FYP FSB

DIVERSITY AND DISTRIBUTION OF FAMILY ARACEAE IN GUNUNG STONG STATE PARK (GSSP), KELANTAN

by

MUHAMMAD HAFIZZUDIN BIN ROSLAM

A report submitted in fulfilment of the requirements for the degree of Bachelor of Applied Science (Natural Resources Science) with Honors

FACULTY OF EARTH SCIENCE
UNIVERSITI MALAYSIA KELANTAN

2024

UNIVERSITI MALAYSIA KELANTAN

FYP FSB

DECLARATION

I declare that this thesis entitled "Diversity and Distribution of Family Araceae at Gunung Stong State Park (GSSP), Kelantan" is the result of my research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

Name : **Muhammad Hafizzudin Bin Roslam**

Date : **7 August 2024**

UNIVERSITI
MALAYSIA
KELANTAN

FYP FSB

ACKNOWLEDGEMENT

In the name of Allah, Most Generous, Most Merciful.

I have made a lot of effort to complete my final year project. However, all my efforts would not have been possible without the kind support and help of many individuals and organizations. I would like to express my deep gratitude to all of them.

First of all, I would like to express my gratitude to my creator, Allah S. W. T. for providing me with strength and health to finish my final year project without such difficulties. In this process, I gained a lot of insights about myself as a person and as a student. With all my heart, I thank the holy Prophet Muhammad (Peace be upon him) for his way of life which has been my inspiration.

I would like to express my deepest gratitude to my supervisor, Gs. Dr. Nazahatul Anis Binti Amaludin. I would like to express my gratitude for her guidance and constant supervision as well as for providing necessary information regarding the program. I would also like to thank my mother, Nursiah Binti Yaacob for her financial and moral support towards this research. I want to thank her and my family for their kind cooperation and encouragement which I received from them in the completion of this final year project. I want to take this opportunity to express my gratitude to our guide Encik Zulhairi dan Puan Puteri who has spent time for us and helped us during the field work.

Last but not least, I would like to thank my final-year project members for helping me in the development of the project. They are Sow Bao Jun, Nur Izati Binti Baharom, Norerliana Syafika Binti Abdullah, Muhammad Al-Hafiz Bin Mat Razii, Nur Husna Syasya Binti Shamsul Amri, and Ahmad Adham Bin Abdul Aziz. I also would like to thank them for their opinion and ideas that were helpful in the preparation of my final year project. The work was done with the help of the Faculty of Earth Science of Universiti Malaysia Kelantan which provided materials and good source information for this research.

UNIVERSITI MALAYSIA KELANTAN

Diversity and Distribution of Family Araceae at Gunung Stong State Park (GSSP), Kelantan

ABSTRACT

This research aimed to determine the species of Araceae and the distribution of the plant in Gunung Stong State Park (GSSP), Kelantan. Random sampling and observational methods were used to determine the species present. The Simpson Index and Shannon-Wiener Index were used in the data analysis, while further geographical analysis such as mapping was done using GIS. The study established that there were 33 Araceae species in the study area, with 10 species belonging to 7 genera. The Shannon-Wiener Diversity Index (H') was 2. 189, and Simpson's Diversity Index (D) was 0. 905. Furthermore, two of the species mentioned above were categorized as least concern according to the IUCN Red Data Book. These findings reveal Araceae's species richness and distribution in GSSP and imply that the area harbors several species with stable populations as reflected by their conservation status.

Keywords: Araceae, species diversity, distribution, species richness, biodiversity

FYP FSB

UNIVERSITI MALAYSIA KELANTAN

Kepelbagaian dan Taburan Famili Araceae di Taman Negeri Gunung Stong (GSSP), Kelantan

ABSTRAK

Penyelidikan ini bertujuan untuk mengenal pasti spesies Araceae dan taburan tumbuhan di Taman Negeri Gunung Stong (GSSP), Kelantan. Kaedah persampelan rawak digunakan untuk menentukan spesies yang ada. Indeks Simpson dan Indeks Shannon-Wiener digunakan dalam analisis data, manakala analisis geografi selanjutnya seperti pemetaan dilakukan menggunakan GIS. Kajian mendapati terdapat 33 spesies Araceae di kawasan kajian, dengan 10 spesies tergolong dalam 7 genera. Indeks Kepelbagaian Shannon-Wiener (H') ialah 2. 189, dan Indeks Kepelbagaian (D) Simpson ialah 0. 905. Tambahan pula, dua daripada spesies yang disebutkan di atas telah dikategorikan sebagai kurang kebimbangan mengikut Buku Data Merah IUCN. Penemuan ini mendedahkan kekayaan dan taburan spesies Araceae dalam GSSP dan membayangkan bahawa kawasan itu mempunyai beberapa spesies dengan populasi yang stabil seperti yang ditunjukkan oleh status pemuliharaan mereka.

Kata kunci: Araceae, kepelbagaian spesies, taburan, kekayaan spesies, biodiversiti

FYP FSB
UNIVERSITI MALAYSIA KELANTAN

TABLE OF CONTENT

FYP FSB
UNIVERSITI MALAYSIA KELANTAN

FYP FSB
UNIVERSITI MALAYSIA KELANTAN

LIST OF TABLES

FYP FSB

UNIVERSITI MALAYSIA KELANTAN

LIST OF FIGURES

FYP FSB

UNIVERSITI MALAYSIA KELANTAN

LIST OF ABBREVIATION

HCFV	High Conservation Value Forest
GPS	The Geographical Positioning System
ha	Hectare
m	Meters
cm	Centimetre
GSSP	Gunung Stong State Park
EX	Extinct
CR	Critically Endangered
EN	Endangered
VU	Vulnerable
NT	Near Threatened
LC	Least Concern
DD	Data Deficient
H'	Shannon-Wiener Diversity Ind
D	Simpson's Diversity Index
IUCN	International Union for Conservation of Nature
GIS	Geographic Information System

FYP FSB
UNIVERSITI MALAYSIA KELANTAN

LIST OF SYMBOLS

H'	The value of the Shannon Wiener Diversity Index
=	Equal to
-	Negative value
i =1s	Sum of the proportion of S
pi	Proportion of individuals of species I
ln	The natural logarithm of p_i
S	The number of species in the community.
°	Degree, used for latitude and longitude
( )	Parentheses, used for references and additional information
'	Apostrophe, used for possessives and contractions,
/	Slash, used for boundary

FYP FSB
UNIVERSITI
MALAYSIA
KELANTAN

CHAPTER 1

INTRODUCTION

1.1 Background of the study

Gunung Stong State Park (GSSP) is a forested area with Gunung Ayam, Gunung Tera, Gunung Saji, and Kem Baha. Kelantan, part of the state of Malaysia, has rich biodiversity and endemic species (Kamaruzzaman, et al., 2019). This is over twenty thousand hectares with caves, rivers, and mountains. These include hornbills, panthers, elephants, and other birds. Unique types of plants also exist such as the Rafflesia (the largest flower in the world). Aside from the next-door Stong Waterfall, this is Southeast Asia's tallest waterfall, attaining a height of approximately 1500 feet. In the year of 2003, a scientist expedition visited Gunung Stong Tengah Forest Reserve revealing that it is a unique ecosystem that possesses widespread biodiversity and several Indigenous species (Kamaruzaman & Dahlan, 2006) For instance, the GSSP in Stong Mountain which is a major ecotourism site offers these locals benefits like road upgrading, facilities' improvement as well as income avenues (Sarguna et al., 2017).

The family Araceae possesses more than 140 genera and 3645 formally described species inhabiting the globe (Boyce & Croat, 2011). The family demonstrates deep morphological and ecological diversity so that it can survive in many habitats and well-specified biomes indicating that there may be a rich inventory of life forms and the highest species diversity. It is the third largest family of monocots known by its eight sub-families

FYP FSB
UNIVERSITI MALAYSIA KELANTAN

(Igor & Tomica, 2022). All evolved before the Cretaceous/Tertiary (K/T) boundary and, in this way, it is one of the oldest and psychologically the first members of the angiosperms (Croat et al., 2020). Roots are one of the most important characteristics of the monocot, including plants in the Araceae family. Therefore, the Araceae family has an impressively wide spectrum of growth forms, and the miners are among them and so are the plants that grow low to the ground and the aquatic ones (Simpson 2010).

