



Faculty of Resource Science and Technology

A Preliminary Checklist of Pandanaceae Species in UNIMAS

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Bachelor of Science with Honours
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A Preliminary Checklist of Pandanaceae Species in UNIMAS

Khairunnisha Syahirah Binti Rudy

A thesis submitted in partial fulfilment of the Requirement of The Degree Bachelor of
Science with Honours
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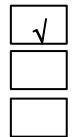
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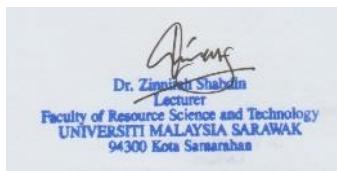
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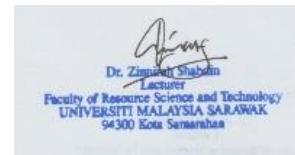
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A Preliminary Checklist of Pandanaceae Species in
UNIMAS

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ABSTRACT

This research is aimed to provide a preliminary checklist of Pandanaceae species available in UNIMAS campus. This checklist can serve as the baseline data for further studies of the same interest. Pandanaceae family is prominent for environmental classification due to their peculiar and readily recognized morphology. They are also significant as microhabitats and insect-pandan associations. Five species were collected in UNIMAS arboretum. They were identified and described according to Stone (1993). Among the species, four species were from genus *Pandanus* and another one from genus *Benstonea*. Only 2 species were identified which were *P. yvanii* Solms and *B. affinis* (Kurz) Callm. & Buerki respectively. The most distinguishable characters to identify the genera would be the flower and fruit but it is often problematic to identify the species within the genera. It is expected that more species could be found in the study area if it is widened and more data for species delimitation can be obtained if the flowers or fruits of the individual are present.

Key words: arboretum, *Benstonea*, Pandanaceae, *Pandanus*, UNIMAS.

ABSTRAK

*Kajian ini bertujuan untuk menyediakan senarai semak awal untuk spesis Pandanaceae yang ada di dalam kampus UNIMAS. Senarai semak ini boleh berfungsi sebagai data asas untuk kajian lanjut dalam bidang yang sama. Keluarga Pandanaceae menonjol untuk pengeleasan alam sekitar disebabkan morfologi yang pelik dan mudah dikenalpasti. Keluarga ini juga penting sebagai mikrohabitat dan hubungan serangga-pandan. Sebanyak 5 spesis telah dikumpul dari arboretum UNIMAS. Spesis-spesis tersebut telah dikenalpasti dan diuraikan mengikut Stone (1993). Daripada lima spesis tersebut, empat daripadanya adalah dari genus *Pandanus* dan satu daripada genus *Benstonea*. Hanya dua spesis telah dikenalpasti sebagai *P. yvanii* Solms dan *B. affinis* (Kurz) Callm. & Buerki. Ciri-ciri yang paling boleh dibezakan untuk mengenalpasti genera adalah bunga dan buah individu tersebut tetapi adalah sering bermasalah untuk mengenalpasti spesis dalam genera tersebut. Lebih banyak spesis dijangka boleh ditemui di dalam kawasan kajian jika ia diluaskan lagi dan lebih banyak data dapat diperoleh untuk persempadan spesis jika adanya bunga dan buah spesis-spesis tersebut.*

Kata kunci: arboretum, *Benstonea*, Pandanaceae, *Pandanus*, UNIMAS.

Table of Content

Declaration	i
Acknowledgements	iii
Abstract	iv
<i>Abstrak</i>	iv
Table of Content	v
List of Figures	vii
List of Abbreviations	viii
CHAPTER 1: INTRODUCTION	1
CHAPTER 2: LITERATURE REVIEW	3
Morphological Characters of Pandanaceae	3
Genus <i>Pandanus</i>	4
Genus <i>Freycinetia</i>	4
Genus <i>Benstonea</i>	5
Genus <i>Sararanga</i>	6
Genus <i>Martellidendron</i>	6
CHAPTER 3: MATERIALS AND METHODS	7
Study Area	7
Collection and Identification	7

