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Density of Araceae in the River Basin Area of Lawua Village, South Kulawi District, Sigi Regency

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Abstract

Araceae are herbaceous plants belonging to the monocotyledonous group of Angiosperms. They exhibit distinct morphological characteristics in their roots, stems, and leaves, and are generally herbaceous, with plant heights ranging from 90 to 180 cm. These plants hold significant economic and ecological value, as they are utilized as ornamental plants, food sources, and medicinal resources. This study aimed to identify and analyze the density of Araceae in the river basin area of Lawua Village, South Kulawi District, Sigi Regency. The research employed a descriptive qualitative and quantitative approach, with sampling conducted using the belt transect method across three different observation stations. Observations involved counting and recording the number of individuals of each Araceae species within the transect paths. Additionally, each species was documented, and samples were collected for identification based on their morphological characteristics, followed by density analysis. Overall, the study identified 16 Araceae species across 11 genera. These genera include: *Alocasia* (1 species), *Colocasia* (3 species), *Dieffenbachia* (1 species), *Epipremnum* (1 species), *Homalomena* (1 species), *Pistia* (1 species), *Rhaphidophora* (1 species), *Scindapsus* (2 species), *Schismatoglottis* (3 species), *Spathiphyllum* (1 species), and *Syngonium* (1 species). The overall density ranged from low to moderate, between 7 and 1,737 individuals, with abiotic conditions including an average temperature of 28 °C, humidity of 62.33%, light intensity of 2,998 Cd, and soil pH of 5.9. These findings provide valuable baseline data for the conservation and sustainable management of Araceae species in tropical riverine ecosystems.

Keywords: Araceae; Species diversity; Plant density; River basin vegetation; Lawua Village.

INTRODUCTION

Indonesia is recognized as one of the countries with the highest levels of biodiversity in the world. Its rich flora and fauna are influenced by its unique geographical conditions, as most of the country lies along the equator and consists of thousands of islands stretching from Sabang to Merauke. Furthermore, Indonesia's strategic location between two continents, Asia and Australia, makes it a distinctive biogeographical transition zone. These conditions have contributed to the formation of diverse ecosystems, including tropical rainforest ecosystems that are rich in endemic species and possess complex and varied ecological characteristics (Nurhidayah & Alam, 2020).

Sulawesi is one of the largest islands in Indonesia and plays a strategic role in biogeographical studies, particularly due to its location within the Wallacea region. This area is known as a unique biogeographical transition zone between the Sunda Shelf in the west and the Sahul Shelf in the east, resulting in flora and fauna that differ significantly from both Asia and Australia (Ali & Heaney, 2021). Consequently, Sulawesi has become an important center of biodiversity, characterized by high levels of endemism across various groups of organisms, including both plants and animals. This high biodiversity is reflected in the diversity of natural ecosystems throughout the island, ranging from mountainous regions and lowland forests to coastal areas (Struebig et al., 2022).

Sigi Regency is one of the administrative regions in Central Sulawesi Province, covering an area of approximately 5,196.02 km², consisting of 15 districts and 156 villages. The regency was formed through a subdivision of the Donggala Regency (Rosid et al., 2023). About 70% of Sigi Regency remains forested, including protected forests, production forests, and conservation areas managed under Lore Lindu National Park (Lamaniu et al., 2023). This makes Sigi Regency an important habitat for various tropical flora and fauna and a region with high biodiversity.

Araceae are herbaceous plants belonging to the monocotyledonous group of Angiosperms (Jdeed et al., 2023). They exhibit clear morphological characteristics in their roots, stems, and leaves, and are generally herbaceous, reaching heights of 90–180 cm (Arogundade

& Adedeji, 2024). These plants hold high economic and ecological value, being used as ornamental plants, food sources, and medicinal resources. Certain Araceae species, such as Colocasia esculenta and Alocasia macrorrhiza, are utilized by local communities as carbohydrate sources, while others are employed for aesthetic purposes in landscaping and traditional ceremonies in regions such as Bali (Sinha & Borkataky, 2025).

