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Diversity and ecology of araceae in the water catchment area of Ulu Sat, Kelantan, Peninsular Malaysia

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Abstract. Araceae or aroid is familiarly known as *keladi* to the locals. The purpose of this study is to assess the diversity and ecology of Araceae in the Water Catchment Area of Ulu Sat, Kelantan, Peninsular Malaysia. The random sampling method was applied. A total of 26 species from 13 genera of Araceae were recorded from the water catchment area of Ulu Sat, Machang, Kelantan, Peninsular Malaysia. This represents about 18.6% out of an estimated 140 species and 46.2% of the 28 genera of Araceae reported for Peninsular Malaysia. The result also shows that 24 species or 92.3% of the collection are the common Araceae species found in lowland dipterocarp forest in Peninsular Malaysia. However, the collection include the species recently recorded, *Aglaonema cochinchinense* Engl. and the endemic species, *Alocasia puber* (Hassk.) Schott for Peninsular Malaysia. The paper will also discuss the distribution and ecology of some important Araceae collected from this area.

1. Introduction

Araceae belongs to the family of monocotyledonous flowering plants. A very common distinguishable feature of this family from others is their spathe-and-spadix inflorescences [1, 2]. The members of this family exhibit greatest diversity in all morphological attributes, life-forms, habitat preferences, growth patterns, phenology and adaptive modifications for effective pollination [3]. Besides, Araceae inhabits different places. Two common conditions of the habitat needed by most of the species are moisture and humidity [1, 4, 5, 6].

Recent record highlights that there are approximately 118 genera and 3 500 published species of Araceae worldwide [5]. However, [7] estimated about 5 435 species of 132 genera that thrive well in various regions of the world. More than two thirds of the species occur in the New World Tropics [2]. In fact, this family also has several centres of diversity in Malesia such as Borneo, Sumatra and New Guinea. In Peninsular Malaysia, a comprehensive account of Araceae was accomplished by [6] that listed 140 species from 28 genera which 25 species are endemic. This paper on Ulu Sat is one of the 61 sites visited by the corresponding author in Kelantan. This study is part of the project on taxonomy and ecology of the Araceae in Peninsular Malaysia. This is the fifth account of Araceae in Peninsular Malaysia, following on from a survey in Pulau Pangkor [8], Gunung Basor [9], Gunung Chamah [10]



and Kuala Koh [11]. As addition, three taxonomic novel species have described from the study: *Alocasia farisii* Zulhazman, H., Norzielawati, S. & P.C. Boyce [12], *Homalonema stongensis* Zulhazman, H., P.C. Boyce & Mashhor, M. [13] and *Homalomena kualakohensis* Zulhazman, H., P.C. Boyce & Mashhor [14].

2. Methodology

The water catchment area of Ulu Sat, Kelantan, Peninsular Malaysia is lying between longitude 102° 19' 0.02" E to latitude 5° 43' 0.01" N. This area comprises of lowland dipterocarp forest with an altitude range of 45 to 128 meter above sea level (a.s.l). Geographically, this area is located on granitic boundary range laying between the States of Kelantan and Terengganu. There are two recreational areas within the area, these are Jeram Linang and Bukit Bakar Forest Ecoparks. The area was classified as permanent forest reserved for water catchment which logging activity is prohibits.

The study was used the random sampling method as introduced by [15]. The procedures explained that the sample in the population are collected by a random process, thus each sample remaining in the population has the same probability of being selected as a sample. The samplings were conducted in two main areas; Jeram Linang and Bukit Bakar Forest Ecoparks. Specimens were collected with data on species identifications, habitats, elevation and location (longitude and altitude). The specimens were later brought to the Universiti Malaysia Kelantan and dried at 60° C. The dried material was processed as herbarium specimens and incorporated. The living specimens were planted at the Agro-Park, UMK as a pool genetic collection.

3. Results and Discussion

From the survey, a total of 26 species from 13 genera of Araceae were successfully recorded as shown in Appendix A. According to our previous surveys of Araceae in Kelantan, the number of Araceae species found in a particular area will indicate a condition of forest as shown in Table 1. Based on this assumption, the water catchment area of Ulu Sat is fall under the category of good forest or recovered disturbed area which 26 species of Araceae were collected.

Table 1. Correlation between number of Araceae species and condition of forest from a study in Kelantan, Peninsular Malaysia.

