LEAF SURFACE COMPARISON OF THREE GENERA OF ARACEAE IN INDONESIA

Perbandingan Permukaan Daun Tiga Marga Araceae di Indonesia

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Abstract

Alocasia, Colocasia and *Remusatia* are the genera of *Araceae* family which have high economic value, such as for food and ornamental plants. Those three genera, previously treated as *Colocasieae* tribe. Study on leaf anatomy of *Araceae* is still poor known. Comparison of three genera of *Araceae*, indicates a difference in the epidermis. *Alocasia* and *Colocasia* have stomata on both leaf surfaces (amphistomatic) but *Remusatia* has stomata only limited on the lower surface. The three genera can be distinguished from epidermal cell shape, stomata complex and the presence of stomata.

Key words : *Colocasieae*, Araceae, leaf anatomy, epidermis, Indonesia

Abstrak

Alocasia, Colocasia and *Remusatia* merupakan marga dalam suku Araceae yang mempunyai nilai ekonomi tinggi, seperti untuk tanaman pangan dan tanaman hias. Ketiga marga tersebut, pada awalnya dimasukkan ke dalam puak *Colocasieae*. Studi anatomi daun pada Araceae masih jarang dilakukan. Perbandingan tiga marga dalam Araceae yaitu *Alocasia, Colocasia* dan *Remusatia* menunjukkan adanya perbedaan pada sel epidermis. *Alocasia* dan *Colocasia* memiliki stomata di kedua permukaan daun (amphistomatic) tetapi pada *Remusatia* stomata terbatas pada permukaan bawah. Ketiga marga dapat dibedakan dari bentuk sel epidermis, kompleks stomata dan keberadaan stomata.

Kata kunci : *Colocasieae*, Araceae, anatomi daun, epidermis, Indonesia

INTRODUCTION

Alocasia, Colocasia and *Remusatia* is the three genera under Araceae family which has high economic value. For example *Colocasia esculenta* (taro) and *Alocasia macrorrhizos* (the giant taro) are known as edible plants. Some species of *Alocasia* are known as ornamental plants. Those three genera occurs in Africa, South and East Asia, Malesia and northern Australia. Those genera most diverse and abundant in the humid tropics and few genera inhabit temperate regions of the world. The growth of Araceae is dependent on the abundant of water and prevailing atmospheric humidity. Structurally and physiologically they are not well adapted to grow in arid and cold condition and hence do not occur in the most extreme environments (Mayo *et al.*, 1997).

The three genera of *Araceae* (*Alocasia, Colocasia* and *Remusatia*) distributed in tropical Asia, tropical Africa, Australasia, Malesia and Melanesia (Hay, 1996). In Indonesia (Sumatera, Java, Lesser Sunda Islands, Kalimantan, Sulawesi,

Moluccas and Papua) are found 20 species consists of 17 *Alocasia* species, two *Colocasia* species and a single species of *Remusatia*. The genus *Alocasia* can be found from western to eastern part of Indonesia, meanwhile the genus *Colocasia* in the wild can be found from western to eastern part of Indonesia except in Kalimantan. In addition, the genus *Remusatia* only occurs in Java, Lesser Sunda Island and Sulawesi (Erlinawati, 2011).

Study of Araceae especially the leaf anatomy within tribe *Colocasieae* is still poorly known. Previously study was done with the leaf epidermal structures of 27 species from 18 genera of Araceae and 1 species from Acoraceae were examined under light microscope, 14 of which were observed with scanning electron microscope (Wang and Zhao, 2002) and Keating (2003) with limited species. Keating (2003) mentioned that anatomical data can be used to classify taxa under the tribe.

MATERIAL AND METHOD

The materials were used for this study are 15 species of the member of three genera, consist of 12 species of *Alocasia* (*A. alba* Schott, *A. brancifolia* (Schott) A. Hay, *A. lancifolia* Engler, *A. longiloba* Miq., *A. macrorrhizos* (L.) G. Don, *A. suhirmaniana* Yuzammi & A. Hay, *A. kerinciensis* A. Hay, *A. megawatiae* Yuzammi & A. Hay, *A. nicolsonii* A. Hay, *A. puber* (Hassk.) Schott, *A. pyrospatha* A. Hay, *A. flemingiana* Yuzammi & A. Hay); 2 species of *Colocasia* (*C. esculenta* (L.) Schott and *C. gigantea* (Blume) Hook.f.); and 1 species of *Remusatia*, namely *R. vivipara* (Roxb.) Schott. (Plate 1-15 and Table 1)

Paradermal sections was conducted for observing stomata and epidermal of *Colocasieae* with HNO_3 solution refer to Cutler (1978) for cuticular. We put the leaf material into boiled HNO3 solution for about 1 – 3 minutes, then raised with water and put on the slide glass. Drop safranin on the leaf and wait for 1 minute, then raised with water. After that put few drops of glycerin and cover with coverslip. Then we examined under light microscope Nikon AFX-IIA 10x40 magnification and pictures were taken by light microscope Nikon Eclipse 80 *i*.