However, the forest ecosystem in Lawua Village, South Kulawi District, Sigi Regency, is under pressure from anthropogenic activities such as land clearing for plantations and long-term intensive agriculture. These activities potentially threaten the conservation of plant species, particularly the Araceae family, by causing habitat degradation and reduced population density. Moreover, local knowledge regarding the diversity, uses, and ecological roles of Araceae remains limited due to the lack of scientific information and research in the area. This study aims to identify and analyze the density of Araceae in the river basin area of Lawua Village, South Kulawi District, Sigi Regency.

MATERIALS AND METHODS

Study area

This study was conducted in the river basin area of Lawua Village, South Kulawi District, Sigi Regency (Figure 1). Sampling was carried out using the belt transect method, which involves a ribbon-shaped transect path used to observe and count individuals of Araceae plants within the study area (Jones et al., 2022). The belt transect employed measured 100 m × 10 m. Within this transect, ten observation subplots measuring 10 m × 10 m each were established, arranged either in parallel or in a zigzag pattern along the transect path. The sampling locations were determined using purposive sampling, which considered areas with a high number of Araceae individuals. Transects were then placed in these areas as observation sites (Thomas, 2022). Sampling was divided into three observation stations along the river basin. Station 1 was located in the western part of the river (residential area), Station 2 in the northern part (Maima waterfall and plantation area), and Station 3 in the eastern part of the village river (forest area).

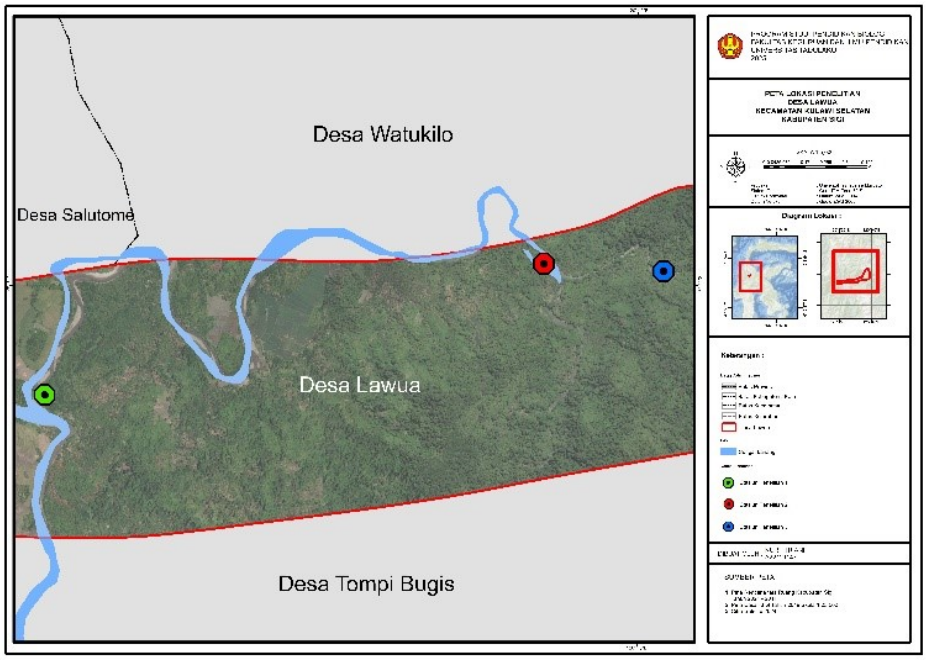

Figure 1. Map of the research location in Lawua Village, South Kulawi District, Sigi Regency.

Procedures

Materials and Equipment

The equipment used in this study included a measuring tape, raffia rope, ruler, hygrometer, lux meter, thermometer, soil pH meter, straightedge, smartphone camera, and stationery. The materials used consisted of all Araceae species found in the river basin area of Lawua Village, South Kulawi District, and an Araceae identification guidebook.

Preparation Stage

The researcher collected various literature sources containing information on Araceae species and their density to serve as references for the study. Field observations and preliminary surveys were then conducted to assess the presence and types of Araceae in the river basin area of Lawua Village. The researcher also borrowed research equipment from the Biology Education Laboratory, Faculty of Teacher Training and Education (FKIP), Tadulako University, and prepared the

necessary materials for the research process. In addition, all administrative requirements needed to support the study on Araceae species and density were arranged.