No. of Araceae species	Forest / area condition
1 – 10	Poor forest / very disturbed area
11 – 20	Moderate forest / less disturbed area
21 – 30	Good forest / recovered disturbed area
30 & above	Very good forest / virgin area

Three species of *Aglaonema* Schott were recorded from this area. All of them are mesophytic plants. The most common species from this genus is *Aglaonema nitidum* (Jack) Kunth. This species is well distributing on forest slope, streambank and wet area at elevation of 100 – 120 meters a.s.l. Meanwhile, *A. simplex* Blume was found scatted on flat, slope, dry and wet areas at lower elevation of 40 – 80 meters a.s.l. One of exciting Araceae species spotted in this water catchment area is *A. cochinchinense* Engl. This species is recently recorded in Kelantan as a new record for Peninsular Malaysia [16]. Records from the previous studies showed that *A. cochinchinense* Engl. is distributed in southern Thailand, Cambodia and South Vietnam [17]. In Ulu Sat, this species was noted on flat, slope and near to streambank at elevation of 80 – 120 meters a.s.l.

Two species of *Alocasia* (Schott) G. Don was found in this area. *Alocasia longiloba* Miq. was noted prominent in both dry and wet spots, on slope and ridge of sparse canopy areas at elevation of 80 – 110 meters a.s.l. Meanwhile, *A. puber* (Hassk.) Schott is considered an endemic and rare species in Peninsular Malaysia. From a total of 61 sites surveyed in Kelantan, this species is only recorded in 12 sites. In Ulu Sat, this helophytic species only found in one particular area in Bukit Bakar Eco Parks. A small population of the species was located in-stream and stream margin of muddy and sandy areas.

Eleven species lianescent Araceae from five genera were collected in Ulu Sat; *Amydrium* Schott, *Anadendrum* Schott, *Epipremnum* Schott, *Rhaphidophora* Schott and *Scindapsus* Schott. All of them are hemiepiphytic plants which start their lives on the ground (soil or rock) and climb trees where they become adults. However, the lifeform of two species; *Rhaphidophora beccarii* Engl. and *R. falcata* Ridl. are both hemiepiphytes and rheophytes. They occurred along or in-streams, frequently clinging to rocks on stream banks. *Amydrium medium* (Zoll. & Moritzi) Nicolson and *Epipremnum giganteum* (Roxb.) Schott were observed on big trees or emergent canopy layers. In Ulu Sat, these two species were noted in edge, ridge and dry forest areas at altitude of 50 – 150 meters a.s.l. *Anadendrum angustifolium* Engl. and *A. microstachyum* de Ver & Becker were found climbing and grows on shrub and understory canopy layers of dry at altitude of 80 – 110 meters a.s.l. Meanwhile, *Scindapsus treubii* Engl. was also found in flat, on slope and dry forest areas on medium size of trees.

There are six species of *Rhaphidophora* Schott observed during the survey. *Rhaphidophora crassifolia* Hook.f. and *R. maingayi* Hook.f. were climbed and dominated on rocks and medium size of trees of dry-ridge area at elevation of 50 – 80 meters a.s.l. In contrast, *R. beccarii* Engl. and *R. falcata* Ridl. were also noted on rocks and trees but in wet area along stream margin. *R. korthalsii* Schott is one of common taxa and widespread throughout Peninsular Malaysia. In Ulu Sat, this species was noted on rocks and trunk trees usually in middle and larger size. The pre-adult stage of *R. korthalsii* Schott is a shingle climber with oblong-elliptic to ovate, slightly falcate upwards pointing leaves overlapping in the manner of roof tiles. Meanwhile, *R. lobbii* Schott was noted on rocks, disturbed forest, open canopy area and along the stream.

As usual, *Piptospatha perakensis* (Engl.) Ridl. grows as rheophytes plant in clear river. The existence of this species indicates that a water appearance looks clean, less sediment and pollution. Meanwhile, *Lasia spinosa* (L.) Thwaites is also helophytes plant and a species hitherto considered very rare in Peninsular Malaysia [18] was noted to occur in inundated areas close to the stream.

Homalomena Schott is one of the most speciose and taxonomically intractable Araceae genera in the Asian tropics. However, there are only four species of *Homalomena* Schott were recorded in Ulu Sat. *Homalomena griffithii* (Schott) Hook.f. is significantly found restricted to a stream margins and wet areas. Occasionally, this species was found growth on rocks and in-stream as rheophytic plant. *H. pontederiifolia* Griff. ex. Hook.f., the commonest of the larger species in Peninsular Malaysia was found throughout the forest especially along the tracking trails, on ridge and dry area. Meanwhile, *H. humilis* Hook.f. and *H. wallichii* Schott were noted in a flat or steep slopes of wet and dense forest canopy.

