Stomata on Leaves – Teacher Notes

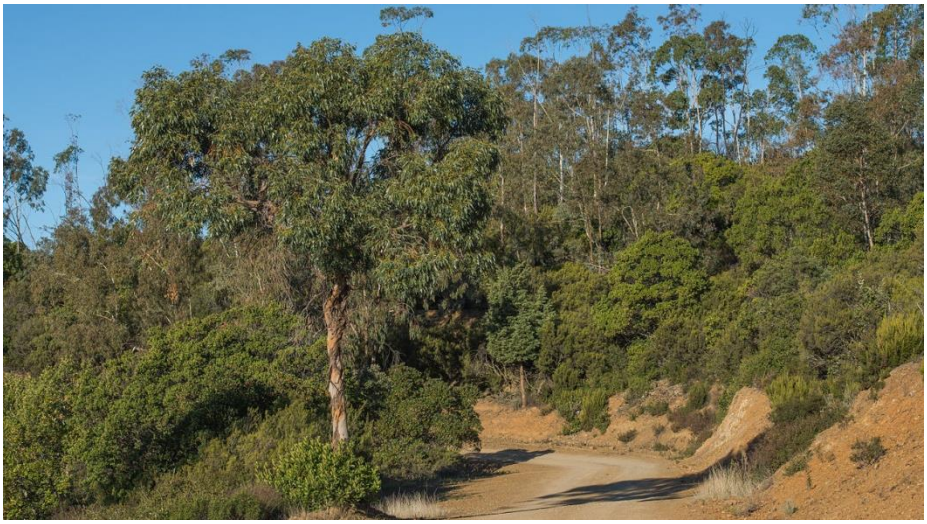
By Louise Lopes

Introduction:

This investigation asks students to identify the stomata on leaves under a microscope. Stomata are tiny openings which allow carbon dioxide into a plant, and they are essential in the process of photosynthesis. Students are asked to develop their own investigation in order to compare the stomata of native Australian plants with an introduced species. This will allow students to develop their science inquiry skills as they plan, conduct and analyse their own experiment.

Students will benefit from closely studying a multi-cellular organism under a microscope. Year 7 students will see how the type and number of stomata on a leaf helps in classification. Year 8 will learn how the specialised function of stomata is essential for life. Year 9 students will learn how stomata form a part of a coordinated and interdependent system which responds to its environment. Year 10 students will benefit from seeing how adaptations of stomata have been a result of natural selection pressures, such as extremes in climate.

This investigation can be extended to include fieldwork, where students collect their own samples, or adapted as a classroom activity by having samples prepared beforehand. Students will gain an appreciation of the Australian landscape by learning about various adaptations that native Australian plants have made in order to thrive in our climate. An environmental focus is provided with a discussion on how a stomatal index is being used in climate change research.



Question:

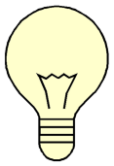
Questions for this investigation are prescribed. In Part 1, students have been given an aim to find stomata under a microscope and identify whether they are open or closed. This will give students the skills necessary to compare and contrast the stomata on different leaves.

In Part 2, students will design a new experiment to investigate whether Australian native plants show adaptations for the Australian climate with respect to their stomata. Students are asked to write a hypothesis for this. They can incorporate knowledge gained from completing Part 1 and any additional information that teachers provide on the plants and environment that is being studied.

Plan:

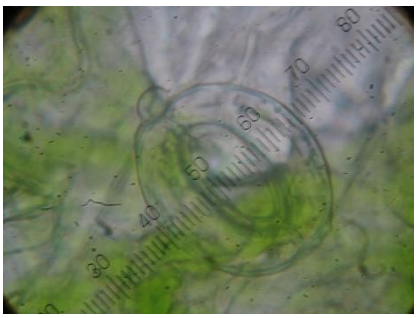
If the field world component is included in this investigation, then site selection is a consideration. When comparing native and introduced plant species, it may be beneficial to visit two different sites. An example of sites could be a suburban garden and a natural bush setting. It would be beneficial for teachers to provide additional information about the environment, such as whether there is ever a threat of a bushfire or drought. Details such as likely sources of water and soil nutrients could also be provided. Therefore, sites that have this information available would be best.

Teachers can also guide students to choose an appropriate plant species to study. Eucalyptus is a native plant which is widely available and also a good plant to test due to its many adaptations to drought and bushfire conditions. For an introduced species, a popular European plant can be chosen, such as a leaf from a rose bush. This is to aid in its classification. If possible, provide students with the scientific name for the plant species they are investigating, or a way to find it.



