Anatomical Characteristics of Six Calamus Species of Kalimantan Barat

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Abstract. The stem anatomy of six species of Calamus from Kalimantan Barat was studied to explore the anatomical character to distinguish the rattan at the species level. The Calamus species has been used as the raw material of plaited art by the indigenous people of the Dayak Iban-Desa. The anatomy character was observed from the transversal section, radial section, and maceration. The main aspect has observed from this research are epidermis, vessel, and fiber dimension. Epidermis cell type, epidermis lumen type, and the number of hypodermis layer were observed as the important character to distinguish the Calamus based on epidermis character. Type of ground parenchyma, present of the canal resin, number of protoxylems, and vessel density are the important characters based on vessel character. Fiber length and fiber wall thickness are the important characters to identify the rattan species and also to predict the quality of rattan stem. The tentative identification key to rattan species has been prepared using the combination of the anatomical character.

1. Introduction

Rattan is one of the non-timber forest product (NTFP) with a high economy value has a wide distribution in Southeast Asia. There are 13 genera and 700 species abundant in this region, and about 10 genera with almost 350 species have recorded in Indonesia [1]. The highest diversity of rattan can be found in Sumatra and Borneo [2]. The abundant of rattan is correlate with the abundant of natural forest as the habitat of rattan. Along with the increasing of forest conversion into plantations and settlement, it may threaten the existing of rattan. Therefore various conservation programme have been held as the effort to complement the decreasing phenomena of the rattan population in their natural habitat. Since long time ago, the kingdom of Kutai has cultivated rattan to provide the needs of rattan export.

Calamus and Daemonorops are the rattan genera known with commercial value such as manau (Calamus manan), tohiti (C. inops), and tretes (Daemonorops heteroides) [3]. There are some possibility to find other resources of rattan which is potentially used for mechanical uses. Several studies to explore the quality value of rattan can be conducted with anatomy characteristic studies such as fiber dimensions and physic-mechanical test. The book of Atlas Rotan Indonesia Edition 1 to 3 published by Research and Ministry of Environment and Forestry has the content about anatomical and physics-mechanical test studies of some trading commodity rattan. Besides, the information about species which only used by indigenous people and another wild species of rattan is not explored completely. In this paper, the object studies of rattan have taken from the Calamus used by the Dayak Iban-Desa in Ensaid Panjang village,
2. Method

2.1. Materials
Materials used for this study were collected from the 6 species of *Calamus* utilized by the Dayak Iban-Desa for plaited raw material. The rattan stems were collected about 2 cm in length and without the leaf sheath. The six *Calamus* species is *Calamus speciosissimus*, *C. blumei*, *C. rugosus*, *C. axillaris*, *C. zonatus*, and *Calamus* sp.

2.2. Procedure
The anatomy character explored through two kinds of microscopic slide made by paraffin and maceration methods. The slide made with paraffin method has two orientation of observation that is in transversal and radial sections. The paraffin method has made following Sass [5] and colored by Safranin and Fast Green. Anatomical character observed on the transversal and radial slide orientation were epidermis cell type, epidermis lumen type, radial measures of epidermis cell, number of hypodermal layer, metaxylem diameter, number of protoxylem cell, phloem diameter, number of phloem on the vascular bundle, vascular bundle diameter, ground parenchyma type and the presence of resin canals [4, 6, 7]. The measurement of quantitative character such as epidermis cell thickness, and the diameter of protoxylem, phloem, metaxylem etc. used 25 times repeated of measurement.

Maceration slide is made by following Schultz’s method [5] The stem cuts into small parts and bowl into HNO$_3$ 1:3 and colored with Safranin. Character observed on the slide is fiber cell long, fiber cell wall-thickness, fiber cell diameter and lumen diameter. Each character measures 25 times repeat. The fiber cell long and fiber cell wall-thickness classified with the IAWA standard to known the criteria of fibre cell character.

