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ASSESSMENT ON DIVERSITY AND ABUNDANCE OF ARACEAE IN LIMESTONE AND PYROCLASTICS AREAS IN GUA MUSANG, KELANTAN, MALAYSIA

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Abstract: The study was conducted in Gua Musang, Kelantan, namely; Kuala Koh N 04° 52' 02.2"/ E 102° 26' 33.3" (represents pyroclastics area) and Tanah Puteh N 04° 46' 11.9"/ E 101° 58' 35.5" (represents limestone area). A square plot (100 x 100 m) was set-up in both locations for sampling of Araceae. The result shows diversity of Araceae in limestone (28 species ha^{-1}) is higher as compared to pyroclastics area (21 species ha^{-1}). The most abundant species in limestone are *Anadendrum microstachyum*, *Homalomena griffithii*, *Rhaphidophora tenuis* and *Schismatoglottis brevicuspis*. In pyroclastics area, the most abundant is *S. calyptrata* followed by, *S. scortechinii*, *S. brevicuspis* and *A. microstachyum*. The common species in both areas was hemiepiphytic *R. mangayi*. The least abundant species in limestone are *Amorphophallus sp*. and Homalomena Chamaecladon Supergroup. Meanwhile, *Scindapsus perakensis*, Homalomena Cyrtocladon Supergroup, *H. pontederiifolia* and *Aglaonema simplex* were counted as least abundant species in pyroclastics area. Geological features, topography (whether on-slope, on-ridge or edge of stream), and altitude are the most influencing factor on distribution and abundance of aroids species.

KEYWORDS: *Araceae, limestone, pyroclastics, diversity, abundance, topography, geography*

Introduction

Araceae Juss. is a family of perennial evergreen to seasonally dormant monocotyledonous herbs defined at the macromorphological level by an inflorescence consisting of a spike of small bractless flowers on a fleshy unbranched axis (spadix) subtended by a bract or modified leaf (spathe) (Yeng, 2009). Well-known as a diverse family of monocotyledon and the third largest monocotyledon family after orchids and grasses and seventh largest of all flowering plants after Asteraceae, Fabaceae, Rubiaceae, and Lamiaceae (Mayo *et al*., 1997). It comprises of approximately 121 genera and probably as many as 6000 species around the world. In Peninsular Malaysia there are about 23 genera with 123 species which have been recorded (Sulaiman and Mansor, 2001). Most aroids are tropical and include members from terrestrial, aquatic, and epiphytic habitats although there are many aroids indigenous to temperate climates (Yeng, 2009).

Vegetatively, the aroids range in size from minute to gigantic, and in habit from lianescent or subshrubby hemiepiphytes, to epiphytes, lithophytes, terrestrial mesophytes, geophytes, rheophytes, sometimes helophytes, and true or free-floating aquatics (Ridley, 1925). They are predominantly tropical in distribution, with 90% of the 110 currently recognized genera and c. 95% of c. 4000+ species restricted to the everwet or perhumid tropics (Bown, 1988). Ecologically they are a very important herbaceous family in terms of their dominance of the understorey and inter canopy herb layer and as indicators of forest quality. Aroids are most abundant and diverse in undisturbed perhumid habitats (Jenny, 1941).

Although Araceae are still poorly known in most Neotropical countries, numerous inventories in humid tropical forests show high aroid richness and often list Araceae among the 10 most species rich families of vascular plants. Furthermore, numerous studies on their ecologies and diversity were done to understand the biology of aroids (Ana-Maria *et al.*, 2005; Croat, 2004; Jenny, 1941; Knab-Vispo *et al.*, 2003; Leimbeck *et al.*, 2004; Mayo *et al.*, 1997; Miyasaka *et al.*, 2003; Plowden *et al.*, 2003).