CHAPTER 4: RESULTS	9
<i>Pandanus</i> spp.	9
<i>P. yvanii</i> Solms.	9
Species 1	12
Species 2	15
Species 3	20
<i>Benstonea</i> sp.	24
<i>B. affinis</i> (Kurz) Callm. & Buerki	24
CHAPTER 5: DISCUSSION	27
CHAPTER 6: CONCLUSION AND RECOMMENDATIONS	30
CHAPTER 7: REFERENCES	32
CHAPTER 8: APPENDICES	34

List of Figures

- Figure 1.** Universiti Malaysia Sarawak (UNIMAS) Arboretum via Google Earth Pro.
- Figure 2.** *Pandanus beccatus* (Sect. Acrostigma, subsect. Ornati).
- Figure 3.** Leaves spirally arranged in *P. yvanii*.
- Figure 4.** Reddish-brown stem with conical thorns.
- Figure 5.** Leaves arrangement in *Pandanus* sp. 1.
- Figure 6.** Aristate leaf apex of *Pandanus* sp. 1.
- Figure 7.** Stemless pandan.
- Figure 8.** Spines along the midrib of the outer leaf.
- Figure 9.** Aristate leaf apex of *Pandanus* sp. 2.
- Figure 10.** Crustacean found in the axil of *Pandanus* sp. 2.
- Figure 11.** Prop roots present in *Pandanus* sp. 3.
- Figure 12.** Spirally arranged leaves.
- Figure 13.** *Pandanus* spp. found in the accessible forested site of UNIMAS Arboretum.
- Figure 14.** *B. affinis* (Kurz) Callm. & Buerki.
- Figure 15.** Longitudinal section of the cephalium.

List of Abbreviations

c.	Circa
cm	Centimeter
et al.	And others
GBIF	The Global Biodiversity Information Facility
Incl.	Including
m	Meter
mm	Millimeter
POWO	Plant of The World Online
Sect.	Section
Subsect.	Subsection
Sp.	Species (singular)
Spp.	Species (plural)
Syn.	Synonym
UNIMAS	Universiti Malaysia Sarawak

CHAPTER 1

INTRODUCTION

Pandanaceae are trees, shrubs or woody climbers comprising c. 700 species throughout the paleotropics (Callmander et al., 2013). In general, Pandanaceae family or also known as the screw pine family are angiosperm classified under the division Magnoliophyta, class Liliopsida and order Pandanales. This family includes five genera: *Pandanus* Parkinson, *Freycinetia* Gaudich, *Sararanga* Hemsl, *Martellidendron* and *Benstonea* Callm. & Buerki (Byng, 2014). Among the genera, *Pandanus* has the widest geographical distributions in which it occurs throughout the Old-World tropics, followed by *Freycinetia* where it is limited to Southeast Asia, the Pacific Islands and Oceania. *Martellidendron* is endemic to Madagascar and the Seychelles Islands. *Sararanga* is constricted to the Philippines, New Guinea and the Solomon Islands (Stone, 1983; Callmander et al., 2003). In Malaysia, there are species from the genera *Pandanus*, *Freycinetia* and *Benstonea*; showing a result of 1,336 occurrences in The Global Biodiversity Information Facility (GBIF). *Benstonea* was mentioned as the third largest genus of Pandanaceae, ranges from India to Australia and the centre of diversity is in Borneo and Peninsular Malaysia which recorded 21 spp. and 14 spp. respectively (Callmander et al., 2012). A study by Stone (1993) on *Pandanus* of Borneo has also been made and most of the species were enumerated from Sabah and Sarawak. The study has found 53 species in Borneo alone.

Pandanaceae species are usually used for cooking, weaving, thatching and to make tools and handicraft. Ningrum & Schreiner (2014) described *P. amaryllifolius* leaves as having the potential to be used as natural colourant, natural flavour in food and as herbal medicine. The presence of compound 2-acetyl-1-pyrroline (2AP) in *P. amaryllifolius*, which

is similar in Basmati and other scented rice, makes it the only species that has fragrance (Wakte et al., 2009). In India, the male flowers of *P. odorifer* are being used in kewda perfume industry as the male flowers possess fragrance. *F. banksii* or known as ‘kiekie’ in New Zealand is one of the native species there. ‘Kiekie’ is the most important plant material used in weaving due to its strong and durable fibres within the leaves. The leaves are used to make bags, mats, raincoats, bird traps and tukutuku panels, traditional decorative wall panels for Māori. The roots are used for bindings in hut or houses of the Māori people of New Zealand and to make fish traps (Schravendijk, 2007).

