana* is a species that has a high density and frequency, and a wide distribution in almost all research locations. The second highest frequency is *Intsia bijuga* and *Calophyllum inophyllum* with a frequency value of 18.52%. While the third highest frequency is *Alstonia scholaris,* and the fourth highest frequency is *Cycas rumphii*, *Ficus virens* with a frequency value of 3.70%. The highest relative dominance was 22.00% for the type of *Gymnostoma papuana*. Based on these data, the relative dominance value of the host tree can certainly affect the size of the

basal area of a species as well as the value of relative dominance. The lowest dominance value is found in *Ficus virens* at 3.72%. The highest IVI was found in the type of *Gymnostoma papuana*, namely 130.67%. The magnitude of the IVI shows the function of the species in the community.

Description of Host Tree Species

1. *Alstonia scholaris* (L.) R. Br.

Alstonia scholariss (L.).R..Br. is a medium to large tree with a height of 10-50 (-60) m and a trunk diameter of 20-80 (-130) cm. The bark is finely scaly or shallowly cracked and exfoliated in oblong, yellowish-brown, or light brown with white latex. Branches smooth or slightly rough, scaly, with thin or dense lenticels. Corky leaves or whorls with 4-8 (-9) leave. The petioles are glabrous and measure 5-20 (-25) x 1-2 (-3) mm. Leaf blade glossy and dark green, paler or green below, subcoriaceous when dry, narrowly elliptical to detach, (5-) 6-17(-22) x (1.5-) 2.5-7.5 (-8.5) cm. The ends of the leaves are blunt or rounded.

Figure 12. *Alstonia scholaris* (L.) R. Br.

2. *Calophyllum inophyllum* L.

Plant height reaches 20 m with a trunk diameter of 1.50 m. It has very short, low-branching stems near the ground, growing in groups. The leaf shape is an odd-pinnate compound with lanceolate leaves, the base of the leaf is tapered with a length of 10-12 cm and a width of 2.5 - 3 cm and the edges are flat. Unlimited compound interest. The fruit is round in shape with a tapered tip with a diameter of 22 cm. The seeds are protected by a green seed coat, brown when ripe.

Figure 13. *Calophyllum inophyllum* L.

3**.** *Gymnostoma papuana* Miq.

The tree height reaches 35-60 meters. Stem diameter 100-150 cm. Branch-free height of 10 meters. The main stem is straight, and cylindrical in shape. Sometimes with buttresses. The foliage consists of slender branches. Grows along rivers and rocky locations.

Figure 14. *Gymnostoma papuana* Miq.

4. *Cycas rumphii* Miq.

The body shape is somewhat similar to that of a palm but is not a true palm. It has a short and unbranched stem. It has compound leaves with pinnate strands. The leaves are arranged tightly in a spiral around the stem. Has a long taproot. Stem near the base of the root grows shoots which is a way of vegetative propagation.

Figure 15. *Cycas rumphii Miq.*

5. *Intsia bijuga* (Colebr.) O.K.

It can reach 50 mm in height with a branch-free stem of between 20 cm. Compound leaves consist of 2 pairs of leaflets which are round asymmetrically and have a blunt tip to bend, with a rounded base, bare and smooth surface, and long main leaf veins on the underside. Usually, the flowers are collected in bouquets at the terminal. Pods. Black seeds.

Figure 16. *Intsia bijuga* (Colebr.) O.K.

6. *Ficus virens* Aiton.

More than 30 m high, with a trunk diameter exceeding 1.8 m. The bark is smooth and gray with various ridges and lenticels (small pores) on the trunk. Fine little branches. The leaves are lanceolate ovate, thin leaves shiny green above and dull pale green below. The base of the leaf is slightly rounded. Flowers form syconium. The fruit is brown with red spots.

Figure 17. *Ficus virens* Aiton

Epiphyte diversity index

The calculation results show that the diversity index for each type of epiphyte in each observation plot is in a low category. While the calculation results for all species show that the diversity index of all species in all plots is 1.98. According to Barbour et al (1987) in Natalia (2019), this diversity is in the moderate category.