RESULTS AND DISCUSSION

The 3 genera of the member of tribe *Colocasieae* in Indonesia can be distinguished by the distribution of the stomata on leaves epidermal cell shape, stomata complex and the presence of stomata.

Alocasia

The leaves on all the members of *Alocasia* have anticlinal epidermis with straight walls both above and below the surface, except for the leaf epidermis of *A. suhirmaniana, A. longiloba and A. megawatiae* with sinuous wall (very wavy). Epidermis cell with polygonal shape and irregular in *A. suhirmaniana, A. longiloba* and *A. megawatiae* while in *A. lancifolia*, the stomata complex is composed by a pore which surrounded by two, four neighboring cells or up to six cells. Stomata are not only found on the lower surface of the leaf but also on the upper surface. This type of stoma called as tetracytic, Keating (2003) was called brachytetracytic and brachyhexacytic. Trichome mostly absent, but present on the *A. puber* leaf surface as multicellular and non glandular type. The species observed in this study were *A. alba* Schott, *A. brancifolia* (Schott) A. Hay, *A. lancifolia* Engler, *A. longiloba* Miq., *A. macrorrhizos* (L.) G. Don, *A. suhirmaniana* Yuzammi & A. Hay, *A. kerinciensis* A. Hay, *A. megawatiae* Yuzammi & A. Hay, *A. nicolsonii* A. Hay, *A. puber* (Hassk.) Schott, *A. pyrospatha* A. Hay, *A. flemingiana* Yuzammi & A. Hay.

1. *A. alba* Schott

In both surfaces of the leaf, epidermis cell wall is straight with pentagonal-polygonal epidermis cell shape. Stomata distributed in both surfaces. None of trichome is present in both surfaces.

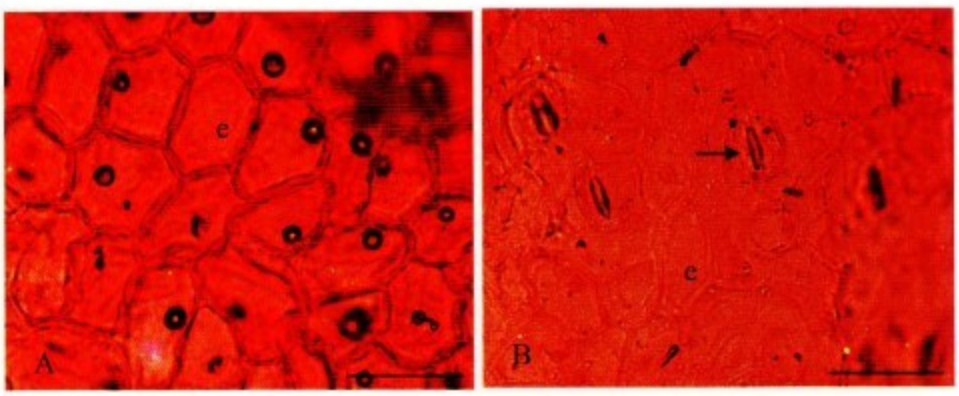

Figure 1. Upper (A) and lower (B) leaf surface of *A. alba*. e: epidermis and stomata showed by arrow. Scale 50 µm.

2. *A. brancifolia* (Schott) A. Hay

Upper epidermal cells are straight-slightly wavy, while lower epidermal cells are straight. Shape of epidermal cell is polygonal. Stomata complex is arranged by pore surrounded by 4 – 5 subsidiary cells and distributed in both leaf surfaces.

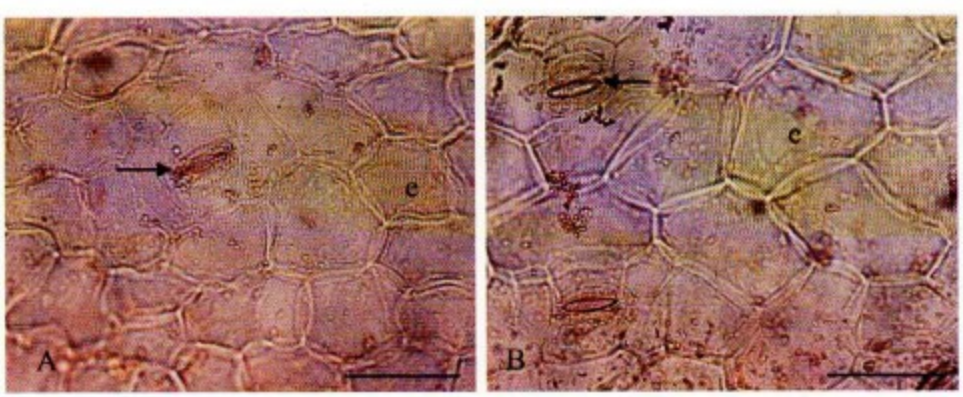

Figure 2. Upper (A) and lower (B) leaf surface of *A. brancifolia*. e: epidermis and stomata showed by arrow. Scale 50 µm.