Although numerous publications have been produced on Pandanaceae of Borneo (Merill, 1922; St. John, 1961, 1965, 1968; Stone, 1993; Callmander et al., 2012, 2013), there are still insufficient data of Pandanaceae in Sarawak, especially on its taxonomic, ethnobotanical, entomological and phytochemical studies. The relationship among and within the genera is not well understood, as well as species identification is often problematic. An arboretum is defined as a place for cultivating trees, shrubs, and herbaceous plants for scientific and educational purposes. It serves as a ‘plant library’ which can easily be accessed by researchers to study plants, as well as the faunal composition. UNIMAS Arboretum consists of two forest types which are peat swamp forest and secondary forest. To understand the species diversity of this family, it is best to utilize this area to preliminary record the available Pandanaceae species. Therefore, the objectives of this research are:

1. To determine the species available in UNIMAS arboretum.
2. To describe the morphology of Pandanaceae species available in UNIMAS.

CHAPTER 2

LITERATURE REVIEW

2.1 Morphological Characters of Pandanaceae

The stems are usually sympodial branched and annulated with leaf scars. The roots are adventitious and sometimes branched and divaricate which function as prop roots or clasp roots. The leaves are spirally arranged, 3-ranked in *Freycinetia* and *Pandanus*, or 4-ranked in *Sararanga*. They are linear-ensiform, entire but armed on margins with prickles. The inflorescences are terminal, but sometimes they are lateral or axillary. They are usually unisexual, in spikes or racemes of spikes in *Pandanus*, in pseudo-umbels of spikes in *Freycinetia*, and in repeatedly branched panicles in *Sararanga*. Male flowers are sessile or pedicellate (in *Sararanga*); numerous stamens and fasciculate; 2-celled anthers, dehiscing by slits; and sometimes pistillode is present. Female flowers are either with or without staminodes; pistils are free or aggregated with superior ovary and the ovules are anatropous and bitegmic, solitary to numerous (Utteridge, 2015). The lower bracts are foliaceous meanwhile the upper bracts are variously coloured, sometimes fragrant and slightly sweet. The flowers are strictly unisexual in most *Pandanus* or with vestiges of the other sex and they do not have perianth. The flowers are distinct in most *Pandanus* and *Sararanga* but indistinct in *Freycinetia*. The fruits are drupe in *Pandanus* or berry in *Freycinetia* and *Sararanga*. The seeds are straight in *Pandanus* and *Sararanga* and straight or vigorously curved in *Freycinetia*. The seedcoat in *Pandanus* is thin and membranous whereas in *Sararanga* and *Freycinetia* is thickened (Stone et al., 1998).

2.2 Genus *Pandanus*

Pandanus in the family Pandanaceae are trees, shrubs or herbs which comprise c. 600 species. Pandan has developed into epiphytic shrubs, some have pseudo-lianas growth type and others are cespitose, stemless and mostly small shrubs (Stone, 1983). This unisexual, dioecious woody palm-like plant has long, entire, and narrow leaves in 3 regular, close-set spirals with deep channels along the midrib and pleated on each side of the leaves. The leaves have thick cuticles and bear spines or prickles on the underside of the midrib and along the margins. The male inflorescence is paniculate with spiniform branches subtended by secondary spathes which are usually coloured; the branches are covered with numerous stamens and the flowers are not individually discernible. Meanwhile, the female inflorescence is globose to cylindrical clusters or several carpels aggregate; the flowers are also not individually discernible. The fruits are hard drupe, syncarpous and comprise an aggregation of individual connate, angled and fibrous phalanges. The carpels are either free or connate into multi-carpel, several-seeded drupes with endocarp extending between the seed locules surrounded by mesocarp. The stigma(s) is 1 to numerous and are always on the adaxial side of the style, varies in shape but neither sharp nor linear (Callmander et al., 2012; Wu & Raven, 2010; Hyndman, 1984).