EUCLID is a database containing 917 Australian species and subspecies of eucalypts. It is produced by the Centre for Plant Biodiversity Research. Resource can be found here: http://keyserver.lucidcentral.org:8080/euclid/

Scientific names for plants are binomial, meaning they contain two words, the first referring to the genus and the second being a name specific to that species. For example, the scientific name for River Red Gum (a widespread tree in Australia) is *Eucalyptus camaldulensis*. Eucalyptus falls under the plant family Myrtaceae.



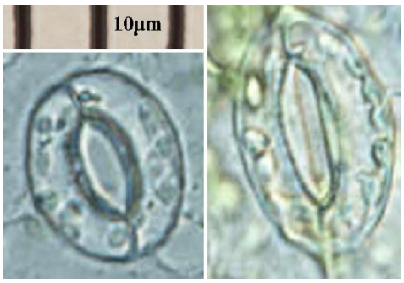
Instructions on how to prepare the slides for viewing under a microscope have been given, however this can be a difficult skill to learn; therefore students may benefit from a class demonstration before commencing. Safety precautions and correct handling procedures could be discussed at this point. This investigation involves the use of nail polish, which can be a hazard if inhaled or ingested.

For Part 2, students are to develop their own investigation. They will have to think of how to conduct a fair test. Teachers may ask that students write a general description of what they plan to do or a more formal step-by-step method. Further guidance can be given by providing the following table, which asks students to identify and list their variables, as well how they plan to measure or control for them.

	Control variable	Independent variable	Dependant variable
Variable			
Measurement			

Conduct:

Field Work: Students can perform field work in order to collect their leaf samples. This gives students the opportunity to make observations of the plant and its environment. They can observe if the plant sits in full sun or shade and what 'layer' the plant occupies, such as the understory or the canopy. Additional observations to make are the density of leaf coverage and the way that leaves are attached to their branch. If students wish to identify the name of the plant, then taking photos will assist with this. Students can also observe the inclination of the land, whether water is nearby, and any signs of disease. Students can also comment on the diversity of plant life nearby.



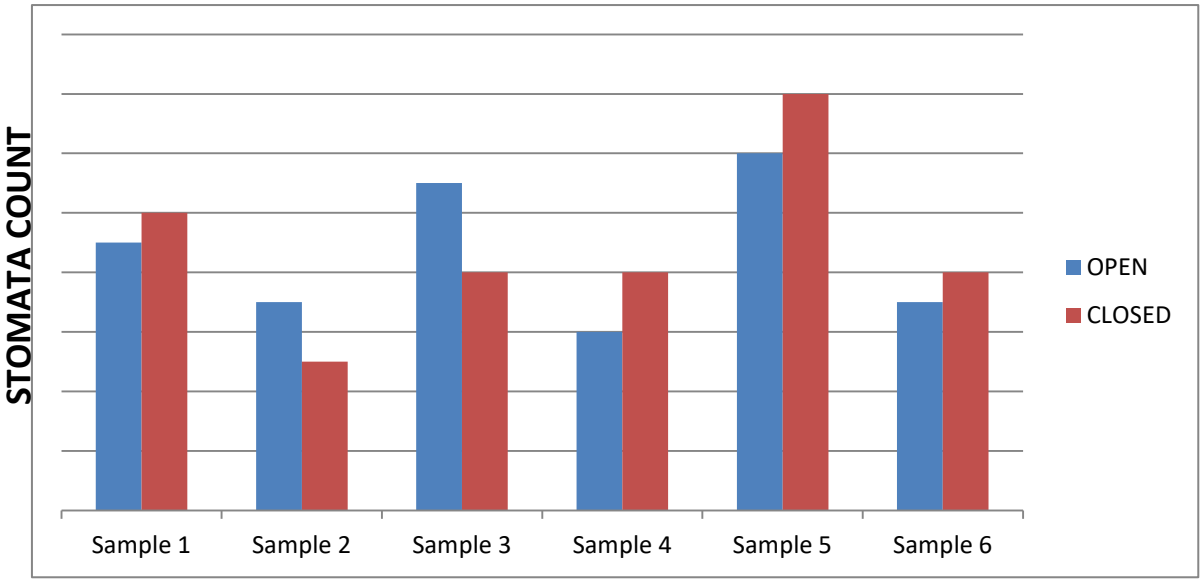
Examining Samples: Students are to count the number of stomata that are open and closed by preparing slides and using a microscope. This can be challenging as not all stomata look alike. They will be different sizes; some are also sunken or encrypted. Therefore, teacher guidance in being able to interpret what is seen through the view-finder is recommended. Students must choose a way to keep the results consistent between samples (using the same amount of surface area for counting) and how to record this data. A table similar to below could be provided to assist students in this:

STOMATA ON LEAVES				
Plant	Sample	Open Stomata per mm²	Closed Stomata per mm²	Observations
Rose Leaf	1			
	2			
	3			
Eucalyptus Leaf	1			
	2			
	3			

Qualitative data could be collected as students are observing the leaf under a microscope. Students can include things like plant hairs, waxy deposits and any irregularities in the network of cells. These things can be written or drawn with labels. Date and time that the sample was collected would also be valuable as stomata usually close at night.

Analysis:

Students must choose how they will analyse their data in order to make effective comparisons between the different plant species. Students are given the suggestion to either represent their data graphically or make calculations. Students may choose to work out the ratio of the number of stomata from one leaf to another, or they may choose to work out what percentage of stomata is open for each sample. These calculations will provide numerical comparisons. Students may instead choose to draw a graph, such as the following:



Problem-Solving:

Students have been provided with a list of key concepts about stomata. Using this information and results from their investigations, students are required to write a report on whether Australian native plants show adaptations for the Australian climate with respect to their stomata. Students are to describe any identifiable differences between the Australian native leaf samples and the introduced-species leaf samples. Teachers may also include additional information specific to each species, such as how fast the plant tends to grow, whether it is a perennial or an annual, how abundant it is in the area, etc.

Knowing the role of stomata in photosynthesis may help students when making predictions on how any special features found could be adaptations to the Australian climate. Plants are required to allow air to pass into the epidermis layer of the leaf, but every time this occurs water is lost in the form of water vapour. Water is a valuable resource for plants, and if they dehydrate too much it can be fatal. This system is therefore tightly regulated by guard cells which open and close the stomata.

Adaptations of Australian Native Plants: The amount and size of stomata that a leaf has is affected by environmental factors such as temperature, atmospheric carbon dioxide, light intensity and how many hours of sunlight the leaf receives. Australia has many drought and dry climates that are prone to bushfires. The plants living in those environments have adapted to these conditions. Common features among native Australian species are thick leaves and sunken or

encrypted stomata. Encrypted stomata sit in 'crypts', which are large chambers that contain fine plant hairs and accumulations of wax. This traps moisture and provides protection against smoke exposure.

Eucalyptus trees have many adaptations to the Australian climate. For example, Eucalyptus leaves have a shiny waxy coating that reduces the internal temperature of the leaf. This reduces the leaf's reliance on water for evaporative cooling. Eucalyptus trees also have their leaves hanging straight down. This reduces the amount of sun exposure on those parts of the leaf with the highest concentration of stomata. Another adaption to the Australian climate is the reduction of daylight hours that stomata remain open. Whilst most plants are open during daylight hours and closed at night, some Eucalyptus trees will only have their stomata open for six hours. This means that their stomata is open from dawn and closes around midday. This is to minimise water loss during the hottest parts of day.

Climate Change Research: The main role of stomata is to allow carbon dioxide into the leaf. Atmospheric carbon dioxide concentrations have been found to alter the function and prevalence of stomata. As a result, scientists have been using fossil leaf samples to provide estimates for historical atmospheric carbon dioxide concentration. This research can provide insight on how climate change has impacted Australian ecosystems in the past. From this, we can make predictions on how our environment will be impacted by future climate change.

Extension: Students can research how a stomatal index has been created in order to predict CO_2 content in the atmosphere. Stomatal index is different for each plant so correlation charts have been constructed for each species studied. Students can compare this method to the ice core record.

Evaluate: At this stage students can evaluate whether their experimental design was satisfactory. Did they test the correct things in order to obtain an answer to their question? Did they conduct a fair-test? Did students identify the main control variables, and were they able to implement strategies to keep them consistent throughout? Where there any forms of human error? What else could be affected by the application of nail polish on the leaves? What other questions could you ask with this investigation? How could you improve this investigation to get better results? Discuss these issues with students as they assess the reliability of their results.

Conclusion:

In this section, students are asked to bring it all together by summing up their report in just a few statements. This would be a great time to see if any of the students' predictions were correct and if they feel as though the aim of their report has been achieved.

References:

Image 1 – Christian Ferrer, https://commons.wikimedia.org/wiki/Eucalyptus#/media/File:Eucalyptus,_Cessenon-sur-Orb_01.jpg
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