1.2 Problem Statement

The expected results of the study on the diversity and distribution of Araceae in Gunung Stong State Park (GSSP), Kelantan, can include various aspects including scientific knowledge. The information available about the species on the internet is not extensive enough because there are few articles on the topic especially at GSSP, Kelantan. Moreover, the last study of this species in that area was years ago. Therefore, the information about the diversity and distribution of Araceae needs to be updated.

In this way, the distribution of various species and their role in ecosystems, as well as the potential impact of changes in population density on ecosystems can be better understood, and the public can be educated about the need for the preservation of biological diversity. It can also be a useful tool for teaching students and the public.

1.3 Expected Outcome

This is research that would go a long way in renewing and sharing valuable information about the studied organism, both to other researchers and the public. By doing this, it can improve our overall understanding of this species, thereby providing critical

FYP FSB
UNIVERSITI MALAYSIA KELANTAN

details for future research studies. The increased spread of the added information can make the audience and researchers aware of their surroundings. Provided information can be used as a valuable source for future readers and researchers of studies. In addition, it may reveal the major ecological role that the endangered species plays in its habitat, emphasizing its ecological significance.

The main study outcome will list Araceae species in GSSP. This inventory will not only entail the identification of species but also information on their location and distribution pattern in the ecosystems of the GSSP. This level of detail is important for comprehending the interactions of these species within the GSSP.

In addition, the study will help to identify the distribution of Araceae species in GSSP and the differences between them. With the understanding of the diversity of Araceae in the GSSP, there could be suggestions on the conservation measures to be taken. Furthermore, knowledge of the Araceae was useful in the identification of threatened species in the GSSP and may offer conservation imperatives.

1.4 Objective

The objectives of this research are as follows:

1. To identify the diversity of Araceae in Gunung Stong State Park (GSSP), Kelantan
2. To determine the distribution of Araceae in Gunung Stong State Park (GSSP), Kelantan

FYP FSB
UNIVERSITI
MALAYSIA
KELANTAN

1.5 Scope of study

This study is focused on the exploration of the diversity and distribution of Araceae in the district of Kelantan, which is Gunung Stong State Park. First, there is a laborious process of categorizing and naming all detectable Araceae species found in the study area. First, an extensive survey and identification exercise was undertaken to map out all the species of Araceae found in this bio-diverse area. The study was focused on the Araceae family. This temporal analysis was involved the use of varied days and dates resulting in a dynamic picture of issues of Araceae in the GSSP, Kelantan.

1.6 Significance of Study

There are no identified locations at the GSSP about the presence of Araceae specifically. Such a study can be used as a source of this data. The significance of this study is that it could form a base upon which future researchers can draw diverse pieces of information about this species. This study can be useful in understanding the species under the Araceae family. Such research allows us to define what the species needs to survive and conduct purposeful conservation measures. Conservationists would take necessary actions towards the preservation and promotion of Araceae due to improved knowledge of its ecological requirements.

A guide for conservationists, providing crucial data for protecting the species in the natural setting. This information not only covers important parts but also creates a base for the conservation of this threatened plant species. Easier for subsequent researchers to understand the species. The species was categorized as endangered in the study area. A

FYP FSB
UNIVERSITI MALAYSIA KELANTAN

clear understanding of the condition of the species, the suitable environment for it to live and the appropriate care for the plant could lead to the protection of the species. The other vital part of this study is for conservation. From this study, conservators can collect some data that can be used in the future to protect the species.

FYP FSB

UNIVERSITI
MALAYSIA
KELANTAN

FYP FSB

CHAPTER 2

LITERATURE REVIEW

2.1 Araceae

Araceae commonly known as the arum family includes a variety of plants, many of which are known for their unique foliage and flowers (Sulaiman et al., 2002). The Araceae family includes 144 genera and 3,645 identified species that are found worldwide (Boyce & Croat 2011). The flowers grow on a unique flowering called a spadix, and most of them have a single spathe leaf surrounding them. While some of these species have become popular indoor plants, many belong to the florist industry. Araceae are found all over the world but are most common in tropical regions. Family of climbers, herbs, and rooted or free-floating aquatics. These are common plants, commonly known as aroids which also include many common houseplants and cut flowers used in flower arrangements. Their flowers normally grow on a unique spike called a spadix, and they are usually surrounded by a single resembling bract called a spathe. Several species are important in the floral industry, and a number are common houseplants. The following is a list of some of the major genera and species in the family Araceae, arranged alphabetically by common name or genus (Petruzello, 2023).

According to the IUCN Red List, approximately 6.7% of the assessed species are labelled as Critically Endangered (CR), indicating an extremely high risk of extinction. Additionally, 10.0% fall under the category of Endangered (EN), suggesting an extremely

high risk of extinction in the wild. Another 17.3% are classified as Vulnerable (VU), facing a substantial risk of extinction. The group labeled as Near Threatened or Least Concern/Not Threatened (NT or LR/nt) encompasses around 6.4% of the assessed species. This category includes species that are close to meeting the criteria for higher-threat categories or those considered to have a lower risk of extinction. A significant proportion, about 33.7%, are categorized as Least Concern or Least Risk/Lower Risk/Least Concern (LC or LR/lc), indicating a relatively low risk of extinction for these species. Lastly, 25.9% of the assessed species fall under the designation of Data Deficient (DD), signifying insufficient information available to determine their conservation status accurately.

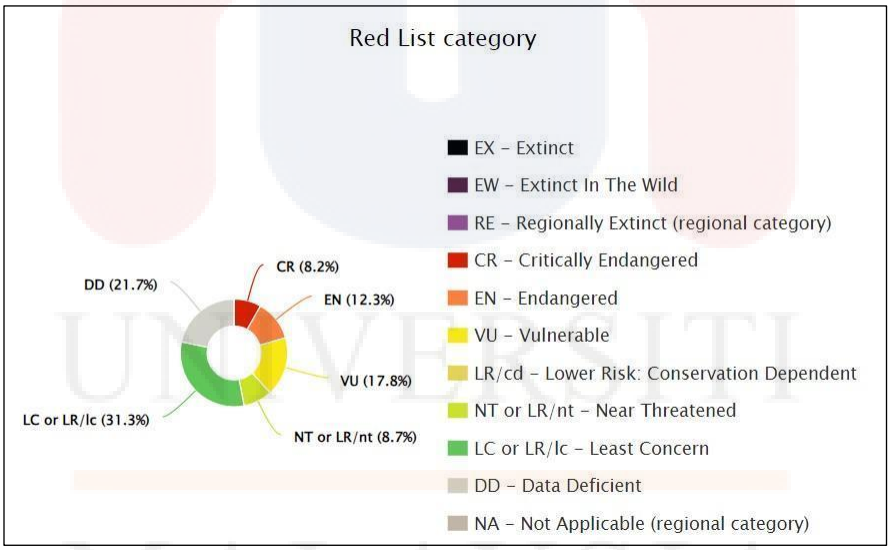

Figure 2.1: Percentages of the IUCN Red List category of Araceae.

FYP FSB
UNIVERSITI MALAYSIA KELANTAN

2.2 Morphological Characteristics of Araceae

Araceae have a variety of leaf shapes and patterns that help plants combine different strategies either to fit with the shade or to protect from the sun, including geometrical or classic figures. Araceae leaves have many kinds and are often represented by some types of leaves that allow them to hide worldwide, regardless of the environment (Croat & Ortiz 2020). Given the diversification of the family Araceae (monocots) identified by different analysts, the morphology of this family displays different characteristics. Aroids' morphology consists of cylindrical spikes given helical disposition to monoecious flowers, trilocular fruit with a seed inside a locule, and petal remnants to stamens of the utmost fertility. This species of the oboe spadix bogneri corresponds to these special characters (Stockey et al., 2023). The morphological features of a certain plant species from the Araceae family are as diverse as the species diversity. The line of these is the complex biology featuring life forms as diverse as ground-hugging, geophytes, terrestrial, epiphytic, and aquatic species (Suleman et al., 2022). The size of the leaf in Araceae plants is like a heart (ovate), horseshoe (cordate), sword (lanceolate), curved like a boat (cuneate), needle-like shield shape (peltate), sharp like an arrow (sagittate), spearhead (hastate), palmately lobed, bipinnately lobed, and tripinnately lobed (Risa et al., 2020). In addition to that, the spadices of the Araceae plants can feature either unisexual or bisexual inflorescences and they are covered by a spathe in most cases (Hong et al., 2023). This method has fewer identified errors when categorizing monocots or recognizing homoplecous taxa separated from monolepate ones in the Araceae family. Leaf and spadix fossil evidence has also demonstrated the distinctive nature of certain leaf

FYP FSB

and spadix particularities in previously identified extinct Proto-Araceae species (Stockey et al., 2021).