Only two species of *Schismatoglottis* Zoll. & Moritzi were noted in Ulu Sat As usual, these species, *Schismatoglottis calyptrata* (Roxb.) Zoll. & Moritzi and *S. wallichii* Hook. f. were found restricted to wet areas on slope, streambank and stream margins.

4. Conclusion

This preliminary study has listed 26 species from 13 genera of Araceae from the water catchment area of Ulu Sat, Kelantan, Peninsular Malaysia. Most of the collection are the common species in lowland dipterocarp forest in Kelantan and Peninsular Malaysia. However, a rare and recently recorded species, *A. cochinchinense* Engl. shows that a further study is needed, especially to correlates the distribution of Araceae in this area with southern Thailand, Cambodia and South Vietnam.

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Appendix A

List of Araceae found in Ulu Sat Forest Reserve, Kelantan, Peninsular Malaysia.

LC = Living Collection; R = Rare Species, C = Common Species.

No.	Genus	Species	Lifeform	Habitat	Remarks
1.	<i>Aglaonema</i> Schott	<i>cochinchinense</i> Engl.	Mesophytes	Flat area, on slope, streambank, wet area	R
		<i>nitidum</i> (Jack) Kunth	Mesophytes	Streambank, on slope, wet area	C
		<i>simplex</i> Blume	Mesophytes	Flat area, on slope, wet and dry areas	C
2.	<i>Alocasia</i> (Schott) G. Don	<i>longiloba</i> Miq.	Mesophytes	Flat area, on slope, wet and dry areas	C
		<i>puber</i> (Hassk.) Schott	Helophytes	Stream margin, sandy and wet area	R
3.	<i>Amydrium</i> Schott	<i>medium</i> (Zoll. & Moritzi) Nicolson	Hemiepiphytes	On ridge, on slope, dry area	C
4.	<i>Anandendrum</i> Schott	<i>angustifolium</i> Engl.	Hemiepiphytes	Flat and dry area	C
		<i>microstachyum</i> de Ver & Becker	Hemiepiphytes	Flat and dry area	C
5.	<i>Colocasia</i> Schott	<i>esculenta</i> (L.) Schott	Mesophytes	Streambank, wet area	C
6.	<i>Epipremnum</i> Schott	<i>giganteum</i> (Roxb.) Schott	Hemiepiphytes	Flat, on ridge, dry area	C
7.	<i>Homalomena</i> Schott	<i>griffithii</i> (Schott) Hook.f.	Rheophytes, Mesophytes	On slope, stream margin, streambank, on rock, sandy and wet area	C
		<i>humilis</i> Hook.f.	Mesophytes	On slope, wet area	C
		<i>pontederifolia</i> Griff. ex. Hook.f.	Mesophytes	Flat area, on ridge, dry area	C
		<i>wallichii</i> Schott	Mesophytes	Flat area, on slope, dry and wet areas	C
8.	<i>Lasia</i> Lour.	<i>spinosa</i> (L.) Thwaites	Helophytes	Stream margin, wet area	C
9.	<i>Piptospatha</i> N.E.Br.	<i>perakensis</i> (Engl.) Ridl.	Rheophytes	Stream margin, on rock, wet area	C
10.	<i>Rhaphidophora</i> Hassk.	<i>beccarii</i> Engl.	Rheophytes, Hemiepiphytes	Stream margin, streambank, on tree and rock, wet area	C
		<i>crassifolia</i> Hook.f.	Hemiepiphytes	Flat area, on slope, dry area	C
		<i>falcata</i> Ridl.	Rheophytes, Hemiepiphytes	On slope, stream margin, on tree and rock, wet area	C
		<i>korthalsii</i> Schott	Hemiepiphytes	On slope, dry area	C
		<i>lobbii</i> Schott	Hemiepiphytes	Flat and wet area	C
		<i>maingayi</i> Hook.f.	Hemiepiphytes	Flat area, on slope, on rock and tree, dry area	C
11.	<i>Schismatoglottis</i> Zoll. & Moritzi	<i>calytrata</i> Zoll. & Mor.	Rheophytes, Mesophytes	Stream margin, on slope, on rock and soil, wet area	C
		<i>wallichii</i> Hook.f.	Mesophytes	On slope, streambank, wet area	C
12.	<i>Scindapsus</i> Schott	<i>treubii</i> Engl.	Hemiepiphytes	Flat area, on slope, on tree, dry area	C
13.	<i>Typhonium</i> Schott	<i>Trilobatum</i> (L.) Schott	Geophytes	Flat area, on slope, dry area	C