Notes on Araceae in Lojing Highlands, Kelantan, Peninsular Malaysia

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Abstract. Araceae is recognized as keladi hutan or ubi keladi to the local community in Malaysia. The aim of this study is to provide an update checklist and description on ecology of Araceae in Lojing Highlands, Gua Musang, Kelantan, Peninsular Malaysia. The survey was applied the random sampling technique. The result shows that a total of 25 species from 15 genera of Araceae were revealed from the area. This figure constitutes about 17.9% out of 140 species and 53.6% of the 28 genera of Araceae documented in Peninsular Malaysia. Most of them, 23 species or 92.0% are common in tropical rainforest. However, two species which considered as rare, these are Alocasia inornata Hallier f. and Arisaema anomalum Hemsl.

1. Introduction
Araceae is the monocotyledonous angiosperm plant. The most common differences of morphological characteristic for Araceae as compared to other families is the occurrence of inflorescences in the form of spathe-and-spadix [1, 2]. The species and genus of Araceae show lot of diverse in morphological appearances, microhabitats, lifeforms, phenology and adaptive variations for efficient pollination [3]. Beside, Araceae occupies in multi ranges of elevations and sites. Moisture and humidity are the two most suitable conditions needed by many species of Araceae to thrive [4, 5].

To date, a total of approximately 132 genera and 5,435 species of Araceae were recorded in various regions of the world [6]. The Malesia region such as Malay Peninsula, Borneo, Sumatra and New Guinea were considered as several centres of diversity for Araceae family. In Peninsular Malaysia, [7] was updated an account of Araceae that registered 28 genera and 140 species, including of 25 species were considered as endemic.

This article on Lojing Highlands is one of the 61 places surveyed by the main author in the state of Kelantan. This is the sixth checklist account of Araceae in Peninsular Malaysia, subsequently from the surveys in Ulu Sat [8], Pangkor Island [9], Mt. Basor [10], Mt. Chamah [11] and Kuala Koh [12]. This is also the second account of Araceae after Gunung Chamah which conducted in highland areas at elevation of more than 1,000 meters above sea level. In addition, three novel species of Araceae, Alocasia farisii, Homalonema stongensis and H. kualakohensis [13, 14, 15]; and two new records for Peninsular Malaysia, Aglaonema cochinchinense and A. pumilum [16] were also revealed from the project. Beside taxanomy, the project on Araceae in Peninsular Malaysia also comprised of several other studies such as on phytogeography [17], phytoremediation [18, 19], propagation [20], species utilization [21, 22] and phytochemistry [23, 24, 25].
2. Methodology
The study area, Lojing Highlands is located at the southern part of Kelantan, Peninsular Malaysia. It is laying between latitude of 4° 32′ to 4° 47′ N and longitude of 101° 20′ to 101° 34′ E. The elevation of the area is between 800 to 1,400 meters above sea level. The total land area is 23,435 ha, mostly covered by natural tropical rainforest of hill dipterocarp and sub-montane forests. There are two forest reserves, namely Lojing (14,339 ha) and Sg. Berok (4,041 ha). The highest peak is Mt. Warpu (1,864 meters) [26].

The random sampling technique as adopted from [27] was used in this study. In this technique, the sample in the population are randomly selected, hence each sample in the population has the same possibility of being collected as a sample. The surveys were done in two forested areas; Kg. Jedip and Kg. Sg. Rengit of Lojing Highlands.

During the survey, Araceae species were collected and subsequently and conserved as herbarium specimen for references. If flowers or fruits are available, they will be preserved in 70% ethanol. The position of each Araceae species was taken in longitude and latitude by using the GPS (Global Positioning System). Other physical parameters such as elevation, aspect and slope gradient were also automatically captured by GPS.

The data on habitats of Araceae was also taken. These descriptive parameters are forest floor conditions (dry and moist), the microhabitats (flat area, on-ridge, on-slope, streambank and in-stream), the lifeforms (mesophytes, hemiepiphytes, lithophytes, rheophytes, helophytes and geophytes). The geological data were also noted such as clastic sediment, granite, limestone, metasediment, schist and volcanic. The photography of habitat and morphological characters were also taken such as inflorescence, infructescence, leaf, stem and root.