2.3 Distribution of Araceae in Asia

The Araceae family has a vast distribution over Asia, with most of its diversity found in warm and humid parts of the region (Amarante, 2023). The distribution of Araceae in Asia is high, their abundance is higher in the Southeast Asian countries especially, The Malay Archipelago and the Phillippines (Croat & Ortiz, 2020). Araceae are distributed almost all over Asia, with most consequently of their species, within Southeast Asia, especially in the Malay Archipelago and the Philippines. Approximately 90% of Araceae genera and 95% of the species have their greatest diversity in the tropics, where a lot of these species are endemic (you find them only in one place) in Southeast Asia (Amarante, 2023). The richest region of Aroideae out of terrestrial Araceae is seen in the Sulawesi area, with a total of 22 species from 10 genera identified on one mountain complex just recently (Croat & Ortiz, 2020).

2.4 Distribution of Araceae in Kelantan

Species under this family have a wide distribution such as clustered and scattered across Kelantan State of Peninsular Malaysia, as a summary of 57 species belonging to 18 genera out of which are present in the area. Araceae distribution is in turn influenced by microhabitats, forest types, altitude likeness of the specific region, and rock type. The most optimal microsite for Araceae is a steep slope surface, up to 84%. 2% of species in

FYP FSB
UNIVERSITI MALAYSIA KELANTAN

this are recorded in this category. The lowland rainforest is the most diverse for violet, with 96 percent of all species occurring in this habitat. 5% of species recorded (Zulhazman et al., 2020). There is a total of 204 species. However, Felicuna also documents the highest diversity in terms of species as Rhaphidophora was recorded as having the highest species in Kelantan. This differs from those with the third greatest number of species namely Anandendrum and Scindapsus. Conversely, genera like *Amydrium, Apoballis, Furtadoa, Lasia, Pipthospatha,* and *Typhonium* have the least species diversity in the state. In addition to that, there are many genera like *Aglaonema, Alocasia, Anadenium, Amorphophallus, Amydrium, Carolasia, Homalomena, Lasi, Rhaphidophora, Scindapsus* and *Schismatoglottis,* which have a very significant relation with altitude.

2.5 Usage and Function of Araceae

Aroid plants are used for different purposes, like food, medicine, decoration, and animal feed. In Cisoka Village, West Java, the local community uses 20 species and 13 varieties of Araceae for their tubers, petioles, and leaves, which are used as food, medicine, decoration, and fish feed (Rizal et al., 2022). The Araceae family of plants, which is a family worldwide, has a lot of antimalarial species, and the most used parts for decoctions are the leaves and tubers (Asep Zainal Mutaqin et al., 2018). Nowhere else in the world apart from Vietnam's Hau River, 18 Araceae species are grown for decoration purposes whereas the other ones like Alocasia and Colocasia are used as food for humans and cattle (Frausin et al., 2015). In southern Africa, species such as Cussonia and Neocussonia from the Araliaceae family are used in traditional medicine for the treatment of various diseases and this proves the pharmacological activities of these plants which

FYP FSB

are analgesic, antibacterial, and antioxidant (Yuzammi, 2014). Araceae plants in Kelantan, Malaysia, have different uses. They are utilized as food, medicine, ornament, and even fish feed and, thus, represent the multifaceted nature (Asep et al., 2018). Besides, Araceae species are also used in Kelantan for their participation in the ceremonies, for their feeding of the animals as well as for their ornamental characteristics (Ni & Kurniawan, 2019). The Araceae species found in Kelantan have the potential as food, aromaticity, medicinal use, flavoring, and ornamental plants (Rizal et al., 2022). Araceae distribution in the Gowa Regency, South Sulawesi, is influenced by factors such as altitude, light intensity, soil pH, and moisture, demonstrating the significance of the relationship between Araceae and abiotic factors for the conservation and management of this species. The Araceae in Kelantan are of great significance in different aspects of life and cultural activities (Asep et al., 2020).

FYP FSB

UNIVERSITI
MALAYSIA
KELANTAN

CHAPTER 3

MATERIALS AND METHOD

3.1 Study area

Gunung Stong State Park (GSSP) is in Kelantan, Malaysia, laying between 5.3294329° latitude and 101.9471705° longitude. GSSP covers an area of 21,950 hectares and has been designated as a state forest park (Kamaruzaman & Skidmore, 200). It is acknowledged as a major ecotourism site where the local community gets benefits (Santhosam, 2017). The park is rich in biodiversity, with over 1500 species of plants, and diverse of wildlife.

GSSP is a 21,950-hectare protected forest designated as a High Conservation Value Forest (HCVF). The Kelantan government has designated 15 hectares in Compartments 11, 17, and 19 as HCVF to protect the endemic species of *Licuala stongensis*. Gunung Stong State Park (GSSP) in Kelantan, Malaysia stated by the HCVF as being an important place for species of fauna and flora encompassing small mammals such as bats and vulnerable rodents. There is ample evidence that supports the theory that the park has a favorable impact on the preservation of the region's natural biological and physical resources, and therefore should be considered for the successful future implementation of ecotourism. Further, GSSP strengthens sustainable tourism revenues with income derived from local stakeholders in the community, illustrating income support for conservation education among local dwellers. Moreover, there are nearby forest reserves where this remote sensing technology was used and managed forest

FYP FSB

resources can educate the public on the aspects of forest conservation to foster an understanding of the profession by preserving areas such as GSSP for future generations due to their ecological and economic value.

Furthermore, there is a high distribution of wildlife animals and plants, particularly small mammal species some of which are identified as vulnerable (Jayaraj et al., 2012). GSSP is a unique biodiversity and sustainable ecotourism viewed as one of the potential paths in the future, with a specific focus on visitor management and protection of natural resources (Hassin et al., 2017). Activities such as hiking and camping are common at GSSP, and good facilities are available (Abidin, 2017). The park is also a center for wildlife tourism, where flagship species attract positive perceptions from tourists (Anathan, 2017).

Figure 3. 1: Jelawang waterfall Gunung Stong State Park

FYP FSB
KELANTAN

Interest in the study includes the investigation of the diversity and distribution of Araceae in some regions of GSSP. Nevertheless, these fields of study will assist in gaining a greater knowledge concerning the wealth of plants and wildlife present in the park from the Gunung Stong Resort to the top of Gunung Stong covering from lowland to montane forests.

