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Filicinae Taxonomic Diversity in the Tourism Area of Tretes Waterfall Wonosalam Kabupaten Jombang

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ABSTRACT

Filicinae is a fern with the most species members. The Filicinae includes approximately 170 genera and 7000 species. Filicinae grows in wet, humid, and shady environmental conditions, like waterfall areas with an altitude of 1100-1300 meters above sea level (m a s l). The study aimed to determine the taxonomic diversity of the Filicinae in the Tretes Wonosalam Waterfall Tourism area. Taxonomic diversity is very important in tourism areas because it prevents species extinction due to the destruction of the habitat, they live in. This was descriptive research with exploration and observation techniques used purposive sampling methods based on altitude. The results of the study were stated in the form of an inventory list of species and families of each station. Data gained of species diversity were analyzed using taxonomic diversity with the formula (Δ) and dominance diversity with the formula (Δ*). Exploration results found 37 species from 12 families composed of 10 species from 7 families at station 1; 12 species from 6 families at station 2; 14 species from 7 families at station 3; and 22 species from 12 families at station 4. The highest taxonomic diversity (Δ) was station 4 with 106.8 while the lowest for station 1 was 25.63. Dominance diversity (Δ*) at all stations in this study was in the medium category. The highest family found in the study was Tectariaceae with six species.

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INTRODUCTION

Filicinae (Pteridophyta) is one of the plants with high diversity and distribute widely in Indonesia. Ferns are distributed in tropical and subtropical regions, live terrestrial, epiphytes on tree surfaces, and at different altitudes (Sandy et al. 2016). There are approximately 10.000 known species of ferns in the world and approximately 1.300 species are found in Indonesia (Sandy et al. 2016). Among those numbers 515 fern species were found in Java Island (Darajati et al., 2016).

Filicinae is a class of Pteridophyta with the highest diversity. Filicinae is also known as true ferns. Filicinae has include approximately 170 genera and 7000 species (Nurchayati, 2016). The characteristics of the Filicinae are as follows macrophiles leaves with double pinnate compound types (Pranita et al. 2016); young leaves are coiled and sorus on the lower surface of the leaves (Sulasmi, 2017); some leaves, petioles and leaf branches are sometimes covered with a layer of scale-like hairs called palea (Sianturi et al., 2020).

The diversity of fern species is strongly influenced by indirect environmental factors, such as temperature, humidity, soil acidity (pH), altitude, and light intensity. The ideal temperature for the growth of ferns in tropical region is usually around 21–27 °C (Imaniar et al., 2017). Ferns prefer shady areas with a high humidity level. The percentage of humidity 30% is the lowest moisture value that fern can tolerate (Situmorang & Hasibuan, 2021). The range of 50-80% is the ideal humidity range for the growth of ferns (Lestari et al, 2020)

Besides to temperature and humidity, pH also influences the growth of ferns. Usually, the range of 5.5–6.5 is the ideal pH for ferns that live terrestrially in the forest (Sianturi et al. 2021). Ferns live well in shaded environment. Light intensity for good growth of ferns ranges from 117–1603 lux (Sandy et al. 2016). The ideal altitude for the growth of ferns is 1.100-1.300 m a s l (Lubis, 2009).

Ferns are part of biodiversity belonging to plant communities that have quite important ecological functions in forest ecosystems, such as ground cover vegetation, waste mixers for soil nutrient formation, and producers in the food chain (Anderson, 2021). Ferns also have a role as a direct blocker and suppressor of rainwater flow in steep and runoff area (Brock et al. 2016). In addition, ferns have potential as food and medicine also role as a source of germplasm (Suneetha et al. 2021).

One of the places where Filicinae can grow well is in the waterfall area. This is a green open area that has an ideal natural bioecology so that it can support various plant life, including Filicinae (Hussen et al. 2019). Fern's diversity in a green open space of the waterfall area includes Coban Rondo Waterfall Tourism Area, Malang Regency. There are 19 species of ferns that have high diversity (Efendi et al. 2013). For the amount of 24 species of ferns have moderate diversity in the Jurang Nganten Waterfall Tourism Area, Jepara Regency (Windari et al. 2021). The Huai Yang Waterfall National Park Tourism Area in Thailand has high diversity of ferns composed of 125 species (Yuyen & Boonkerd, 2002).