3. Results and discussion
The result shows that a total of 25 species from 15 genera of Araceae were documented in Lojing Highlands as tabulated in Table 1. From the total, 23 species were considered as common and only two species were noted as rare. Based on our earlier studies of Araceae in Kelantan, the number of Araceae species collected will indicate the status of forest in a particular area as shown in Table 2. According to the hypothesis, Lojing Highlands was classified as good forest or recovered disturbed area.

In general, the forested area in Lojing is still regarded as one of the pristine natural areas in Kelantan which many parts are still covered by hill dipterocarp and sub-montane forests. However, the areas surveyed are slightly disturbed due to frequent visits by tourists and proximity to the indigenous villages. The occurrence of Rafflesia kerri Meijer [28, 29], the gigantic flower in Lojing Highlands has attracted many tourists especially international tourists to visit this area [30].

The most diverse species of Araceae collected in Lojing Highlands is from the category of lianescent or climbing herb. They are hemiepiphytic plants, begin their survives on the forest floor (on soil or rock) and then climb and colonize the tree trunks where they become adults. A total of eleven species of climbing Araceae from six genera were recorded in Lojing Highlands; Amydrium Schott, Anadendrum Schott, Epipremnum Schott, Pothos L., Rhaphidophora Schott and Scindapsus Schott. As usually, Amydrium medium (Zoll. & Moritzi) Nicolson and Epipremnum giganteum (Roxb.) Schott were always seen creeping on big trees up to emergent strata. Meanwhile, Anadendrum microstachyum de Ver & Becker and Pothos scandens L. were colonized on shrub and understory stratum. In Lojing Highlands, these said species were prominent in steep slope, on ridge and dry areas at an altitude of 600-1,000 meters above sea level (a.s.l.).

Three species of Rhaphidophora Schott were noted during the sampling. Rhaphidophora korthalsii Schott is one of the common species and widely distributed in the tropical rainforest of Peninsular Malaysia. In Lojing Highlands, the species was observed on flat area and gentle slope at an altitude of 1,000 meters a.s.l. They usually found thriving on the rocks and stem trees of medium to bigger sizes. The juvenile stage of R. korthalsii Schott is a shingle liana with oblong-elliptic to ovate, more or less falcate upwards pointing leaves overlying in the manner of roof tiles. Therefore, R. maingayi Hook.f.
was also conquered on rocks and climbed on medium size of trees of dry ridge areas at an altitude of 900 meters a.s.l. Meanwhile, *R. puberula* Engl. also thrived on rocks and trees in dry area but frequently spotted on flat areas at an altitude of 800-900 meters a.s.l.

