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SORUS MORPHOLOGY IN FERNS OF THE *Polypodiaceae* AND *Tectariaceae* FAMILIES IN THE ATO WATU WATERFALL AREA, AMONGGEDO DISTRICT

Morfologi Sorus Tumbuhan Paku Keluarga *Polypodiaceae* dan Keluarga *Tectariaceae* di Kawasan Air Terjun Ato Watu Kecamatan Amonggedo

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ABSTRACT
This study aims to determine the shape, color, and location of sori as well as the presence or absence of annulus in ferns (Pteridophyta) of the Polypodiaceae and *Tectariaceae families* in the Ato Watu Waterfall area, Amonggedo District, Konawe Regency, Southeast Sulawesi. The method used in this study was qualitative descriptive research with an exploratory method by exploring the Ato Watu Waterfall area to collect fern samples that had sori. The results of the study found six species of ferns in the *Polypodiaceae family*, including *Drynaria quercifolia* (L.), J, *Lemmaphyllum accedens* (Blume), *Leptochilus henryi* (Baker) X.C.Zhang, *Microsorum membranifolium* (R.Br.) Ching, Pyrrosia longifolia (Burm.fil.) C.V.Morton, Selliguea heterocarpa Bl., Fl. Jav (Mehltreter, et al., 2010: 835-838) And 5 species of ferns from the *Tectriaceae family*, including *Tectaria angulata* (Sw.) S. *Chandra*, *Tectaria aurita* (Sw.) S. *Chandra*, *Tectaria barberi* (Hook), *Tectaria devaxa* (Kze) *Copel*, *Tectaria fuscipes* (Wall. ex Bedd) C. Chr,. Of the 6 species of the *Polypodiaceae family*, 5 species of the *Tectariaceae family* found, they have different sorus characteristics, and each species has an annulus (Shin & Keun, 2017: 317-320).

Keywords: *Polypodiaceae and Tectariaceae families, sorus morphology, Pteridophyta*

ABSTRAK
Penelitian ini bertujuan untuk menentukan bentuk, warna, dan lokasi sorus serta keberadaan atau ketidakberadaan annulus paku (*Pteridophyta*) pada *famili Polypodiaceae* dan *Tectariaceae* di kawasan Air Terjun Ato Watu, Kecamatan Amonggedo, Kabupaten Konawe, Sulawesi Tenggara. Metode yang digunakan dalam penelitian ini adalah penelitian deskriptif kualitatif dengan metode eksplorasi dengan menjelajahi kawasan Air Terjun Ato Watu untuk mengumpulkan sampel tumbuhan paku yang telah memiliki sorus. Hasil penelitian menemukan 6 spesies tumbuhan paku dalam famili *Polypodiaceae*, termasuk *Drynaria quercifolia* (L.), J, *Lemmaphyllum accedens* (Blume), *Leptochilus henryi* (Baker) X.C.Zhang, *Microsorum membranifolium* (R.Br.) *Ching*, *Pyrrosia longifolia* (Burm.fil.) C.V.*Morton*, *Selliguea heterocarpa* Bl., Fl. Jav (Mehltreter, et al., 2010: 835-838) Dan 5 spesies tumbuhan paku dari keluarga *Tectriaceae*, termasuk *Tectaria angulata* (Sw.) S. *Chandra*, *Tectaria aurita* (Sw.) S. *Chandra*, *Tectaria barberi* (Hook), *Tectaria devaxa* (Kze) Copel, *Tectaria fuscipes* (Wall. ex Bedd) C. Chr, Dari 6 jenis keluarga *Polypodiaceae*, 5 jenis keluarga *Tectariaceae* yang ditemukan memiliki karakteristik sorus yang berbeda, dan setiap jenis memiliki annulus (Shin & Keun, 2017: 317-320)

Kata Kunci: *Famili Polypodiaceae dan Tectariaceae, Morfologi Sorus, Pteridophyta*