Species diversity is the diversity of organisms that live in the ecosystem area, such as land or water. Each species has different characteristics from other species. Species diversity is not only measured by the number of species in an area but also by taxon diversity (taxonomic groups, namely classes, orders, families, and genera) (Darajati et al. 2016). Diversity needs special attention to solve the basic problem of decreasing of biodiversity. This is because biodiversity is one of the basic conservation effort to prevent extinction so that species are maintained at this time until the future (Anderson, 2021). The number of individuals of each species of biodiversity always changes from year to year or from one place to another.

Taxonomic diversity is the overall variation of living things related to naming, characterizing, and classifying taxonomic diversity which is used as a conservation effort because diversity cannot be done if it has nothing to do with taxonomy (New, 1995). Taxonomy is not only used for naming and for grouping. It can also provide information about the basic characteristics of living things. An area that does not know what to protect, will not be able to become a conservation area because the character of organisme has not been identified yet (Anderson, 2021).

The role of taxonomy today is essential. Many studies on biodiversity emphasize the need to document natural assemblages as a basis for conservation (New, 1995). The role of taxonomy as a basis of functional ecology is not only in naming species but also focuses on the importance of taxonomic structures that create ecosystem functions (Cousins, 1994). Differences among organisms are the main of interactions that occur in ecosystems. As the correlation the task of taxonomy is to describe and relate those differences.

The lack of taxonomists leads to bias and underrepresentation of the species lists compiled. Taxonomy in translating biodiversity in terms of conservation by trying to explain how species between taxon are interrelated (Giangrande, 2003). The taxonomic diversity approach is used to manage and monitor species diversity from phylogenetic to functional diversity. Such approaches have been carried out on the use of taxonomic and phylogenetic diversity in conservation efforts (Bisby et al. 1995).

Tretes Waterfall is a waterfall tourist area located in Galengdewo Village, Wonosalam District, Jombang Regency, East Java. The Tretes Waterfall Tourism Area has a height of 170 meters and is located at an altitude of 1.250 m a s l (Dian, 2014). The altitude of the Tretes Waterfall area is an ideal place for various species of ferns, especially the Filicinae class to live and settle. Tretes Waterfall comes from the upstream of the Sumber Watu Bonakah river and has a beautiful natural panorama located on Mount Jurung Guah. Waterfalls that are used as tourist areas can lead to species extinction due to the destruction of the habitat they live in so biodiversity has decreased (Imaniar et al. 2017)

Based on this explanation, the Tretes Waterfall area has the potential as a habitat for Filicinae species to live and settle. However, until now there is no information about the diversity of Filicinae in the Tretes Wonosalam Waterfall Tourism Area. To correctly identify the presence of Filicinae in an area, it is necessary to carry out observation, exploration, collection, and identification activities regarding the taxonomic diversity of the Filicinae in the Tretes Waterfall Tourism Area. The need for this research is done see it relates to biodiversity.

Research on biodiversity is very important because its utilization and conservation cannot be done without scientific research (Suhartini, 2009). Thus, research on diversity, especially the diversity of Filicinae's taxonomy in the waterfall area, needs to be continuously developed so that the biological resources used can be used sustainably and can continue to coexist and be in line with nature.

MATERIALS AND METHODS

This research was a descriptive research with an exploration and observation technique. The main stages in this research included exploration, observation, collection, identification, and analysis of the diversity. Sampling was carried out in the Tretes Wonosalam Waterfall Tourism Area, located in Jombang Regency. Geographically, Tretes Wonosalam Waterfall was located at coordinates 7o46'20,867o to 7o46'41,543 south latitude and 112o23'3,485" to 112o24'23,804" east longitude (Figure 1).

The object in this study was the Filicinae species in Tourism area of Waterfall Tretes, Wonosalam, Kabupaten Jombang. Observations were made to obtain data related to growth type, morphological characteristics, and environmental factors of the Filicinae. Morphological characteristics composed of stature, leaves (includes type and shape); and sorus (includes arrangement, shape, and color) (Suryadi et al. 2020). Environmental factors carried out were measuring soil moisture and pH using a soil tester, light intensity using a lux meter, and temperature using a thermometer.

Determination of stations in this study were carried out by a certain method of consideration (purposive sampling), namely based on the presence of Filicinae. Determination of stations based on height or topography along the path to the waterfall (Coviello et al. 2015). The stations that had been determined are station 1 (960 m a s l), station 2 (1000 m a s l), station 3 (1100 m a s l), and station 4 (1200 m a s l) using elevation records (Pambudi & Roziaty, 2020). Each station used a rectangular plot with a size of 50 m x 5 m (Wardiah et al. 2019).