### Table 1. Checklist of Araceae recorded in Lojing Highlands, Kelantan, Peninsular Malaysia

| No. | Genus              | Species                     | Lifeform     | Habitat                        | Voucher No. | Remarks |
|-----|--------------------|-----------------------------|--------------|--------------------------------|-------------|---------|
| 1   | Aglaonema Schott   | nitidum (Jack) Kunth        | Mesophytes   | Streambank, on slope, moist area | UMK00277    | C       |
| 2   | Alcassia (Schott) G. Don | inornata Hallier f.            | Mesophytes   | On slope, dry areas             | UMK00289    | R       |
| 3   | Amorphophallus Blume | praianii Hook.f.             | Geophytes    | On slope, moist and dry areas   | UMK00162    | C       |
| 4   | Anthodium Schott   | medium (Zoll. & Mortiz) Nicolson | Hemiepiphytes | On ridge, on slope, dry area    | UMK00164    | C       |
| 5   | Anadenandrum Schott | microstachyum de Vr. & Becker | Hemiepiphytes | On slope and dry area           | UMK00170    | C       |
| 6   | Apollis Schott     | mutata (Hook.f.)            | Mesophytes   | In colony, shady moist area, on-slope | UMK00179    | C       |
| 7   | Artsaema Mart.     | anomalous Hems.             | Mesophytes   | On slope, on rock, shady and moist areas | UMK00270    | E, R    |
| 8   | Cococasia Schott   | excudenta (L.) Schott       | Mesophytes, Hemiphytes | Streambank, moist area | UMK00244    | C       |
| 9   | Epipremnium Schott | giganteum (Roxb.) Schott    | Hemiepiphytes | Flat, on rigde, dry area        | UMK00276    | C       |
| 10  | Homalomena Schott  | curvata Engl.               | Mesophytes   | On slope, ridge, close canopy area | UMK00131    | C       |
|     |                    | pontederiforma Griff. ex. Hook.f. | Mesophytes  | Flat area, on ridge, dry area   | UMK0005     | C       |
|     |                    | wallichii Hook.f.           | Mesophytes   | Flat area, on slope, dry and moist areas | UMK00018    | C       |
| 11  | Piptospatha N. E. Br. | perakensis (Engl.) Engl.  | Rheophytes   | Stream margin, on rock, moist area | UMK00291    | C       |
| 12  | Pothos L. scandens |                            | Hemiepiphytes | Flat area, on ridge, dry area, often on medium trees. | UMK00085    | C       |
| 13  | Bhaphidophora Hassk. | korthalsii Schott           | Hemiepiphytes | On slope, on rock and tree, dry and moist areas | UMK00038    | C       |
|     |                    | maingayi Hook.f.            | Hemiepiphytes | Flat area, on slope, rock and tree, dry area | UMK00045    | C       |
|     |                    | puberula Engl.              | Hemiepiphytes | Flat area, on slope, rock and tree, dry area | UMK00052    | C       |
| 14  | Schismatoglottis Zoll. & Mortizt. | brevicuspis Hook.f.        | Mesophytes   | Shady moist area, colonial on muddy and sandy stream banks | UMK00292    | C       |
|     |                    | calyptra (Roxb.) Zoll. & Moritzi & Schormatociss Hooke.k. | Mesophytes, Rheophytes | Stream margin, on slope, rock and soil, moist area | UMK00295    | C       |
|     |                    | scortechinii Hook.f.        | Mesophytes   | On slopes, shady moist areas, stream margins | UMK00056    | C       |
| 15  | Scindapsus Schott  | perakensis Hook.f.          | Hemiepiphytes | Shady moist area, on rocks, trees and soil | UMK00311    | C       |
|     |                    | pictus Hassk.               | Hemiepiphytes | Shady moist area, on slopes, ridge areas, on trees and soil | UMK00297    | C       |
|     |                    | scortechinii Hook.f.        | Hemiepiphytes | Flat area, on slope, on tree, dry area | UMK00316    | C       |
|     |                    | treubii Engl.               | Hemiepiphytes | Flat area, on slope, on tree, dry area | UMK00320    | C       |

E = Endemic; R = Rare Species, C = Common Species.

### Table 2. Association between no. of Araceae species and status of forest condition in Kelantan, Peninsular Malaysia

| No. of Araceae species | Status / Condition of forest |
|------------------------|-----------------------------|
| 1 to 10                | Poor / very disturbed forest |
| 11 to 20               | Moderate / less disturbed forest |
| 21 to 30               | Good / recovered disturbed forest |
| 30 & above             | Very good / virgin forest |

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*Source:* [doi:10.1088/1755-1315/842/1/012076](https://doi.org/10.1088/1755-1315/842/1/012076)*

*Note:* The table entries are based on the data provided in the text, with the species and habitat conditions listed for each, along with the voucher numbers for each entry.
Four species of Scindapsus Schott. were collected during the survey, namely Scindapsus perakensis Hook.f., S. pictus Hassk., S. scortechinii Hook.f. and S. treubii Engl. The most noticable species is S. pictus Hassk. usually thrive at higher altitude of shady moist and undisturbed forest on soil slopes area. In Lojing Highlands, this species was spotted at an altitude of 1,050 meters a.s.l. This species also has a great potential to develop as in-door ornamental plant due to the attractive color of the leaves and ability to grow under relatively low light, humid environment and easily to maintain [31].