3. *A. flemingiana* Yuzammi & A. Hay

Epidermis cell walls in both surfaces are straight to wavy, the epidermis cells have a polygonal shape, but sometimes it shows epidermis cells without angles or irregular shape. Stomata type is paracytic or tetracytic or anomacytic with 5 subsidiary cells. None of trichome is found

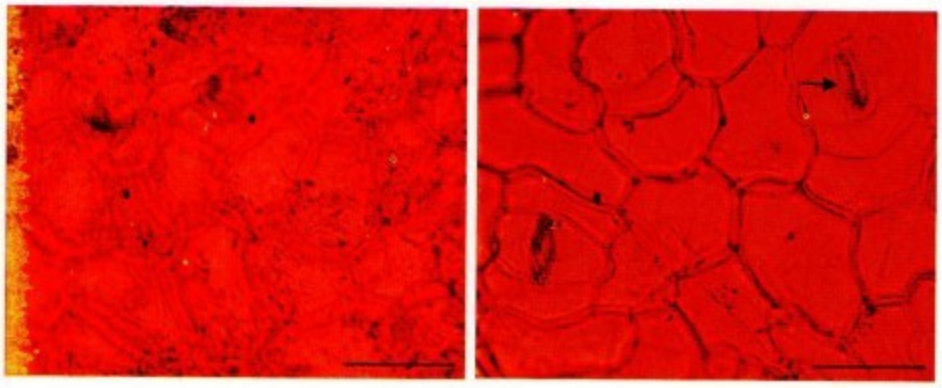

Figure 3. Upper (A) and lower (B) leaf surface of *A. flemingiana*. e: epidermis and stomata showed by arrow. Scale 50 µm.

4. *A. kerinciensis* A. Hay

Upper and lower epidermis cells are straight to slightly wavy (*undulate*). Epidermis cell shapes are polygonal. Stomata restricted in the lower surface (*hypostomatic*); without trichomes. Stomata type was parasitic which mean pore was surrounded by 2 subsidiary cells.

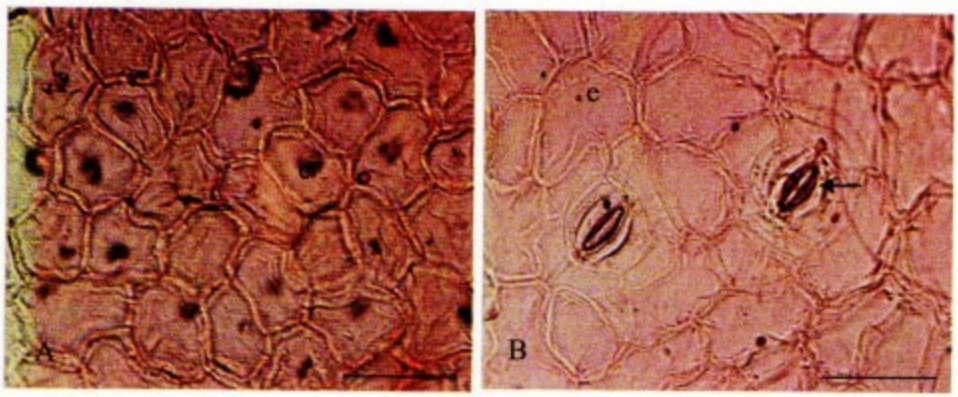

Figure 4. Upper (A) and lower (B) leaf surface of *A. keinciensis*. e: epidermis and stomata showed by arrow. Scale50 µm.

5. *A. lancifolia* Engler

Upper and lower epidermal cells are sinuous. Shape of epidermis cells is irregular. Stomata complex is arranged by pore surrounded by 4-6 subsidiary cells and distributed in both leaf surfaces.

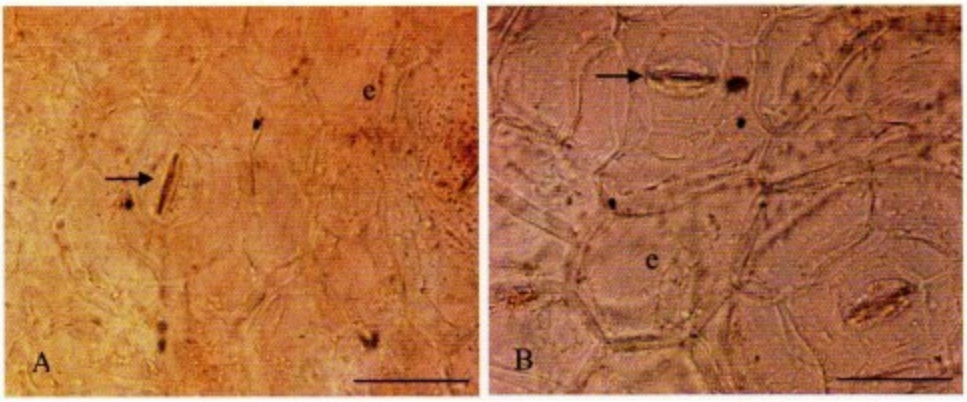

Figure 5. Upper (A) and lower (B) leaf surface of *A. lancifolia*. e: epidermis and stomata showed by arrow. Scale 50 µm.