Sampling in the area around Tretes Waterfall starteds from the parking lot to the waterfall based on station placement **(Figure 2**). Specimen collection was carried out along the transect line with a specimen collection limit of 2 meters to the right and left and 1.5 meters if epiphytic spikes were found (Imaniar et al. 2017). The Filicinae species found in location were labeled the habitat was counted in the number of individuals (2 clump of ferns was counted as an individual) for each species. Filicinae specimens were collected for identification at the species level using the Flora of Malaya reference book (Holtum, 1968), Fern Diversity in East Java (Efendi & Iswahyudi, 2019), and the Fern Guide book (Sianturi et al. 2020).

RESULTS AND DISCUSSION

The results of exploration in the Tretes Wonosalam Waterfall Tourism Area at different altitudes had been identified and presented in the form of species and family's inventory (Table 1). Total identified Filicinae species were 37 species from 12 families. Station 1 covered 10 species belonging to 7 families, station 2 covered 12 species belonging to 6 families. Station 3 covered 14 species from 7 families, and station 4 covered 22 species from 12 families. Total families found including 12 families from two orders, namely Cyatheales and Polypodiales. Cyatheales consisted of Cycatheaceae family while the order Polypodiales consisted of families, such as Pteridaceae, Aspleniaceae, Athyriaceae, Dryopteridaceae, Thelypteridaceae, Lamariopsidaceae, Davalliaceae, Polypodiales, Tectariaceae, Dennstaeditiaceae, and Neprolepidaceae.

Based on Table 1, the results of the study found various Filicinae from four station. Family with the highest species diversity was Tectariaceae with six species, while the highest diversity of genus was *Tectaria* with five species. The highest diversity of Filicinae species was found at station 4 (1200 m a s l) with 22 species, while the lowest diversity was at station 1 (960 m a s l) with 10 species. Two other stations, namely station 2 (1000 m a s l) and station 3 (1200 m a s l) had 12-14 species of Filicinae diversity.

Each station showed different and unique families and species characteristics. Two stations had distinctive families, namely Cyathaeceae family at station 1 and Lomariopsidaceae, Neprolephidaceae, and Dennstaeditiaceae families at

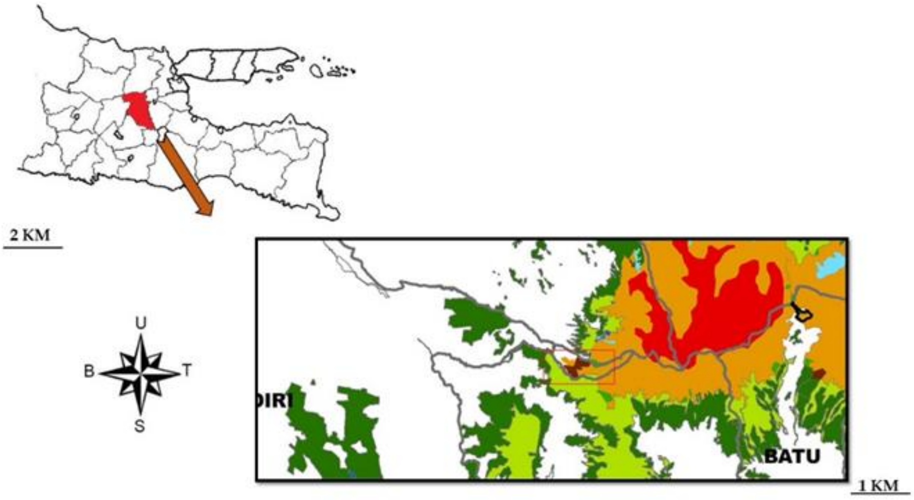

Figure 1. Research Area Map (Source: UPT Tahura)

Figure 2. Research Station Placement Map, : Pick-up point with an altitude of 960 m above sea level; : Pick-up point at an altitude of 1000 m above sea level; : The pick-up point is at an altitude of 1100 m above sea level; : Point of elevation 1200 m above sea level; : Parking area; : River; : Waterfall; : Footpath

Filicinae species diversity was analyzed using taxonomic diversity which is obtained from the formula Δ (1) and dominance diversity from the formula Δ* (2) (Warwick & Clarke, 1995) (Braun, 2015).