3. Result and discussion

3.1. Epidermal variation
Epidermis cells structure as the outer part of the plant has different characters which is used to distinguish plant on the species to genera and family taxa. In rattan, the epidermal layer is found in the peripheral zone with less of vascular bundle in this area [8]. In this study, the epidermal variation observation included epidermis cell type, epidermis lumen type, epidermis layer thickness, and number of hypodermal layer.

The epidermal layer on *Calamus* has one silicified layer of cell with a number of sunken stomata present [9, 8, 10, 7, 11]. Besides, there is another species of Calamus with two epidermal cell layers such as *C. acanthospathus* [12] The epidermal cell observed on this study has radial elongated cell type with papilla-like structure and tabular type. Tabular cell type only found in *Calamus* sp., besides another five species has radial elongated cell type with papilla-like structure (see Figure 1). Both of epidermal cell type also founded by Bhat, Nasser and Thulasidas [13], on the Calamus from South India with some type of lumen variation.

The outer wall of epidermal cell is generally more thicker than the inner and lateral walls [11]. The cell wall thickness of epidermal causes variation of the lumen type. About five variations on the lumen cell type identified on the specimen that is columnar, pendulum-shaped, club-shaped, and triangular. Columnar lumen type showed by the pillar-like structure with the upper and the base part lumen wider and rounded (Figure 2a). This type was founded on *C. speciosissimus*. Another study by Bhat, Nasser and Thulasidas [13] also found those types of lumen on *C. karnatakensis*. The pendulum-shaped lumen
type founded in *C. blumei* (Figure 2b). The lumen rounded near the base of epidermal and long-narrow up to the upper side of cell. The club-shaped lumen identified in *C. rugosus* epidermal cell. It’s almost similar to the pendulum-shaped lumen, but different at the base with bigger round structure and shorter narrow lumen at the upper side. Triangular lumen type was founded on *C. axillaris* and *C. zonatus*. Those four types of lumen are generally found on the Calamus and Daemonorops genera that have wide variety of epidermal lumen shape [7]. Another unique shape of lumen cell is square type, which is observed on *Calamus* sp. For some genera, this type of lumen was specific on four genera from Asia that is Korthalsia, Myrialepis, Plectocemia and Plectocomiopsis [7]. While the Calamus species has wide variation of lumen cell type, the square type is also found on the rattan from this genera such as *C. nagbettai*, *C. thwaitesii*, an *C. travancoricus* [13] and also *C. lepastopadix* [12].

![Figure 1](image_url)  
Figure 1 Variation of epidermal cell and lumen type on the Calamus (showed by the arrow): (a) Radial elongated with papilla-like structure and columnar lumen type on *C. speciosissimus*; (Photo from radial section with 40x); (b) Radial elongated with papilla-like structure and pendulum-shaped lumen type on *C. blumei* (Photo from transversal section with 40x); (c) Radial elongated with papilla-like structure and club-shaped lumen type on *C. rugosus* (Photo from radial section with 40x); (d and e) Radial elongated with papilla-like structure and triangular lumen type on *C. axillaris* and *C. zonatus* (photo from radial and transversal section with 40x); f. Tubular structure with square lumen type on *Calamus* sp. (photo from transversal section with 40x).
The epidermal cell of *Calamus* has 20 – 46 µm radial length of epidermal cell. *C. speciosissimus* and *C. blumei* have longer epidermal cells with 42.68 µm and 46.8 µm in length, besides the other species have 20 – 28 µm in length. Comparison with another study showed that the epidermal cell length of *Calamus* species on this study is shortened then another species like *Calamus didymocarpus* and *C. inops* (69 µm). Another species are known with 45 µm epidermal cell in length and the rattan with about 20 µm in the range is *C. zollingeri* with 28.47 µm in length [6]. The past studies by Bhat, Nasser and Thulasidas [13] observed that the length of epidermal cell is a weak character and statistically insignificant range on size. Furthermore, it has been said that it might be any correlation between the length of epidermal radial cell with the rattan stem diameter, although the corellation is not determined yet because some data are overlapped between some class of stem diameter. The large-diameter rattan (> 18 mm) have size 25 – 32 µm in length; the medium-diameter rattan (10-18 mm) have size > 40 µm in length; and the small-diameter rattan (< 10 mm) have size 24-45 µm in length [13]. Another study by Siripatanadilok [14], shows that the longer epidermal cell is reflecting the high quality of rattan cane (study case on the *C. manan* which know as the number one class of rattan have cell length about 62.5 µm). In this study, the rattan species only use by local people and not commercially sell on trade. So, it’s cannot be suggested that there is any corellation between the size of epidermal cell with the cane quality.