Three species of Schismatoglottis Zoll. & Moritzi were found in Lojing Highlands. Schismatoglottis brevicuspis Hook.f., S. calyptrata (Roxb.) Zoll. & Moritzi, S. scortechinii Hook.f. are commonly found in stream margins and shady moist areas at an altitude of 600-1,000 meters a.s.l. All of them are mesophytic plants, however, S. calyptrata (Roxb.) Zoll. & Moritzi also was noted as rheophytes that thrive in fast moving water currents clinging on river bedrock and rocky streams. In addition, Apoballis mutata (Hook.f.) S.Y. Wong & P.C. Boyce also grow in moist, damp and shady areas. As typical, Piptospatha perakensis (Engl.) Ridl. was noted as rheophytes herb in clearwater rapids, streams and main rivers of Sg. Dekong. The presence of this species became as bioindicator for clean water, less sediment and pollution in the river.

Homalomena Schott is one of the most diverse genera in the tropical rainforest. However, from a total of eleven species recorded in Kelantan, only three species were noted in Lojing Highlands at an altitude of 650-950 meters a.s.l. Homalomena curvata Engl. was observed thriving on the slope and ridge of close canopy areas. Meanwhile, H. wallichii Schott was spotted on a flat or steep slope of moist and dense forest canopy. Therefore, H. pontederiifolia Griff. ex. Hook.f., the largest species in Peninsular Malaysia was noted along the trails, on ridge and dry areas.

Two species of Alocasia (Schott) G. Don were collected during the sampling. Alocasia longiloba Miq. was found in scattered, both in dry and moist areas, on slope and ridge of sparse canopy areas at an altitude of 600-900 meters a.s.l. Meanwhile, A. inornata Hallier f. (Figure 1), a robust herb up to 80 cm tall is considered a rare species in Peninsular Malaysia. This species was noted along the tracking trail near to bamboo colonies, on the dry slopes and ridges at an altitude of 890 meters a.s.l. Therefore, only one species from the genus Colocasia Schott was observed in this area, Colocasia esculenta (L.) Schott was spotted as helophytic plant in large colony of shallow pondy area at an altitude of 870 meters a.s.l. C. esculenta (L.) Schott is a non-indigenous species and had been utilised for decade by local Malay as a food crop [21].

Lastly, one species each from the genera of Aglaonema Schott, Amorphophallus Blume and Arisaema Mart. were collected from Lojing Highlands. Aglaonema nitidum (Jack) Kunth. is widely distributes on forest slope, streambank and moist areas at an elevation of 650 meters a.s.l. Meanwhile, the geophytes plant, Amorphophallus prainii Hook.f. was spotted thrive on a slope, moist and dry areas at an altitude of 650-850 meters a.s.l. The most exciting Araceae species revealed from Lojing Highlands is Arisaema anomalum Hemsl. (Figure 2) which considered rare and endemic for Peninsular Malaysia. This species is the highlander plant which only found at an altitude more than 1,000 meters a.s.l. The species also a new record for Kelantan after earlier report by [32] Gusman & Gusman (2006) in Perak and Selangor. The species was noted in moist shady sites, on rocks and over deep soil of granitic area.
Fig. 1. *Alocasia inornata* Hallier f.  
A & B – Plants in habitat, mesophytic.  
C – Inflorescence and early stage of infructescences.  
D – Leaf-blade, adaxial surface.  
E – Leaf-blade, abaxial surface.  
F – Infructescences. Images © Zulhazman H.
Fig. 2. *Arisaema anomalum* Hemsl. A – Plant in habitat, lithophytic. B – Variation in colour of leaf-blade, adaxial surface. C – Inflorescence at female anthesis. D – Detail of spadix, spathe artificially removed. E – Unripe infructescence. Images © Zulhazman H.
4. Conclusion
The study has listed 25 species from 15 genera of Araceae from Lojing Highlands, Guan Musang, Kelantan, Peninsular Malaysia. All collections are common species except two species which considered as rare, these are *Alocasia inornata* Hallier f. and *Arisaema anomalum* Hemsl. The results indicated that this area is diverse with Araceae species. Further studies are needed in order to better understanding the diversity and ecology of Araceae in this area.

Acknowledgements
The authors would like to thank the Gua Musang District Council and Kelantan State Forestry Department for giving an opportunity to conduct the survey in Lojing Highlands. The project is financing by Universiti Malaysia Kelantan via the short-term research grant R/SGJP/A03.00/00279A/001/2009/000021.

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