To date, no extensive studies on diversity and abundance of Araceae had been related to geological and geographical features in Kelantan state, Peninsular Malaysia. The state's rich and lavish varieties of geological types and derived soils are remained unexplored for the suitability of plant growth. Many enigmatic species of aroids such as species from *Homalomena* and *Aglaonema* genus are poorly studied in term of their locality and endemism and their diversity comparison from different substrates. However, the bold increase in our geological and botanical knowledge since the days of the early plant geographers has widened our horizon and enlarged our retrospect (Just, 1947).

Materials and method

Study Site

Study sites Kuala Koh Wildlife and National Park Protection (PERHILITAN) (N 04° 52' 02.2"/ E 102° 26' 33.3") at Kuala Koh, Gua Musang, Kelantan and an area nearby Pusat Konservasi Hidupan Liar (PKHL PERHILITAN) (N 04° 46' 11.9"/ E 101° 58' 35.5") at Tanah Puteh, Gua Musang, Kelantan. Kuala Koh National Park, Kelantan is under the authority of PERHILITAN (Wildlife and National Park Protection) Malaysia agency and become a section of Taman Negara, Malaysia's premier national park which straddles across Kelantan and two other neighbouring states; Terengganu and Pahang. Taman Negara is one of the oldest rainforests in the world, estimated to be 130 million years old. In addition, the area is very well-known for its high species diversity of flora and fauna due to its complex and rich ecosystem in the world. Spread over 1,043 sq km, this dense undisturbed jungle is home to various flora and fauna (Ministry of Tourism, 2009). All of the data collections were conducted from February 2011 until April 2011.

Sampling Procedures

Aroid samples were collected from the study sites. The relative abundance of aroids was obtained by setting up a plot of 1 hectare (ha) width within the study area. Aroid plants were surveyed in 1 ha major plot divided into 100 equal 10m x 10m plots located through stratified random sampling. The information such as their latitude and longitude of the sampling site and the number of aroids in each was collected. Width (A) calculation of a square plot as below:

Width (A) = 1 ha

1 hectare (ha) = 100 m x 100 m

= 10, 000 m^2

While sampling in each plot, aroid samples were identified and counted for individual species number as species abundances per 1-ha plots. Aroids collected for each species need to be done for at least three replicates. For each different species of aroids found in the plots, we divided into two aroid trees to be recultivated ex-situ at the conservatory area in UMK Agro Park, Pengkalan Chepa, Kelantan and the last tree to be made as herbarium specimen for the species identification and further references in the future.

Herbarium Specimen Preparation

All of aroid samples collected were pressed using square wooden press (1m x 1m in size) before being dried. After pressing, pressed aroid samples were dried in an oven (Leica 560 Oven) for a week in 50°C. After drying process, the samples were placed on the A3-sized herbarium sheet covered with plastics and systematic tags containing the details of samples such as collector's name, places of collection, date of collection, species name, and habitat were adhered on the herbarium sheets.

Identification of Aroid Samples

Specimen identification was done at the Herbarium Laboratory, Faculty of Biological Sciences, Universiti Sains Malaysia, Penang. Furthermore, identification of the specimens were done using keys provided by Bown (1988), Boyce, (1998), Boyce, (1999), Hay, (1998a, 1998b), Mayo *et al.* (1997) and Ridley (1925).

Results and discussion

Diversity and Abundance of Aroids in Tanah Puteh

A total of 5900 free-standing and climbing aroids represents 28 species from 11 genera were recorded in 1 hectare plot at Tanah Puteh, Gua Musang (Table 1). Among 11 genera of aroids noted in Tanah Puteh, the most diverse genus was *Homelomena* with 10 species. The least diverse genera were *Pothos, Aglaonema, Alocasia, Amorphophallus, Colocasia* and *Epipremnum* with only one species for each. The genus of *Anadendrum*, which was represented by three species, was considerably more abundant than any other species of aroids. *Anadendrum microstachyum* is the most abundant aroids in Tanah Puteh (Figure 1). Its juveniles and adults were noted in every subplot of 10m x 10m. *A. microstachyum* represents a total of 1441 individuals with relative density of 24.4%. It was followed by *Homalomena griffithii* with 760 individuals (12.9%) and hemiepiphytic *Rhaphidophora tenuis* with 678 individuals (11.5%).

