

# Red Leaf Green Leaf

## A VICTORIA SCIENCE TEACHING RESOURCE

### WHO?



Dr Ignatius Menzies from Victoria University of Wellington.

### WHAT IS THE QUESTION?



While the majority of leaves are green, there are many red-leaved plants throughout the world. Why this is isn't fully understood. In this study, Dr Menzies tested the idea that red coloured leaves act as a warning signal to herbivores that they contain chemicals that make them unpleasant to eat (antifeedant) and whether this gave them an advantage over green-leaved plants.

### WHAT PLANT DID HE USE?



The native mountain horopito, or *Pseudowintera colorata*. This particular species of horopito is perfect because its leaves can vary between completely green or completely red. The red colouring comes from compounds called 'anthocyanins', which are known to have antifeedant properties.

### WHAT WERE THE HYPOTHESIS?



1. That the warning signal given by red leaves would make them less likely to be targeted by herbivorous insects.
2. Red mountain horopito would have a higher fitness than green horopito due to this warning signal effect.

### HOW WAS THIS STUDY DESIGNED?



*Before you read on, design your own method to test their hypothesis.*

Dr Menzies randomly selected thirty pairs of mountain horopito on Belmont Trig in Wellington. Each pair had one plant that was predominantly green, and one that was predominantly red. The plants in each pair were no more than two metres away from each other, with care taken to control for other important variables.

- *What other variables would need to be controlled for?*

From late spring to early summer the leaves of the sample pairs were examined for native leafroller caterpillars or evidence of their activity. The caterpillars were left on the leaves to test for fitness later on in the season. From late summer to early autumn, the plants were re-examined, this time looking at the number of fruits with a sample of the fruits taken to look at the number and weight of seeds inside.

- *What do you think looking at the fruit and seeds of the plants would tell Dr Menzies?*

### WHAT DID HE FIND?



- Red leaves had 22% fewer caterpillars than nearby green plants.
- Despite this, there was no difference in the amount of fruit produced by red or green plants, or any difference in the amount and weight of the seeds.
- This suggests that red plants do not have a higher fitness than green plants.

# Examining the Results

## A MISSING PIECE OF THE PUZZLE

There is one crucial piece of data that Dr Menzies collected that hasn't been mentioned yet. It may give the best explanation for why red plants aren't more successful than green plants.

- *What do you think it is?*

Dr Menzies looked at the rate at which red and green leaves take up  $\text{CO}_2$ , showing the rate of photosynthesis in the different plants.

- *Which colour leaf do you think would have the higher rate of photosynthesis?*

What Dr Menzies discovered was that the rate of  $\text{CO}_2$  absorption averaged 47% higher in green plants than it was in red plants. The total amount of chlorophyll was also significantly higher in green plants. This means that green plants were able to photosynthesise at a much higher rate, enabling faster growth.

- *What does this mean for both of Dr Menzies' hypotheses?*

## A BALANCING ACT

Even though the red plants had, on average, less caterpillars on them, they still didn't have an advantage over the green plants. This may be because having higher concentrations of anthocyanin in leaves to make them look red and be less edible has the side effect of reducing their ability to photosynthesise. The green plants may be eaten more by caterpillars, but this is made up for by their ability to grow faster than the red plants.

What Dr Menzies proposes is that mountain horopito plants have two strategies for dealing with herbivorous insects – resistance, making the leaves less edible, or tolerance, allowing more damage from herbivores but having increased growth to compensate.



## FURTHER INVESTIGATION

- What could Dr Menzies look at to further support his findings?
- What advantages might having different combinations of red and green leaves give the mountain horopito over other species of plant?
- Are there any plants with red leaves in your area? Are there any differences between their smell and the smell of green leaves?
- Are there any other examples of a balancing act between two different defensive strategies in the plant or animal kingdom?
- Why is green the best colour for photosynthesis?