6. *A. longiloba* Miq.

Upper and lower epidermal cells are straight. Shape of epidermis cells is polygonal. Stomata complex is arranged by pore surrounded by 4 subsidiary cells and distributed in both leaf surfaces.

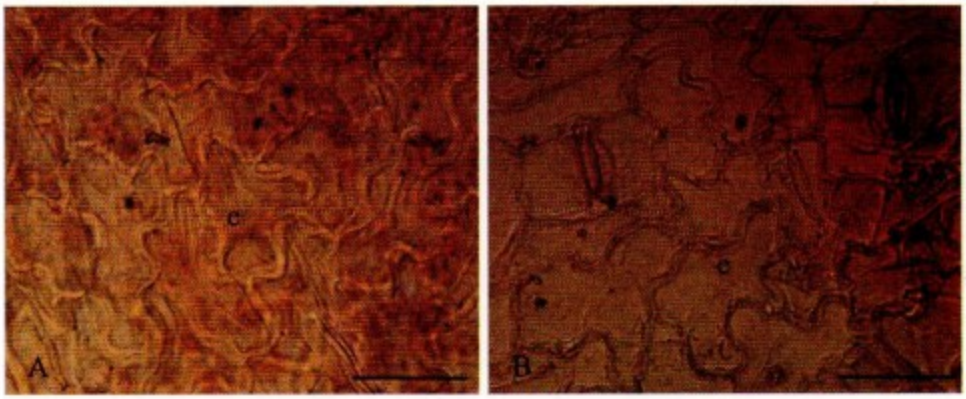

Figure 6. Upper (A) and lower (B) leaf surface of *A. longiloba*. e: epidermis and stomata showed by arrow. Scale 50 µm.

7. *A. macrorrhizos* (L.) G. Don

Upper and lower epidermis are straight. Shape of epidermis cells polygonal. Stomata complex is arranged by pore surrounded by 4 subsidiary cells and distributed in both leaf surfaces.

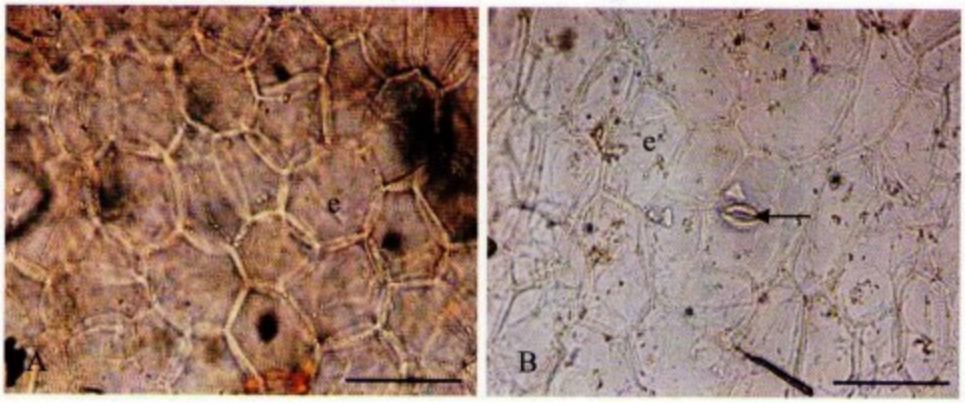

Figure 7. Upper (A) and lower (B) leaf surface of *A. macrorrhizos*. e: epidermis and stomata showed by arrow. Scale 50 µm.

8. *A. megawatiae* Yuzammi & A. Hay

Epidermis anticlinal cell wall in both surfaces are sinuous. Stomata distributed in upper and lower surfaces (*amphistomatous*), paracytic-tetracytic type; no trichomes.

