



# Leaf epidermal anatomy of some aquatic plants in Chiang Mai University



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## Abstract

This study aims to study leaf epidermal tissue of 17 species of aquatic plants in Chiang Mai University, including *Echinodorus cordifolius* (L.) Griseb, *Hydrocotyle umbellata* L., *Pistia stratiotes* L., *Colocasia esculenta* (L.) Schott, *Lasia spinosa* (L.) Thwaites, *Canna indica* L., *Ipomoea aquatica* Forsk., *Cyperus involucreatus* Roxb., *Hydrilla verticillata* (L.f.) Royle, *Thalia geniculata* L., *Marsilea crenata* C. Presl, *Nelumbo nucifera* Gaertn., *Nymphaea capensis* Thunb., *Bacopa caroliniana* (Walt.) B.L. Robins, *Eichhornia crassipes* (Mart.) Solms, *Salvinia cucullata* Roxb. ex Bory and *Salvinia molesta* D.S.Mitch. Five leaves per species were collected, bleached with 3% sodium hypochlorite, and stained with 0.1% Toluidine blue. Leaf epidermal tissue was studied under the compound microscope. The results showed that the epidermal cells were 5 different shapes: rectangular, graminous, irregular, isodiametric, and polygonal. Five types of stomata, including actinocytic, anisocytic, anomocytic, diacytic, and paracytic were observed. Two types of trichomes, unicellular and multicellular were found. Also, six types of crystals were found, namely acicular, plate, prism, raphide, rod, and rosette, respectively. The length of guard cells and stomatal index were different depending on plant species.

## Introduction

Aquatic plants are commonly found in water sources or waterlogged areas. They are just as important as terrestrial plants, offering numerous benefits. In terms of environmental benefits[1], they help purify and improve water quality, increase oxygen levels in the water, and reduce bank erosion. For aquatic animals, they serve as a food source and habitat. For humans[2], they are used in cooking and as herbal remedies. Additionally, they can be used as economic resources for processing and export. Efficient utilization of aquatic plants in these various aspects is crucial.

Aquatic plant epidermal tissue is vital for gas exchange, water and nutrient uptake, and UV protection. Adaptations like changes in cell shape and stomatal characteristics indicate environmental adjustments.

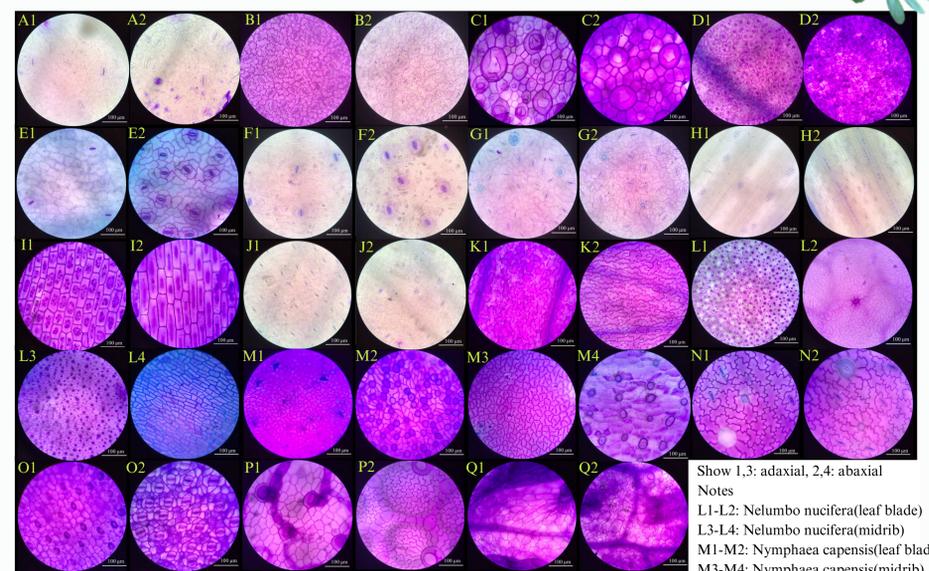
### Objective

To study the anatomical characteristics of leaf epidermal cells of some aquatic plants found in Chiang Mai University.

To determine the epidermal density, stomatal density and stomatal index of some aquatic plants found in Chiang Mai University.



## Results



A: *Echinodorus cordifolius* (L.) Griseb, B: *Hydrocotyle umbellata* L., C: *Pistia stratiotes* L., D: *Colocasia esculenta* (L.) Schott, E: *Lasia spinosa* (L.) Thwaites, F: *Canna indica* L., G: *Ipomoea aquatica* Forsk., H: *Cyperus involucreatus* Roxb., I: *Hydrilla verticillata* (L.f.) Royle, J: *Thalia geniculata* L., K: *Marsilea crenata* C. Presl, L: *Nelumbo nucifera* Gaertn., M: *Nymphaea capensis* Thunb, N: *Bacopa caroliniana* (Walt.) B.L. Robins, O: *Eichhornia crassipes* (Mart.) Solms, P: *Salvinia cucullata* Roxb. ex Bory, Q: *Salvinia molesta* D.S.Mitch.

