Differences in Survival Strategies Between Trees in Japan and Australia

Research Question

How do the shapes and structures of leaves in Australian trees differ from those in Japanese trees?

Hypothesis

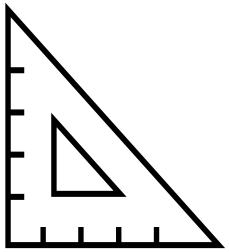
To adapt to dry environments, Australian tree leaves are expected to have the following characteristics:

- Smaller leaf size and surface area compared to Japanese trees
- Lower Stomatal density (number of stomata per unit area) than Japanese tree leaves

Research Methods
- Leaf Measurements

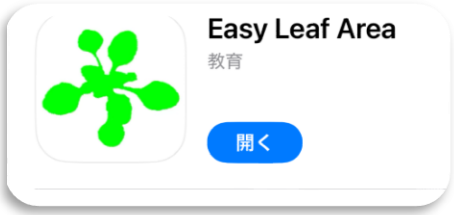
- Leaf Size Measurement:

  - Measure leaf length and width using a ruler



- Surface Area Measurement:

-Use the application “Easy Leaf Area”



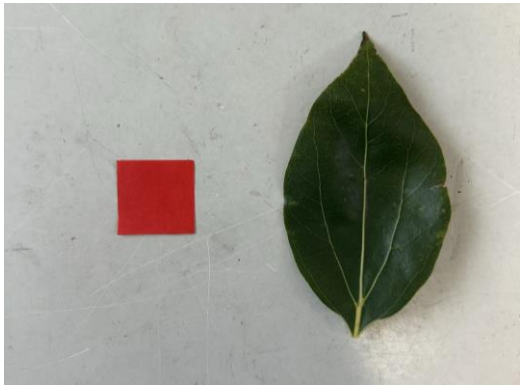
- Stomatal density Measurement:

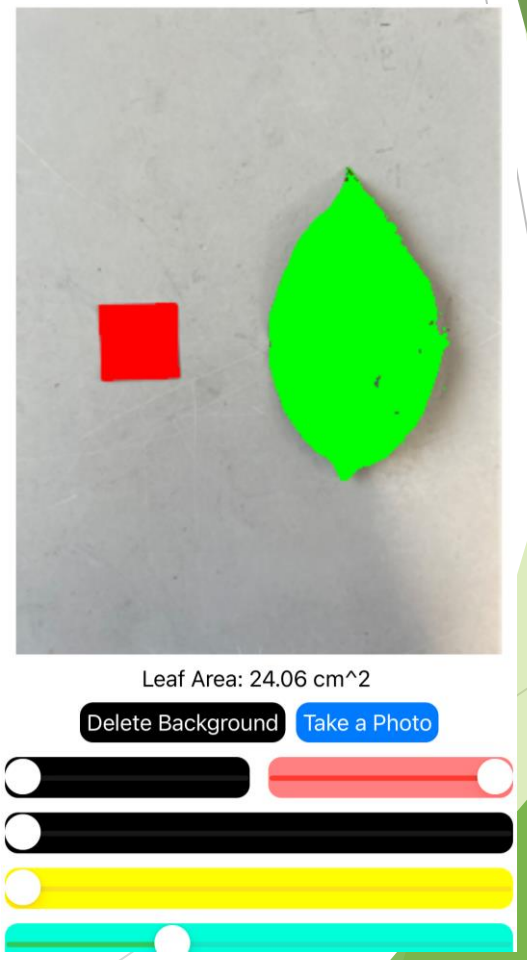
  -Observe under a microscope and count stomata per $1mm^2$

Surface Area Measurement

Using the “**Easy Leaf Area**” app

1. Take a photograph of the leaf together with a red reference paper (4 cm^2)
2. Calculate the area of the leaf from the ratio of red to green pixels





Selection of Research Subjects

- Select broadleaf trees whose leaves are easy to observe under a microscope.
- Select evergreen trees because there are many evergreen trees in Australia, and because it is currently winter in Japan and only evergreen trees can be observed for their leaves.