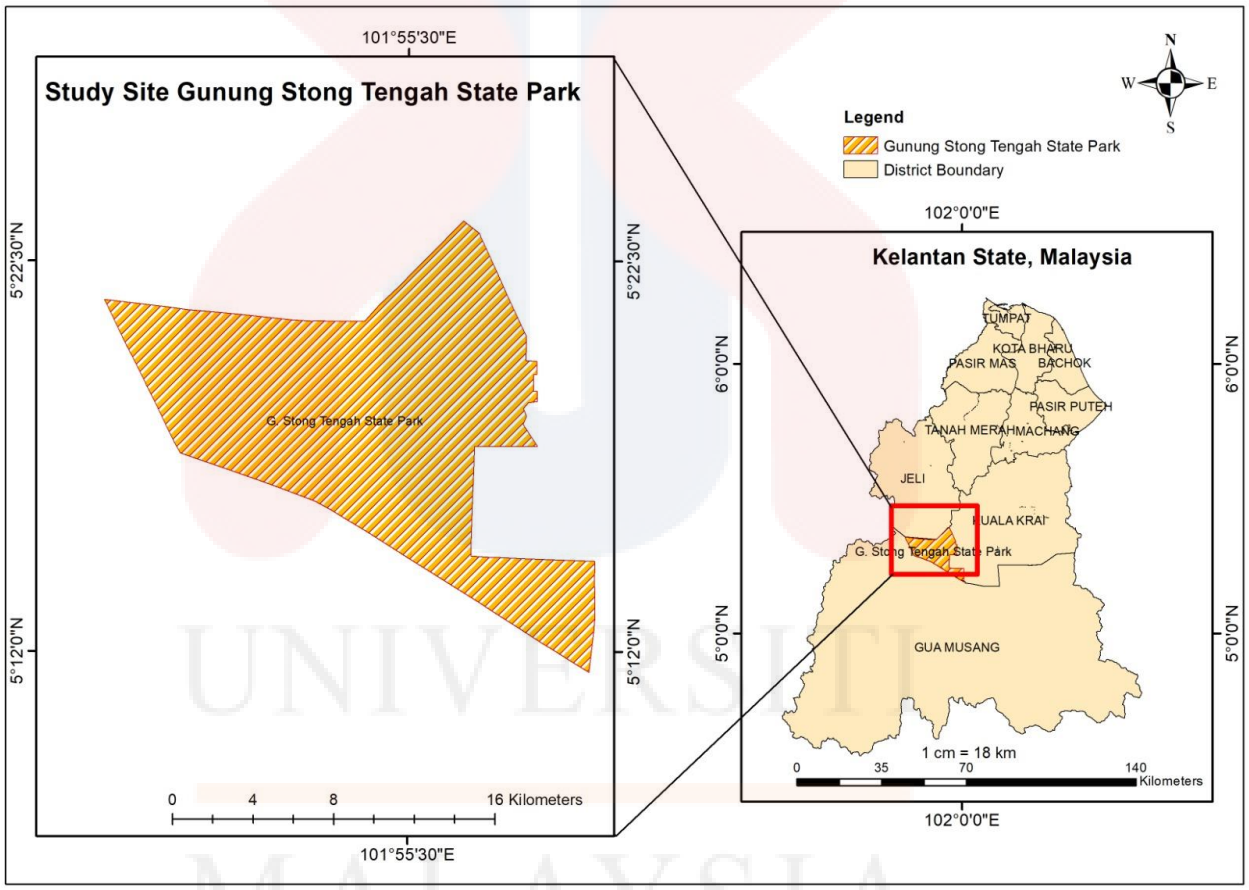

Figure 3. 2: Study area at Gunung Stong Tengah State Park, Kelantan.

3.2 Materials

The material used in this study is presented in Table 3.1 below:

Table 3. 1: List of material and its function

Name	Function
1. Global Positioning System (GPS) receiver	A radio wave receiver will be used to provide coordinates that give the exact position of an element in a certain space (Gunung Stong State Park)
2. Measuring tape	To survey to measure horizontal, vertical or slope distances for every distance when do the mapping.
3. Camera Phone	To capture and identify the species found using any app like planetNet, iNaturalist, Google Lens
4. Noted book and pen	To write and record the species data such as its diameter and length

These are the materials that were used to conduct this research at GSSP to obtain the data for the diversity and distribution of Family Araceae. Several items including measuring tape used in the first steps of fieldwork. The measuring tapes are important equipment because they were used to record the species' diameter and length.

FYP FSB
UNIVERSITI MALAYSIA KELANTAN

A notebook was used to note down every important detail about any data collected in the field. A navigation device, the GPS device, provided precise georeferencing of collection sites, making any subsequent analysis and interpretation more accurate. It is also used to record the species' location and altitude so that later can be transferred its data into the ArcGIS to generate a map to show the distribution of the family Araceae in the study site. Additionally, a phone's camera was also used to take detailed pictures of the specimen's appearance. These photos served as a reference for future research on the plants.

3.3 Method

The methods used in this study are discussed in sub-topics below:

3.3.1 Random sampling

Random sampling was a technique used to record species from their habitat, where each species had an equal probability of being selected. This method ensured that the sample was representative of the entire population without any bias. Every type of Araceae was observed and photographed during the climb to Gunung Stong. Specific data were recorded for each species, such as its leaf's height and width. The trail was 3.4 km from the starting point at the foot of the mountain to Kem Baha on the first day. For the next three days, the same method was used, but 500 meters apart for each of those three days. The area distance for the sampling area was approximately 5 km for the results of the study conducted. This involved documenting the geographical coordinates to pinpoint the exact location of each species using GPS, the altitude at which each species was found,

FYP FSB

and the width and length of the plant. This extensive data collection helped in documenting the distribution and other features of the familyAraceae species in Mount Stong effectively and in detail for the study. The recorded data were included in the thesis as a significant result of the study.

3.3.2 Species identification

Araceae in the study area were counted as data for the research. Species identification was made for writing their details in the thesis. In addition, the process of identifying Araceae was also done with the help of plant experts, especially the expertise of Araceae who were experienced in identifying the species, and with the help of apps such as PlantNet and iNaturalist and also various oldest research papers. It was important to identify Araceae in GSSP with full details because Araceae had many characteristics like other Araceae species. The identification process involved careful observation of the plant's morphology, including its leaves, stems, and flowers. The plant's habitat and distribution were also recorded to provide a comprehensive understanding of the species. The data collected were then analyzed to identify patterns and trends in the distribution and characteristics of the Araceae species. The results of the study were presented clearly and concisely, providing valuable insights into the diversity and distribution of Araceae in the study area. Species identification was also referred to in a book titled ‘Notes on Araceae of Kuala Koh, Kelantan, Peninsular Malaysia’ written by Zulhazman Hamzah, Mashhor Mansor and P.C. Boyce.

FYP FSB

3.3.3 Data Analysis

In this study, there are 2 data indexes were used to analyse the data such as:

a) Simpson Index

The Simpson index is a measure of diversity in a population, particularly used in ecological studies. It quantifies the level of diversity within a population by considering the abundance of different species. The index has no closed formula and is difficult to evaluate numerically for large populations. It is commonly used by ecologists to study forest dynamics and measure biodiversity (Arnauld et al, 2020).

$$D=1-\sum N(N-1)ni(ni-1) \qquad \text{Equation 1}$$

Where:

H' = Shannon diversity index

Pi = fraction of the entire population made up of species i

S = the number of species

∑ = sum of species 1 to species

b) Shannon-Wiener Index

The Shannon-Wiener index is a measure of species diversity in ecology, specifically the evenness or equitability of species representation in a sample. It is not much affected by sample size and is one of the indicators used to determine species diversity. The index, which is represented as a number or score, comes from the idea of evenness. It is frequently employed as an index and has been widely used in the

FYP FSB
UNIVERSITI MALAYSIA KELANTAN

monitoring of ecological change. As a result, a graphical characteristic that is employed in many scientific areas is the Wiener index.

$$D=1-\sum N(N-1)ni(ni-1) \qquad \text{Equation 3.2}$$

ni = the number of individuals in species i

N = total number of individuals of all species

S = species richness.

3.3.4 Geographic Information System

A Geographic Information System (GIS) is a computer system that captures, stores, analyses, and displays geospatial data. GIS was used in this study to create the mapping. The study used a Geographic Information System (GIS) to map the distribution of Araceae species in Gunung Stong State Park. The researchers transferred data collected from field surveys to DNRGPS software, which is an open-source application that allows users to transfer data between handheld GPS receivers and GIS software. This enabled the researchers to create a point map displaying the distribution of Araceae species in the study area, for which the location and value were known.

FYP FSB
UNIVERSITI MALAYSIA KELANTAN

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Diversity of Araceae at GSSP, Kelantan

Sampling has been constructed and the entire species and its total are shown in Table 4.1. The study recorded a total of 35 individuals representing 13 species under the family Araceae from the sampling site which is located at Gunung Stong State Park (GSSP), Kelantan.

Table 4. 1: Lists of species found at GSSP, Kelantan

Species name	Genus	IUCN Red List	Number of Individuals
Epipremnum giganteum	Epipremnum	Not Evaluated (NE)	6
Amydrium medium	Amydrium	Not Evaluated (NE)	5
Scindapsus pictus	Scindapsus	Not Evaluated (NE)	5
Colocasia esculenta	Colocasia	Lost Concern (LC)	4

FYP FSB

Alocasia puber	Alocasia	Not Evaluated (NE)	3
Homalomena curvata	Homalomena	Not Evaluated (NE)	3
Alocasia longgiloba	Alocasia	Not Evaluated (NE)	2
Homalomena pontiderifolia	Homalomena	Not Evaluated (NE)	2
Schismatoglottis wallichii	Schismatoglottis	Not Evaluated (NE)	2
Homalomena sp.	Homalomena	Not Evaluated (NE)	1

In this study, a total of 10 species from 143 species of Araceae have been identified from a study site located at GSSP, Kelantan, and 8 genera of Araceae were discovered in the State of Kelantan, specifically at GSSP, Kelantan. This represents 6.7% of an estimated 143 species worldwide.