The hypodermal layer variation in this study is single and two-layer. The single-layer hypodermal observed in *C. speciosissimus, Calamus sp.*, *C. rugosus*, and *C. axillaris*, besides the two-layer of hypodermal were observed in *C. blumei* and *C. zonatus*. The hypodermal layer which is called as endodermis is the layer under the epidermal with unilignified cell [13] and it was predicted as the placed to produce sillica that will be precipitated in the epidermal layer. While the epidermal cells are arranged upright, the hypodermal cells arranged procumbent [6]. Some genera have identical hypodermal structure as the special character that is yellow carps. Yellow carps are the sclerenchyma cell layer that is founded at the top of the fiber bundle on the cortex area. It looks boldly colored and easy to recognize under the transverse orientation slide This character founded in Korthalsia, Myrialepis, Plectocomia, and Plectocomiopsis [6].

The other characters that are usually found in the periphery zone are the present of stomata and the fiber bundle in peripheral zone. The stem stomata usually found with sink at the edge of parenchyma, urge, or even sunked in 1 to 2 epidermal layer (based on the study in *C. didymocarpus, C. zollingeri, C. inops, and C. minahassae*) [13, 6]. In this study, none of stomata has been founded in the epidermal. Meanwhile, the fiber bundles in the pheriperal zone do not exist, either. This structure is not an important character to identified rattan at the genera level, but in some species it was a specific character to the species. The fibers are usually combine with the vascular bundle. But in some species, we can found the fiber bundle in the pheriperal zone with the structure is smaller than the vascular bundle. The fiber bundle is usually arranged in a single layer with alternate pattern (founded in *Daemonorops didymophylla*) or without any specific pattern (founded in *Plectocomiopsis gerninflora, Korthalsia flagellaris*, dan *C. exilis*) [15]. The rattan *Eremospatha macrocarpa* and *Laccosperma acutiflorum* have two layers of fiber bundle arranged in the pheriperal zone [10]. In this study, there is no fiber bundle found in the peripheral zone.

### 3.2. Variation of the vascular bundles

The vascular bundles were embeded in the ground parenchyma. The arrangement of vascular bundles was like another monocot stem, spreading on the central corpus area. Variation of the vascular bundles can be a specific character to the genera and species taxa. The character consist of qualitative and quantitative character.

According to the study from Weiner and Liese [7], there are four type of vascular bundles on rattan. Type A consist of one phloem field and metaxylem vessel; type B consist of two phloem fields, one metaxylem vessel, and horseshoe shape fibre bundles sheath; type C consist of one phloem field and two metaxylem vessel, type D consist of two phloem field with uniseriate and biseriate sieve tubes and one metaxylem vessels. All species used in this study have type B of vascular bundle.


**Tabel 1. Qualitative character of the Calamus**

| Species        | Type of ground parenchyma | Type of vascular bundles | Presence of resin cannals |
|----------------|---------------------------|--------------------------|---------------------------|
| *C. speciosissimus* Furtado | Type B *(pebble like)* | Type B                   | Absent                    |
| *C. blumei* Becc. | Type A *(puzzle like)* | Type B                   | Absent                    |
| *Calamus* sp. | Type B *(pebble like)* | Type B                   | Absent                    |
| *C. rugosus* Becc. | Type B *(pebble like)* | Type B                   | Present                   |
| *C. axillaris* Becc. | Type B *(pebble like)* | Type B                   | Absent                    |
| *C. zonatus*    | Type B *(pebble like)* | Type B                   | Absent                    |

![Figure 2](image_url)  

Figure 2 Type of ground parenchyma: (a) Type B “pebble like” with resin canals (see the arrow) on *C. rugosus*; (b) Type A “puzzle like” on *C. blumei*.