Species	Number of aroids (ha^{-1})	Relative density (%)
Anadendrum microstachyum	1441	24.4
Homalomena griffithii	760	12.9
Rhaphidophora tenuis	678	11.5
Schismatoglottis brevicuspis	557	9.4
Anadendrum angustifolium	486	8.2
Scindapsus perakensis	385	6.5
Rhaphidophora maingayi	266	4.5
Homalomena wallichii	264	4.5
Schismatoglottis calyptrata	236	4
Aglaonema nitidum	188	3.2
Homalomena new related to *H. giamensis*	156	2.6
Homalomena curvata c.f.	120	2
Schismatoglottis wallichii	86	1.5
Homalomena pontederiifolia	56	0.9
Homalomena truncata	47	0.8
Homalomena in Hanneae complex	43	0.7
Pothos scandens	27	0.5
Anadendrum marginatum	23	0.4
Rhaphidophora falcata	17	0.3
Scindapsus hederaceus	17	0.3
Scindapsus treubii	16	0.3
Alocasa longiloba	9	0.2
Colocasia gigantea	5	0.08
Epipremnum giganteum	5	0.08
Homalomena in Chamaecladon *(H. humilis)*	4	0.07
Homalomena in Chamaecladon *(H. pumila)*	4	0.07
Homalomena in Chamaecladon *(H. angustifolia)*	3	0.05
Amorphophallus sp.	1	0.02

Table 1: List of species and relative density of aroids in Tanah Puteh, Gua Musang, Kelantan.

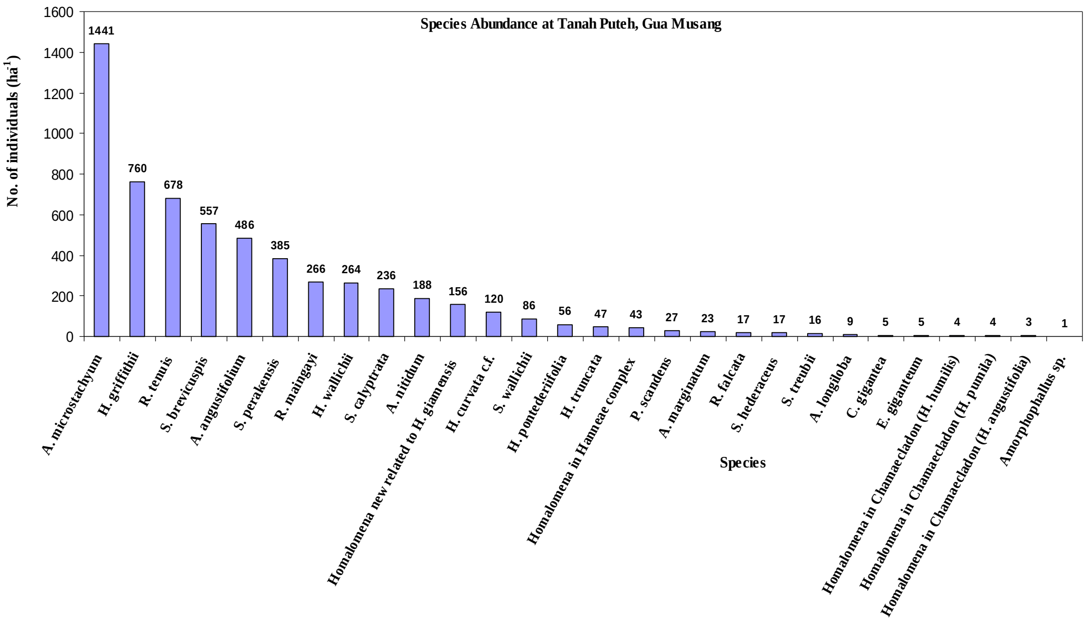

Figure 1: Species and abundance of aroids ha^{-1} in Tanah Puteh (limestone), Gua Musang, and Kelantan.

