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Comparative Leaf Blade Anatomy of Selected Philippine Melastomataceae

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ABSTRACT

Transverse sections of leaf blade of seven species of Melastomataceae, representing four genera, namely, *Astronia*, *Dissochaeta*, *Medinilla*, and *Melastoma* were analyzed. Similarities and differences among the species were observed in terms of the presence of adaxial hypodermis as well as the number of cell layers in palisade and spongy mesophyll. Except for *Dissochaeta acmura*, all species exhibit a hypodermis occurring below the upper epidermis, and among the species having this specialized tissue, the number of cell layers varies. Sclerified palisade mesophyll was observed in *Medinilla annulata*, *M. inaequifolia*, and *M. merrittii*. These non-epiphytic species of *Medinilla* differ from previously studied epiphytic *Medinilla* in having thinner hypodermis and abundant air spaces in the spongy mesophyll. Candelabra hairs were observed in *D. acmura* while shaggy hairs were observed in *M. inaequifolia* and *Melastoma malabathricum*. No hairs were found in the leaf blades of the other four species. These anatomical characters contribute to the available baseline information needed for understanding diversity of Family Melastomataceae.

Keywords: *Astronia*, *Dissochaeta*, *Medinilla*, *Melastoma*, sclerified mesophyll, hypodermis, candelabra hairs

INTRODUCTION

Melastomataceae are a tropical family of shrubs, herbs, trees, and lianas including 188 genera and about 4,950 species (Simpson, 2013). The family is represented by 19 genera in the Philippine archipelago (Merrill, 1923) prior to revisions and recognitions of synonymy in some genera (Clausing, 2000; Maxwell and Veldkamp, 1990; Meyer, 2001; Regalado, 1995; Veldkamp, 1978) and new records. With these considered, the family is represented by 16 genera in the archipelago.

Plant anatomy is useful in plant taxonomy and studying adaptations of plants to their environment. Among species of *Ficus*, leaf anatomy provided useful characters for classification (Sonibare, Jayeola, & Egunyomi, 2006). In Family Pandanaceae, the genera *Sararanga*, *Pandanus* and *Freycinetia* can be distinguished at the generic level using leaf characters such as the hypodermis, presence or absence of papillae, stomatal arrangement, and bundle sheath extension (Santika, 2014). Anatomical features of plants can also provide better understanding with regards to their major adaptive shifts associated with selective pressures (Simpson, 2013).

Anatomical features of the leaves of several taxa of Melastomataceae were mentioned by Metcalfe and Chalk (1950). Multiple epidermis and trichomes of various types were recorded in different genera. Hypodermis is commonly found in several genera including *Astronia* and *Medinilla*. Ant domatia were known to be present in *Myrmidone* and *Tococa*. The palisade mesophyll consists of 1-3 layers of cell, and "sclerosed" cells in this layer were found in *Medinilla* species. In certain genera various types of sclerenchyma cells are present and in some taxa, these cells have diagnostic value. Clustered crystals commonly occur in the family, and sometimes, large crystals appear as transparent dots in the mesophyll. Styloids occur in some genera including *Astronia*, *Beccarianthus*, and *Pternandra*.

Mentink and Baas (1992) surveyed the leaf anatomy of 151 genera of Melastomataceae (including Memecylaceae and Crypteroniaceae) and concluded that the family is very heterogeneous in that aspect. It was also pointed out that the heterogeneity in terms of leaf anatomy among the members of subfamily Melastomatoideae does not support tribal classifications.

Marques et al. (2000) studied the leaf anatomy of two species of *Miconia* and associated the observed features to their environment. Somavilla and Graciano-Ribeiro (2011) described the leaf blade anatomy of *Lavoisiera bergii*, *Macairea*

radula, and *Trembleya parviflora*. Anatomical features including sclerophylly were observed in these three species of Melastomataceae.

Recent anatomical studies emphasized on the epiphytic adaptations of some members of this family. Reginato et al. (2009) compared the anatomy of roots, stems, and leaves of three epiphytic species of *Pleiochiton* and a species of *Clidemia*. The leaves of the four species were found to have water-storing hypodermis occupying about 50% of the volume of the organ. Compact spongy mesophyll was also observed. Rayos and Hadsall (2016) described the anatomy of the leaf blades of four epiphytic *Medinilla* species and highlighted the features that are associated with epiphytism. These features include thick hypodermis and compact spongy mesophyll which were also observed in *Pleiochiton* and *Clidemia*.

OBJECTIVES OF THE STUDY

This study aimed to compare and analyze the anatomical characteristics of the leaves of selected species of Philippine Melastomataceae. Specifically, the study aimed to relate these anatomical features with the evolutionary response of these plants to the environment. The results of this study will contribute to the existing knowledge about the diversity of this family.