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INTRODUCTION

Southeast Sulawesi is a province with extensive forest areas. Konawe is one of 17 districts/cities in Southeast Sulawesi Province, famous for its various waterfalls, one of which is the Ato Watu waterfall located in Amonggedo District, Konawe Regency, Southeast Sulawesi. This area has very high biodiversity, one of which is ferns (*Pteridophyta)*. This is due to the cool and humid environmental conditions, as well as the tall trees that grow there, making it a suitable habitat for ferns (*Pteridophyta)*. Ferns (*Pteridophyta)* are plants whose life cycle begins when spores fall in a suitable place, where they develop into prothallia, which are gamete-producing generations (Tjitrosoepomo, 2015: 210).

The *Polypodiaceae* family has the following characteristics epilithic, and only some are terrestrial. The leaves can be simple or compound, with young leaves that are rolled up (circular), the edges of the leaves are usually straight and wavy, and the veins are free (*reticulate*). The sori are shallow, oval, round, and usually elongated (*acrostoic)*, scattered across the entire or part of the underside of the leaf, located parallel to the veins and between the veins. The spores are bilateral, rounded (*monolete)*, smooth (*verrucose)*, *tuberculate,* or *spinulose.* (Negi, et al., 2009: 48). The *Tectariacea* family has morphological characteristics, with erect to creeping rhizomes, stems covered with scales, single to double pinnate leaves, round sori scattered on the underside of the leaves, and some species located along the leaf veins arranged in rows (Jayanti, 2020: 50). Many types of ferns have diverse sorus morphology. This sorus morphology includes shape, color, location of the sorus, and the presence of an annulus on the sporangium, which is a very important identifying feature. The environment plays an important role in the process of sorus rupture in ferns. The location and shape of sorus in ferns vary, ranging from sorus located at the edge or near the edge of the leaf, to those located on the leaf veins, in the form of lines, elongated, and round (Tjitrosoepomo, 2007: 213).

Sorus is part of the reproductive system of ferns that plays an important role in protecting spore cases. A collection of sori is called a sori, and inside the sporangium there are a number of covering cells called annulus (ring-shaped and thick-walled). When the annulus dries, the cells shrink and the sporangium breaks, releasing the spores (Kalsum & Hanin. 2022: 86).

Previous research has shown that there are several types of ferns (*Pteridophyta*) in the Ato Watu Waterfall area, Amonggedo District, Konawe Regency, Southeast Sulawesi. A total of 49 fern species were found, of which were identified to the species level and 1 species was only identified to the family level, namely *Polypodiaceae*. The fern plants found are divided into 9 orders, 21 families, and 32 genera, with 44 types of terrestrial fern plants and 6 types of epiphytic fern plants (Sidik, et al, 2019 93 & 97).

Based on observations conducted in the Ato Watu waterfall area, various types of ferns were found, including the *Tectariacea* and *Polypodiaceae* families with different sorus characteristics. However, to date, there is no clear data or information regarding the characteristics of the sori in these two families in the area. Therefore, it is necessary to identify the different characteristics of the sori in the *Tectariaceae* and *Polypodiaceae* families so that they can be used as a reference in monitoring biodiversity, especially ferns.

The morphological differences in sori among each fern plant, and the large number of fern species from each family found in the Ato Watu Waterfall area, as well as the lack of previous research conducted to determine the morphology of fern sori in the *Polypodiaceae* and *Tectariaceae* families*,* it is necessary to conduct research entitled "Morphology of Fern Sori in the *Polypodiaceae* and *Tectariaceae* Families in the Ato Watu Waterfall Area, Amonggedo District."