Diversity and Abundance of Aroids in Kuala Koh

Meanwhile, a total of 6404 individuals of aroids represents 21 species from seven genera were documented in Kuala Koh, Gua Musang (Table 2). Nevertheless, in Kuala Koh study site, the most diverse genus was corresponding with the one at Tanah Puteh, genus *Homalomena* which represented by 7 species (Table 2) and followed by *Schismatoglottis* (n=5) and *Scindapsus* (n=3). However, in Kuala Koh, *Anadendrum* was a single species genus counting on only *Andendrum microstachyum* species together with *Alocasia* genus which was represented by only *Alocasia longiloba* species. From the total number of individuals, two species had only one individual for the entire survey in the plot, which were *Scindapsus perakensis* (0.02%) and *Aglaonema simplex* (0.02%) and became rare species in Kuala Koh. *Schismatoglottis* was a promising genus that could thrive well in Kuala Koh ecosystems since its number of individuals a lot greater than any other genera found (Figure 2).

Noted that *Schismatoglottis calyptrata* became the most abundant species with the relative density of 32.2% (2060 individuals). They were transforming most of the small streams with static, shallow water and muddy conditions into its colonies. It was followed by *S. brevicuspis* which mostly infested small streams and *S. scortechinii*, which thrived at the edge of streams or inundated slope area. For the number of individuals, *Schismatoglottis scortechini* showed 1651 individuals and *Schismatoglottis brevicuspis* had 1066 individuals. For the relative density, *Schismatoglottis* genus provided more than a half of the density of aroids composition in Kuala Koh which outnumbered other genera with 74.6%.

Species	No. of aroids (ha^{-1})	Relative density (%)
Schismatoglottis calyptrata	2060	32.2
Schismatoglottis scortechinii	1651	25.8
Schismatoglottis brevicuspis	1066	16.6
Anadendrum microstachyum	349	5.5
Aglaonema nitidum	289	4.5
Rhaphidophora mangayi	285	4.5
Rhaphidophora korthalsii	168	2.6
Schismatoglottis wallichii	113	1.8
Homalomena truncata	86	1.3
Scindapsus sp1	76	1.2
Homalomena griffithii	75	1.2
Scindapsus scortechinii	61	1
Homalomena wallichii	54	0.8
Homalomena curvata	29	0.5
Alocasia longiloba	22	0.3
Scindapsus treubii	11	0.2
Homalomena in Chamaecladon	3	0.05
Homalomena in Cyrtocladon	2	0.03
Homalomena pontederiifolia	2	0.03
Aglaonema simplex	1	0.02
Scindapsus perakensis	1	0.02

Table 2: Complete list of aroids, identified over 1 ha plot, including the number of aroids and their relative density in Kuala Koh (pyroclastics area), Gua Musang, Kelantan.