Taxonomic Diversity Formula (Δ)

$$\Delta: \left[\sum j = 1, \ldots, n \sum i < j \ \omega_{ij} X_i X_j \right] / \left[n\,(n - 1)/2 \right] \ \ldots\ldots.. (1)$$

Information:

Δ = Taxonomic Diversity

ω_{ij} = Representation of the link between the two species in a hierarchical classification

ω_1: Genera with different species

ω_2: Families with different genera

ω_4: Class and order

n = Total number of individuals in the sample

XiXj = Species abundance indicator

The criteria for taxonomic diversity are divided into three categories, namely the low category ($\Delta < 26.06$); the medium category (26.06 – 69.07); and the high category ($\Delta > 69.07$) (Sirait et al. 2018).

Dominant Diversity Formula (Δ*)

$$\Delta^* = \left[\sum j = 1, \ldots, n \sum i < j \ \omega_{ij} X_i X_j \right] / \left[\sum_j = 1, \ldots n \sum_{i<j} X_i X_j \right] \ldots\ldots (2)$$

Note:

Δ* = Dominance of diversity

ω_{ij} = Representation of the link between the two species in a hierarchical classification

ω_1: Genera with different species

ω_2: Families with different genera

ω_4: Class and order

N = Total number of individuals in the sample

XiXj = Species abundance indicator

The criteria for dominance diversity are divided into three categories, namely low (Δ* < 3.0); medium (3.1 – 6.0); and height (Δ* > 6.1) (Wahyuningsih et al. 2019)

Table 1. Inventory of Filicinae in Tretes Waterfall Tourism Area

No.	Species Name	Families	Orders	Station			
				1	2	3	4
1	*Adiantum capillus-veneris* L.	Pteridaceae		√			
2	*Asplenium adiantum-nigrum* L.	Aspleniaceae		√			
3	*Asplenium excisum* C. Presl.						√
4	*Athyrium accendens* (BIume) Milde.					√	
5	*Athyrium asperum* (Blume) Milde.	Athyriaceae					√
6	*Athyrium esculentum* (Retz.) Copel.		Polypodiales		√		√
7	*Athyrium filix-femina* (L.) Roth.	Dryopteridaceae					√
8	*Athyrium procumbens* (Holttum)	Athyriaceae			√		√
9	*Bolbitis heteroclita* (C. Presl) Ching.	Dryopteridaceae			√	√	√
10	*Chingia clavipilosa* Holttum	Thelypteridaceae				√	
11	*Christella dentata* (Forsk.) Brownsey & Jeremy						√
12	*Cyathea contaminans* Copel	Cyatheaceae	Cyatheales	√			
13	*Cyathea squamulata* (BIume) Copel.			√			
14	*Cyclopeltis crenata* (Fee) C. Chr.						√
15	*Davallia canariensis* (L.) Sm.	Lomariopsidaceae				√	
16	*Davallia denticulata* (Burm.f.) Mett. ex Kuhn.	Davalliaceae			√		
17	*Davallia Trichomanoides* BIume			√			
18	*Dryopteris carthusiana* (Vill.) H. P. Fuchs	Dryopteridaceae			√		
19	*Dryopteris concolor* (Langsd. & Fisch.) Kuhn	Pteridaceae					√
20	*Dryopteris cycadina* (Franch. & Sav.) C. Chr.	Dryopteridaceae				√	
21	*Goniophlebium sobauriculatm* (BIume) C. Presl.	Polypodiaceae				√	√
22	*Heterogonium sagenoides* (Mett.) Holt.	Tectariaceae			√	√	
23	*Loxogramme involuta* (D. Don.) C. Presl.	Polypodiaceae				√	
24	*Macrothelypteris torresiana* (Gaudich.) Ching	Thelypteridaceae	Polypodiales	√	√	√	√
25	*Microlepia speluncae* (L.) T. Moore.	Dennstaeditiaceae					√
26	*Nephrolepis biserrata* (Sw.) Schott	Nephrolepidaceae					√
27	*Phegopteris connectilis* (Michx.) Watt	Thelypteridaceae					√
28	*Pteridium aquilinum* (L.) Kuhn	Dennstaeditiaceae					√
29	*Pteris biaurita* L.			√	√		√
30	*Pteris fauriei* Hieron.	Pteridaceae				√	
31	*Pyrrosia adnascenes* (Sw.) Ching.	Polypodiaceae		√			
32	*Sphaerostephanos heterocarpus* (Blume) Holt.	Thelypteridaceae					√
33	*Stenosemia aurita* (Sw.) C. Presl			√	√	√	√
34	*Tectaria inges* (Atk.) Holt.				√	√	
35	*Tectaria melanocaula* (Blume) Copel.	Tectariaceae					√
36	*Tectaria multicaudata* (Wall.) Ching.			√	√	√	√
37	*Tectaria vasta* (Blume) Copel.				√	√	√