METHODOLOGY

Fresh leaf samples of seven species of Melastomataceae representing four genera (*Astronia*, *Dissochaeta*, *Medinilla*, and *Melastoma*) were collected. *Astronia candolleana* Cogn. and *A. rolfei* S. Vidal were collected from Mt. Makiling. *Dissochaeta acmura* Stapf & M.L. Green, *Medinilla annulata* C.B. Rob., *M. inaequifolia* C.B. Rob., *M. merrittii* Merr., and *Melastoma malabathtricum* (L.) Smith, were obtained from UP Land Grant. The collection of specimens from Mt. Makiling was done with permit granted by Makiling Center for Mountain Ecosystems (MCME) while the collection of specimens from UP Land Grant (Laguna-Quezon) was permitted by UPLB Land Grant Management Office.

For each species, a rectangular portion (about 3 x 5 mm) of the mature leaf including the midrib was cut. These were fixed in formalin-acetic acid-ethyl alcohol (FAA) solution for 24 hours. The fixed samples were used for preparing leaf cross sections with paraffin method following Jensen (1962). The prepared slides were observed under light microscope and then photographed.

RESULTS AND DISCUSSION

Microscopic observations revealed diversity in leaf anatomy among the seven species of Melastomataceae. Figure 1A and 1B show the transverse sections of leaf blades of *Astronia candolleana* and *A. rolfei* showing the hypodermis located between upper epidermis and palisade mesophyll. In *A. candolleana*, the palisade mesophyll has 2-3 layers of non-sclerified cells while *A. rolfei* has only one. In both species, the spongy mesophyll has 9-10 layers of loosely arranged parenchyma cells with some of the cells containing druse crystals.

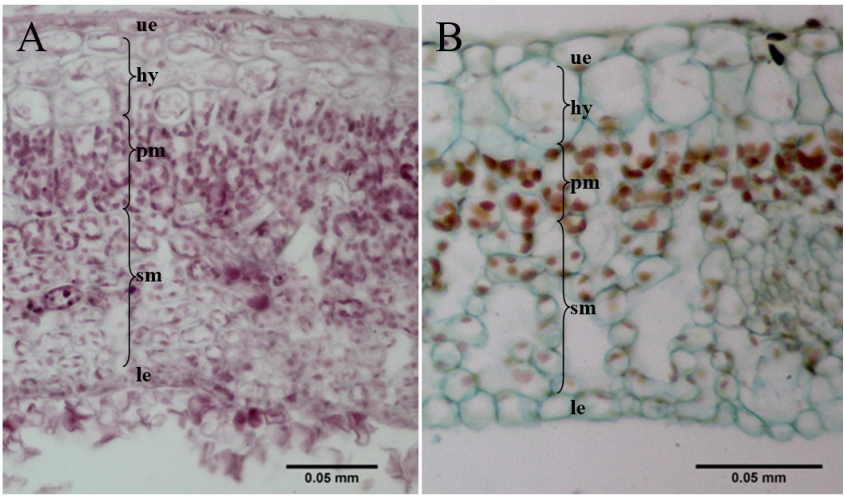

Figure 1. Transverse sections of leaf blades of (A) *Astronia candolleana* and (B) *A. rolfei*, showing the upper epidermis (ue), hypodermis (hy), palisade mesophyll (pm), spongy mesophyll (sm), and lower epidermis (le).

Figure 2A shows the leaf cross section of *Dissochaeta acmura* with uniseriate upper and lower layers of epidermis. Two layers of cells comprise the palisade mesophyll while the spongy mesophyll has 4-5 layers of loosely arranged cells. Druse crystals are also present in this layer.

Candelabra hairs were observed in the lower epidermis of *D. acmura* (Figure 2B). This type of non-glandular trichomes was also reported to occur in other genera (*Dichaetanthera*, *Dissotis*, *Kibessia*, *Marumia*, *Meriania,* & *Omphalopus*) of Melastomataceae (Metcalfe & Chalk, 1950). Trichomes may have taxonomic significance since they are usually of a distinctive type within a species (Cutter, 1969).