- Japan: Camphor tree, Kurogane holly, Ubame oak
- Australia: Eucalyptus

Survey of Trees in Japan

Japanese Trees and Drought Resistance

- Camphor tree: Low drought resistance
- Kurogane holly: Moderate drought resistance
- Ubame oak: High drought resistance

Three leaves were collected from each tree under the following conditions

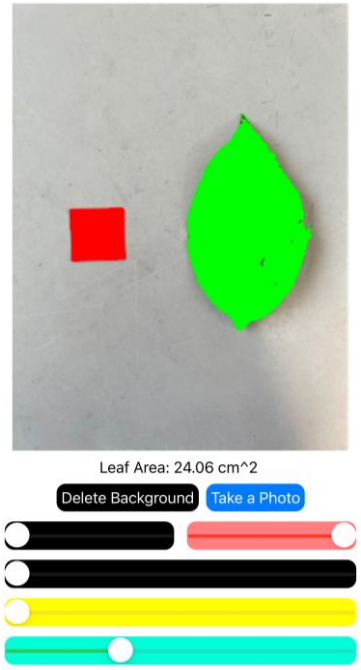
- Young leaves that are growing and mature
- Leaves that are about average among mature leaves (eyeball measurement)
- Leaves with good exposure to the sun
- Leaves that are free of disease and have beautiful color
- Leaves that are not chipped

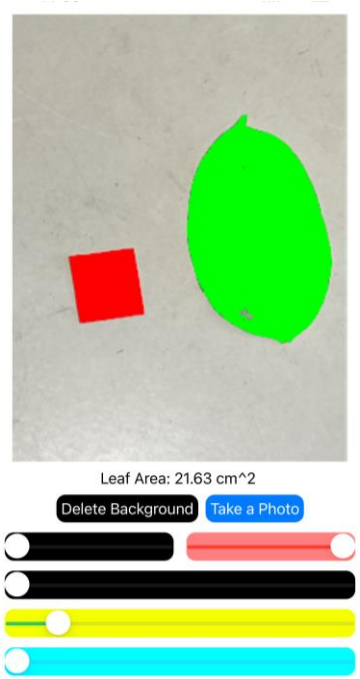
Leaf Size Measurement Results

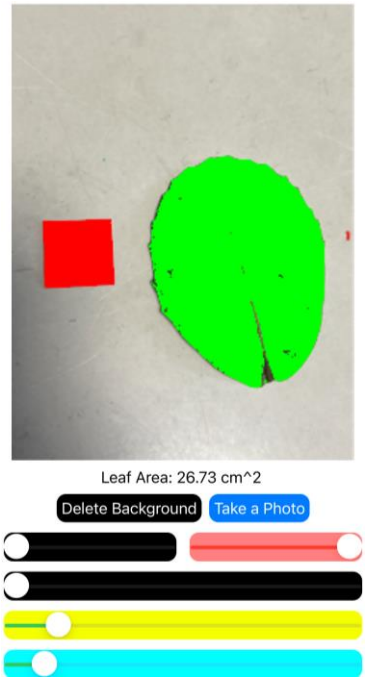
- Camphor tree
- Length (cm): 9.8, 7.9, 8.9 (Avg. 8.9)
- Width (cm): 5.9, 4.8, 4.8 (Avg. 5.2)

- Kurogane holly
- Length (cm): 7.7, 7.5, 6.8 (Avg. 7.3)
- Width (cm): 3.8, 4.3, 3.7 (Avg. 3.9)

- Ubame oak
- Length (cm): 6.8, 6.4, 6.6 (Avg. 6.6)
- Width (cm): 4.8, 4.6, 5.2 (Avg. 4.9)