2.3 Genus *Freycinetia*

Freycinetia are scrambling or climbing shrubs, rarely herbs, comprising c. 299 accepted species. It is characterized by its climbing habit, having multi-ovulate carpels and berry fruits. There are aerial roots present. Leaves are more or less densely crowded, linear or lanceolate, basally with membranous, marcescent or caducous sheath margins. The inflorescences are either terminal or lateral, consist of pedunculate simple spadices which

are usually 2–5, in an umbel or short raceme arrangement and enclosed by several crowded at initial, 3-seriate, green or coloured, caducous spathes. Flowers are unisexual, rarely bisexual with no perianth. Stamens and ovaries are densely congested on rachis and the ovaries are usually surrounded by minute staminodes, 1-locular; there are numerous ovules, congested on 2 or more parietal placentae; the stigmas are 2 or more, separate or confluent. Fruit is a berry, with or without a hardened apex and there are numerous seeds (Wu & Raven, 2010).

2.4 Genus *Benstonea*

Benstonea (c. 50 spp.) was formerly classified as *Pandanus* sect. *Acrostigma* but it was recognized as new genus of Pandanaceae in 2012 (Callmander et al., 2012). They are acaulescent or short-stemmed shrubs, usually epiphytic, rarely tall trees and the genus comprises of 61 accepted species. The leaf apex is adaxially spinulose along the two main pleats where spines are rarely absent. The inflorescences are terminal or lateral on short side-branches, pistillate cephalia solitary, sometimes spicately disposed. The cephalia are always of simple drupes and the drupes never connate into phalanges; the pileus is normally distinct and calyprate, grading upward into a hard, spiniform style; the stigma is linear and the position is on the abaxial side of the style. Staminate inflorescence is normally spicate. Staminate flowers are sessile, possessing free stamens with anthers that are much longer than the short or nearly obsolete filaments, apiculate, and sometimes the stamens are arranged in pauci-staminate dyads, phalanges or triads.

2.5 Genus *Sararanga*

Sararanga comprises two species namely *S. philippinensis* and *S. sinuosa*. This genus is characterized by its paniculate inflorescence and the flowers with a perianth. There are presence of aerial roots. The leaves are set in 4 spiral rows, elongated, coriaceous and stoutly armed. The inflorescences are paniculate, terminal and bracteate. The male flowers are pedicellate, and the perianth is a short entire undulate-margined cupule. There are numerous stamens, the filaments are narrowing at the tips and the anthers are oblong. The pollen is ellipsoid and minutely papillate, meanwhile female flowers are shortly pedicellate and perianth free. They are a bit fleshy with many carpels around 10-80, one-seeded and arranged in a biserrate sinuous row. The stigmas are sessile, sub opposite in pairs, with a ventral sutural pore. Ovules are anatropous and fruit is a succulent polypyrenoid drupe (Stone, 1961).

2.6 Genus *Martellidendron*

Martellidendron comprises six species. It was previously classified as a section in the genus *Pandanus* but then separated in 2003 as a distinct genus of Pandanaceae (Callmander et al., 2003). This genus is characterized by its drupaceous fruits and potentially bisexual flowers with the presence of carpellodia and staminodia in the staminate and pistillate flowers respectively. They were recorded as having distinguishable morphology such as the pollen grains having reticulum with small lumina and 3 layered exines; the anther structure has no endothelial thickenings in the lateral part of the connective and the proximal part of anther walls; the endocarp does not extend between the seed locules and replaced by mesocarp which extend from the apex to the base; and the constant number of stigmas (2) where the stigmas are close and opposite (Callmander, 2001).

CHAPTER 3

MATERIALS AND METHOD

3.1 Study Area

This research study was conducted in the accessible forested site within UNIMAS. The study area was focused in the arboretum ($1^{\circ}27'54.60"N, 110^{\circ}26'53.22"E$). Arboretum UNIMAS consists of two types of forest, peat swamp forest and secondary forest. The species were collected from both forest type.