station 4. Each station also had a special species. Station 1 contained six typical species including *A. capillus-veneris*; *A. adiantum-nigrum*; *C. contaminants*; *C. squamulata*; *P. adnascenes* and *D. trichomanoides* (Fig. 3). There were to distinct species at station 2, namely *D. denticulata* and *D. carthusiana* (Figure 4). Station 3 contained six typical species including *A. accendens*; *C. clavipilosa*; *D canariensis*; *D. cycadina*; *L. involuta* and *P. fauriei* (Figure 5). Station 4 contained 12 species with distinctive characters

Figure 3. Characteristics of species at station 1 consisting of *A. adiantum-nigrum* species; *C. contaminants*; *P. adnascenes*; and *D. trichomanoides. A. adiantum-nigrum* has an elongated brown sorus arranged parallel to it. *C. contaminans* contained round brown sorus arranged in regular rows adjacent to the mother leaf bone. *P. adnascenes* has an epiphytic habitat, the sterile leaves are short, oblonand g while the fertile leaves are long like ribbons. *D. trichomanoides* is an epiphytic fern with double pinnate compound leaves.

Figure 4. Characteristics of station 2 species which consist of two species. the first species *D. denticulata* epiphytes habitat, double-pinnate compound leaves. Sorus goblet-shaped yellowish that was located at the edge of the leaf and appears at the tip of the leaf veins. The second species, *D. carthusiana*, was a terrestrial and compound-leaved. Sorus round yellowish arranged scattered in the middle of the veins on the lower surface of the leaf.

Figure 5. Characteristics of station 3 species consisting of two species, namely *A. accendes* and *D. canariensis. A. accendens* has a terrestrial habitat and has compound leaves. The sorus are yellowish stripes, inditium and arranged along the entire length of the leaf veins. *D. canariensis* has an epiphytic habitat, double pinnate compound leaves. Sorus goblet-shaped (convex) yellowish which was located at the edge of the leaf and appears at the tip of the leaf veins.

Figure 6. Characteristics of station 4 species which consist of three species. the first species is *S. heterocarpus* which has a terrestrial habitat with pinnate compound leaves. The sorus are round or almost round brown, arranged in parallel in two rows located on each leaf vein, approaching the midrib of the leaf. The second species, *M. speluncae*, has a terrestrial habitat and has compound leaves. Sorus are round brown in shape arranged in parallel which is located under the leaf surface near the notch or leaf lobe. And the third species is *A. asperium* which has a terrestrial habitat and has compound leaves with alternating leaflets. Sorus is a brown line that is located almost throughout the leaf veins, from the base to the middle or near the leaf edge and has a thin indusium.

Table 2. Taxonomic diversity and dominance diversity of Filicinae in Tretes Waterfall Tourism Area

Stations	Taxonomic diversity	Category	Dominance diversity	Category
Station 1 (960 m a s l)	25.63	Low	3.80	Medium
Station 2 (1000 m a s l)	28.23	Medium	3.58	Medium
Station 3 (1100 m a s l)	63.04	Medium	3.68	Medium
Station 4 (1200 m a s l)	106.8	High	3.84	Medium

Note: station 1: 1= 1, 4= 4; station 2: 1= 1, 2= 2, 4=4; station 3: 1= 1, 2= 2, 4=4; and stasion 4: 1= 1, 2= 2, 4=4

Table 3. Abiotic factors of each research station

	Abiotic factors			
	pH	Temperature	Humidity	Light intensity
Station 1 (960 m a s l)	5.6	22 °C	40%	3320 lux
Station 2 (1000 m a s l)	6.1	21.7 °C	45%	2500 lux
Station 3 (1100 m a s l)	6.4	21°C	49%	1742 lux
Station 4 (1200 m a s l)	6.5	21°C	65%	397 lux

The results of data analysis showed that the calculation at station 1 only used two types of omega, namely $\omega_1 = 1$ and $\omega_4 = 4$ so the diversity was lowest. This is because station 1 there were no species belonging to the same family with different genera. However, for the rest stations the calculation used all types of omega, because each station contained species belonging to one family with different genera so the diversity was various from medium to high.