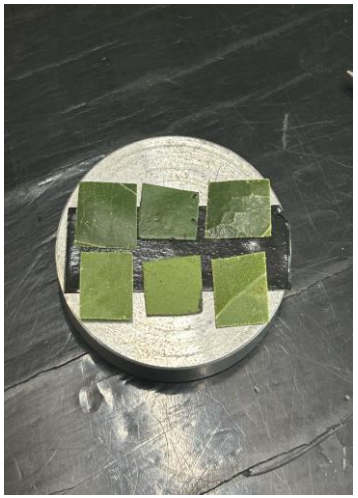
Leaf Surface Area Measurement Results

- Camphor tree(cm^2): 24.06, 26.54, 26.56 (Avg. 25.72)
- Kurogane holly(cm^2): 21.63, 20.78, 18.66 (Avg. 20.36)
- Ubame oak(cm^2): 27.10, 23.36, 26.73 (Avg. 25.73)

Stomatal density measurement

- I measured the leaves of Japanese trees using an electron microscope

The sample was cut out as shown above



The top three are the front surface and the lower three are the back surface

From left, camphor tree, kurogane holly, and ubame oak

Stomata Density Calculation

- Fix the magnification at 300×
- Stomatal density (stomata/mm²) is calculated using the following formula:

Stomatal density = (Number of stomata displayed on the screen) ÷ (Displayed screen area)

- Displayed screen area:

297 μm × 423 μm = 0.297 mm × 0.423 mm = 0.125631 mm²

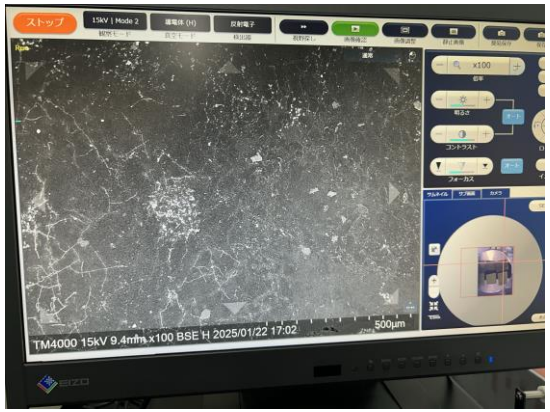
→ For calculation, use 0.126 mm²

- Final formula for stomatal density:

Stomatal density (stomata/mm²) = (Number of stomata displayed on the screen) ÷ 0.126

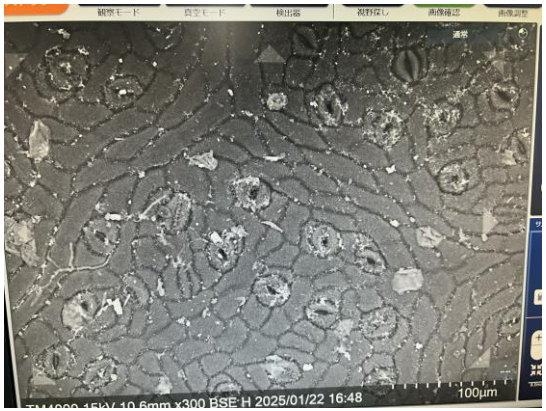
- This formula is used to determine stomatal density

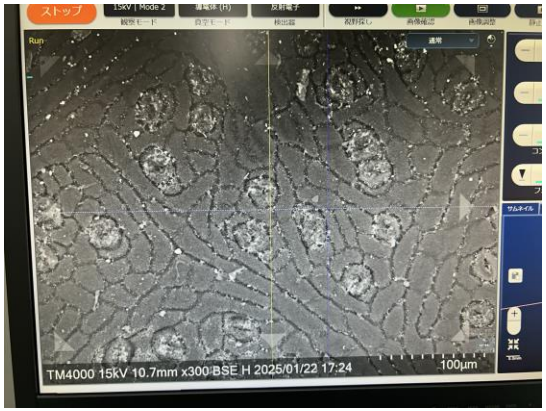
Stomatal Density Surveys



From left to right: camphor tree, blackberry, and ubame oak (x100)