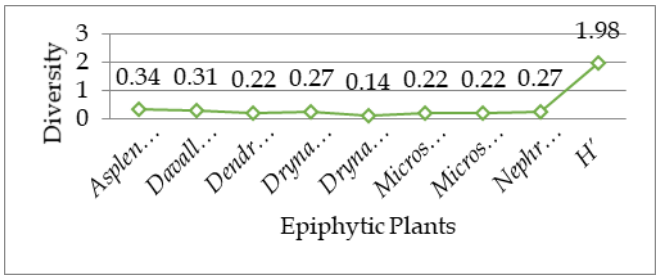

Figure 18. Epiphytic plant diversity

Host tree diversity index

The calculation results show that the diversity index for each host tree in the observation plot is in a low category. While the calculation results for all species show that the diversity index of all species in all plots is 1.26. If using the criteria of Barbour et al (1987) in Natalia (2019), the species diversity index of 1.26 is included in the medium category. The area of all observation plots affects the density value of each species. Table 4 shows that the type of *Gymnostoma papuana* is the species with the highest total relative density and frequency, namely RD 60.53% and RF 48.15% compared to other types found in the study area, this shows that the type of *Gymnostoma papuana* is distributed more in several plots

than other species. In addition, *Gymnostoma papuana* also has the highest relative dominance, namely RDo 22.00%.

Natalia (2019), said that the dominance value of each species is calculated on the basis of the diameter of the stem at breast height so that the amount of dominance is determined by the species density and the average size of the stem diameter. The type of *Gymnostoma papuana* has the highest dominance value because the natural distribution of this species is abundant in the study area compared to other species that have the same texture and hardness as Gymnostoma papuana. *Gymnostoma papuana* (130.67%), *Calophyllum inophyllum* (62.70%), *Intsia bijuga* (42.74%) were the species with the highest IVI.

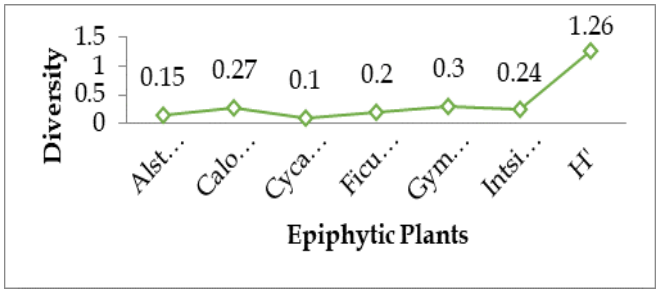

Figure 19. Host tree diversity index

IVI species in a community is an important indicator in showing the role of the species in the community. The greater the IVI value of a species, the greater the mastery of the community. If a species manages to occupy a large part of the resource compared to the others, then of course that species is more dominant.

Figure 20 shows that the IVI value at the research location is 130.67%. This value is included in the high category. According to Fachrul (2007), the categorization of IVI values is as follows: IVI > 42.66 is categorized as high, IVI is 21.96-42.66 moderate, and IVI < 21.96 is categorized as low. The magnitude of the IVI value also indicates the level of influence of a vegetation species on ecosystem stability.

Observations at the study site showed that epiphytes were more likely to attach to host plants that had a thick, grooved, and fibrous skin texture and hard skin. According to the opinion (Ewusie, 1990 in Nawawi et al, 2014) states that the skin of the host plant which has grooves and crevices will make it easier for the epiphytes to grow very fertile, while the skin of the host plant which is smooth or smooth can make it difficult for the epiphytes to attach.

Epiphytic stature is more common in host plants with hard skin because they are better able to maintain or attach epiphytic root bonds attached to the tree bark so that they can maintain the presence of epiphytes in these host plants. Lubis, (2009) in Nawawi et al, (2014) said that epiphytic ferns in the forest are very dependent on their host plants as a habitat and not as a source of food. Therefore, if the host plant has a soft bark texture, it can pose a threat to the epiphyte, because the host does not have the ability to support or maintain its roots.

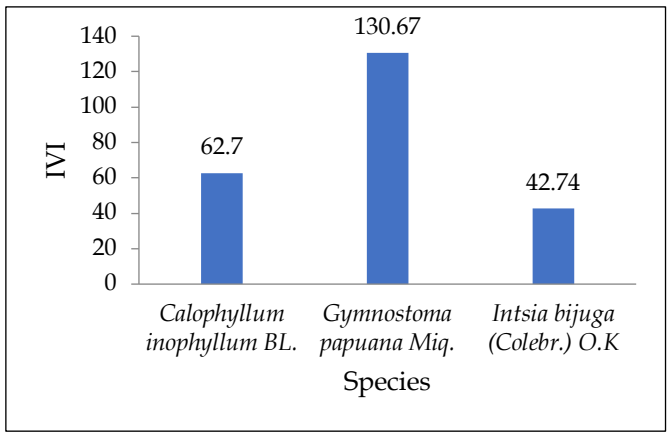

Figure 20. Highest host tree Important Value Index (IVI).

