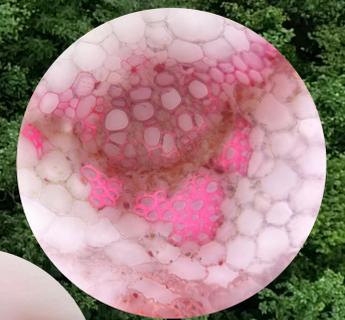
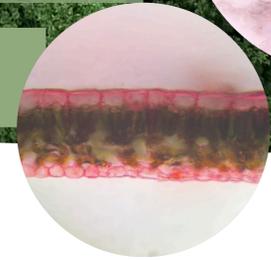




ANATOMY OF LEAF CROSS-SECTIONS OF PLANTS USED FOR FOREST RESTORATION

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Abstract

The leaf cross-section anatomy of eight plant species used for forest restoration, including *Gmelina arborea* Roxb., *Holoptelea integrifolia* Roxb. Planch., *Artocarpus lacucha* Roxb. ex Buch.-Ham., *Choerospondias axillaris*, *Elaeocarpus lanceifolius* Roxb., *Azadirachta excelsa* (Jack) Jacobs, *Diospyros glandulosa* Lace, and *Cinnamomum iners* Reinw. ex Blume, was studied to apply as a database for plant carbon storage research. The leaf samples of eight species were collected and cross-sectioned using a free-hand sectioning technique, and stained with 0.1% Safranin O. Then, leaf anatomy was examined under a compound microscope. Results showed that mesophyll thickness ranged from 0.06 to 0.23 mm, with *Elaeocarpus lanceifolius* having the highest thickness (0.23 ± 0.014 mm), while *Holoptelea integrifolia* had the lowest thickness (0.06 ± 0.007 mm). The palisade: spongy ratio varied between 0.60–0.95, with *Elaeocarpus lanceifolius* showing the highest ratio (0.95 ± 0.120) and *Cinnamomum iners* showing the lowest ratio (0.60 ± 0.082).

Introduction

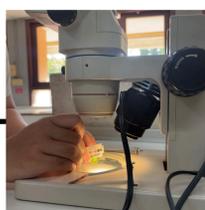
Global warming is a significant environmental crisis caused by the increase of greenhouse gases, particularly carbon dioxide. This crisis has led to rising average temperatures, more frequent and severe natural disasters, and various impacts on ecosystems. In Thailand, the average temperature has increased by approximately 1°C over the past 70 years and is expected to rise by an additional 2–4°C by 2100. Forest restoration represents an approach to mitigating global warming, as trees absorb carbon dioxide through the process of photosynthesis in their leaves. Leaves contain stomata and mesophyll (divided into palisade and spongy mesophyll) that play crucial roles in gas exchange and photosynthesis. This study examines the anatomical characteristics of leaf cross-sections from eight plant species used for forest restoration in northern Thailand. The research seeks to understand the internal leaf structures. The findings will provide an essential database for developing guidelines to select plant species with high efficiency in carbon dioxide absorption and forest restoration, contributing to sustainable mitigation of global warming.

Methods

Cross-section



The leaf samples



Cross-section



0.1% Safranin O

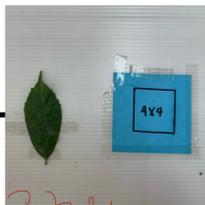


Microscopic

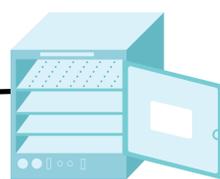
Specific Leaf Area



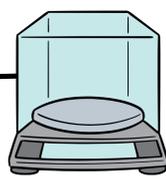
The leaf samples



Leaf area analysis



Drying oven



Analytical balance 4 digits

Acknowledgement

I would like to thank Associate Professor Dr. Arunotai Champeethong, the special problem advisor, who has always provided me with advice, training, and care. I would like to thank the special problem examination committee, Assistant Professor Dr. Suttathorn Chairuangsi and Assistant Professor Dr. Narin printrakool, for their kindness in being a member of the special problem examination committee. Finally, I would like to thank the Department of Biology, Faculty of Science, Chiang Mai University, for their budget and laboratory support.

REFERENCES

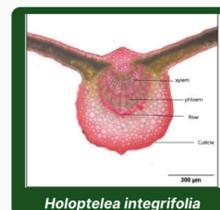
Ivanova, L. A., & P'yankov, V. I. (2002). Structural adaptation of the leaf mesophyll to shading. *Russian Journal of Plant Physiology*, 49(3), 419-431.
McMurtrie, R. E., & Dewar, R. C. (2011). Leaf-trait variation explained by the hypothesis that plants maximize their canopy carbon export over the lifespan of leaves. *Tree Physiology*, 31(10), 1007-1023.