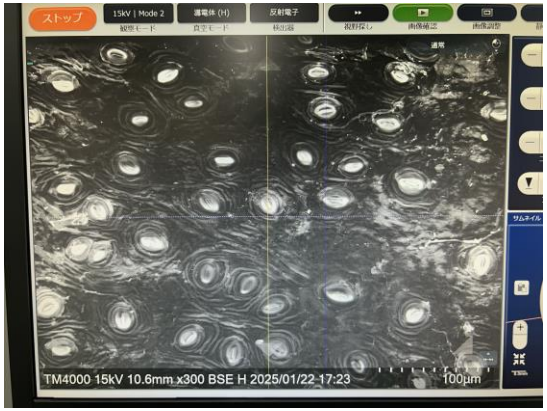
- I could not find stomata on all leaf upside surfaces of camphor tree, kurogane holly, and ubame oak
- I searched for them in many places with low magnification, but still could not find them
- So, from now on, I will only research the underside of the leaves





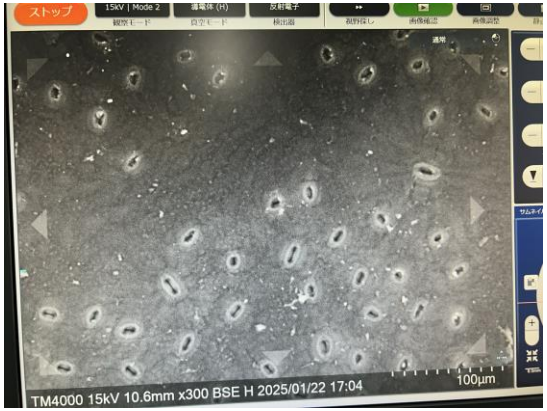
Camphor Tree

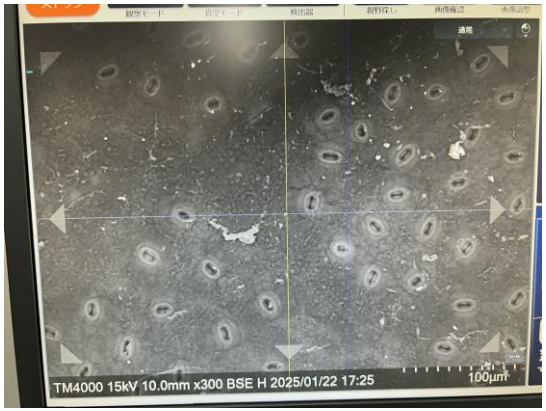
- From left: 31, 28, 24 stomata
- Average: 27.6 stomata
- Average stomatal density: 219.0 stomata/mm^2



Kurogane Holly

- From left: 41, 30, 37 stomata
- Average: 36 stomata
- Average stomatal density: 285.71 stomata/mm^2





Ubame Oak

- From left: 45, 43, 38 stomata
- Average: 42 stomata
- Average stomatal density: 333.33 stomata/mm^2

Considerations Based on Measurement Results of Leaf Size

- The more adapted to dry conditions, the shorter the leaf length became.

↪ Therefore, the leaves of Australian trees, which are adapted to dry conditions, may also be shorter.

- The ratio of (length) ÷ (width) is as follows:

• Camphor tree: **1.7**

•Kurogane holly: **1.8**

• Ubame oak: **1.3**

↪ Many Australian trees adapted to dry conditions may also show a low value like Ubame oak, meaning their leaves tend to have a round shape.

Considerations Based on Measurement Results of Stomatal Density

- Contrary to expectations, plants adapted to dry conditions had higher stomatal density.

↪From this, I thought that having more stomata allows plants to take in carbon dioxide quickly while keeping them open for a short time, which helps reduce water loss.

- I also wondered if the leaves of Australian trees might have even higher stomatal density.