The species of *Gymnostoma papuana* prefer epiphytic plants as a place of life, one of which is the epiphyte Asplenium nidus. This is because Gymnostoma papuana has tree bark that has a hard texture, is grooved, fissured, or has cracks that make it easier for epiphytic plants to attach and grow on the tree. In addition, the intensity of sunlight also affects the presence of epiphytes on a host tree, where the epiphytic habitat is covered with trees and the sun's rays are low (rather shady), so the number of individual epiphytes is more found on the host tree.

Apart from light, there are also abiotic factors that affect epiphytic plants to grow on a host tree, namely temperature, humidity, and soil pH. The dependence between epiphytic ferns and their hosts is caused by air humidity because this factor supports the spore germination process. Humidity and temperature have a close relationship, where air humidity will be lower with decreasing temperature. Low temperatures will affect the growth of the tree canopy, the tree canopy will affect the quantity of oxygen and carbon dioxide in the air. The canopy can inhibit light intensity and cause the air temperature in the forest to become lower so that the air in the forest feels cool (Supu & Munir in Roziaty, 2016).

At the research location, it was found that the temperature in that place was 26^{o}C. According to Imaniar & Murdiyah (2017) ferns in the tropics generally grow with an optimal temperature range of 21-27^{o}C. Low temperatures result in high humidity, this is due to the low light intensity. Roziaty et al (2016) said that soil temperature ranges from 4.9^{o}C–6.8^{o}C where soil moisture is up to 20%-61%. In this climatic situation, it is very good for the development of nails. The distribution of fern species in tropical forest areas is highly dependent on the appropriate temperature.

The dependence of Asplenium sp on its host is influenced by the texture of the trunk of a tree species.

The number of individuals of each species found in a tree shows that the host is a suitable habitat for its survival. This is in line with research showing that generally old trees with rough bark are very good for the survival of epiphytic plants. This is related to epiphytic plant spores that fall in a suitable place and will be able to germinate and grow to form new epiphytic individuals (Shukla and Chandel, 1977 in Dharma 2017).

Suzuki et al, (1997) in Imaniar et al, (2017) said that *Asplenium nidus* is influenced by air humidity and host plant stratification. Stratification of host plants is an important thing that can have a major influence on the growth of epiphytic ferns on a tree. Nawawi et al (2014), added that most of the hosts favored by epiphyte ferns have thick, grooved, fibrous skin texture, have hard skin, and should be suspected as factors influencing the association between host plants (phoropyte) and their epiphytes. Shannon-Wiener species diversity index (H'). The first highest diversity index was *Asplenium nidus* (0.34), the second species was *Davallia trichomanoides* (0.31) and the third species was *Drynaria quercifolia* (0.27).

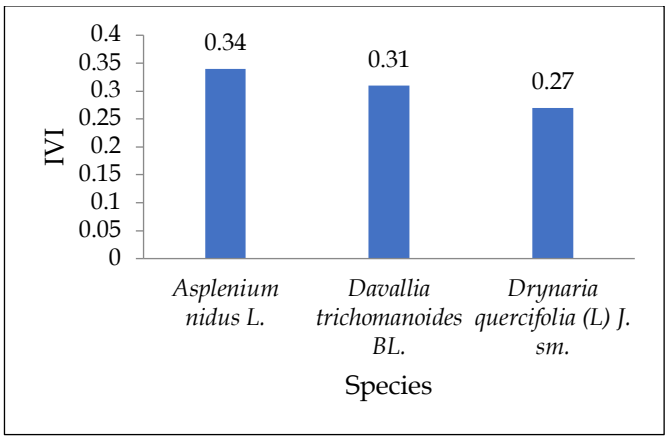

Figure 21. The highest epiphytic Shannon Wiener Diversity Index

The diversity of a plant community is influenced by the number of species and the number of individuals of each species. As explained by Indriyanto (2006) states that species diversity can serve to express community structure. Species diversity can be useful as an indicator of a stable community, namely having a level of ability to protect itself from threats.