Table 4.1 presents the list of species of Araceae that were found in GSSP, Kelantan. The list includes ten plant species along with their IUCN Red List statuses and the number of individuals observed. *Epipremnum giganteum*, *Amydrium medium*, and *Scindapsus pictus*, each not evaluated (NE) by the IUCN, have 6, 5, and 5 individuals respectively. *Colocasia esculenta*, categorized as Least Concern (LC), has 4 individuals.

FYP FSB
UNIVERSITI MALAYSIA KELANTAN

Alocasia puber, *Homalomena curvata*, and *Alocasia longgiloba*, all not evaluated (NE), have 3, 3, and 2 individuals respectively. Similarly, *Schismatoglottis wallichii*, also not evaluated (NE), has 2 individuals. *Homalomena sp*., with 1 individual, and *Homalomena pontiderifolia*, with 2 individuals, are both not evaluated (NE)

4.1.1 Species Diversity of Araceae

Table 4. 2: The values of diversity indices used for Araceae in GSSP, Kelantan

Indices	Values
Shannon – Wiener Diversity Index (H')	2.189
Simpson's Diversity Index (D)	0.905

From the results, Table 4.2 provides a summary of the biodiversity in a community of 10 different species using the Shannon-Wiener diversity index (H'). This index considers both species richness (the number of species present) and species evenness (the distribution of individuals among species). Each species' relative abundance (Pi) is calculated by dividing the number of individuals of that species by the total number of individuals across all species. In this sample, there are 33 individuals from 10 species.

The natural logarithm of Pi (ln(Pi)) is then multiplied by Pi to obtain Pi*ln(Pi), which quantifies each species' contribution to the overall diversity. Summing these values for all species results in a total of approximately -2.189. Taking the negative of this sum yields the Shannon-Wiener diversity index (H'), which is approximately 2.189. This value indicates a moderate level of diversity, suggesting that while some species are more

FYP FSB

dominant, there is still a reasonably even distribution among the species present, contributing to the community's ecological balance.

The data was also used to calculate Simpson's Diversity Index (D) and its related measure, the Simpson's Index of Diversity (1 - D). These indices quantify the biodiversity of a community by considering both species richness and species evenness. The sum of all "n(n-1)" values was calculated to assess the community's biodiversity. For the given data, D = 0.095, which indicates the probability that two randomly chosen individuals from the community will belong to the same species. The Simpson's Index of Diversity, calculated as 1 - D, provides a complementary view: D = 0.095 and 1 - D = 0.905. This value represents the probability that two randomly chosen individuals from the community will belong to different species. In this case, a value of 0.905 indicates a high level of diversity, suggesting a well-balanced ecosystem where individuals are relatively evenly distributed among the different species.

FYP FSB
UNIVERSITI
MALAYSIA
KELANTAN

4.2 Distribution of Araceae in Gunung Stong State Park, Kelantan

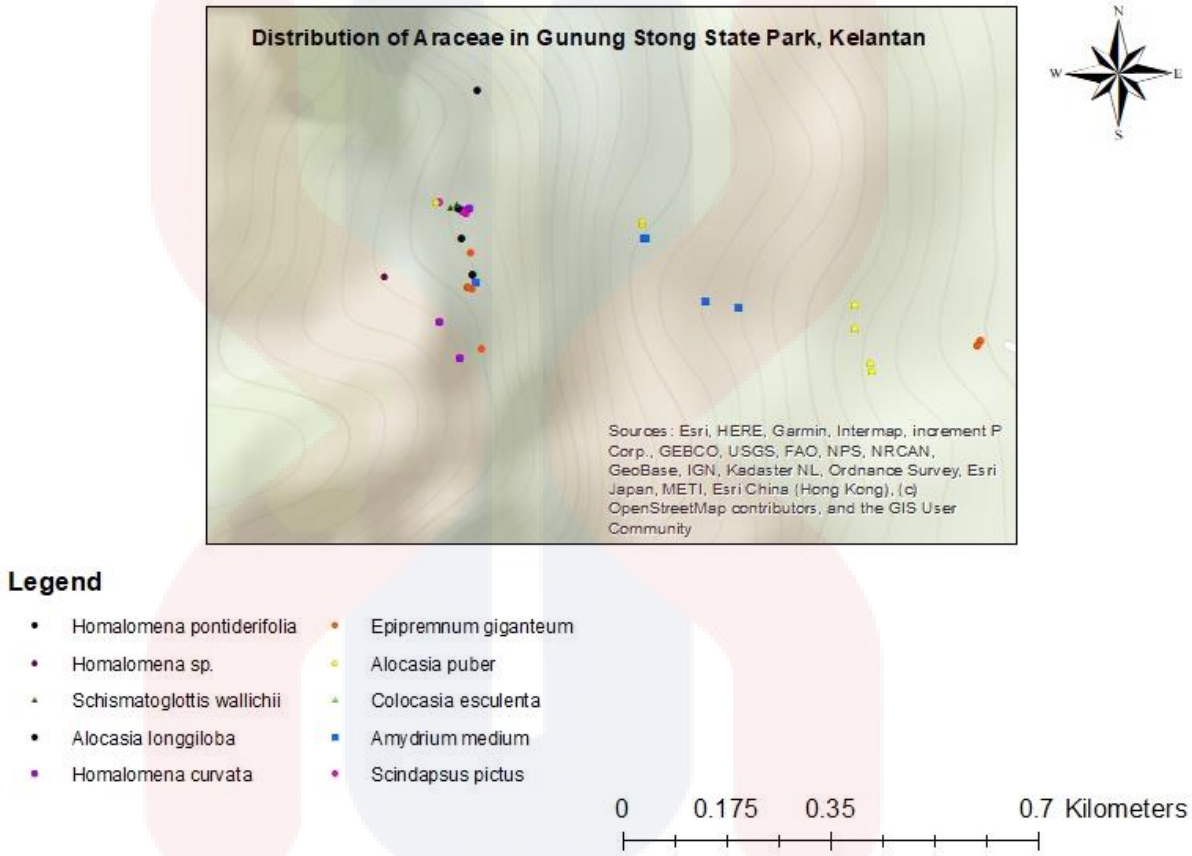

Figure 4. 1: Distribution map of Family Araceae recorded at GSSP, Kelantan

Figure 4.1 shows the maps for the species distribution of Araceae, representing 10 species and 33 individuals. Each species has been tagged along with coordinates and elevation for each species. Based on the diagram, *Epipremnum giganteum* has the most individuals, with 6 individuals, marked with fire red on the map. *Scindapsus pictu*s and *Amydrium medium* follow, each with 5 individuals. *Scindapsus pictus* is marked with ginger pink and *Amydrium medium* with Cretan blue. *Colocasia esculenta comes* next with 4 individuals, marked in medium green. *Alocasia puber* and *Homalomena curvata*

each have 3 individuals. *Alocasia puber* is marked with solar yellow, and Homalomena curvata with anemone violet. *Alocasia longiloba* and *Homalomena pontiderifolia* each have 2 individuals. *Alocasia longiloba* is marked with medium lime, and *Homalomena pontiderifolia* with black. *Schismatoglottis wallichii* also has 2 individuals, marked with fir green, and *Homalomena sp.* has 1 individual, marked with a purple heart.

4.2.1 *Epipremnum giganteum*

Epipremnum giganteum also known as the Giant Epipremnum, is a species of flowering plant in the genus *Epipremnum.* Its natural habitats are forests and thickets of lowland and foothill situations in south-eastern Asia, including Peninsular Malaysia. This plant is characterized by a large stem and leaf; stems may be up to 10–35 mm in diameter and the length of the leaves may be from 30–91 cm with the width of the leaves being 15–23cm. The species found in GSSP, Kelantan has a leaf length of 23.8 cm with a leaf width of 46.1 cm. This is because the leaves are also leathery, oblong, and have vigorous striate venation on their surface. The plant is also known by various other Malay local names which includes Rengut, Ringut, Rengot, Akar anggerik dahan, Akar pisang dahan, Akar ulu-ulu, and Akar resdung. There is a total of 6 individual species of *Epipremnum giganteum* found at GSSP, Kelantan out of 33 species found. This represents about 18.18% out of a total of 33 Araceae found at GSSP, Kelantan. The distribution for *Epipremnum giganteum* is scattered as it grows in different areas. It's also an epiphytic plant.

