Comparative Anatomy of Leaves and Spathes of Dayflowers (*Commelina*: Commelinaceae)

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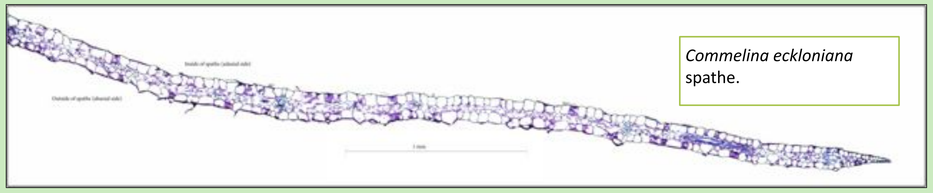

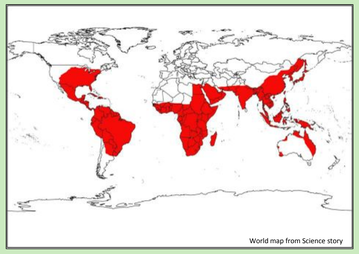

Figure 1. The global distribution of Commelinaceae and *Commelina.*

Background Information

Commelinaceae, commonly known as the dayflowers or spiderworts, is a diverse family of plants with 41 genera and approximately 650 species. Commelinaceae are found worldwide, in a great variety of habitats, but especially in the tropics (Figure 1). The largest genus in the family is *Commelina*, which has approximately 170 species (Faden, 1998). *Commelina* species possess several characteristics that make them easily recognizable. Most have leaves that unroll like a scroll. They also have modified leaves called spathes that enclose the inflorescences, or flower clusters, and the fruits (see Figure 2-4).

Purpose

This project addresses one main question: how do leaves and spathes differ anatomically in the genus *Commelina*? To answer this question anatomical characteristics of the leaves and spathes in seven species of *Commelina* were studied. Although both are green, leaves and spathes have different functions: leaves make food for the plant and spathes provide protection for the flower buds and developing fruits. We predict that since spathes have a different function from leaves, they will have significantly different anatomical characteristics. Since spathes provide important characters for recognizing and distinguishing different species of *Commelina,* we hypothesize that new traits will be found that may be taxonomically useful.

Figure 2. *Commelina merkeri* leaf and spathe.

Figure 3

Figure 4

Figure 3 & 4. Spathe of *Commelina zambesica*. Figure 3 shows a complete spathe with the flower exposed. Figure 4 shows the spathe that has been cut so the flower buds and young fruit can be seen.

Table 1. *Commelina* Collections Used

Commelina Species	Sample Collection Origin
arenicola	Somalia
eckloniana ssp. *echinosperma*	Tanzania
eckloniana ssp. *thikaensis*	Kenya
foliacea ssp. *amplexicaulis*	Tanzania
kurzii	Sri Lanka
polhilli	Tanzania
reptans	Kenya

Methods

A list of anatomical characteristics were compiled and a spreadsheet with 73 different characters was made. *Commelina* leaves and spathes were collected from the Department of Botany Research Greenhouse at the Smithsonian Institution Museum Support Center. Other specimens that were used had been collected previously and stored in 70% ethanol in the Plant Anatomy Lab. Seven species of *Commelina* were studied (see Table 1). Three types of slides were made: whole mount clearings, paradermal sections (slices taken parallel to the epidermis), and cross sections (slices taken perpendicular to the epidermis). Whole mount clearings were prepared using 5% sodium hydroxide to clear the specimens, which were then stained with Safranin O/Celestine Blue B. For paradermal and cross sections specimens were subdivided into five millimeter pieces, were infiltrated and then embedded in wax. A rotary microtome was used to section the embedded specimens. The sections were cut at a thickness of 5-7 microns, stained and mounted on 3”x2”slides. Sections were stained using buffered Toluidine Blue O. These permanent slides were extensively studied under a Zeiss Universal light microscope using bright-field, phase contrast, Nomarski DIC, and polarized light. The specimens were photographed so their anatomical characteristics could be recorded on the spreadsheet.

Anatomical characters studied

In analyzing the anatomical characteristics the main resource used was Tomlinson (1966). Following are a few of the anatomical characters analyzed in this study:

Margins

There are three types of margins: rounded, tapered, and intermediate (Figures 5-7). All three margin images are of spathes.

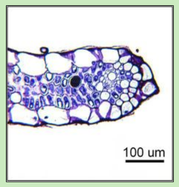

Figure 5. *Commelina reptans.*

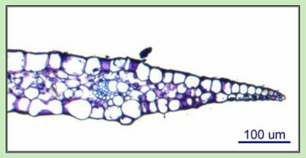

Figure 6. *Commelina eckloniana* ssp. *thikaensis.*

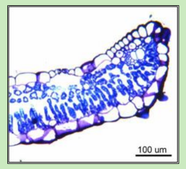

Figure 7. *Commelina foliacea* ssp. *amplexicaulis.*

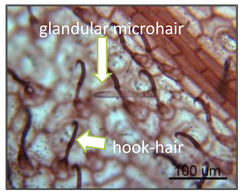

Figure 8. *Commelina eckloniana* leaf. Glandular microhair and hook-hairs.

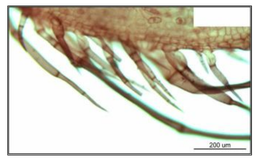

Figure 9. *Commelina polhillii* spathe. Marginal uniseriate hairs.