## Materials and Methods

1 Explore plants in the area

- Ang Kaew Reservoir
- Palm park
- Department of Biology

2 Collect plant specimens

Collect 5 leaf samples per plant species, from separate individuals.



Soaked in 3% sodium hypochlorite. Until the leaf becomes translucent.

Preserve plant tissue specimens by submerging them in 70% ethanol in a tightly sealed vessel.

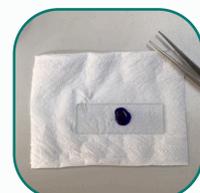
4 Data collection

- Type of epidermal and number of epidermal cells
- Type of trichome
- With or without glands
- Type of stomatal, the length of guard cells and number of stomatal cells

5 Calculation

$$\text{Stomatal index (\%)} = \frac{\text{Stomatal density}}{\text{Stomatal density} + \text{Epidermal density}} \times 100$$

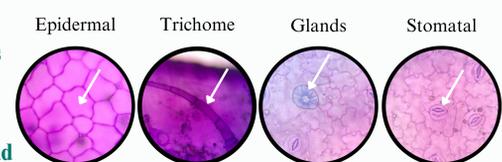
3 Microscopic examination



Cut the cleared tissue into small pieces and stain with 0.1% toluidine blue.



Observe under a compound microscope, examine the abaxial (lower) and adaxial (upper) leaf surfaces, take photographs, and record data.



scientific name	Stomata type	Stomatal arrangement	Epidermal cell shape	Stomatal location		Trichome		Gland		Crystals
				Adaxial surface	Abaxial surface	Adaxial surface	Abaxial surface	Adaxial surface	Abaxial surface	
<i>Echinodorus cordifolius</i>	paracy.	rand. dist.	irreg.	/	/	-	-	-	-	Rod, Plate, Prism
<i>Hydrocotyle umbellata</i>	paracy., aniso.	rand. dist.	irreg.	/	/	-	-	-	-	Plate, Prism, Rosette
<i>Pistia stratiotes</i>	anomo.	rand. dist.	polyg.	/	/	multicell.	unicell.	-	-	Rosette, Raphide, Rod, Plate
<i>Colocasia esculenta</i>	anomo.	rand. dist.	polyg.	/	/	unicell.	unicell.	-	-	Rosette, Raphide
<i>Lasia spinosa</i>	paracy.	rand. dist.	irreg.	/	/	-	-	-	-	Rosette, Plate, Prism
<i>Canna indica</i>	paracy.	par. vein	isodiam.	/	/	-	-	-	-	Rod, Prism, Plate
<i>Ipomoea aquatica</i>	paracy.	rand. dist.	irreg.	/	/	-	-	/	/	Rosette, Plate, Rod, Prism
<i>Cyperus involucreatus</i>	gramine.	par. vein	gram.	/	/	unicell.	unicell.	-	-	-
<i>Hydrilla verticillata</i>	-	-	rect.	-	-	unicell.	unicell.	-	-	Acicular, Rod, Plate, Rosette
<i>Thalia geniculata</i>	paracy.	par. vein	irreg.	/	/	-	-	-	-	Rod, Plate
<i>Marsilea crenata</i>	aniso., diacy.	par. vein	irreg.	/	/	-	-	-	-	-
<i>Nelumbo nucifera</i>	actino.	rand. dist.	polyg., irreg.	/	/	unicell.	-	-	-	Rosette, Prism, Plate
	actino.	rand. dist.	polyg.	/	-	unicell.	-	-	/	Rosette
<i>Nymphaea capensis</i>	actino.	rand. dist.	irreg., polyg.	/	-	unicell.	-	-	-	Rod, Plate
	-	-	irreg., polyg.	-	-	unicell.	-	-	-	Acicular
<i>Bacopa caroliniana</i>	aniso., diacy.	par. vein	irreg.	/	/	-	-	/	/	Plate, Rosette, Rod
<i>Eichhornia crassipes</i>	paracy.	par. vein	isodiam.	/	/	-	-	-	-	Raphide
<i>Salvinia cucullata</i>	anomo.	rand. dist.	irreg.	/	-	multicell.	multicell.	-	-	-
<i>Salvinia molesta</i>	aniso.	rand. dist.	irreg.	/	-	multicell.	multicell.	-	-	Rosette

Table 1: Anatomical characteristics of 17 aquatic plant species.

Stomata type: actinocytic (actino.), anisocytic (aniso.), anomocytic (anomo.), diacytic (diacy.), paracytic (paracy.) gramineous (gramine.) stomatal arrangement; random distribution (rand. dist.), arranged parallel to leaf venation (par. vein) epidermal cell shape; rectangular (rect.), graminous (gram.), irregular (irreg.), isodiametric (isodiam.), polygonal (polyg.) Trichome; unicellular trichome (unicell.), multicellular trichome (multicell.)