Based on Table 2, the highest diversity value was shown at station 4 by the amount of 106.8 with 22 species, while the lowest was at the station 1 by the amount of 25.63 with 10 species. The dominance diversity value obtained at all stations was included in the medium category (between 3.1 – 6.0). The highest score was obtained at the station 4 by the amount of 3.84, while the lowest value was obtained at the station by the amount 2 of 3.58. The determination of high and low diversity was based on the use of ω value. The greater ω value, the higher the diversity, and vice versa.

Table 3, it could be seen that the highest soil pH was station 4, which is 6.5 and the lowest was at station 1, with the score of 5.6. The highest ambient temperature was the station 1 at 22^{o}C and the lowest temperature was the station 3 and station 4 at 21^{o}C. The highest humidity was at station 4 was at the station 4 reaching the amount of 65% while the lowest humidity was at the station 1 by the amount of 40%. The highest light intensity was at station 1 of 3320 lux and the lowest light intensity was at station 4 of 397 lux.

Based on the results of observations, explorations, collections, and identifications, 37 species of Filicinae from 12 families were found. The family consists of families Cycatheaceae, Pteridaceae, Aspleniaceae, Athyriaceae, Dryopteridaceae, Thelypteridaceae, Lamariopsidaceae, Davalliaceae, Polypodiales, Tectariaceae, Dennstaeditiaceae and Neprolepidaceae. This proved that Tretes Waterfall Tourism Area was ideal for the growth and development of Filicinae since abiotic conditions (pH, temperature, humidity, and light intensity).

The Filicinae species in the Tretes Wonosalam Waterfall Tourism Area were mostly ferns lived in terrestrial habitat. In line with the results of research by Pranita et al. (2016), the Filicinae species in the Watu Ondo Waterfall Area most commonly found were terrestrial ferns with nine species when compared to four species of epiphytic ferns. The results of Asri's research (2020), showed that the fern species that grow in the Joben Montong Gading Tourism Area, East Lombok Regency, mostly had a terrestrial habitat compared to epiphytes. The lack of habitat for epiphytic plants was found because there were few trees that could be used as host trees for the attachment of ferns. Most of the trees found in this area had a dry texture, such as *Brugmansia sauveolens*, while ferns prefered trees with a rough texture and thick skin. Confirming to Harrington & Watts (2021), that usually the host plants favored by ferns are tree plants that have a thick, grooved and, stringy texture, and have hard skin which is thought to come from the influence of the association between the host plant and its epiphytes.

Species diversity was a community-level characteristic that corresponds to its biological organization. The high diversity of species proved that the community in an area has high complexity. This is because of very high reciprocal relationship between species in the community. According to Schweiger et al. (2018), diversity was used to express the level of species diversity in a particular area. The more the number of species, the higher the diversity. Conversely, the fewer the number of species, the community was only dominated by one or a few species (Odum, 1996). Species diversity was also influenced by the distribution of individuals within each species because even though a community had many species, the distribution of individuals was not evenly distributed, so the diversity was low (Efendi et al. 2013).

The highest taxonomic diversity was at station 4, which was 106.8 including 22 species belonging to 12 families. The high diversity was due to the environmental conditions (Table 3) in the Tretes Wonosalam Waterfall Tourism Area which were very supportive for the growth and development of the Filicinae. The altitude at station 4 (1200 m a s l) also affected the diversity of ferns. This was in line with the research of Nugroho & Roziaty (2020), in the Girimanik Forest Area of Central Java that station 1 with an altitude of 1200-1300 m dpl found the most species compared to station 2 with an altitude of 1350-1500 m a s l. Station 1 (1200 – 1300 m a s l) found 15 species while station 2 (1350 – 1500 masl) had 13 species of ferns. As explained by Lubis (2009), the highest diversity was at altitude of 1100-1300 m a s l when compared to an altitude of 1300-1500 m a s l and 1500-1750 m a s l. However, research conducted by Sandy et al. (2016) in the Lawean Sendang Waterfall area, Tulungagung Regency showed different results, at the initial location of the study (1109 m a s l) more fern species were found than at the final location of the study (1225 m a s l). The initial location of the study (1109 m a s l) found 16 species of Filicinae and 1 species of Lycopodiinae while at the last location of the study (1225 m a s l) found 4 species of Filicinae and 1 species of Lycopodiinae. Sandy et al. (2016), stated that the higher the research location, the more homogeneous and less numerous fern species were found.