The ground parenchyma consist of the cell with a thin wall. One to another cell was connected with the simple pit [6]. Two variations of the ground parenchyma are Type A (puzzle like) and Type B (pebble like). Those variations are usually found on the *Calamus* stem with two phloem fields [8]. All of the *Calamus* in this study has the Type B of ground parenchyma, except the *C. blumei* with type A of ground parenchyma. The ground parenchyma on type B was arranged within the vascular bundles with no regular cycle pattern, and the parenchyma cell bigger than the type A (see Figure 2). Otherwise, the ground parenchyma on type A were arranged like a circular narrow branch pole around the vascular bundles. The resin canals also found in the type A ground parenchyma, on this study found in *C. rugosus*. According to another studies by Krisdianto, Jasni and Tutiana [15], the species of rotan batu (*C. zonatus*) has the type A ground parenchyma and the resin canals among the parenchyma cell. But both of the character are not found in the *C. zonatus* in this study. There might be another variation in this species which need deep observation.
| Species               | Number of vascular bundles / mm² | Vascular bundles diam. (µm) | Meta-xylem diam. (µm) | % Meta-xylem | Number of proto-xylem | % Proto-xylem | Phloem fields diam. (µm) | % Phloem | Fiber sheath diam. (µm) | % fiber sheath | % Axial parenchyma |
|----------------------|---------------------------------|-----------------------------|-----------------------|--------------|-----------------------|--------------|--------------------------|-----------|------------------------|---------------|-------------------|
| *C. speciosissimus*  | 2                               | 409,89 ± 57,16              | 156 ± 41,15           | 38,26        | 1-3 sel               | 35,21 ± 10,97 | 38,26 ± 11,94           | 11,03     | 138,08 ± 25,38         | 116,22        | 26,42 ± 8,9       |
| *C. blumei*         | 3                               | 483,21 ± 86                 | 221,13 ± 40,95        | 46,28        | 1-7 sel               | 40,67 ± 19,28 | 8,12 ± 10,59            | 10,26     | 123,82 ± 24,37         | 116,22        | 26,42 ± 8,9       |
| *Calamus sp.*       | 6                               | 294,06 ± 20,62              | 98,67 ± 21,72         | 33,72        | 1-7 sel               | 23,88 ± 6,28  | 8,14 ± 7,56             | 9,89      | 116,22 ± 33,88         | 116,22        | 26,42 ± 8,9       |
| *C. rugosus*        | 7                               | 291,64 ± 28,43              | 147,73 ± 21,1         | 50,86        | 2-6 sel               | 26,63 ± 8,76  | 9,12 ± 6,56             | 9,17      | 80,34 ± 17,47          | 80,34         | 27,99 ± 2,74      |
| *C. axillaris*      | 4                               | 387,27 ± 48,05              | 177,64 ± 31,56        | 45,78        | 2-6 sel               | 30,6 ± 11,86  | 7,84 ± 11,1             | 13,6      | 98,67 ± 25,27          | 98,67         | 26,05 ± 6,71      |
| *C. zonatus*        | 8                               | 264,22 ± 32,73              | 104,05 ± 13,82        | 39,72        | 1-3 sel               | 21,39 ± 8,67  | 8,26 ± 6,65             | 12,18     | 67,08 ± 18,57          | 67,08         | 25,78 ± 14,04     |

Tabel 2 Quantitative character of the Calamus
Every species of *Calamus* used on this study have the different number of vascular bundles/mm². The *C. speciosissimus* is the rattan with only 2 vascular bundles/mm², while the *C. zonatus* have the higher number with 8 bundles/mm². Another study from Bhat, Nasser, and Tulassidas [13], shows the other high number of vascular bundles, such as *C. travancoricus* (19 bundles/mm²), *C. pseudotenuis*, *C. lakshmana*, *C. rotang* (14 bundles/mm²). The relation between vascular bundles density to the rattan cane quality is still undiscovered yet [14].