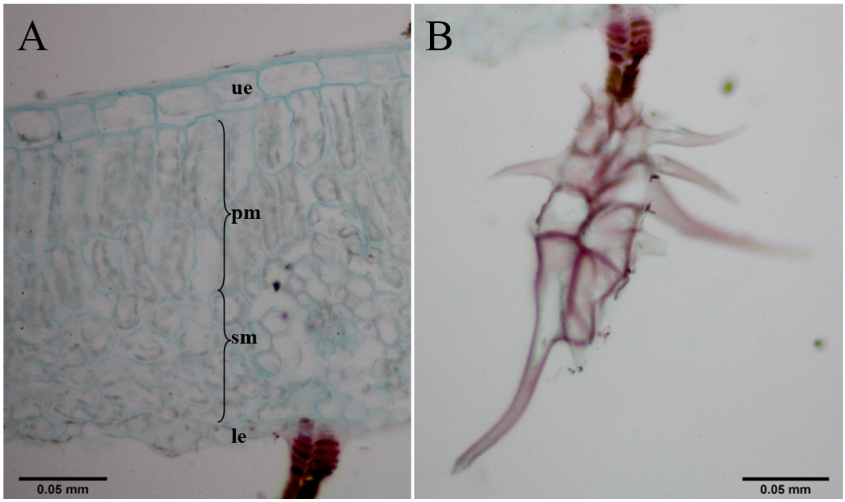

Figure 2. Transverse section of leaf blade of *Dissochaeta acmura* showing the single layer of cells comprising the upper epidermis (ue), two layers of palisade mesophyll (pm), spongy mesophyll (sm), and lower epidermis (le) in A; and a candelabra hair in B.

Three species of *Medinilla* were considered in this study, and their anatomical features are shown in Figure 3. The figure shows that the three species have adaxial hypodermis with 2-3 layers of cells and one-layered palisade mesophyll with "sclerosed" cells (Metcalfe & Chalk, 1950). The number of cell layers in the spongy mesophyll was found to be varying among the three species: 4-5 in *M. inaequifolia*, 7-8 in *M. annulata*, and 9-10 in *M. merrittii*. These species of *Medinilla* are not epiphytic unlike the species (*M. magnifica*, *M. miniata*, *M. pendula*, & *M. teysmannii*) previously studied by Rayos and Hadsall (2016). Significant differences between the epiphytic and non-epiphytic species were observed. The previously studied epiphytic species have very thick water-storing hypodermis tissues that comprise either half or more than half the thickness of the entire lamina. This feature allows them to store high amount of water in their leaves. The three non-epiphytic species in the current study have thinner hypodermis comprising less than half the thickness of the lamina. Since these species are not regularly subjected to water shortage unlike the epiphytic species, they do not need to have thick hypodermis. In the spongy mesophyll of the epiphytic species, the cells are closely packed (allowing them to prevent rapid water loss) unlike in the spongy mesophyll of the non-epiphytic species where

air spaces are abundant. The lacunose structure of mesophyll allows a thorough gas exchange between the environment and the chlorenchyma cells (Esau, 1953). Like the four previously studied epiphytic species, these three species of *Medinilla* have druse crystals.

Non-glandular shaggy hairs were observed in *M. inaequifolia* as shown in Figure 3C. This type of trichome was seen in species of *Tibouchina* (Metcalfe and Chalk, 1950).

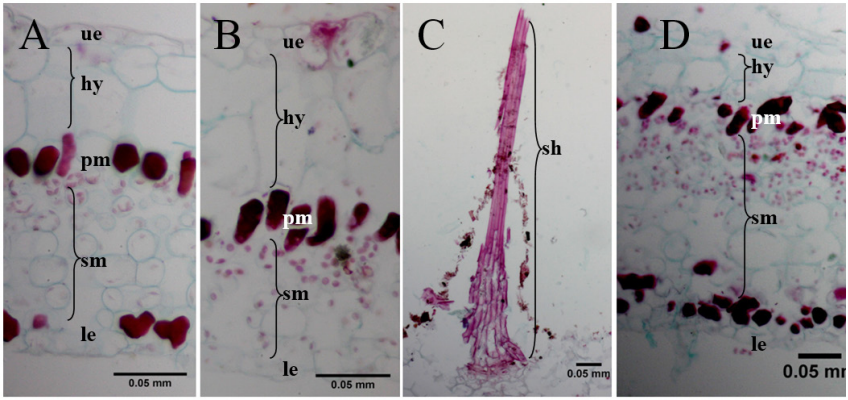

Figure 3. Transverse sections of leaf blades of (A) *Medinilla annulata*, (B, C) *M.inaequifolia*, and (D) *M. merrittii*, showing the single layer of cells comprising the upper epidermis (ue), hypodermis (hy) consisting of two layers of parenchymatous cells, sclerified palisade mesophyll (pm), spongy mesophyll (sm), lower epidermis (le), and a shaggy hair (sh).

Transverse sections of leaf blade in *Melastoma malabathricum* showed a hypodermis consisting of 2-3 layers of parenchymatous cells. This is the first record of a hypodermis existing in a species of *Melastoma*. The palisade mesophyll is one-layered while the spongy mesophyll has 4-5 layers of loosely arranged cells (Figure 4A).