Survey of trees in Australia

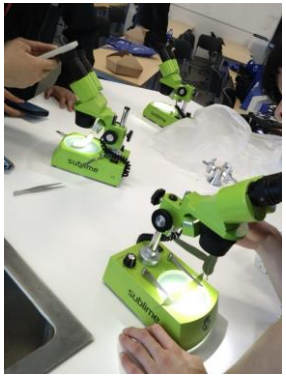
オーストラリア研修でしたこと

- Merymedeで教授にユーカリ(River Red Gum)についての講義をしてもらった

学んだこと:ユーカリ(River Red Gum)の葉は細長い槍状である
葉の向きは垂直になっていて、強い日差しを避ける働きをしている
長さの計測:葉の長さの平均･･･約10cm、幅の平均･･･約2.5cm
↪オーストラリアの葉は丸く長さの短い形をしているという仮説は否定された。また、葉の向きを変えることで、効率よく光合成しつつ、水分喪失を抑えている。

オーストラリア研修でしたこと

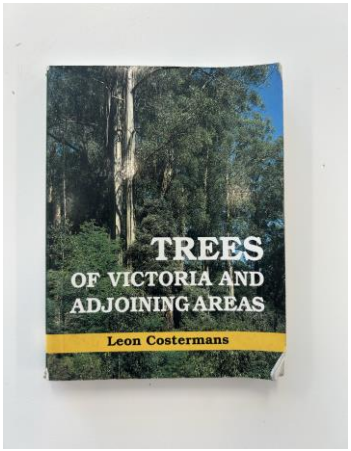
- Merymedeでは、教授による講義のあと、校内のユーカリの葉を取らせてもらい、顕微鏡での観察をした



- 調査の際に使用した本

「TREES OF VICTORIA AND ADJOING AGRES」

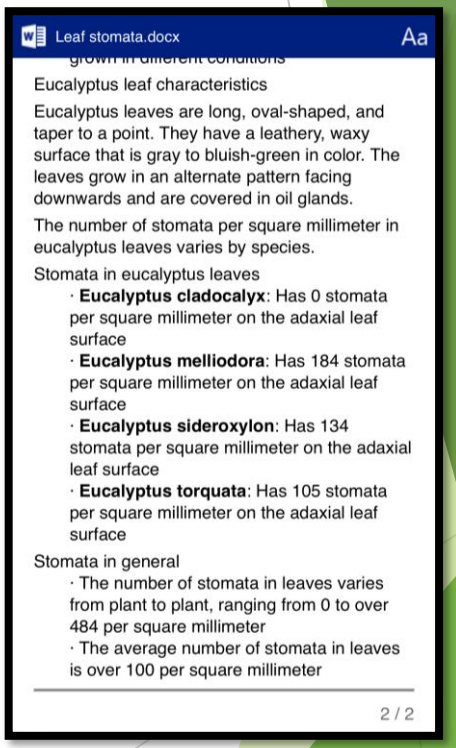
Leon Costermans



オーストラリア研修でしたこと

- Merymedeで各種類ユーカリの気孔密度についての調査をしてもらい、その調査結果を提供してもらった
- 調査結果

• Eucalyptus melliodora: Has 184 stomata per square millimeter on the adaxial leaf surfaceEucalyptus sideroxylon: Has 134stomata per square millimeter on the adaxial leaf surface• Eucalyptus torquata: Has 105 stomataper square millimeter on the adaxial leaf surface



・ユーカリ・メリオドラ：184個/mm^2

・ユーカリ・シデロキシロン：134個/mm^2

・ユーカリ・トルクアタ：105個/mm^2

いずれも葉の裏側の気孔密度

↪日本の樹木の葉より低い値が出た

オーストラリア研修で学んだことのまとめ

- 予想通り、オーストラリアに生息する樹木の葉は、オーストラリアの乾燥した日差しの強い気候に適応した生存戦略をもっていた
- しかし、仮説とは違い、葉の大きさや面積が日本の樹木の葉より極端に小さいことはなく、大きさや面積以外の部分(例えば葉の向きを垂直下向きにすることで、葉の面積を減らすことなく水分喪失を抑えるなど)でオーストラリアの環境に適応した生存戦略が見られた
- また気孔密度に関しては、初期の予想の通り、オーストラリアの樹木の葉の方が日本の樹木の葉より小さい値となっていた