Sampling Stage

Sampling of Araceae was conducted using a survey method along the predetermined observation paths. At each research station, three belt transects were established as observation areas. Every individual Araceae plant found within the transect paths was counted and recorded. Specimens were collected using free collection techniques, accompanied by notes on habitat conditions, characteristics, and morphological traits prone to change. Each Araceae species encountered was also documented using a camera. Environmental physical conditions were measured, including air humidity, light intensity, soil pH, and air temperature. Collected samples were then identified using the Araceae identification guidebook and validated through species descriptions, identification keys, and reference photographs from relevant literature sources. The data obtained were subsequently analyzed to determine the density of Araceae at the study site.

Data analysis

Data in this study were analyzed using the *Araceae Digital Flora Indonesia* guidebook and the formula for plant density and density scale as follows:

Density (D)

$$K = \frac{N}{A}$$

D = density of a species
N = number of individuals of the species
A = area of the plot

RESULTS AND DISCUSSION

Result

Overview of the Study Location

This study was conducted in the river basin area of Lawua Village, South Kulawi District, Sigi Regency, Central Sulawesi. Geographically, the village is located at coordinates 1°34′47.96″S and 120°05′10.93″E, covering an area of 83.41 km². Topographically, the northern part of Lawua Village borders Salutome Village and Watukilo Village, the southern part borders Tompi Bugis Village, the western part borders Palamaki Village, and the eastern part borders Poso Regency. The elevation of Lawua Village ranges from 450 to 670 meters above sea level. The average temperature in the village ranges between 18 °C and 30 °C. Ecologically, the topography of Lawua Village, located in a mid-altitude zone, contributes to the formation of microclimatic conditions that differ from those in lowland areas (Mendy et al., 2022).

Environmental Physical Condition Measurements

The measurements of environmental physical conditions conducted in this study included temperature, humidity, soil pH, and light intensity. Based on the measurements, the average values at the study site are presented in Table 1.

Table 1. Measurements of environmental physicochemical conditions in the River Basin Area of Lawua Village, South Kulawi District, Sigi Regency.

No	Parameter	Physicochemical Environmental Conditions			Average
		Station 1	Station 2	Station 3	
1	Temperature (°C)	29	27	28	28
2	Humidity (%)	52	65	70	62.33
3	Light Intensity (Cd)	6713	1193	1089	2998
4	Soil pH	5.7	6	6.2	5.9

Diversity of Araceae Species

A total of 16 Araceae species were recorded in the river basin area of Lawua Village, all of which were successfully identified. These species represent 11 genera: *Alocasia*, *Colocasia*, *Dieffenbachia*, *Epipremnum*, *Rhaphidophora*, *Homalomena*, *Pistia*, *Scindapsus*, *Schismatoglottis*, *Spathiphyllum*, and *Syngonium*. This taxonomic diversity reflects the habitat heterogeneity in the study area and indicates environmental conditions that support the growth of various Araceae groups (Table 2 and Figure 2).

Table 2. Araceae species recorded in Lawua Village, South Kulawi District, Sigi Regency.

No	Genus	Species	Habitat
1	Alocasia	*Alocasia plumbea* var. nigra K.Koch. ex van Houtte.	Geofit
2	Colocasia	*Colocasia esculenta* (L.) Schott.	Geofit
3		*Colocasia oresbia* A.Hay.	Geofit
4		*Colocasia* sp.	Geofit
5	Dieffenbachia	*Dieffenbachia seguine* (Jacq.) Schott.	Geofit
6	Epiprenum	*Epiprenum pinnatum* (L.). Engl.	Geofit
7	Homalomena	*Homalomena rubescens* (Roxb.) Kunth.	Aquatik
8	Pistia	*Pistia stratiotes* L.	Geofit
9	Raphidophora	*Raphidophora* sp.	Hemiepifit
10	Scindapsus	*Scindapsus pictus* Hassk.	Hemiepifit
11		*Scindapsus glaucescens* (Engl. & K.Krause) Alderw.	geofit
12	Schismatoglottis	*Schismatoglottis* sp.1	Geofit
13		*Schismatoglottis* sp.2	Geofit
14		*Schismatoglottis calyptrata* (Roxb.) Zoll. & Moritzi.	Hemiepifit
15	Spathiphyllum	*Spathiphyllum commutatum* Schott.	Geofit
16	Syngonium	*Syngonium podophyllum* Schott.	Geofit