Results

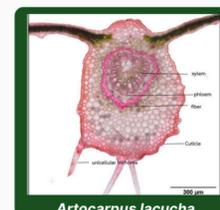
VASCULAR TISSUE SYSTEM



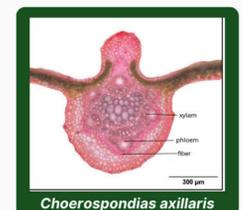
Gmelina arborea



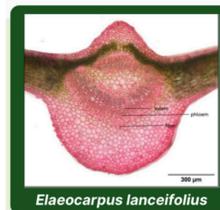
Holoptelea integrifolia



Artocarpus lacucha



Choerospondias axillaris



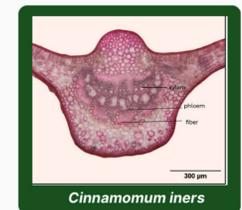
Elaeocarpus lanceifolius



Acrocarpus fraxinifolius



Diospyros glandulosa Lace



Cinnamomum iners

TRICHOME



Gmelina arborea



Holoptelea integrifolia



Artocarpus lacucha



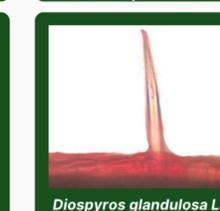
Choerospondias axillaris



Elaeocarpus lanceifolius



Acrocarpus fraxinifolius



Diospyros glandulosa Lace



Cinnamomum iners

Table 1 Comparison of Specific Leaf Area

Group	Scientific Name	SLA (cm ² /g)
High SLA	<i>Choerospondias axillaris</i>	420.30±23.97
	<i>Gmelina arborea</i>	351.80±27.44
Moderately high SLA	<i>Diospyros glandulosa</i> Lace	283.80±43.81
	<i>Artocarpus lacucha</i>	277.56±11.75
Medium SLA	<i>Acrocarpus fraxinifolius</i>	262.10±20.89
	<i>Holoptelea integrifolia</i>	261.83±26.59
Low SLA	<i>Elaeocarpus lanceifolius</i>	184.39±15.74
	<i>Cinnamomum iners</i> Reinw	133.56±7.93

Table 2 Comparison of the thickness of Mesophyll, palisade, and spongy layers (in millimeters) and the ratio between palisade and spongy layers

Scientific Name	Mesophyll	Palisade	Spongy	Palisade/Spongy
<i>Gmelina arborea</i>	0.084±0.005	0.04±0.002	0.05±0.005	0.86±0.133
<i>Holoptelea integrifolia</i>	0.080±0.010	0.04±0.002	0.05±0.006	0.78±0.061
<i>Artocarpus lacucha</i>	0.06±0.007	0.03±0.003	0.03±0.005	0.94±0.080
<i>Choerospondias axillaris</i>	0.06±0.005	0.03±0.004	0.03±0.002	0.87±0.095
<i>Elaeocarpus lanceifolius</i>	0.23±0.014	0.11±0.006	0.12±0.015	0.95±0.120
<i>Acrocarpus fraxinifolius</i>	0.10±0.009	0.04±0.003	0.06±0.008	0.75±0.064
<i>Diospyros glandulosa</i> Lace	0.098±0.006	0.04±0.006	0.06±0.007	0.81±0.152
<i>Cinnamomum iners</i> Reinw	0.11±0.006	0.04±0.003	0.07±0.006	0.60±0.082

Conclusion

From the cross-sectional study of leaf blades, it was found that all eight plant species had cuticles and trichomes covering the leaf epidermis. Glands were observed in *Gmelina arborea*, *Artocarpus lacucha*, *Choerospondias axillaris*, *Diospyros glandulosa* Lace and *Cinnamomum iners*, while no glands were found in *Holoptelea integrifolia*, *Elaeocarpus lanceifolius* and *Acrocarpus fraxinifolius*. The arrangement of the mesophyll was dorsiventral, with palisade parenchyma arranged on the upper side adjacent to the upper epidermis, and spongy parenchyma positioned on the lower side adjacent to the lower epidermis. *Elaeocarpus lanceifolius* exhibited two layers of palisade parenchyma and had the greatest thickness of mesophyll, including palisade parenchyma and spongy parenchyma, while *Choerospondias axillaris* had the least thickness of mesophyll, including palisade parenchyma and spongy parenchyma. Regarding the vascular bundles, xylem on the inside and phloem on the outside, surrounded by fibers. Calculation of the Specific Leaf Area (SLA) showed that *Choerospondias axillaris* and *Gmelina arborea* had the highest values, while *Elaeocarpus lanceifolius* and *Cinnamomum iners* were in the group with the lowest SLA values.