FYP FSB
UNIVERSITI MALAYSIA KELANTAN

Figure 4. 2: *Epipremnum giganteum*

4.2.2 *Scindapsus pictus*

One of the most Araceae found in the study area is *Scindapsus pictus. Scindapsus pictus* commonly known as Satin pothos or silver vine, is a plant from the Araceae family, subfamily Monstereae, and genus *Scindapus* with evergreen climbers that are grown as foliage ornamental (Chang et al., 2023). It is a popular plant, commonly called Satin pothos or silver vine belongs to the family Araceae (Musniati Azis et al., 2022). *Scindapsus pictus* is one of the most Araceae species that has been found at GSSP with 5 individuals each for its species. The distribution of *Scindapsus pictus* was recorded with coordinates at the elevation start range from 468m until 447.6m at GSSP. Geographically, *Scindapsus pictus* in the study area are randomly distributed in the environment or described as scattered. The plants are not localized but they spread across different areas, none of which could be said to be predominantly occupied by the plants. This sparse pattern is due to certain environmental forces influencing the growth of *Scindapsus pictus*

or a particular environmental requirement for its growth. In IUCN Red List, this species is labelled as Not Evaluated (NE).

Figure 4. 3: *Scindapsus pictus*

4.2.3 *Homalomena pontiderifolia*

Homalomena pontideriifolia, belonging to the family Araceae, Homalomena pontederiifolia is native to the tropical lowland forests, and this indicates that it grows in areas with moisture and low light conditions. It is grown in several parts of the world and, besides being a culinary herb, the plant is admired for its aesthetic value because of the appearance of its leaves and the fragrance they emit. This species contributes to the biodiversity of the Araceae family and is of interest to both ecological studies and horticultural practices. Its aromatic properties may also have potential applications in traditional medicine or as a natural fragrance source. The species found in GSSP, Kelantan has a leaf length of 29.5 cm with a leaf width of 31.4 cm. According to Brummit (2013). Based on IUCN Red List, *Homalomena pontideriifolia* has not yet been assessed making it Not Evaluated (NE).

FYP FSB

FYP FSB

Figure 4. 4: *Homalomena pontiderifolia*

4.2.4 *Homalomena curvata*

Homalomena curvata also known as Shield Plant is a vivid tropical perennial that is grouped under the Araceae family. It is characterized by having large heart-shaped leaves and that makes it to be used more for ornamental purposes. Since it is a perennial plant, it has a vigorous growth habit, and thus can be decorative in the tropics and as a potted plant. South Asia is the region from where this plant originates. However, it is distributed in many areas of Southern Asia and the Southwestern Pacific. Scientific studies have established *Homalomena curvata* at GSSP (Gunung Stong State Park) in Kelantan, which has been spotted on three occasions. On average, the specific plant at this site of deployment depicts an average leaf size of about 13 cm in length and an average width of about 15. 9 cm. The people of GSSP include three distinct individuals of *Homalomena curvata* and thus, they enhance the richness of the locality. Of the 33 plant species recorded in the area for this study around GSSP, *Homalomena curvata* constitutes about

9.09% of the total plants. Concerning the ecological density of the species at GSSP, the *Homalomena curvata* species grow close to each other. This kind of clustering behaviour may be significant in their mating behaviour and existence in the natural environment. Based on the IUCN Red List, *Homalomena curvata* has not yet been assessed making it Not Evaluated (NE).

Figure 4. 5: *Homalomena curvata*

4.2.5 *Amydrium medium*

Amydrium medium whose other name is Amydrium Medium Silver is a flowering species in the family *Amydrium* under the arum family, Araceae. It is a native of southern Asia, growing mainly in countries like Malaysia. *Amydrium medium* contributes to the rich array of plant species found in various regions (Ho et al., 2019). *Amydrium medium* has a leaf length of 19.7 cm with a leaf width of 14.3 cm. There is a total of 5 individual species of *Amydrium medium* found at GSSP, Kelantan out of 33 species found. This represents about 15.15% out of a total of 33 Araceae found at GSSP, Kelantan. *Homalomena curvata*, or Shield Plant, is often found growing in clusters, where

FYP FSB

individuals are closely grouped. This clustered distribution is influenced by several factors, including the availability of nutrients, sunlight, and moisture. This clustering allows them to effectively utilize shared resources and create a supportive microhabitat for their growth and survival. This species is Not Evaluated (NE) based on the IUCN Red List.

Figure 4. 6: *Amydrium medium.*

4.2.6 *Colocasia esculenta*

Colocasia esculenta is a plant that has corms and leaves that are eaten in various parts of the world but is most famous in tropical lands as a vegetable plant. It is most known as a perennial herbaceous plant in the Araceae family grown in East Asia. Giant taro arose from *Colocasia esculenta* as it possesses large, heart-shaped, or arrow-shaped leaves, which may contain up to 40 cm of length and 25 cm of width. The leaves are lanceolate, up to 7 cm long, entire, and with a dark green upper surface and pale green lower surface, as well as being pubescent. There are a total of 4 individual species of

FYP FSB
UNIVERSITI
MALAYSIA
KELANTAN

Colocasia esculenta found at GSSP, Kelantan out of 35 species found. This represents about 12.12% out of a total of 33 Araceae found at GSSP, Kelantan. According to Nguyen (2011), *Colocasia esculenta* has most recently been assessed for *The IUCN Red List of Threatened Species* in 2010. This plant prefers aquatic areas and frequently occurs in paddy fields at the sides of ponds and water courses. It is also used in many areas for several activities like providing fodder for animals, for use in preparing medicine or it is even grown for use in ornamental purposes. Since it is a very common species and there are no significant threats that are putting this animal in danger, it is listed under the Least Concern (LC) category.

Figure 4. 7: *Colocasia esculenta*.

4.2.7 *Alocasia puber*

Alocasia puber, commonly known as the Chinese Taro, is a member of the Araceae family, native to regions in Peninsula Malaysia and the western and central parts of Java. This subshrub thrives in wet tropical biomes, characterized by its striking foliage and unique features. Alocasia puber produces large leaves that are shaped like elephants

FYP FSB

and are generally bluish green with very noticeable ribs. It is characterized by its pubescent petioles as well as red horizontal lines on the surface of the leaf's substrate. These characteristics accrue to aesthetics and for this reason, many plant enthusiasts prefer it. There are a total of 3 individual species of *Alocasia puber* found at GSSP, Kelantan represents about 9.09% out of a total of 33 Araceae found in the study site. The giant taro or giant elephant's ear plant scientifically known as *Alocasia puber* acts under the Araceae family and is endemic to South Asia and the Pacific Islands. It bears crescent-shaped fruit measuring approximately 4 cm in length and 3 cm across, with a sprawling plant approximately 2-4 meters tall, sometimes reaching up to 5 m. It produces large cordate leaves which are prominently veined, wavy margined, green in color, and can be up to 3-6 ft. in length and 3-4 ft. in breadth. The leaves are of a long-stemmed shape with rolled borders and presented on rather brittle stems that grow from the erect stem that can reach the height of some six feet in time (Rojas et al., 2022). The distribution for this species is clustered as they grow close to each other in an area. This species is Not Evaluated (NE) based on the IUCN Red List.

Figure 4. 8: *Alocasia puber*

FYP FSB

4.2.8 *Alocasia longiloba*

In the study site, there are 2 identified *Alocasia longiloba* out of 33 species found. This represents about 6.06% of 33 Araceae found in the study site. *Alocasia longiloba* commonly referred to as the "African Mask Plant" is an aglaonema type of plant belonging to the Araceae family of flowering plants. It has large, elongated leaves that have distinguishable white venation which gives this plant a very interesting appearance. *Alocasia longiloba* found in the study site has a leaf length of 29.9 cm with a leaf width of 14.4 cm average. In the study site, *Alocasia longiloba* can be found at an altitude of 460.1m at GSSP based on the research conducted. This species is Not Evaluated (NE) based on the IUCN Red List and its distribution is clustered.

Figure 4.10: *Alocasia longgiloba*

4.2.9 *Schismatoglottis wallichii*

In the study site, there are 2 identified *Schismatoglottis wongii*, out of 33 species found. This represents about 6.06% of 33 Araceae found in the study site. *Schismatoglottis*

FYP FSB

wallichii, also known as Wong's Schismatoglottis, is a plant species belonging to the Araceae family. This plant species usually bears leaf laminae at the base which may be cordate to round, and the plant may exhibit pleasing stripping of colors. The leaves are matte in appearance. *Schismatoglottis wallichii* found in the study site has a leaf length of 9.8 cm with a leaf width of 2.4 cm average. In the study site, *Schismatoglottis wongii* can be found at an altitude of 467.09m and 474.47m. Based on IUCN Red List, *Schismatoglottis wongii* has not yet been assessed making it Not Evaluated (NE). The distribution for this species is scattered as it grows randomly and not close to each other.