The vascular bundles consisted of metaxylem, protoxylem, phloem, fiber bundle sheath and ground parenchyma. The variation of vascular bundles diameter on this study was about 264.22 – 483.21 µm in range. The other discovered study showed that the increase of vascular bundles diameter was connected to the rattan cane strengths to solitary growth or climbing the trees [9]. Different from the dicot, it’s difficult to use the rattan stem which is sliced and observed with the hand lens to distinguish one to another species. It’s caused by the arrangement of the solitary vascular bundles spreading around the ground parenchyma. Therefore, it’s necessary to make microscopic slide to help observation of any distinguish characteristic of the rattan stem anatomy.

The metaxylem and protoxylem vessel can be distinguished through the microscopic observation. Metaxylem were generally consist of one vessel, rounded, and having bigger diameter placed on the center of the bundles. Even though, other rattan genera like Eremospatha and Plectocomia have double metaxylem vessels [12, 10] metaxylem diameter of the specimen in this study was about 98-67 to 221.13 µm in range. The diameter was corellated to the resistance of rattan cane to the powder post beetles attack. The wider diameter of metaxylem is potential to the egg-storing to the beetles, so the intensity of the beetles attack will be increased [15]. In this study, the *Calamus* sp. with the smallest diameter of metaxylem (98.67 ± 21.72 µm) can be assumed to have good resistance to the powder post beetles attack than another species tested. However, the vessels (metaxylem and protoxylem) diameter also has the eco-physiological function. Wide vessel diameter was less resistance to the beetles attack, but it has efficiency function as a conductor. While the narrow vessel diameter have a role in reduction to gas embolism [12].

The protoxylem was the xylem that formed by the growth stem nodus, which is microscopically the wall seen as roled and tightly spiral structure [6]. The protoxylem has a smaller diameter than the metaxylem, elipsoid and soliter from one cell to another and it’s easily to distinguish from the ground parenchyma cell. Generally, the protoxylem can be found more than single cell per vascular bundles and placed below the metaxylem vessels. An early studies reported about 2-6 protoxylem cell founded on the vascular bundles [13] or about 4-7 cell [12]. On this research, we discovered that 4 species have a single cell to multicell of protoxylem (*C. speciosissimus* and *C. zonatus* have 1-3 cell of protoxylem, *C. blumei* and *Calamus* sp. have 1-7 cell of protoxylem). Meanwhile, the *C. rugosus* and *C. axillaris* has 2-6 cell of protoxylem and do not have a single cell of protoxylem. There was still no correlation found about the protoxylem diameter and the rattan cane strengths [15].

The part of vascular bundles which is usually used as the supporting anatomical character on genera taxa was the phloem. The phloem has a single and two phloem field as its variation. The single phloem field was found in five genera, those are *Myrialepis*, *Plectocomia*, *Plectocomiopsis*, *Eremospatha*, and *Laccosperma*, while the double phloem field founded in seven genera that is *Calamus*, *Daemonorops*, *Korthalsia*, *Calospatha*, *Ceratolobus*, *Pogonotium*, dan *Retispatha* [8]. The single phloem field was located above the metaxylem, while the double phloem field arranged laterally on the side of metaxylem with the end of the field was narrowed [16, 6]. All of the specimen used on this research have two phloem field with the range of diameter are 26.48 – 52.45 µm in range. Base on the plant physiological study, the phloem variation about the number of phloem fields and the phloem tube in each fields were influenced by the land altitude. It’s also reported influencing the anatomy stem structure based on the water availability and the environment climate [12].