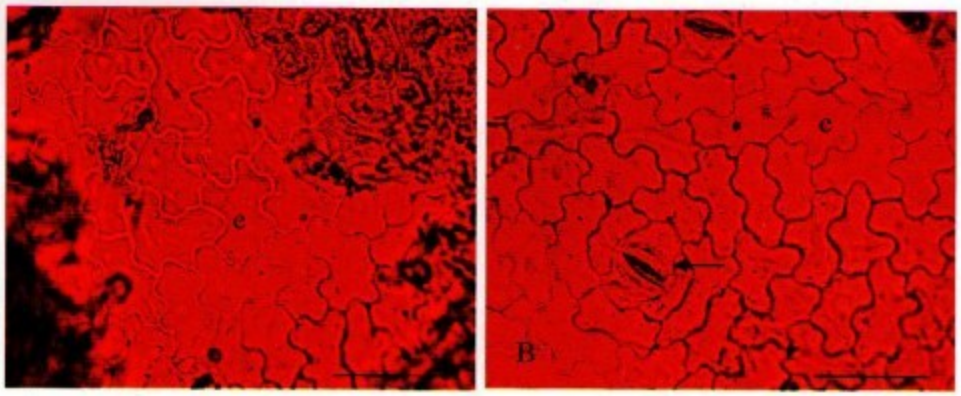

Figure 8. Upper (A) and lower (B) leaf surface of *A. megawatiae*. e: epidermis and stomata showed by arrow. Scale 50 µm.

9. *A. nicolsonii* A. Hay

Upper and lower surfaces have straight epidermis cell wall. Epidermis cell shape is polygonal. Stomata type is paracytic and distributed on upper and lower surafces (*amphistomatous*), without trichome.

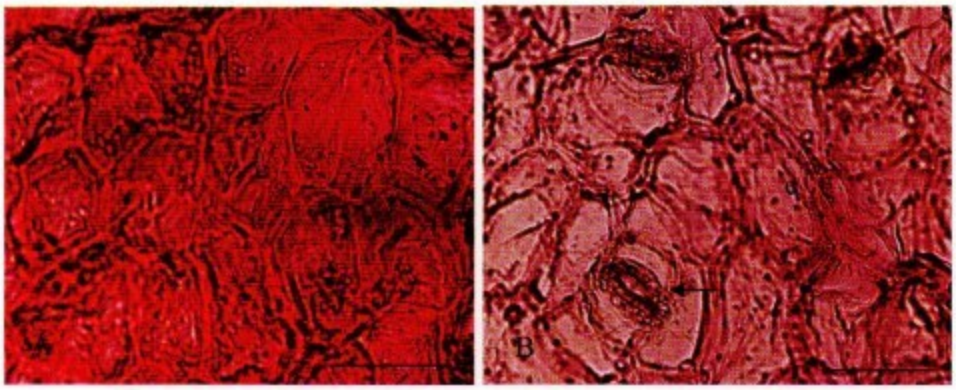

Figure 9. Upper (A) and lower (B) leaf surface of *A. nicolsonii*. e: epidermis and stomata showed by arrow. Scale 50 µm.

10. *A. puber* (Hassk.) Schott

This species has straight anticlinal cell wall in the lower surface; epidermis cell shape is polygonal. This species can be distinguished from other Alocasia by showing multicellular trichome on leaf surface. Stomata type is paracytic.

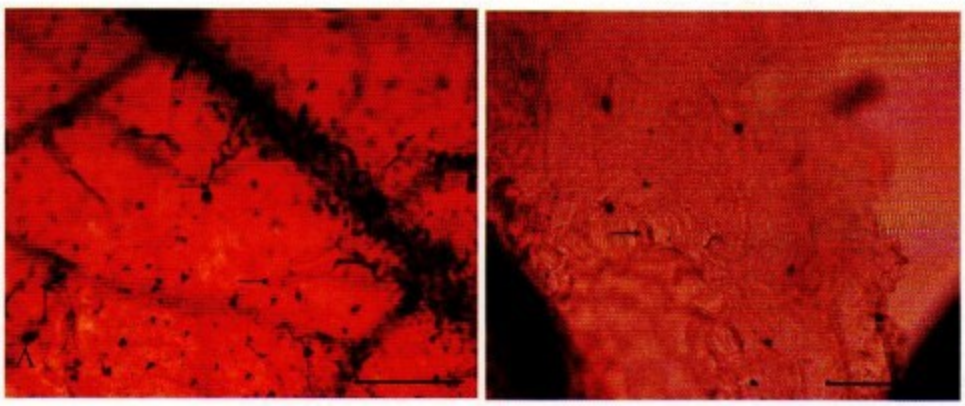

Figure 10. *A. puber* showing trichomes (showed by arrow) in its upper surface (A). Stomata (showed by arrow) distributed only on the lower surface (B) of the leaf. Scale A: 200 µm and B: 50 µm.

11. *A. pyrospatha* A. Hay

Epidermis cell wall is straight to undulate in both surfaces. Epidermis cell shape is irregular. Stomata type is paracytic or tetracytic and spread in the lower surface. Trichome did not present in the both surfaces.