Figure 4.12: *Schismatoglottis wallichii*

4.2.10 *Homalomena sp.*

In the study site, there are 1 unidentified *Homalomena sp.*, out of 33 species found. This represents about 3.03% of 33 Araceae found in the study site. *Homalomena sp.* is a plant species that belongs to the genus *Homalomena* under the family Araceae. This species is commonly known as the Heart-shaped *homalomena.* These species are native to Southeast Asia such as Malaysia. This genus includes plants that spread and grow from

FYP FSB
UNIVERSITI MALAYSIA KELANTAN

a center point, are evergreen, have leaves that are heart-shaped, and arrowhead-shaped, and small flowers that do not have petals. The distribution for this species cannot be categorized either it scattered or classterre as it only 1 species found.

Figure 4.13: *Homalomena sp.*

FYP FSB
UNIVERSITI
MALAYSIA
KELANTAN

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The objectives of this research were to identify the species of Araceae, the richness, and community patterns of the plant in GSSP, Kelantan. In a way, the study offered a well-elaborated list of 13 Araceae species from 8 genera in the GSSP. Therefore, the impact assessment revealed that the most frequently encountered species were *Amydrium medium* and *Scindapsus pictus*.

Based on the results of the Shannon-Wiener Diversity Index and Simpson's Diversity Index. Therefore, confirmed the explicit multiplicity of species and tendentious equality within GSSP. This study unveiled the following findings about the distribution patterns of Araceae species regarding geographical coordinates and altitude. Also, species such as *Scindapsus pictus*, *Epipremnum giganteum*, and *Philodendron grandipes* let to understand specific conditions in their localization and their form. The study also pointed to the value of Araceae species in GSSP's ecological system and their possibilities in the sphere of conservation. Therefore, the presented findings point to the necessity to improve the current knowledge of Araceae species distribution, which will help in conservation planning and youth environmental education.

FYP FSB

In sum, it can be suggested that the research question of the current study has been answered appropriately based on the detailed insights into the distribution and diversification of Araceae in the GSSP, Kelantan. This helps to add information significant for science and contributes to further investigations and the preservation of populations in the area.

5.2 Recommendations

In future research on the diversity and distribution of Araceae at GSSP, Kelantan, the following suggestions are recommended: The sampling coverage should be increased, and other factors examined to provide complete and precise data. Since the current study only focused on a hiking trail, locating sampling points across other areas in GSSP will give a broader view of environments where Araceae can grow and establish themselves. Therefore, it is important to also consider aspects such as weather conditions during the sampling process, mainly because the project was conducted during the dry season, which highly influences the Araceae growth and thus the findings.

The information collected in this work may be useful for further studies by providing new, contemporary information on the Araceae distribution within the region. In the same way, the large coverage area and increased number of sample points shall improve the datasets that would help the relevant organizations in the efficient utilization and protection of this important ecological region.

FYP FSB
UNIVERSITI
MALAYSIA
KELANTAN

REFERENCES

Ali, S., Jawad, A., Md. Habibullah, Yixian Quah, Lee, E., Biruk Tesfaye Birhanu, Suk, K., & Seung

Amarante, C. (2023). Diversity and Distribution Patterns of Araceae Family. *Academia.edu*. https://doi.org/10.3390/plants9060737.

Arnaud Guillin, Franck Jabot, & Arnaud Personne. (2020, July 11). *On the Simpson index for the Wright–Fisher process with random selection and immigration*. ResearchGate; World

Asep Zainal Mutaqin, Kurniadie, D., Iskandar, J., Mohamad Nurzaman, & Ruhyat Partasasmita. (2020). Ethnobotany of suweg (Amorphophallus paeoniifolius): Folk classification, habitat, and traditional conservation in Cisoka Village, Majalengka District, Cimanuk Watershed Region, Indonesia. *Biodiversitas*, *21*(2). https://doi.org/10.13057/biodiv/d210216

Asep Zainal Mutaqin, Muthi Fatharani, Iskandar, J., & Ruhyat Partasasmita. (2018). Utilization of Araceae by local community in Cisoka Village, Cikijing Sub-district, Majalengka District, West Java, Indonesia. *Biodiversitas*, *19*(2), 590–601. https://doi.org/10.13057/biodiv/d190236

Asep Zainal Mutaqin, Muthi Fatharani, Iskandar, J., & Ruhyat Partasasmita. (2018). Utilization of Araceae by local community in Cisoka Village, Cikijing Sub-district, Majalengka District, West Java, Indonesia. *Biodiversitas*, *19*(2), 590–601. https://doi.org/10.13057/biodiv/d190236

Boyce, P. C., & Croat, T. B. (2011). The Überlist of Araceae, totals for published and estimated number of species in aroid genera. https://doi.org/10.13140/RG.2.2.24820.0960

Brummitt, N. 2013. Philodendron grandipes. The IUCN Red List of Threatened Species 2013: e.T44393081A44396832. https://dx.doi.org/10.2305/IUCN.UK.2013-2.RLTS.T44393081A44396832.en. Accessed on 02 June 2024.

Chang, C.-Y., Tang, W.-C., & Chu, C.-C. (2023). First Report of *Dickeya dadantii* Causing Bacterial Soft Rot of *Scindapsus pictus* in Taiwan. *Plant Disease*, *107*(8), 2516–2516. https://doi.org/10.1094/pdis-12-22-2885-pdn

Croat, T. B., & Ortiz, O. O. (2020). Distribution of Araceae and the Diversity of Life Forms. *Acta Societatis Botanicorum Poloniae*, *89*(3). https://doi.org/10.5586/asbp.8939

FYP FSB

Croat, T. B., & Ortiz, O. O. (2020, November 12). *Distribution of Araceae and the Diversity of Life Forms*. ResearchGate; Polish Botanical Society. https://www.researchgate.net/publication/345778215_Distribution_of_Araceae_and_the_Diversity_of_Life_Forms

Engrid Juni Astuti, Susi Ernawati, Sovia Aprina Basuki, & M. Artabah Muchlisin. (2022, September 15). *Activity of Ethanol Extract of Homalomena Occulta Rhizome in Inhibiting Kidney Stone Formation in Wistar Rats*. ResearchGate; Knowledge E DMCC. https://www.researchgate.net/publication/363591480_Activity_of_Ethanol_Extract_of_Homalomena_Occulta_Rhizome_in_Inhibiting_Kidney_Stone_Formation_in_Wistar_Rats

Figueroa, D. S., Zabalgoitia, A., Perla Velázquez Ríos, & Huerta, O. (2023, June 6). A new species of Triphora (Orchidaceae: Triphoreae, Triphorinae) from Mexico. ResearchGate; Magnolia Press. https://www.researchgate.net/publication/371339481_A_new_species_of_Triphora_Orchidaceae_Triphoreae_Triphorinae_from_Mexico

G. Frausin, Lima, S., Hidalgo, A. F., Ming, L. C., & A.M. Pohlit. (2015). Plants of the Araceae family for malaria and related diseases: a review. *Revista Brasileira de Plantas Medicinais*, *17*(4), 657–666. https://doi.org/10.1590/1983-084x/14_024

Hassin, N. H., Noor, A., Mungkar, A. N., Hafira Ulfah Hasnil, Rahman, N., Muhamad Azahar Abas, & Karim, A. (2019). A pilot study for sustainable ecotourism at Gunong Stong State Park, Kelantan using Visitor Experience and Resource Protection (VERP) management framework. Journal of Tropical Resources and Sustainable Science (JTRSS); https://www.semanticscholar.org/paper/A-pilot-study-for-sustainable-ecotourism-at-Gunong-Hassin-Noor/00eb4e08d9c6b4654fcfa85cc90755b42b29fb63

Hassin, N. H., Noor, A., Mungkar, A. N., Hafira Ulfah Hasnil, Rahman, N., Muhamad AzaharHo, B. C., Lua, H. K., Ibrahim, B., Yeo, R. S. W., Athen, P., Leong, P. K. F., Ibrahim, A., Koh, S. L., Ibrahim, H., Lindsay, S., Chin, L. L., Seah, W. W., & Middleton, D. J. (2019). The plant diversity in Bukit Timah Nature Reserve, Singapore. *Gardens' Bulletin Singapore*, *71*(suppl.1), 41–144. https://doi.org/10.26492/gbs71(suppl.1).2019-04