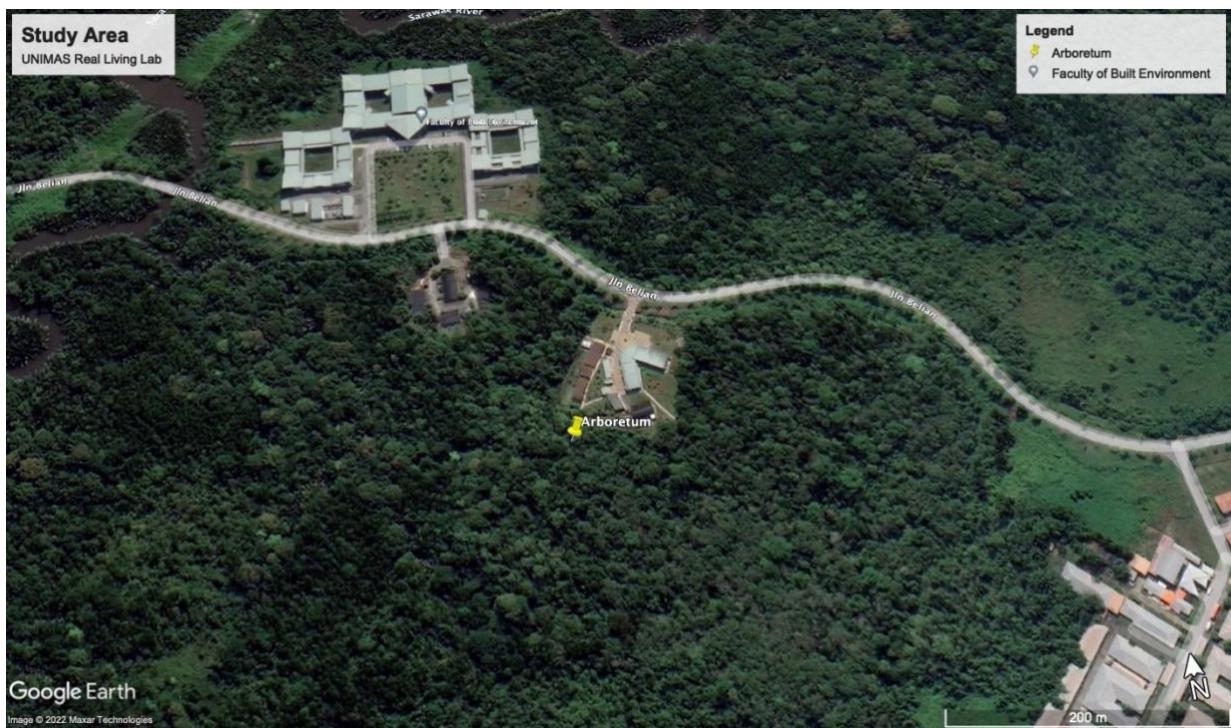


Figure 1. Universiti Malaysia Sarawak (UNIMAS) Arboretum via Google Earth Pro

3.2 Collection and Identification

Fresh leaves of Pandanaceae were collected from accessible forested site in UNIMAS. The coordinates for the species were recorded. The leaves were cut off using a secateur and measured using measuring tape. All the measurements were recorded including the leaf base (A), middle portion (B) and terminal portion (D) which is referred to as leaf

apex in this paper, as in **Figure 2**, together with the distance of the prickles from the tip and base, along the margin or/and the midrib. The morphological characters were described and recorded. Species identification was done using the identification keys and morphological characters according to Stone (1993).