The diversity index value describes the condition of the epiphytic species in the tourist area of Kali Bak Kampung Harapan. Vegetation diversity in the area is categorized as moderate (1.98) because in the area there are human activities such as plantations, tree felling, and even regional infrastructure development to serve as a tourist spot. When compared with the results of the form of landslides, sedimentation, flooding, and shortages of clean water downstream diversity in Natalia's research (2019), experienced a high level of diversity with a diversity index value of 3.77. High species diversity illustrates high productivity, balanced ecosystem conditions, and reciprocal relationships between flora and fauna in it. This is supported by Natalia's research (2019) which states that the dependence between Asplenium sp. and host trees that interact with each other so that the ecosystem remains balanced. The first highest diversity index was *Gymnostoma papuana* (0.30), the second species was *Calophyllum inophyllum* (0.27), and the third species was *Intsia bijuga* (0.24).

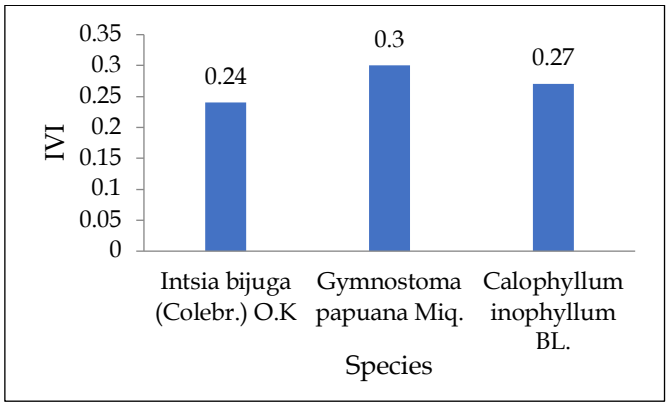

Figure 22. Highest host tree Shannon-Wiener Diversity Index

Handayani (2021) suggests that an area can be said to have high diversity if it has an even composition of species. Species diversity in the Kali Bak Kampung Harapan tourist area is categorized as moderate, this is due to the different and uneven number of host trees obtained for each species so that the total H' of all host trees is 1.26. The uneven number of host tree species in the Kali Bak Kampung Harapan tourist spot is indicated due to several disturbances that can cause damage. This disturbance, for example, is the behavior of some people who use the Kali Bak Kampung Harapan tourist area as plantation land which results in the trees in the area having to be cut down to be planted with homogeneous plants such as pineapples. The felling of these trees will also have an impact on the number of epiphytic plants in the area because it will be very difficult for epiphytic plants to survive without trees as their habitat (a place to grow).

This shows the interaction relationship of the various constituent components that are influencing. So that if there are components making up the area it is disrupted and has an impact on other components. One example is forest encroachment which disrupts the ecosystem in these tourist spots and results in the disruption of hydrological and ecological functions in

Epiphytic and host plants

Table 4. Types of epiphytic plants and their hosts

Epiphyte	Transect 1					Transect 2					Transect 3					Transect 4					Host Tree Transect 5				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Asplenium nidus	gp	cr	gp		gp				gp					gp	gp			gp	gp	gp					
Davallia trichomanoides						gp							fv			gp			as						
Dendrobium sp								gp		fv	as		gp												
Drynaria quercifolia																as			as			ib			
Drynaria rigidula																								as	
Microsorum sp						gp							gp												
Microsorum punctatum		as		as																	as	ci			
Nephrolepis falcata											gp		ci												

Information:
as: *Alstonia scholaris*
ci: *Calophyllum inophyllum*
cr: *Cycas rumphii*
fv: *Ficus virens*
gp: *Gymnostoma papuana*
Ib*: Intsia bijuga*

Conclusion

There were 5 families of 8 epiphytic species with a total of 44 individuals, which were found in 25 observation plots in the Kali Bak tourist area of Kampung Harapan, where the bird's nest fern (Asplenium nidus) species had the highest IVI of 54.99% while for host tree species there were 6 families of 6 species with a total of 38 individuals, with the highest IVI of 130.67% for mountain cypress (*Gymnostoma papuana*). The diversity index value for epiphytic species was 1.98 which was classified as moderate criteria and the diversity index for host trees was 1.26 which was classified as moderate criteria.

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