Shaggy hairs were observed as shown in Figure 4B. Haron and Veeramohan (2015) showed this type of hair in this same species as viewed in the surface (not in cross section).

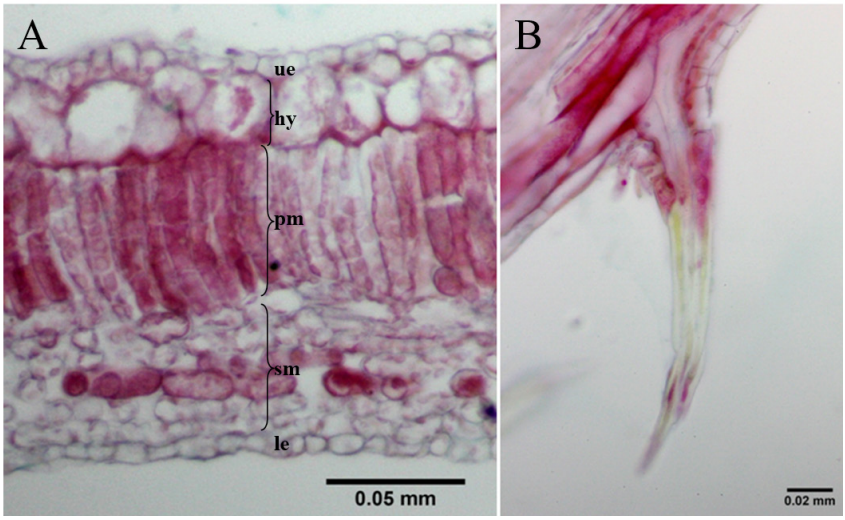

Figure 4. Transverse section of the leaf blade of *Melastoma malabathricum* showing upper epidermis (ue), hypodermis (hy), palisade mesophyll (pm), spongy mesophyll (sm), and lower epidermis (le) in A; and a shaggy hair in B.

Anatomical characteristics of the lamina of the seven species examined in this study are summarized in Table 1.

Table 1. Comparison of anatomical features of the leaf blades of seven species of Melastomataceae considered in this study.

Species	Hypodermis	Palisade Mesophyll	Spongy Mesophyll
Astronia candolleana Cogn.	present; 2-3 cell layers	2-3 cell layers; without sclerified cells	9-10 cell layers; loosely arranged
Astronia rolfei S. Vidal	present; 1-2 cell layers	1 cell layer; without sclerified cells	9-10 cell layers; loosely arranged
Dissochaeta acmura Stapf & M.L. Green	absent	2 cell layers; without sclerified cells	4-5 cell layers; loosely arranged
Medinilla annulata C.B. Rob.	present; 2-3 cell layers	1 cell layer; with sclerified cells	7-8 cell layers; loosely arranged
Medinilla inaequifolia C.B. Rob.	present; 2-3 cell layers	1 cell layer; with sclerified cells	4-5 cell layers; loosely arranged
Medinilla merrittii Merr.	present; 2-3 cell layers	1 cell layer; with sclerified cells	9-10 cell layers; loosely arranged
Melastoma malabathricum (L.) Smith	present; 2-3 cell layers	1 cell layer; without sclerified cells	4-5 cell layers; loosely arranged

Druse crystals which are described as "spheroidal aggregates of prysmatic crystals" (Fahn, 1990) are present in all species studied. These crystals function for calcium regulation and defense against herbivores (Franceschi & Nakata,

2005). Druse crystals can also increase photosynthetic efficiency by collecting and dispersing light to the surrounding chloroplasts (Horner, 2012). In some cases, plant crystals can offer structural support similar to hardening of cell wall (Webb, 1999).

All species except for *Dissochaeta acmura* have adaxial hypodermis. The same feature was also observed in epiphytic species of *Medinilla* (*M. magnifica*, *M. miniata*, *M. pendula*, & *M. teysmannii*) (Rayos & Hadsall, 2016). The hypodermis is reported to store water in mangroves (Baylis, 1940; Saenger, 2002) and limit uncontrolled transpiration in pines (Larcher, 1995). These non-epiphytic species of Melastomataceae are still subjected to water shortage during dry season while epiphytes encounter this problem even during wet season. Thus the presence of hypodermis still gives them advantage.

CONCLUSION

Diversity among representative species of Philippine Melastomataceae was observed in terms of presence of hypodermis and number of cell layers in the palisade and spongy layers. Druse crystals functioning for calcium regulation, defense against herbivores, increasing photosynthetic efficiency, and structural support were observed in all species. All species except for *Dissochaeta acmura* have hypodermis that helps them survive during dry season. This study included only a small fraction of the Melastomataceae in the Philippine archipelago, so it is recommended that more species will be collected and considered for anatomical studies.

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