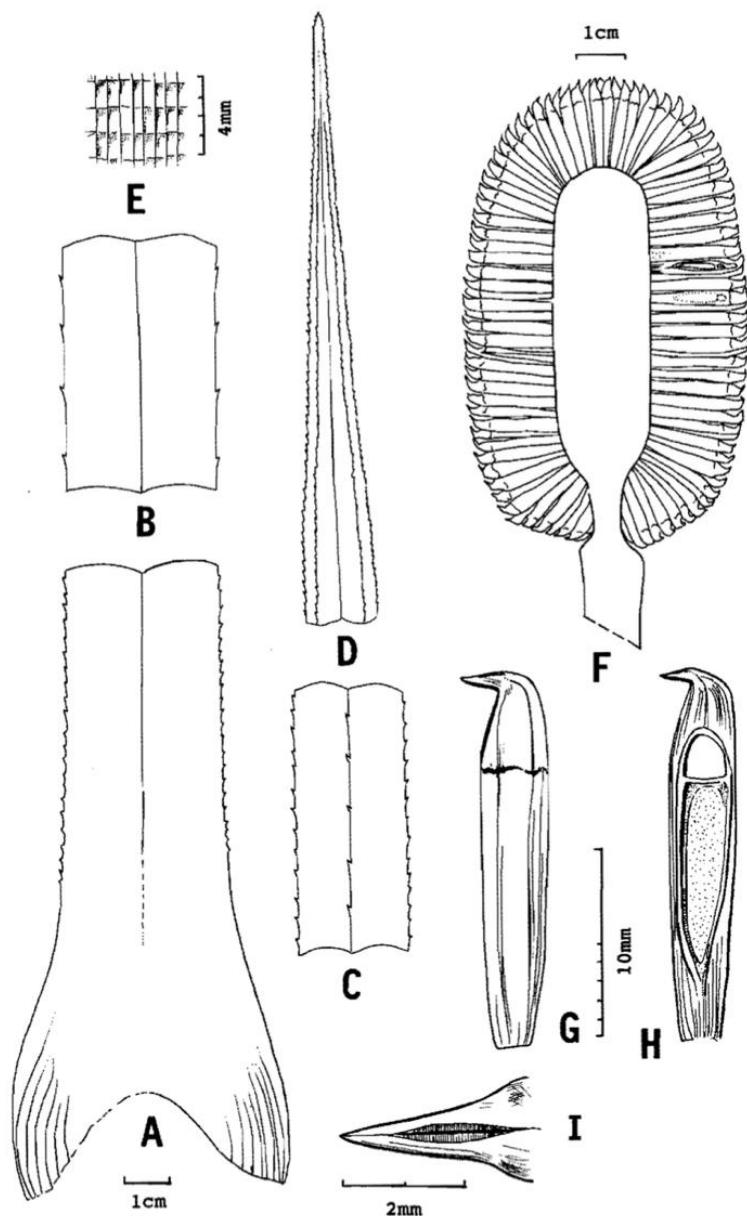


Figure 2. *Pandanus beccatus* (Sect. Acrostigma, subsect. Ornati). **A.** Leaf base. **B.** Middle portion of leaf. **C.** Distal portion of leaf showing prickly midrib on abaxial side. **D.** Terminal portion of leaf showing antrose prickles on upper secondary pleats. **E.** Vein tessellation near distal part of leaf. **F.** Longitudinal section through cephalium. **G.** Drupe. **H.** Longitudinal section through drupe. **I.** Grooved stigma of drupe. All from SNP 1054.

CHAPTER 4

RESULTS

A total of five Pandanaceae species were collected and among them were four species from genus *Pandanus* and one species from genus *Benstonea*. Only two of the Pandanaceae species were identified namely *P. yvanii* Solms and *B. affinis* (Kurz) Callm. & Buerki from genus *Pandanus* and *Benstonea* respectively. All the species were found at both forest type in UNIMAS Arboretum, the secondary forest and the peat swamp forest.

4.1 *Pandanus* spp.

P. yvanii Solms

Description. 2-3 m tall. Prop roots absent. Leaves are spirally arranged in 3 ranks. The internode is 3.2 cm. Leaves are 4.7-59.5 cm long, 1-2.3 cm wide, with deep channels along the midrib and pleated on each side of the leaves. Acute to acuminate apex, 12 cm long and the tip is 5.1 cm long. Margin with spines throughout the length. The tips of the spines are red, facing upwards, 13.4 cm from base along the margin. The underside of the midrib is almost unarmed near base with 1-2 red-tipped spines facing downward 10.6 cm from base. The stems are deep reddish brown with wide leaf scars and sharp conical thorns. Figure 3 – Figure 4.

Habitat. Pond or shallow water.

Distribution. Reported found in Malay Peninsula, Borneo and Kalimantan.



Figure 3. Leaves spirally arranged in *P. yvanii*.



Figure 4. Reddish brown stem with conical thorns.

***Pandanus* sp. 1**

Description. 3-4 m tall. Prop root absent. Long, branched stem. Leaves in a rosette and spirally arranged, with deep channels along the midrib and pleated on each side of the leaves. The leaf collected is 271 cm long. Leaf base is 4.2 cm, and the middle portion is 3.8 cm long. Aristate apex, 34.4 cm long and the tip is 25 cm long. Margin with spines throughout the length. The underside of the midrib bearing spines 71.4 cm from the tip and 1-3 spines 5.5 cm from the leaf base. The middle portion, midrib is almost unarmed.

Figure 5 – Figure 6.

Habitat. Shoreline or peat swamp.

Distribution. Arboretum UNIMAS

Notes. Centipedes and ants were found in the leaf axils.



Figure 5. Leaf arrangement in *Pandanus* sp. 1.



Figure 6. Aristate leaf apex.