ชื่อวิทยาศาสตร์	Epidermal density		Stomatal density		Stomatal index (%)		Guard cell length	
	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
<i>Echinodorus cordifolius</i>	374.115 - 442.702	367.880 - 554.940	31.176 - 49.882	43.647 - 81.058	7.7 - 10.1	10.1 - 12.7	47.0 ± 1.6	45.8 ± 1.8
<i>Hydrocotyle umbellata</i>	1415.400 - 1677.281	978.93 - 1165.99	299.292 - 336.703	124.705 - 249.410	16.7 - 19.1	11.3 - 17.6	24.8 ± 0.7	26.3 ± 0.9
<i>Pistia stratiotes</i>	536.231 - 735.759	342.938 - 611.054	143.411 - 286.821	37.411 - 99.764	20.7 - 28.9	8.1 - 15.2	17.8 ± 0.8	22.0 ± 1.0
<i>Colocasia esculenta</i>	1371.754 - 1720.927	1415.400 - 1895.514	124.705 - 162.116	37.411 - 87.293	6.7 - 8.6	1.9 - 5.6	20.0 ± 0.8	20.3 ± 1.0
<i>Lasia spinosa</i>	579.878 - 704.583	567.407 - 748.229	12.470 - 24.941	87.293 - 99.764	1.8 - 4.1	11.1 - 13.3	37.5 ± 0.8	38.8 ± 0.7
<i>Canna indica</i>	486.349 - 567.407	505.055 - 704.583	18.706 - 24.941	56.117 - 68.588	3.2 - 4.9	8.1 - 10.0	44.0 ± 1.5	36.8 ± 1.2
<i>Ipomoea aquatica</i>	847.993 - 972.698	766.935 - 960.228	99.764 - 149.646	137.175 - 280.586	9.7 - 14.5	12.5 - 24.4	28.8 ± 0.9	31.5 ± 1.0
<i>Cyperus involucreatus</i>	542.466 - 754.465	1134.814 - 1477.753	31.176 - 49.882	261.880 - 311.762	4.0 - 8.0	15.7 - 20.4	39.3 ± 1.2	34.8 ± 0.9
<i>Hydrilla verticillata</i>	268.116 - 342.938	324.233 - 455.173	-	-	-	-	-	-
<i>Thalia geniculata</i>	1328.107 - 1671.045	1016.345 - 1178.461	137.175 - 205.763	31.176 - 74.823	9.1 - 11.6	2.7 - 6.1	29.5 ± 0.5	32.0 ± 1.0
<i>Marsilea crenata</i>	536.231 - 604.819	598.583 - 723.288	87.293 - 137.175	137.175 - 205.763	13.3 - 20.4	16.9 - 22.1	27.5 ± 0.7	27.8 ± 1.0
<i>Nelumbo nucifera</i>	2494.098 - 4589.140	1097.403 - 1820.691	698.347 - 1446.577	0.000 - 12.470	21.0 - 26.4	0.0 - 0.8	20.0 ± 1.6	20.8 ± 3.7
	2469.157 - 3940.674	1521.400 - 2244.688	498.820 - 648.465	-	14.1 - 18.9	-	19.3 ± 1.3	-
<i>Nymphaea capensis</i>	1671.045 - 3117.622	791.876 - 1527.635	249.410 - 405.291	-	11.5 - 14.3	-	25.5 ± 0.8	-
	1446.577 - 2119.983	573.642 - 1097.403	-	-	-	-	-	-
<i>Bacopa caroliniana</i>	230.704 - 386.585	486.349 - 529.996	12.470 - 24.941	37.411 - 56.117	3.9 - 5.1	6.9 - 9.6	47.8 ± 1.7	40.0 ± 0.9
<i>Eichhornia crassipes</i>	679.642 - 1184.696	785.641 - 1172.226	99.764 - 168.352	105.999 - 137.175	10.8 - 16.0	8.7 - 14.9	38.8 ± 1.1	37.3 ± 0.9
<i>Salvinia cucullata</i>	698.347 - 910.346	816.817 - 953.992	81.058 - 411.526	-	10.4 - 31.1	-	9.8 ± 0.6	-
<i>Salvinia molesta</i>	417.761 - 635.995	286.821 - 685.877	93.529 - 193.293	-	16.8 - 23.3	-	14.0 ± 0.8	-

Table 2: Calculated values of epidermal density, stomatal density, stomatal index, and guard cell length

## Acknowledgement

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## Conclusion

The seventeen aquatic plant species found at Chiang Mai University exhibit variations in their leaf epidermal tissue anatomy and calculated values of epidermal cell density, stomatal density, and stomatal index, depending on the species, growth habits, and habitat location. This data serves as preliminary information, necessitating further studies of aquatic plants in various water sources for comparative analysis and to establish a foundational database for future research.