



A-LEVEL - Investigating the resting posture of peppered moth larvae

The purpose of this activity is:

- to investigate a hypothesis about the resting posture of peppered moth larvae
- to evaluate methods for measuring the angle of rest of larvae on hawthorn twigs from photographs
- to analyse the results and identify any pattern
- to evaluate the hypothesis in the light of the results

Peppered moth larvae feed at night and rest during the day. At rest, they stay rigid and motionless, holding their bodies at an angle to the twig. Combined with their colour and knobby texture, this means that they mimic the twig on which they rest and so are protected from predation to some extent. They feed on many plants: rose, bramble, willow, birch, elm and hawthorn. One hypothesis about the angle of rest is that it is similar to the angle of divergence between shoots and twigs on the food plant

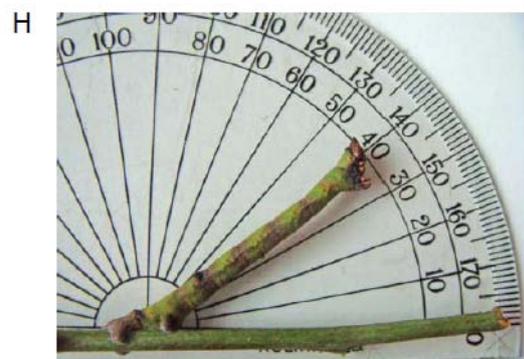
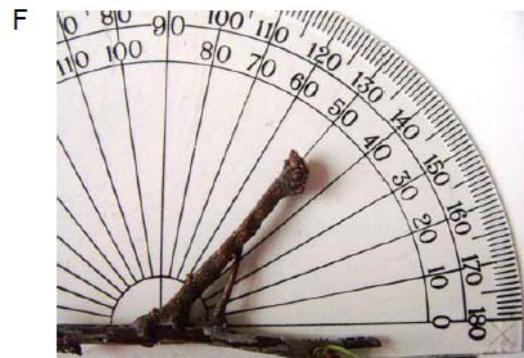
Procedure

SAFETY: When measuring the angles of divergence in rose or bramble stems or hawthorn twigs, take care as they have sharp thorns. Wash your hands thoroughly (with soap and hot water) after handling stems. Seek first-aid treatment for any cuts and scratches.

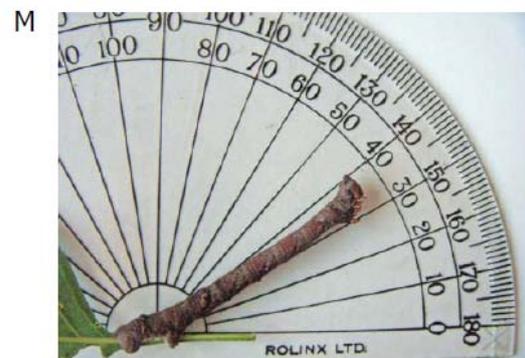
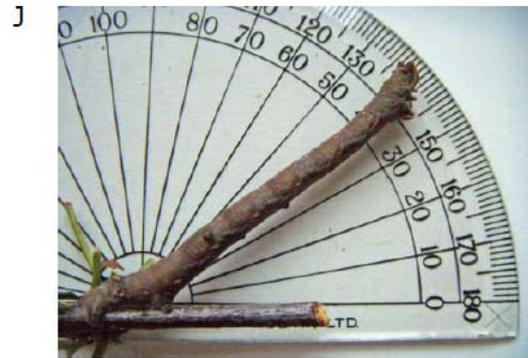
Investigation