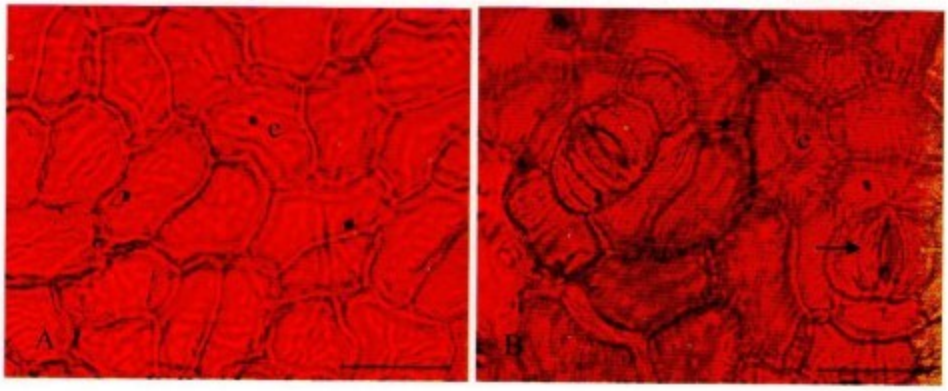

Figure 11. Upper (A) and lower (B) leaf surface of *A. pyrospatha*. e: epidermis and stomata showed by arrow. Scale 50 µm.

12. *A. suhirmaniana* Yuzammi & A. Hay.

Upper and lower epidermis cells are sinuous. Shape of epidermis cells is irregular. Stoma complex is arranged by pore surrounded by 4 subsidiary cells and distributed in both leaf surfaces.

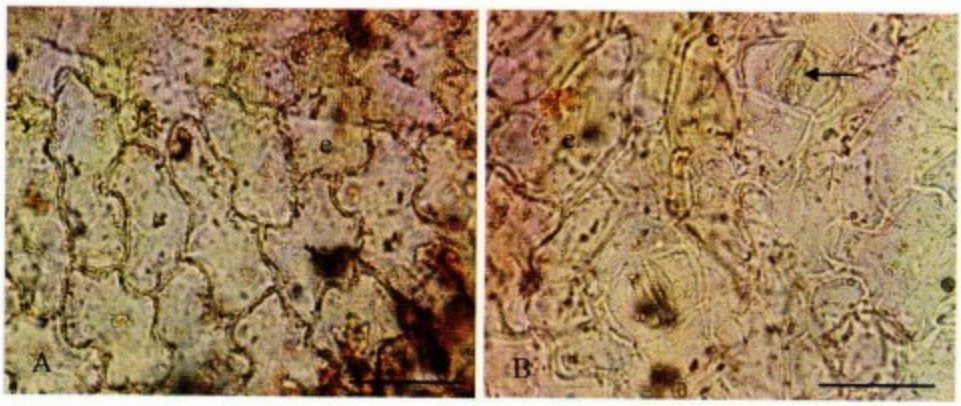

Figure 12. Upper (A) and lower (B) leaf surface of *A. suhirmaniana*. e: epidermis and stomata showed by arrow. Scale 50 µm.

Colocasia

Two species of *Colocasia* in Indonesia namely *C. esculenta* and *C. gigantea* have anticlinal epidermal cells with straight walls and polygonal cell shape. The complex stoma is composed by a stoma surrounded by four neighboring cells. It is not like *Alocasia* in which neighboring cells of *Colocasia* can not be distinguished from the epidermal cells shape around it.

The species observed i.e. *C. esculenta* (L.) Schott and *C. gigantea* (Blume) Hook.f.

1. *C. esculenta* (L.) Schott

Upper and lower epidermis cells are straight. Shape of epidermis cells is polygonal. Stomata complex is arranged by pore surrounded by 4 subsidiary cells and distributed in both leaf surfaces. Neighboring cells can not be differentiated from epidermis cells surrounds.

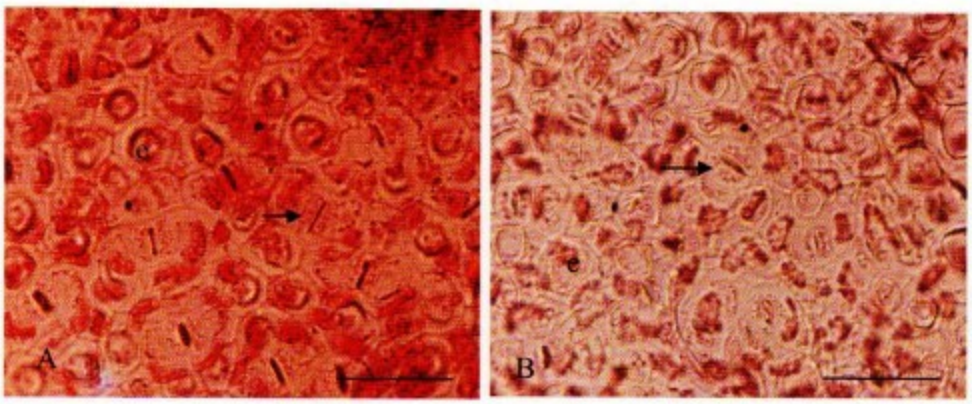

Figure 13. Upper (A) and lower (B) leaf surface of *C. esculenta*. e: epidermis and stomata showed by arrow. Bar 50 µm.