The lowest taxonomic diversity was at station 1, which was 25.63 with 10 species from 7 families. Station 1 (960 m a s l) was an area that mostly used as a parking area. It caused Filicinae difficult to grow in this area. In line with the research of Imaniar et al. (2017), in Kapas Biru Waterfall Area, Lumajang Regency that station 1 (630 m a s l) which functioned as parking area had the least number of species compared to station 2 (593 m a s l) and station 3 (521 m a s l). There were 9 Filicinae species out of 30 species. In line with the research of Mila et al. (2021), that the low diversity of ferns in the Matalawa National Park area on the island of Sumba was strongly influenced by human activities and environmental factors. Nugroho & Roziaty, (2020), said that the felling of trees due to the change of functioning in a tourist area caused the reduction of ferns existence.

The diversity of Filicinae dominance species in all research stations had been classified to moderate, which was in the range (Δ^*) = 3.58–4.84. In line with Sari & Bayu research (2019), the diversity of dominance in the Benua Forest Area of Hulu Sungai Tengah Regency had a medium dominance diversity of 39.90. Astuti et al. (2018), argued that the few species or at least the dominant species in a community, the dominance diversity could be said as low. Conversely, the abundance of species with the same or nearly the same number in a community could be started as high dominance diversity. Efendi et al. (2013), added that the more extreme environmental conditions, such as the increasing climate, soil, or altitude, the less diversity of species composition in vegetation, and one or two species would be more dominant.

The family that had the highest number of species was Tectariaceae with six species. In line with the research of Mila et al. (2021), the high number of Tectariaceae species in the Matalawa National Park area was ninety-two individuals because this family had good adaptation to various environmental conditions. The Tectariaceae included 20 genera and 400 species distributed throughout tropical region (Wang & Wu, 1999), and some species extended north and south of temperate regions (Brownsey & Perrie, 2014). The Tectariaceae family was a terrestrial fern, with single to compound leaves, and a round sorus located on the underside of the leaves with different indusium (Fuwu et al. 2013).

The Cyatheacae family was a characteristic of the family at station 1 that was not found in other stations. Station 1 (960 m a s l) has a high light intensity of 3320 lux. In line with the research of Hanum et al. (2014), the *Cyathea* genera in Bali was found at an altitude of 200-1600 masl. According to Dong (2009), most of the Cyatheaceae family grows under all kinds of conditions, especially light intensity and wind speed. Other family characteristics, Lomariopsidaceae, Neprolephidaceae, and Dennstaeditiaceae families, were found at station 4. The three families were only found at station 4 because most of the species were only able to live in certain environmental different conditions at each station cause each station to had species characteristics. One of the specific characteristics of each station was a species of *C. contaminans* with tree stature, and double pinnate compound leaves at the station 1. Round brown sorus was arranged in regular rows adjacent to the mother leaf bone (Hanum et al. 2014). Station 2 containeds species of *D. carthusiana* with herbaceous stature and compound leaves. Yellowish round sorus arranged scattered in the middle of the veins on the lower surface of the leaf (Efendi & Iswahyudi, 2019). Station 3 containeds the species of *A. accendens*, which is herbaceous and had compound leaves, the sorus was in the form of a yellowish line, had an indusium, and arranged along the entire length of the leaf veins (Efendi & Iswahyudi, 2019). Station 4 containeds a species of *M. speluncae* with herbaceous stature and compound leaves. Sorus was brown with indusium and located in each leaf groove (Hidayah et al. 2021).

The existence of the Filicinae species in Tretes Wonosalam Waterfall Tourism Area needed to be protected. One of the efforts to protect its sustainability was to find out the conservation status of the Filicinae species. Based on the search results through the IUCN Red List (2022), all Filicinae species obtained in the Tretes Wonosalam Waterfall Tourism Area had a conservation status that was still safe or not at risk of being threatened with extinction. The number of Filicinae species obtained based on exploration is 37 species with