Anatomical characters (continued)

Types of hairs present

Hairs are thought to protect the leaves and spathes in *Commelina*. Following is a list of the hair types found:

Glandular microhairs – These are 3-celled with a rounded terminal cell and may slightly look deflated.

Uniseriate hairs – these are 2- to several-celled hairs and have a pointed terminal cell.

Hook-hairs – These are 2- to several-celled and have a terminal cell in the shape of a hook.

Prickle hairs – These are short, 2-celled and have a pointed terminal cell.

Papillae – These are terminally rounded and are just 1-celled.

A new hair type – It is most commonly 2-celled (sometimes 3-celled) and has a terminal cell that is rounded.

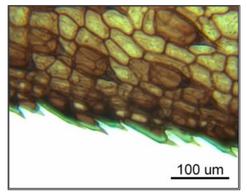

Figure 10. *Commelina eckloniana* ssp. *thikaensis* leaf. Marginal prickle hairs.

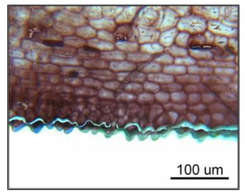

Figure 11. *Commelina eckloniana* ssp. *thikaensis* leaf. Marginal papillae.

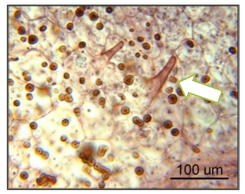

Figure 12. *Commelina arenicola* spathe. New hair type (arrow).

Hypodermis

This is a tissue composed of large, thin-walled cells found beneath the upper epidermis. It can be lacking, confined to the midvein area, appear in patches throughout the lamina (leaf blade), or form a continuous layer throughout the lamina. Figure 13 shows two cell layers of hypodermis just under the epidermis around a vein in the leaf.

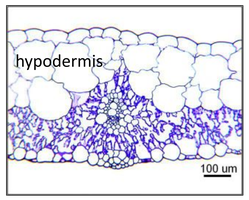

Figure 13. *Commelina* polhillii leaf.

Palisade layer

This layer consists of cylindrical cells just under the epidermis that are elongated at right angles to the flat surface of the leaf or spathe (Figure 14). These are the main food-making cells of the leaf.

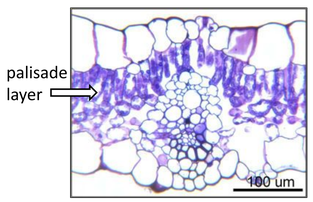

Figure 14. *Commelina* eckloniana leaf.

Table 2. Anatomical Characteristics of Seven Species of *Commelina*. X equals presence of a character; --- equals absence of a character; 1 equals confined to central lamina; 2 equals throughout the lamina

Commelina Species		Margin form	Hook Hairs	Palisade layer	Hypodermis	Uniseriate hairs	Prickle Hair
arenicola	Leaf	rounded	---	X	1	---	---
	Spathe	rounded	---	---	---	---	---
eckloniana ssp. *echinosperma*	Leaf	intermediate	X	X	1	---	X
	Spathe	tapered	X	X	---	---	---
eckloniana ssp. *thikaensis*	Leaf	rounded	X	X	1	---	X
	Spathe	tapered	X	---	---	---	---
foliacea ssp. *amplexicaulis*	Leaf	intermediate	---	X	1	---	X
	Spathe	intermediate	---	X	1	X	X
kurzii	Leaf	rounded	X	X	1	X	X
	Spathe	tapered	X	---	1	X	---
polhillii	Leaf	rounded	---	X	2	X	---
	Spathe	rounded	---	X	1	---	---
reptans	Leaf	rounded	---	X	2	---	---
	Spathe	rounded	---	---	---	X	---

Results and Discussion

Some of the data collected on the different anatomical characters of the leaves and spathes of seven species of *Commelina* can be found in Table 2. From the data collected it can be seen that there is a strong correlation between the presence (or absence) of hook-hairs on the leaves and spathes of the same species. The palisade layer and the hypodermis are present in the leaves, but are not always present in the spathes. The leaf possesses a more defined palisade layer than the spathe, in which the palisade may be lacking altogether, and from this observation we may conclude the leaf is more efficient in photosynthesis than the spathe. Prickle hairs and papillae were found only on leaf margins, except in *C. foliacea* ssp. *amplexicaulis* where they were also found on the spathe margins. From this study we conclude that leaves and spathes are similar in some anatomical features, but the spathes lack some characters that the leaves possess. In all the species studied the spathes differed from the leaves in their anatomy. Too few species were studied to conclude whether leaf and spathe anatomy can useful taxonomically.

Future directions

From this study it is evident that future research should incorporate more species. This will add much more data to the study and perhaps, from those results, some generalizations can be made to further identify and classify *Commelina*. Since the collections used in this study reflect a wide range of differing habitats, a question should be added about how the different habitats relate to the great diversity observed in the anatomy of the leaves and spathes. Evolutionary relationships can be explored through this project. Since some spathes possess a palisade layer and others do not, how did this occurrence result through evolution? Did the palisade layer on the adaxial surface of the leaves not develop in some spathes, because the surface inside the closed spathe may lack sufficient light? If a leaf possesses multiple palisade layers, does that determine whether or not a spathe has a palisade layer? From generalizations that can be made by compiling a large sampling of *Commelina* species, many of the questions above can be resolved along with other questions that have yet to be asked. Hopefully through extensive study *Commelina* species can be more easily identified and their relationships and evolution better understood.

Acknowledgements

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