2. *C. gigantea* (Blume) Hook.f.

Upper and lower epidermis cells are straight. Shape of epidermis cells is polygonal. Stomata complex is arranged by pore surrounded by 4 subsidiary cells and distributed in both leaf surfaces. Neighboring cells can not be differentiated from epidermis cells surrounds.

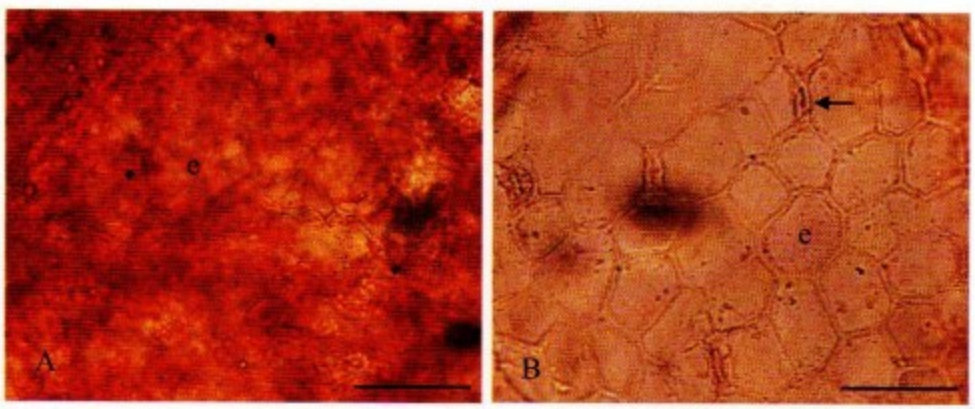

Figure 14. Upper (A) and lower (B) leaf surface of *C. gigantea*. e: epidermis and stomata showed by arrow. Bar 50 µm.

Remusatia

In Indonesia there is only one species of *Remusatia*, namely *R. vivipara*. The anticlinal epidermal cell wall on the upper surface is straight, while the lower surface is the straight- undulate. Epidermal cells shapes on both the leaf surfaces are polygonal. The stoma complex consists of stoma surrounded by four neighboring cells that form can not be distinguished from epidermal cells around it. Stomata confined to lower surface only. The species observed was *R.. vivipara* (Roxb.) Schott.

R. vivipara (Roxb.) Schott.

Upper epidermis straight and polygonal shape, while lower epidermis cells are straight to undulate. The shape of epidermis cells is polygonal. Stomata complex is arranged by pore surrounded by 4 subsidiary cells and restricted on the lower leaf surface. Neighboring cells can not be differentiated with epidermis cells surrounds.

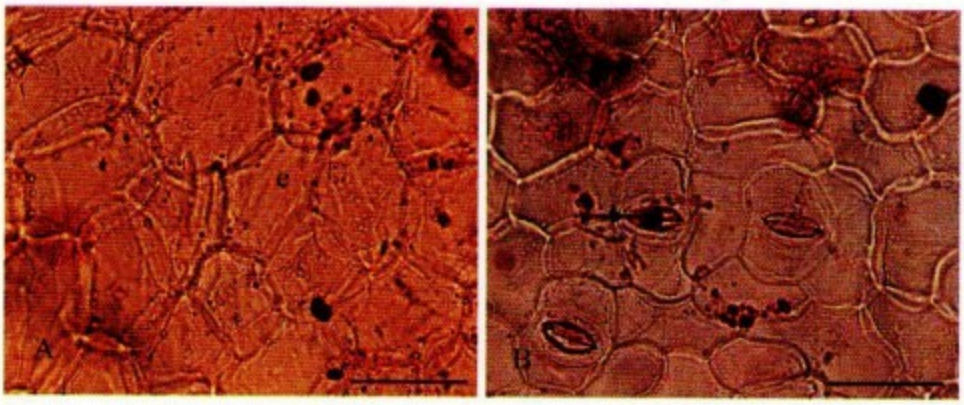

Figure 15. Upper (A) and lower (B) leaf surface of *R.. vivipara.* e: epidermis and stomata showed by arrow. Bar 50 µm.

CONCLUSION

The three genera of Araceae have a difference in the epidermis. *Alocasia* and *Colocasia* have stomata on both leaf surfaces (amphistomatic) but *Remusatia* has stomata only limited on the lower surface. The three genera can be distinguished from epidermal cell shape, stomata complex and the presence of stomata.