Figure 2. Araceae species recorded in Lawua Village, South Kulawi District, Sigi Regency. 1. *Alocasia plumbea*, 2. *Colocasia esculenta*, 3. *Colocasia oresbia*, 4. *Colocasia* sp., 5. *Dieffenbachia seguine*, 6. *Epiprenum pinnatum* (L.), 7. *Homalomena rubescens*, 8. *Pistia stratiotes*, 9. *Raphidophora* sp, 10. *Scindapsus pictus*, 11. *Scindapsus glaucescens*, 12. *Schismatoglottis* sp 1, 13. *Schismatoglottis* sp 2, 14. *Schismatoglottis calyptrata*, 15. *Spathiphyllum commutatum*, 16. *Syngonium podophyllum*.

Araceae Density Analysis

Further analysis of the community structure was conducted by calculating the density of the Araceae species observed. Quantitative data on the density of each species are presented in detail in Table 3.

Table 3. Araceae density analysis.

No	Genus	Species	N(ha)	K
1	Alocasia	*Alocasia plumbea* var. nigra K.Koch. ex van Houtte.	7	Low
2	Colocasia	*Colocasia esculenta* (L.) Schott.	124	Low
3	Colocasia	*Colocasia oresbia* A.Hay.	36	Low
4	Colocasia	*Colocasia* sp.	166	Low
5	Dieffenbachia	*Dieffenbachia seguine* (Jacq.) Schott.	69	Low
6	Epiprenum	*Epiprenum pinnatum* (L.). Engl.	108	Low
7	Homalomena	*Homalomena rubescens* (Roxb.) Kunth.	89	Low
8	Pistia	*Pistia stratiotes* L.	1737	Low
9	Raphidophora	*Raphidophora* sp.	291	Low
10	Scindapsus	*Scindapsus pictus* Hassk.	142	Low
11	Scindapsus	*Scindapsus glaucescens* (Engl. & K.Krause) Alderw.	33	Low
12	Schismatoglottis	*Schismatoglottis* sp.1	86	Low
13	Schismatoglottis	*Schismatoglottis* sp.2	87	Low
14	Schismatoglottis	*Schismatoglottis calyptrata* (Roxb.) Zoll. & Moritzi.	144	Low
15	Spathiphyllum	*Spathiphyllum commutatum* Schott.	118	Low
16	Syngonium	*Syngonium podophyllum* Schott.	41	Low

Discussion

The distribution of Araceae species in the river basin area of Lawua Village reflects the strong influence of habitat type, microclimatic conditions, and environmental heterogeneity on species composition and density. Geophytic Araceae, including *Alocasia plumbea*, *Colocasia esculenta*, *Colocasia oresbia*, *Colocasia* sp., *Dieffenbachia seguine*, *Homalomena*, *Schismatoglottis* sp.1, *Schismatoglottis* sp.2, *Schismatoglottis calyptrata*, *Spathiphyllum commutatum*, and *Syngonium podophyllum*, were predominantly found in understory habitats. These species occupy the forest floor, which is characterized by relatively stable environmental conditions, including moderate light, consistent moisture, and high organic matter availability. Their ecological roles as understory plants are significant; they contribute to water regulation, soil stabilization, and erosion prevention, which in turn supports the overall resilience of the forest ecosystem (Francini et al., 2021).

The frequent occurrence of geophytic Araceae in the study area is likely driven by favorable microenvironmental factors, such as air humidity ranging from 50–70%, average temperatures of 26–30 °C, and canopy coverage that permits adequate sunlight penetration to the forest floor. High rainfall in the region also maintains soil moisture levels necessary for growth and survival (Croat & Ortiz, 2020; Rohman et al., 2024). These findings align with studies in similar tropical rainforest systems, where understory Araceae are shown to thrive under moderate light conditions and soils rich in organic matter, highlighting their adaptability to microhabitat variations.