MATERIAL AND METHODS

This research was conducted from August to November 2023 in the Ato Watu Waterfall area, Amonggedo District, Konawe Regency, Southeast Sulawesi. The type of research used was qualitative descriptive research using the exploration method, which involved exploring the Ato Watu Waterfall area and taking samples of *Polypodiaceae* family ferns that had visible sori on the underside of their leaves. The exploration area started from the top of the waterfall to the bottom of the waterfall by following the river flow. Then, the ferns were identified by observing the morphology of each sorus based on the following criteria: black or brownish sporangia located under the leaf surface. The *Polypodiaceae* family has the characteristics of being epiphytic, with single or compound leaves, usually straight and wavy lamina edges, and reticulate veins. The sori are shallow, oval, round, and usually elongated (acrostoic), scattered across the entire or partial underside of the lamina, located parallel to the leaf veins, at the tips of the leaves and between the leaf veins. Meanwhile, the *Tectariacea* family has leaflets located at the bottom of the leaf stalk extending downward in a ribbon-like shape, with flat edges and coarse serrations. The sorus is round and brown in color, located under the leaf surface, and in some species, it is located along the leaf veins arranged in a single row. The indicators in this study were the location of the sorus, the color of the sorus, the shape of the sorus, and the presence or absence of an annulus on the sporangium of ferns in both families at the Laboratory of the Department of Biology Education, Faculty of Teacher Training and Education, Halu Oleo University, Kendari. The data from this study were processed and analyzed descriptively.

The research location map can be see in Figure 1 below:

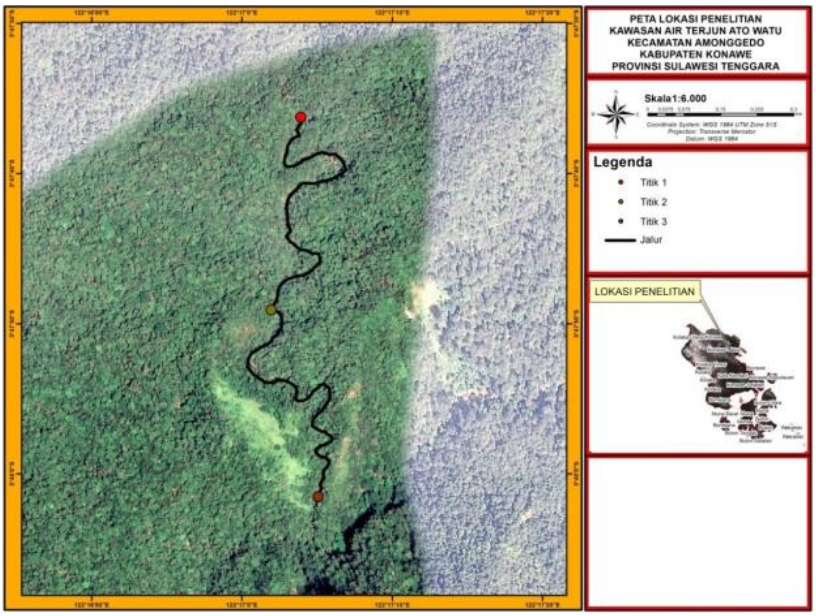


Figure 1. Researching location map

RESULT AND DISCUSSION

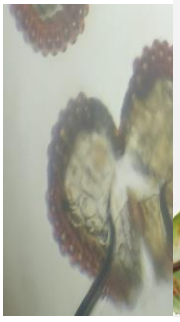
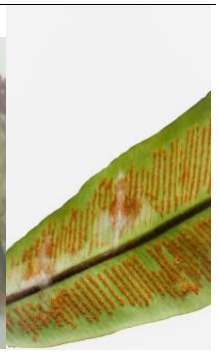
Result

Ferns (*Pteridophyta*) are a group of plants with a large number of species. This is due to the cool and humid environmental conditions and the presence of very tall trees, making it suitable for fern habitatats. Measurements taken in the Ato Watu Waterfall area in Amonggedo District, Konawe Regency, Southeast Sulawesi provided an overview of the environmental conditions in the area. The measurements showed that the temperature in the area ranged from 22^{o} C to 28^{o} C with humidity ranging from 61-75%. Based on these measurements, it can be concluded that the environmental. conditions in the Ato Watu waterfall area are very