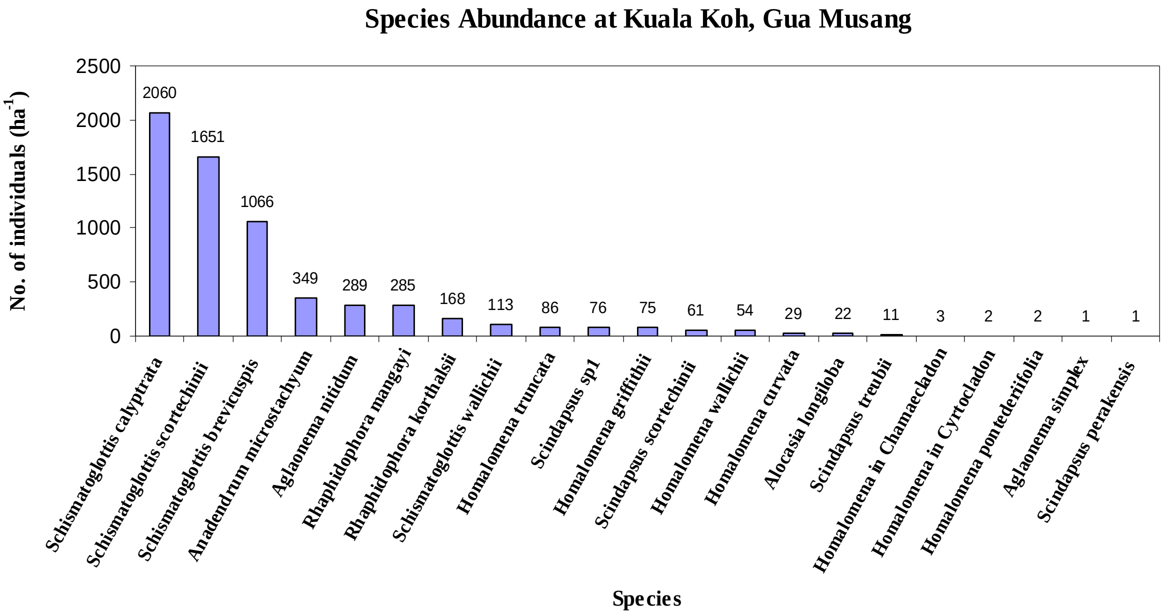

Figure 2: Species and abundance of aroids ha^{-1} in Kuala Koh (pyroclastics), Gua Musang, and Kelantan.

In Tanah Puteh, most of aroids were found at an altitude between 100-200m a.s.l. However, the altitude in Kuala Koh is generally below than 100m. According to Leimbeck *et al.* (2004), in their study in Ecuador the diversity of aroids is slightly higher at lower altitude. They found Araceae species richness is highest between sea level and 1500m and there is a steady decrease in diversity with increasing altitude. Another study done by Bown, (1988) stressed that species richness is greatest between sea level and middle elevations to about 1500 meters. However, diversity drops off dramatically above 2000 m except for certain species that can survive in higher altitude up to 3750m.

For the species comparison between two areas, *Amorphophallus* was not found in Kuala Koh area and existed in Tanah Puteh even in sparse number. Another species comparison was *Pothos* genus. *Pothos* species were pretty great in numbers in Tanah Puteh and became the most dominant species on most limestone walls. Yet in Kuala Koh, there is hardly any single species is noted. This is due to the differences in geomorphological of the locations. Researchers found not all habitat types are equally suitable to support dense Araceae populations (Knab-Vispo *et al.*, 2003) and soils (weathered products of rocks) which reflect quality of parent material, both in physical properties and chemical content select certain species from a region's available flora to grow (Kruckeberg, 2002). With this fact, it gives species difference in Kuala Koh and Tanah Puteh in term of their richness.

In both areas of study, common epiphytic aroid species were *Anadendrum microstachyum* and *Rhaphidophora maingayi*. From this, we can conclude that the common category of aroid species in both sites was epiphytic aroids. This circumstance may be elaborated by (Ana-Maria *et al*., 2005), which found two genera of epiphytic Araceae also, *Philodendron* and *Anthurium*, in quantitative census of vascular epiphytes of Colombian Amazon. In addition, *Philodendron* and *Anthurium* had the highest species richness in studying epiphytes ecologies. Further studies of epiphytes aroids found that they are having a high dispersal ability, which would allow a more rapid colonization and should lead to a wide distribution of many epiphyte species in all landscapes (Ana-Maria *et al*., 2005).

Conslusion

In recent years, numerous studies had been done to increase our geological and botanical knowledge and their interactions. Yet, the information to understand specific Araceae family in relation to their geological features are lacking. This study increased our knowledge and understandings of aroid communities with their parent materials (geologically-derived substrates). Further studies of aroid and their relations with geomorphical characteristics are vital since geological factors are much more important causes of plant distribution and diversity patterns than others.

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