Hong Thien Van, Nguyen-Phi, N., & Hong Truong Luu. (2023). Applications of molecular markers in taxonomic identification of Araceae species from Vietnam – A short review. *Israel Journal of Ecology & Evolution*, *69*(03-04), 162–168. https://doi.org/10.1163/22244662-bja10058

FYP FSB

Igor Borsic, & Tomica Rubinić. (2022). First record of Pistia stratiotes L. (Araceae) in Croatia, with the consideration of possible introduction pathways. *Periodicum Biologorum*, *123*(1-2), 35–39. https://doi.org/10.18054/pb.v123i1.7674

Jayaraj, Vijaya Kumaran, et al. "Species Diversity of Small Mammals at Gunung Stong State Park, Kelantan, Malaysia." Journal of Threatened Taxa, vol. 4, no. 6, 26 June 2012, pp. 2617– 2628, https://doi.org/10.11609/jott.o3015.2617-28. Accessed 27 Nov. 2021.A, Boyle. (2022). Data collection. doi: 10.31219/osf.io/h9an8

Liyana, N., Hamzah, Z., Mohamed, M., & Amaludin, N. (2020). A Distribution of Homalomena Genus (Araceae) using the Ecological Niche Modeling in the State of Kelantan, Peninsular Malaysia. *International Journal of Advanced Science and Technology*, *29*(5s), 1967–1975. http://myscholar.umk.edu.my/bitstream/123456789/1555/1/17913-Article%20Text-26756-1-10-20200524%20%281%29.pdf

Musniati Azis, Pince Salempa, & Maryono Maryono. (2022). Isolasi dan Identifikasi Senyawa Metabolit Sekunder Ekstrak Metanol Batang Belajang Susu (Scindapsus pictus Hassk.). *Chemica*, *23*(1), 59–59. https://doi.org/10.35580/chemica.v23i1.33862

Ni, & Kurniawan, A. (2019). STUDI ARACEAE BALI : KERAGAMAN DAN POTENSINYA. *Jurnal Widya Biologi*, *10*(02), 135–147. https://doi.org/10.32795/widyabiologi.v10i02.411

R.S. Policegoudra, Goswami, S., Aradhya, S. M., Chatterjee, S., Datta, S., R. Sivaswamy, Chattopadhyay, P., & Singh, L. (2012). Bioactive constituents of Homalomena aromatica essential oil and its antifungal activity against dermatophytes and yeasts. *Journal of Medical Mycology*, *22*(1), 83–87. https://doi.org/10.1016/j.mycmed.2011.10.007

Risa Suryani Wilyasari, Yulianty Yulianty, Zulkifli Zulkifli, & Endang Nurcahyani. (2020). Morphological Characteristics of Araceae Plants in Liwa Botanical Garden, West Lampung. *Jurnal Ilmiah Biologi Eksperimen Dan Keanekaragaman Hayati (J-BEKH)*, *7*(1), 35–40. https://doi.org/10.23960/j_bekh.v7i1.2523

Rizal Koen Asharo, Ayu Novitasari, Devi, S., Rahadian Ajeng Saraswati, Fani Setyaningsih, Puput Apriliani, Rizky Priambodo, Pinta Omas Pasaribu, Rizkawati, V., & Usman, U. (2022). Araceae Floristic and Potential Study in Bogor Botanical Gardens, West Java, Indonesia. *Jurnal Riset Biologi Dan Aplikasinya*, *4*(1), 9–18. https://doi.org/10.26740/jrba.v4n1.p9-18

FYP FSB
UNIVERSITI MALAYSIA KELANTAN

Rizal Koen Asharo, Ayu Novitasari, Devi, S., Rahadian Ajeng Saraswati, Fani Setyaningsih, Puput Apriliani, Rizky Priambodo, Pinta Omas Pasaribu, Rizkawati, V., & Usman, U. (2022). Araceae Floristic and Potential Study in Bogor Botanical Gardens, West Java, Indonesia. *Jurnal Riset Biologi Dan Aplikasinya*, *4*(1), 9–18. https://doi.org/10.26740/jrba.v4n1.p9-18

Rojas-Sandoval, J., & Acevedo-Rodríguez, P. (2022). Alocasia macrorrhizos (giant taro). *CABI Compendium*. https://doi.org/10.1079/cabicompendium.4220

Sao-Mai, Dam., Hong, Thien, Van. (2022). Chemical profiles and biological activities of essential oils of Arisaema and Homalomena species (Araceae) – A review. The Journal of Phytology, doi: 10.25081/jp.2022.v14.7444

Sarguna D.S, A Tharshini, Zaza Amira Z.A, Mohd, N., & Zulhazman Hamzah. (2017). Assessment on Local Community Perception of Gunung Stong State Park and its Role in Income from Sustainable Tourism. *Journal of Tropical Resources and Sustainable Science*. https://doi.org/10.47253/jtrss.v5i2.594

Saurov, Jyoti, Roy., Prantik, Sharma, Baruah., Lipika, Lahkar., Lisha, Gurung., Debanjali, Saikia., Bhaben, Tanti. (2019). Phytochemical analysis and antioxidant activities of Homalomena aromatica Schott. Journal of Pharmacognosy and Phytochemistry, Scientific.https://www.researchgate.net/publication/342895528_On_the_Simpson_index_for_the_ Wright-Fisher_process_with_random_selection_and_immigration

Simpson, M. G. (2010). Diversity and Classification of Flowering Plants. *Elsevier EBooks*, 181–274. https://doi.org/10.1016/b978-0-12-374380-0.50007-5

Stanly, C., Bhatt, A., Sulaiman, B., & Chan Lai Keng. (2012). Micropropagation of Homalomena pineodora Sulaiman & Boyce (Araceae): a new species from Malaysia. *Horticultura Brasileira*, *30*(1), 39–43. https://doi.org/10.1590/s0102-05362012000100007

Stockey, R. A., Hoffman, G. L., & Rothwell, G. W. (2021). Fossil evidence for Paleocene diversification of Araceae:*Bognerospadix*gen. nov. and*Orontiophyllum grandifolium*comb. nov.. *American Journal of Botany*, *108*(8), 1417–1440. https://doi.org/10.1002/ajb2.1707

Stockey, R. A., Rothwell, G. W., Beard, G., & Gemmell, J. (2023). Refining Our Understanding of Late Cretaceous–Paleogene Evolution within the Monocot Family Araceae: *Appianospadix bogneri* gen. et sp. nov.. *International Journal of Plant Sciences*, *184*(6), 470–484. https://doi.org/10.1086/725163

FYP FSB

Suleman, S. M., I Made Budiarsa, Achmad Ramadhan, Iqbal, M., & I Komang Suletra. (2022). The Relationship of Plant Types Familia Araceae on The Mountain Sidole Track Central Sulawesi Based on Morphological Character. *Jurnal Biologi Tropis/Jurnal Biologi Tropis*, *22*(4), 1092–1097. https://doi.org/10.29303/jbt.v22i4.4138

Van Son Dang, Ba Vuong Truong, Quoc Bao Nguyen, Quoc Trong Pham, Van Tu Nguyen, Hong Son Le, Van Nga Nguyen, Rene Alfred Anton Bustamante & Khant Zaw Hein. (2023). A New Species of Homalomena (Araceae: Homalomeneae) from Con Dao National Park, Vietnam, with lectotypification of Homalomena philippinensis. Taiwania, 68(3), 269-274. https://doi.org/10.6165/tai.2023.68.269

Yuzammi Yuzammi. (2014). Conservation Status of Amorphophallus Discophorus Backer & Alderw. (Araceae) In Java, Indonesia. *Reinwardtia*, *14*(1), 27–27. https://doi.org/10.14203/reinwardtia.v14i1.392

Zulhazman Hamzah. (2020). A study on Araceae species diversity and its distribution in Kelantan, Peninsular Malaysia - Digital Special Collection (UMK Repository). *Umk.edu.my*. http://discol.umk.edu.my/id/eprint/10128/1/Zulhazman%20bin%20Hamzah.pdf

FYP FSB

UNIVERSITI
MALAYSIA
KELANTAN