supportive and in line with ideal environmental conditions. This has resulted in a high diversity of fern families. According to Akmalsyah, et al (2016: 42), in the Lahundape Pos Watu-Watu area of the Nipa-Nipa Nature Reserve in Southeast Sulawesi, 14 species of epiphytic ferns were found, including the *Polypodiaceae* family from the *Pteridophyta* division. Furthermore, Laeto et al. (2021: 71), based on research conducted in the Lambusango Wildlife Reserve Forest in Buton Regency found 21 ferns belonging to 14 genera and consisting of 9 families. Based on topography, flat areas have the most fern species, namely 16 species, while valleys and hills each have 12 fern species.

Based on the results of the study, 6 species of ferns of the *Polypodiaceae* family and 5 species of ferns of the *Tectariaceae* family were found in the Ato Watu Waterfall area with diverse sorus morphology and each species having an annulus. The research data are presented in Table 1.1 and Table 1.2.

Table 1.1 Morphology of the Sorus of Ferns of the *Polypodiaceae* Family in the Ato Watu Waterfall Area, Amonggedo District

No.	Species Name	Sorus Morphology				Image
		Location	Shape	Color	Annulus	
1.	*Drynaria quercifolia* (L.) J. Sm.	Sorus are scattered across the entire underside of the leaf.	Sorus are flat and round in shape	The sorus is golden brown in color.	There are 	
2.	*Leptochilus henryi (Baker) X.C.Zhang*	Sorus located underneath the leaf surface along the leaf veins but not reaching the leaf margins.	The sorus is Long lines	The sorus is brown in color	There are 	
3.	*Lemmaphyllum accedens* (Blume) Donk	Sorus located beneath the leaf surface between the leaf veins.	Sorus is elongated (oval) in shape	The sorus is light brown in color	There are 	

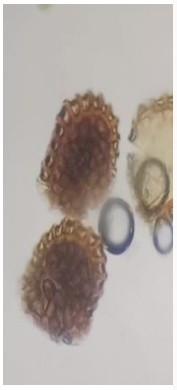
No.	Species Name	Sorus Morphology				Image
		Location	Shape	Color	Annulus	
4.	*Microsorum membranifolium (R.Br.) Ching*	Sorus is located beneath the leaf surface, between the leaf veins.	The sorus is round and raised above the leaf surface.	The sorus is orange in color.	There are 	
5.	*Pyrrosia longifolia (Burm.fil.) C.V.Morton*	Sorus are scattered beneath the leaf surface along the left and right sides and the midrib of the leaf.	The sorus are small, round, and dense (clustered).	The sorus is dark brown in color.	There are 	
6.	*Selligue heterocarpa* Bl., Fl. Jav	Sorus are located beneath the leaf surface along the leaf veins.	Sorus are elongated, clustered, and densely packed.	The sorus is brown in color.	Present 	

Table 1.2. Morphology of the sorus of ferns (Pteridophyta) of the family *Tectariaceae* in the Ato Watu Waterfall area, Amonggedo District.

No.	Species Name	Sorus Morphology				Image
		Location	Shape	Color	Annulus	
1.	*Tectaria angulata (Sw.) S. Chandra*	Spread across the entire underside of the leaf, with irregular placement	Irregularly rounded	Golden brown	Present 	

No.	Species Name	Sorus Morphology				Image
		Location	Shape	Color	Annulus	
2.	*Tectaria aurita (Sw.) S. Chandra*	Spread across the entire underside of the leaf, neatly arranged along each leaf vein	Oval and hollow in the middle	Brown	Present 	
3.	*Tectaria barberi (Hook).*	Spread across the entire underside of the leaf, irregularly placed	Oval	Golden brown	Present 	
4.	*Tectaria devaxa* (Kze) Copel	Spread across the entire underside of the leaf, with several sori neatly lined up along the edge of the leaf	Perfectly round	Golden brown	Present 	
5.	*Tectaria fuscipes (Wall. ex Bedd) C. Chr*	Spread across the entire underside of the leaf, lined up along the edge of the leaf	Small round spots	Golden brown	Present 	

Discussion

According to Khairunnisa (2024:14), the characteristics of sorus, such as shape, location, color, and the presence of an annulus in ferns, are important distinguishing features for ferns. The location and shape of sorus vary among different types of ferns. These differences can be used as distinguishing characteristics in the classification of plants. Most sorus are located on the underside of the leaf, appearing as spots, growing regularly in rows, clustered, or scattered.