- From two of the photographs provided, measure the angle of rest of a peppered moth larva on a hawthorn twig.
- Compare your measurements from these two photographs with the measurements made of the same photographs by another group.
- Work out a set of instructions to make sure you are all measuring the angle in the same way.
- Measure the angles on all 24 photographs (A to X) and record your results in a table.
- Calculate the mean and standard deviation for this set of values of the angles of rest for this sample of caterpillars.
- Use the data to find the frequency of occurrence of angles of rest in these five classes: $0-17^\circ$, $18-35^\circ$, $36-53^\circ$, $54-71^\circ$ and $72-89^\circ$. Present the frequency information in a suitable graph.
- Select 24 stems from a food plant of the larvae that is readily obtainable. Measure the angle at which one twig diverges from the main stem, using a school protractor. Try to choose the stems you measure in an unbiased way. Record all the angles in a table.
- If possible, repeat this measurement for another food plant of the peppered moth.
- Draw a diagram to compare the angles of rest of caterpillars and the angle of divergence of stems from the food plant(s) you have surveyed.
- Use a statistical test to determine if there is a significant difference between the angles of rest of the larvae and the angles of divergence of the food plant(s).

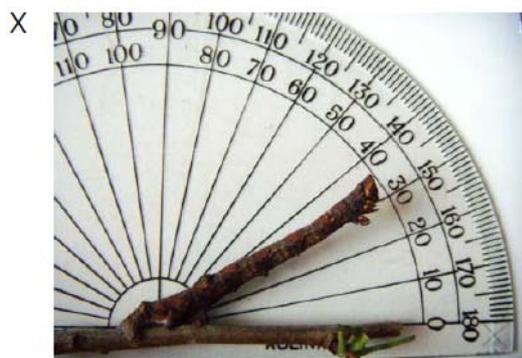
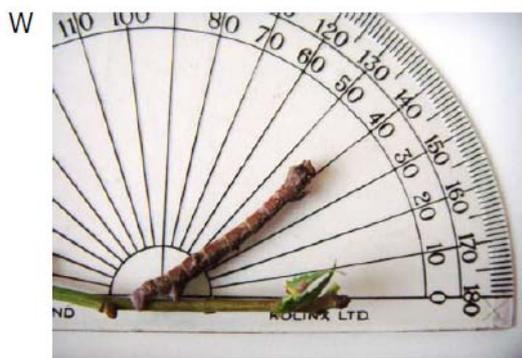
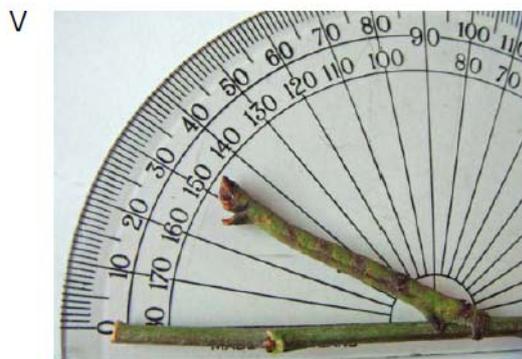
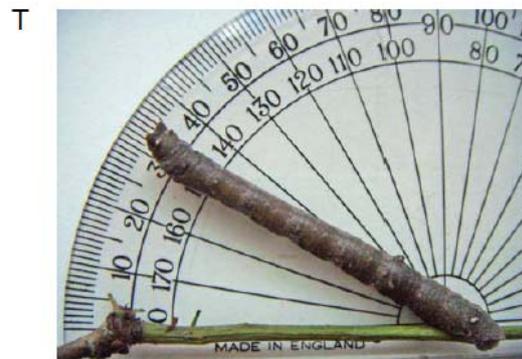
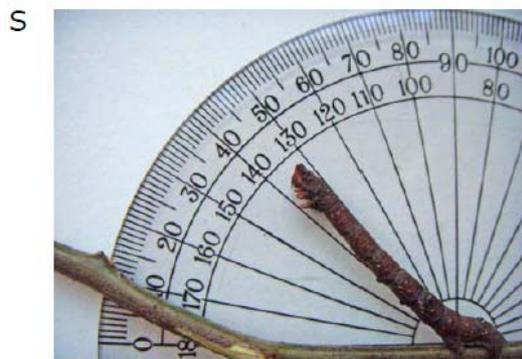
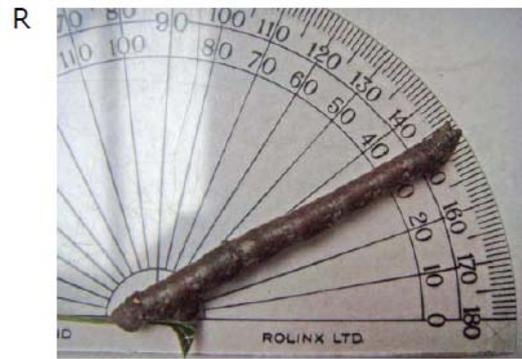
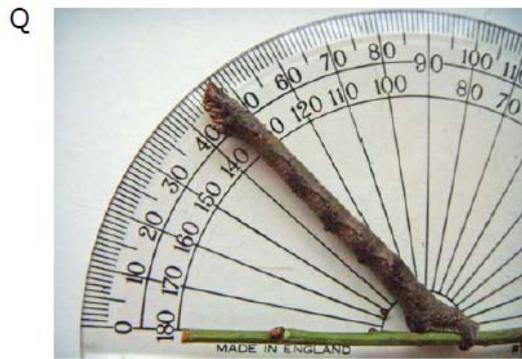
PRACTICAL BIOLOGY STUDENT SHEET