Hemiepiphytic Araceae, such as *Rhaphidophora* sp., *Scindapsus pictus*, and *Scindapsus glaucescens*, display a unique dual life strategy. By growing partly as epiphytes on host trees and partly with roots in the soil, they enhance vertical structural complexity within the forest, connecting the understory with the canopy and creating diverse microhabitats for other organisms (Benítez, 2023). These species also contribute to nutrient cycling and microclimate regulation through water and nutrient absorption from both the host trees and the soil (Eskov & Kolomeitseva, 2022). Morphological adaptations, including aerial roots and water retention structures, allow hemiepiphytic Araceae to survive in highly dynamic tropical forest conditions, where moisture and light availability may fluctuate substantially (Oyedeji, 2023).

Optimal growth of hemiepiphytic Araceae occurs under specific microclimatic conditions: air temperatures around 26 °C, relative humidity up to 86%, and low to moderate light intensity filtered through the canopy (Pfadenhauer & Klötzli, 2020; Nordio et al., 2024). Their rooting substrates, often tree trunks, crevices, or moist tree bases, exhibit slightly acidic to neutral pH, are rich in organic material, and retain adequate interstitial moisture for efficient nutrient and water uptake (Sheeran & Rasmussen, 2023; Brooks et al., 2021). This combination of environmental factors enables hemiepiphytic Araceae to occupy vertical microhabitats effectively, contributing to the structural and functional diversity of tropical rainforest ecosystems (Hietz et al., 2021).

Aquatic Araceae, exemplified by *Pistia stratiotes*, play a critical role in freshwater ecosystem dynamics. They stabilize substrates along riverbanks, prevent soil erosion, and act as buffers between terrestrial and aquatic environments, thereby maintaining ecosystem integrity (Li et al., 2022). Moreover, aquatic Araceae enhance habitat complexity by providing shelter and refugia for a range of aquatic organisms, from microorganisms to small fish, and facilitate nutrient cycling by absorbing nitrogen and phosphorus from sediments (Pott et al., 2022; Asharo et al., 2022). Morphological adaptations, such as aerenchyma tissue and water-resistant roots, allow these species to thrive in permanently or periodically inundated environments, including shallow

ponds, river margins, and organic-rich muddy substrates (García & Jáuregui, 2020).

The density analysis of Araceae in the study area revealed that only *Pistia stratiotes* reached medium density, with 1,737 individuals per hectare, whereas the remaining 15 species were classified as low density. These low-density species, including *Alocasia plumbea*, *Colocasia esculenta*, *Colocasia oresbia*, *Colocasia* sp., *Dieffenbachia seguine*, *Epipremnum pinnatum*, *Homalomena rubescens*, *Rhaphidophora* sp., *Scindapsus pictus*, *Scindapsus glaucescens*, *Schismatoglottis* sp.1, *Schismatoglottis* sp.2, *Schismatoglottis calyptrata*, *Spathiphyllum commutatum*, and *Syngonium podophyllum*, may be limited by specific environmental conditions, including variations in soil pH, light intensity, humidity, and temperature across different stations. This suggests that microhabitat conditions strongly influence the spatial distribution and abundance of Araceae species in tropical riverine ecosystems (Gerst et al., 2021; Withaningsih et al., 2024).

CONCLUSIONS

A total of 3,237 individuals of Araceae were recorded in the river basin area of Lawua Village, representing 16 species. Among these, the density index classified only one species, *Pistia stratiotes*, as medium density, with the remaining 15 species exhibiting low density. The low-density species included *Alocasia plumbea*, *Colocasia esculenta*, *Colocasia oresbia*, *Colocasia* sp., *Dieffenbachia seguine*, *Epipremnum pinnatum*, *Homalomena rubescens*, *Rhaphidophora* sp., *Scindapsus pictus*, *Scindapsus glaucescens*, *Schismatoglottis* sp.1, *Schismatoglottis* sp.2, *Schismatoglottis calyptrata*, *Spathiphyllum commutatum*, and *Syngonium podophyllum*.

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