Based on the results obtained, the *Polypodiaceae* family has diverse sorus morphology. This is in line with the statement (Tjitrosoepomo, 2005:109-110) that the *Polypodiaceae* family has varied sorus, some located at the edge or near the edge of the leaf and on the leaf veins. The shape of the sorus in this family varies, ranging from linear, elongated, round, and so on. The *Polypodiaceae* family has a vertical annulus, but it is imperfect. Meanwhile, the *Tectariceae* family is a type of terrestrial fern that usually grows around

riverbanks or in humid places. It has many leaves that are divided into simple leaves, with leaflets located at the bottom of the petiole. The leaves extend downward and are ribbon- shaped. *The Tectariaceae* family is short and upright. The sorus is located beneath the leaf surface, arranged in a long row along the leaf vein and is round in shape (Holtum, 1967:494).

The rupture of sori in ferns is greatly influenced by environmental factors. Pradipta et al. (2023: 29) state that the rupture of sori in ferns is also influenced by environmental factors, which also affect the process of spore dispersal. Dispersal Each type of fern (*Pteridophyta)* requires

abiotic environmental conditions to live, including temperature, humidity, light intensity, and other physical environmental conditions. According to Hoshizaki: 2011 in (Wardiah, et al., 2019: 92-93), the optimal temperature for the growth of ferns (*Pteridophyta)* growing in tropical areas is around 21-27°C. In general, plant growth will increase with increasing temperature up to a limit of 31°C. If the temperature exceeds 31°C, there will be a decrease in growth activity, but some plants have a tolerance to high temperatures. Air humidity is also an important factor for the growth of pteridophytes in maintaining water content in cells. High transpiration causes cells to lose water rapidly, and if this water is not replaced, it can cause low osmotic pressure in the cells, which disrupts the plant's physiological processes. The relative humidity range for pteridophyte growth is between 60% and 80%. According to Polunin (1994:112), the environment encompasses all external conditions and factors that influence life and development in a particular place. These factors include light, temperature, rainfall, air humidity, and soil.

This is in accordance with the measurements taken in the Ato Watu Waterfall area, Amonggedo District. The measurements provide an overview of the environmental conditions in the area. The measurements show that the temperature in the area ranges from 22°C to 28°C with humidity ranging from 61% to 75%. Based on these measurement results, it can be concluded that the environmental conditions in the Ato Watu Waterfall area are very supportive and suitable for ferns.

CONCLUSION

Based on the results of the study, it can be concluded that six types of ferns from the *Polypodiaceae* family were found, namely *Drynaria* quercifolia (L.), J *Lemmaphyllum accedens* (Blume), *Leptochilus henryi (Baker) X.C.Zhang, Microsorum membranifolium (R.Br.) Ching, Pyrrosia longifolia (Burm.fil.) C.V.Morton, Selliguea heterocarpa* Bl., Fl. Jav.. with different characteristics in shape, location, and color of the sorus, as well as having an annulus, and 5 types of were found in the *Tectariaceae* family, including *Tectaria angulata (Sw.) S. Chandra, Tectaria aurita (Sw.) S. Chandra, Tectaria barberi (Hook), Tectaria devaxa (*Kze) Copel, *Tectaria fuscipes (Wall. ex Bedd) C. Chr.,* with different characteristics in terms of shape, location, color of the sorus, and annulus.