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QUESTIONS

- 1 Explain what the standard deviation of a set of values tells you.
- 2 Why is it important to know the mean and standard deviation of a set of values?
- 3 Describe the pattern in your frequency graph.
- 4 Suggest one reason why the data follow this pattern.
- 5 If you were to carry out a follow-up study of the resting position of peppered moth caterpillars during daylight, suggest two factors you could investigate.
- 6 Why is it important to use a consistent technique to measure the angles?
- 7 How accurately can you measure the angles?
- 8 What problems are there in measuring angles from photographs?
- 9 Is this sample size reasonable? Is it big enough to draw reliable conclusions? Is it small enough to be manageable?
- 10 Comment on the comparison of angles of rest of caterpillars with angles of divergence of twigs on the food plant(s) you have surveyed. Is there a significant difference between the sets of values of angles measured? What test of significance did you use and why?



ANSWERS

- 1 The standard deviation of a set of values tells you the dispersion of the values around the mean.
- 2 The mean and standard deviation together describe the distribution of a set of values, for example, is it a “normal” distribution.
- 3 Describe the pattern in your frequency graph.
- 4 If there is a consistent measure for the angle of resting posture, it may match the typical angle of twigs in the preferred food source. Matching the angle would make the caterpillars harder to spot. If it does not match the angle of the twigs, but is still consistent and significantly different, it could mean that the exact angle is not as significant in camouflaging the caterpillar as the general cryptic colouration and ability to be still.
- 5 If you were to carry out a follow-up study of the resting position of peppered moth caterpillars during daylight, suggest two factors you could investigate.
- 6 It is important to use a consistent technique to measure the angles so that the results are meaningful.
- 7 The accuracy of measurement of the angles will depend on dexterity and reading the scale of the protractors. It could be plus or minus one or two degrees.
- 8 Students may identify some problems in measuring angles from photographs.
- 9 Significance tests require a certain sample size to be meaningful. Answer this according to the tests used. Students should have a view on whether this sample is big enough to draw conclusions you can be sure of and if it is small enough to be manageable.
- 10 The Mann Whitney test would be suitable: this produces a W value of 1006.0 and an associated probability level of $P = 0.000$, so there is a significant difference between the angles of rest of caterpillars and the angle of divergence of hawthorn shoots from twigs.

You could also use A t-test, for unpaired data or independent samples and this produces a value of $t = 6.34$, $df = 49$, $P < 0.001$, so again there is a significant difference between the angles of rest of peppered moth caterpillars and the angle of divergence of hawthorn shoots from a twig.

The fact that caterpillars and hawthorn shoots/twigs are not statistically similar in their angles of divergence means that this is likely not to be a critical factor in the camouflage protection of the posture of the caterpillars.