The rattan fiber bundles usually founded on the vascular bundles, formed like horseshoes or triangle half curved [6, 15]. The fiber bundles structure was easy to identified by the microscopy observation because it’s been thicker than another cell. The thick color of the fiber cell are specific character to the sclerenchyma cell which have thicker cell wall. The *C. zonatus* was having the lowest percentage of
fiber bundles (25.78%) while the *Calamus* sp. have higher percentage (39.97%). The higher percentage reflected the strengths of the rattan cane. Based on the results, it can be assumed that the *C. zonatus* is the weakness cane than another species in this research. According to the local utilization by the people of Dayak Iban-Desa as the raw material of plaited arts, the *C. zonatus* or in the local name called *wi antu’k* were known as the weak rattan among the others. The *C. zonatus* cane were easily rotten when its soaked or touched by the water [4]. Another study to observed the phytochemical content on the cane was needed to describe and giving additional information about the low quality of the *C. zonatus* cane.

The parenchyma axial tissues were located between the protoxylem, metaxylem, and the phloem. The parenchyma axial tissues percentage was not given any significant character to the species identification. The range of parenchyma axial tissues percentage on this research were about 2.74% to 14.04% respectively. According to the results by another studies, those percentage were smaller than the others such as *C. zollingeri*, *C. ornatus*, and *C. inops* with the percentage on 20%, 25% and 21% [6].

### 3.3. Variation on the fiber dimension

The fiber dimension character observed on this research consist of fiber cell length, fiber wall thickness, fiber cell diameter and lumen cell diameter. Some of the data collected from the fiber dimension observation were helped to determine the quality of rattan cane based on the IAWA classification. Besides, the fiber dimension was also used to calculate the derivative value which is used to know the physical and mechanical characters of the rattan. The observation in this research was only focused on the four main characteristics of the fiber dimension.

The fiber cell length criteria from IAWA [17] placed the species with long cell (observed on *C. speciosissimus, Calamus* sp., *C. rugosus*, and *C. zonatus*) and medium-length criteria (observed on *C. blumei* and *C. axillaris*). The shortest fiber were about 760.5 µm and the longest about 2,778.75 µm (Table 3). According to the rattan utilization as material for plaited crafts, there should be have any corellation between the fiber length to the flexibility of the cane and the preferences of the people. The longest fiber cell will support the flexibility of the cane. In fact, only the *C. blumei* cane is prefered by the Dayak Iban-Desa people as favourite cane to plait between another species with long fiber (Dewi 2016).

The fiber wall thickness was usually corellated to the rattan cane strengths. For example, the *C. manan* (rotan manau) with the fiber cell thickness of about 5.4 µm is one of the primer commodity because of its strengths which are used in the furniture industry [15]. All of the *Calamus* species used on the study were classified on the thin to thick criteria based on IAWA [17]. The fiber wall of rattan was supported by the polylamela structure (this structure can be observed in the transverse section). The fiber thickness will be shrunk from the periphery to the corpus central area. The polylamela wall structure will be widely seen on the periphery zone, and it will be narrower when the cell was getting closer to the corpus central [18].