Further research is needed on the morphology of sorus in ferns from different families in the Ato Watu Waterfall area, Amonggedo District, given the vastness of the forest and the large number of fern species (*Pteridophyta)*

REFERENCES

Akmalsyah., Munir, A., dan Darlian, L. 2016. Identifikasi Jenis Tumbuhan Epifit Di Wilayah Lahundape Pos Watu-Watu Dalam Kawasan Taman Hutan Raya Nipa-Nipa. *Jurnal Ampibi*. Vol. 1(3). Hal: 42-46, diakses pada tanggal 8 maret 2023.https://ojs.uho.id/index.php/ampibi/article/view/5044

Holttum. 1967. *Flora of Malaya*. Singapore: Authority.

Jayanti, D.A.N.U. (2020). *Keanekaragaman Tumbuhan*. Malang: CV Multimedia.

Kalsum, U., Hanin, I. (2022). Karakteristik Sorus pada Tumbuhan Paku. Yogyakarta: Yayasan Kita Menulis

Khoirunnisa, N., Nurmiyanti. (2022) *Karakteristik Sorus di KHDTK Gunung Bromo Kecamatan Karanyar. Prosiding Konferensi Pendidikan Biologi.* 19(1), 14-22.

Laeto, A. B., dan Taharu, F. I. 2021. Keanekaragaman Jenis Tumbuhan Paku (*Pteridophyta*) Berdasarkan Topograf Di Kawasan Hutan Suaka Margasatwa Lambusango Kabupaten Buton. *Jurnal Ilmiah Universitas Muhammadiyah Buton*. Vol. 7(1), Hal: 71-84, diakses pada tanggal 8 maret 2023.https://jurnal-umbuton.ac.id/index.php/pencerah/article/view/961

Mehltreter, K., Lawrence, R.W dan Joanne, M.S. 2010. *Ferus Ecology*. Cambridge University Press.

Negi, S., Tewari, L. M., Pangtey, Y. P.S., Kumar, S., Martolia, A., Jalal, J., dan Upreti, K. 2009. Studi Taksonomi tentang Keluarga Polypodiaceae (Pteridophyta) di Nainital, Uttarakhand. *New York Science Journal,* 2(5), 47-83

Polunin, N. (1994). Pengantar Geografi yang Berkembang dan Beberapa Ilmu Serumpun. Gadjah Mada University Press. Yogyakarta

Pradipta, A. T., Hariani, S. A., dan Novenda, I. L. 2023. Identifikasi Tumbuhan Paku Berdasarkan Letak dan Posisi Sorus Dengan Ketinggian Berbeda Di Kabupaten Bondowoso. *Jurnal Biologi Edukasi*,

Shin, W.H., Keun, C. 2017. Tectaria fuscipes (Dinding. ex Bedd.) C. Chr. (Tectariaceae) Takson baru yang Tercatat dari Korea. *Jurnal Taksonomi Tumbuhan Korea.* Vol.47, No.1, hh. 316-321

Sidik, A.B., Munir, A., dan Agriansyah, A. 2019. Jenis-Jenis Tumbuhan Paku (Pteridophyta) di Kawasan Air Terjun Ato Watu, Kecamatan Amonggedo, Kabupaten Konawe, Sulawesi Tenggara. *Prosiding Seminar Nasional Pendidikan Biologi (SNPBIO),* tanggal 12 Oktober 2019. Kendari: Universitas Halu Oleo.

Tjitrosoepomo, G. 2005. *Taksonomi Tumbuhan Obat-obatan*. Yogyakarta: Gadjah Mada University Press.

Tjitrosoepomo, G. 2007*. Taksonomi Tumbuhan*. Yogyakarta: Gadjah Mada University Press.

Tjitrosoepomo, G. (2015). *Taksonomi Tumbuhan*. Yogyakarta: Gadjah Mada University Press.

Wardiah., Sarina, I., Hasanuddin., Nurmaliah, C., dan Andayani, D. 2019. Pteridophyta di Kawasan Air Terjun Suhom, Kecamatan Lhoong, Kabupaten Aceh Besar. *Jurnal Biotic*, 7(2), 92-93.