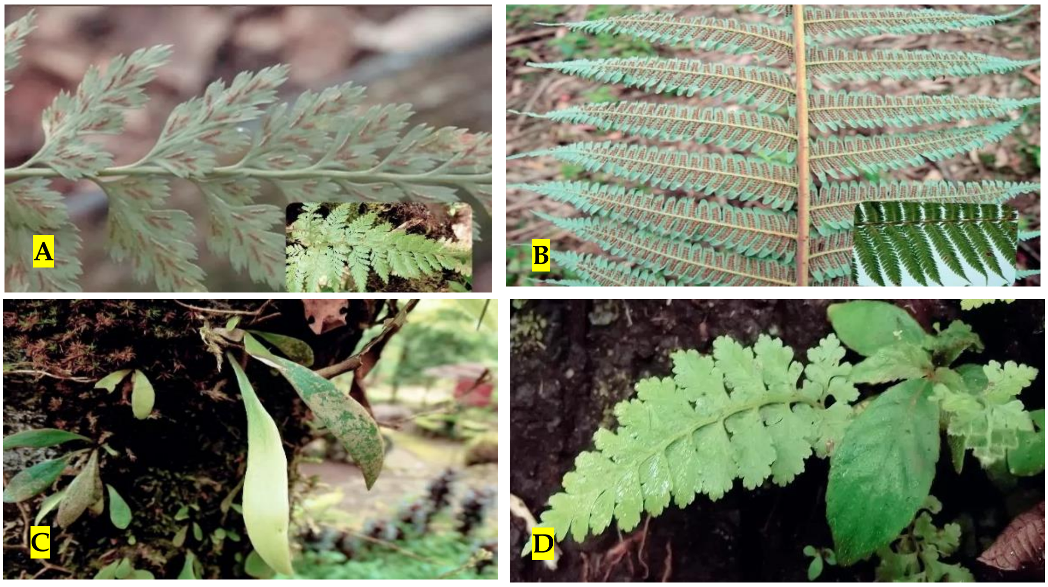

Figure 3. Species characteristics at station 1, A. Sorus *A. adiantum-nigrum*; B. Sorus *C. contaminans*; C. *P. adnascenes*; and D. *D. Trichomanoides*

Figure 4. Characteristics of species at station 2, A. Sorus *D. denticulata* and B. Sorus *D. carthusiana*

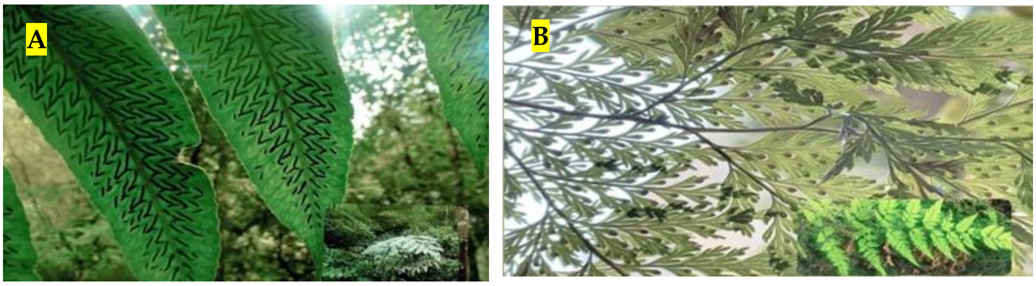

Figure 5. Characteristics of station 3 species, A. Sorus *A. accendens* and B. Sorus *D. canariensis*

Figure 6. Characteristics of station 4 species, A. Sorus *S. heterocarpus*; B. Sorus *M. speluncae*; and C. Sorus *A. asperus*

high diversity category. However, the Filicinae species that existed in the area must be preserved order to prevent increasing of the Red List status in the future. The biodiversity of plants in an area has a strategic role in controlling environmental crises. This was because the abilities possessed could be used as staples and treatment for the community and also the role of the environment was used to balance the ecological system (Robinson et al. 2013).Ecosystems and biological natural resources had functions and benefits as elements of the formation of environment formation and their existence was the most important part of natural resources. Therefore, efforts to conserve living natural resources and their ecosystems needed to be maintained for the present and the future because their nature and role were significant and cannot be replaced for life (Suhartini, 2009).

CONCLUSION

Based on the results of research in Tretes Wonosalam Waterfall Tourism Area, it could be concluded that there was a total of 37 Filicinae species belonging to 12 families with the acquisition of species per station as follows: ten species with seven families at station 1; twelve species with six families at station 2; fourteen species with seven families at station 3; and twenty-two species with twelve families at station 4. The highest taxonomic diversity (Δ) was obtained at station 4 of 106.8 while the lowest was obtained at station 1 of 25.63. The dominance diversity (Δ*) obtained in all research stations was categorized as moderate, ranging from 3.58 to 4.84. The highest family found in the study was Tectariaceae with six species.

The Tretes Wonosalam Waterfall Tourism Area has potential as a Filicinae habitat as evidenced by the level of taxonomic diversity of Filicinae which is included in the high to low category with dominance diversity in the medium category. Nevertheless, the diversity of Filicinae in the Tretes Wonosalam Waterfall Tourism Area needs to be preserved so that it does not extinct in the future. Efforts to preserve the diversity of the Filicinae are crucial because it has a big and irreplaceable role for life.

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