The combination characters between fiber length and the cell wall thickness were used as an important parameter to determine the rattan cane strengths. The longer cell and thickness wall will be increasing the cane’s strengths and the density [19]. The results showed that the *C. rugosus* and *C. speciosissimus* have a thicker cell wall. Both of the rattan also have the medium criteria of fiber length. According to the previous statement by Kalima and Jasni [19], it can be assumed that the *C. rugosus* and *C. speciosissimus* have more strengths of cane than another species used in this studies.
| Species                        | Fiber cell length (µm) | Range of the fiber cell length (µm) | Fiber cell length criteria | Fiber cell wall thickness (µm) | Range of the fiber cell wall thickness (µm) | Cell wall thickness criteria | Fiber cell diameter (µm) | Fiber cell diameter criteria | Fiber cell lumen diameter (µm) |
|-------------------------------|------------------------|-----------------------------------|-----------------------------|-------------------------------|--------------------------------------------|-----------------------------|--------------------------|-------------------------------|--------------------------------|
| Calamus speciosissimus Furtado | 1454,70 ± 415,26       | 780 - 2047,5                      | Medium                      | 3,72 ± 1,18                  | 2,48 - 6,2                                 | Thin to thicker wall         | 18,90 ± 3,51              | Medium                        | 11,45 ± 3,82                    |
| Calamus blumei Becc.          | 1646,97 ± 521,39       | 614,25 - 2632,5                   | Long                        | 2,83 ± 0,84                  | 2,48 - 4,96                                | Thin to thicker wall         | 14,93 ± 3,13              | Medium                        | 9,27 ± 3,1                     |
| Calamus sp.                   | 1576,77 ± 363,47       | 1072,5 - 2486,25                  | Medium                      | 2,43 ± 0,24                  | 1,24 - 2,48                                | Thin to thicker wall         | 15,62 ± 3,26              | Medium                        | 10,76 ± 3,07                    |
| Calamus rugosus Becc.         | 1448,85 ± 324,00       | 760,5 - 1852,5                    | Medium                      | 4,02 ± 1,30                  | 2,48 - 7,44                                | Thin to thicker wall         | 17,16 ± 3,05              | Medium                        | 9,12 ± 3,27                     |
| Calamus axillaris Becc.       | 1685,58 ± 547,44       | 780 - 2778,75                     | Long                        | 2,73 ± 0,50                  | 2,48 - 3,72                                | Thin to thicker wall         | 15,13 ± 3,52              | Medium                        | 9,67 ± 3,18                     |
| Calamus zonatus Becc.         | 1260,09 ± 272,32       | 887,25 - 1803,75                  | Medium                      | 2,93 ± 0,79                  | 2,48 - 4,96                                | Thin to thicker wall         | 15,67 ± 2,69              | Medium                        | 9,82 ± 3,03                     |
3.4. Identification key to the Calamus of Kalimantan based on the anatomy character

According to the anatomy character, we were arranged the tentative identification keys for the *Calamus* species from this study. The identification keys were using the qualitative character observed from the specimen.

1. a. Epidermal tabular cell type, without “papilla-like” structure .................................................. Calamus sp.
   b. Epidermal radial elongated cell type, with “papilla-like” structure ............................................. 2

2. a. Hypodermal consist of single layer cell ................................................................. 3
   b. Hypodermal consist of two layers cell ................................................................. 4

3. a. Epidermal cell with columnar lumen ................................................................. C. speciosissimus
   b. Epidermal cell with triangular lumen ................................................................. C. axillaris

4. a. “Puzzle like” type of ground parenchyma ............................................................. C. blumei
   b. “Pebble like” type of ground parenchyma ............................................................. 5

5. a. The presence of resin cannals on the ground parenchyma ........................................ C. rugosus
   b. The absence of resin cannals on the ground parenchyma ........................................ C. zonatus

4. Conclusion

The anatomy character observed from the rattan stem was divided into three main objects. The epidermal variation showed that the epidermal cell type, lumen cell type, and number of hypodermal layers were the important characters to observe the anatomy of rattan cane study. The lumen epidermal cell was specifically different between the species. From the variation of vascular bundle, the specific character used to identifying rattan cane is the ground parenchyma arranged cell type, presence of the resin cannals, number of the vascular bundles/mm², and number of the protoxylem. The presence of resin cannals is the rare character found on the rattan stem. The fiber dimension observation showed that the combination between the fiber length and the fiber wall-thickness can be used to determine the quality of rattan cane. Identification keys were arranged using five qualitative characters consist of the epidermal cell type, number of hypodermal layer cells, type of the epidermal lumen, type of the ground parenchyma tissue, and the presence of the resin cannals.

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