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APPENDIX

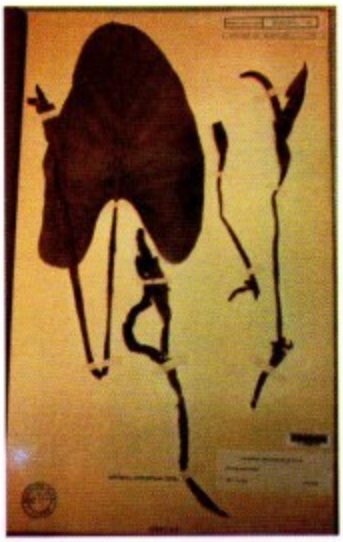

Plate 1. *Alocasia alba*

Plate 2. *A. brancifolia*

Plate 3. *A. flemingiana*

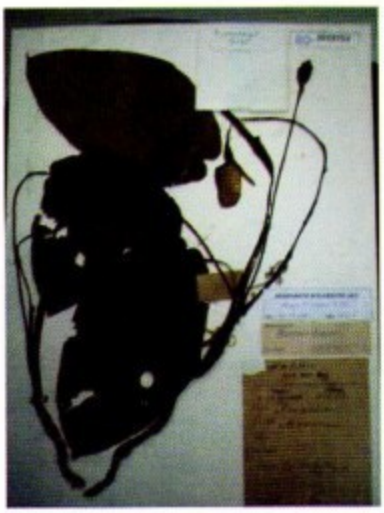

Plate 4. *A. kerinciensis*

Plate 5. *A. lancifolia*

Plate 6. *A. longiloba*

Plate 7. *A. macrorrhizos*

Plate 8a. *A. megawatiae* (daun)

Plate 8b. *A. megawatiae* (bunga)

Plate 9. *A. nicolsonii*

Plate 10. *A. puber*

Plate 11. *A. pyrospatha*

Plate 12. *A. suhirmaniana*

Plate 13. *Colocasia esculenta*

Plate 14. *C. gigantea*

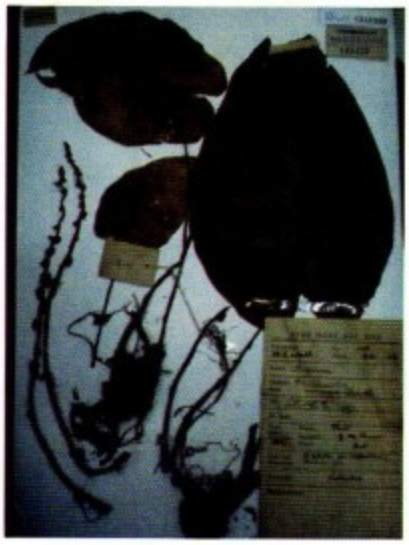

Plate 15. *Remusatia vivipara*

Table 1. Leaf surface of three genera of Araceae

Name of Species	Stomata type	Subsidiary cell number	Stomata distribution	Upper anticlinal epidermal cell wall	Upper epidermal shape	Lower anticlinal epidermal cell wall	Lower epidermal shape	trichome presence
Alocasia alba	tetracytic	4	amphistomatous	straight	pentagonal-polygonal	straight	pentagonal-polygonal	-
A. brancifolia	tetracytic	4 – 5	amphistomatous	straight-slightly wavy	polygonal	straight	polygonal	-
A. flemingiana	paracytic, tetracytic or anomocytic	2 – 5	amphistomatous	straight-wavy	polygonal	straight- wavy	polygonal	-
A. kerinciensis	paracytic	2	hypostomatous	straight-slightly wavy	polygonal	straight-slightly wavy	polygonal	-
A. lancifolia	tetracytic or anomocytic	4 – 6	amphistomatous	sinuous	irregular	sinuous	irregular	-
A. longiloba	tetracytic	4	amphistomatous	straight	polygonal	straight	polygonal	-
A. macrorhizos	tetracytic	4	amphistomatous	straight	polygonal	straight	polygonal	-
A. megawatiae	paracytic or tetracytic	2 – 4	amphistomatous	sinuous	irregular	sinuous	irregular	-
A. nicolsonii	paracytic	2	amphistomatous	straight	polygonal	straight	polygonal	-
A. puber	paracytic	2	hypostomatous	straight	polygonal	straight	polygonal	+
A. pyrospatha	paracytic or tetracytic		hypostomatous	straight-slightly wavy	irregular	straight-undulate	irregular	-
A. suhirmaniana	tetracytic	4	amphistomatous	sinuous	irregular	sinuous	irregular	-
Colocasia esculenta	tetracytic	4	amphistomatous	straight	polygonal	straight	polygonal	-
C. gigantea	tetracytic	4	amphistomatous	straight	polygonal	straight	polygonal	-
Remusatia vivipara	tetracytic	4	hyphostomatous	straight	polygonal	straight-undulate	polygonal	-