Crawling caterpillars

A DVD film resource from the Association for the Study of Animal Behaviour (ASAB) that provides an investigation for Key Stage 2, Years 5 and 6

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Background for teachers

Introduction

Most moth and butterfly caterpillars, or larvae, move very little during daylight in order to reduce the chance of being seen by predators, see Figure 1. If they are out in the open, most moth caterpillars quickly seek a refuge, and then keep very still, until dark. This investigation is based on this behaviour and asks the question - **`Do moth caterpillars move in a straight line when they seek a refuge?`**

It is not known precisely what specific stimuli a caterpillar responds to when seeking a refuge, or at least which ones it selects to respond to, since it will be subject to many different stimuli. What is clear, however, is that it will move to seek a refuge if it finds itself in an open area during daylight. What will be apparent to the children when they see the DVD film footage is that as a caterpillar moves it stops occasionally, re-samples stimuli, makes a decision and then moves on, sometimes in a slightly different direction. This suggests that a caterpillar has an ability to change its behaviour in the light of information from its environment. It could be sensing where the light is brightest, or least bright, or it may be searching for vegetation to contact and crawl up to find a suitable resting place.

Figure 1 Peppered moth caterpillar resting on a hawthorn twig during daylight.

[The caterpillar holds its body rigid, thus masquerading successfully as a twig. It moves and feeds at night.]

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What to do

Open up the DVD `*Crawling caterpillars*`. There is a short introduction for pupils, approximately 3½ minutes, and then the children will see film footage of four caterpillars, one at a time, crawling across a large sheet of paper. The first of the caterpillars, see Figure 2, is introduced into the small inner circle (1.5 cm radius) on the paper by gently brushing the caterpillar off a small spoon. The caterpillar then moves across the surface of the paper and as it moves out of the small circle the hand of a scientist places a small cross, or dot, on the paper just after the caterpillar has moved. Thus the track of the caterpillar is marked out on the large circle as the animal moves from the centre to the perimeter of the circle, see Figure 3. The children will see the first four caterpillars (A – D) complete their tracks and then a summary diagram will appear showing all four tracks.

Figure 2 Large yellow underwing caterpillars.

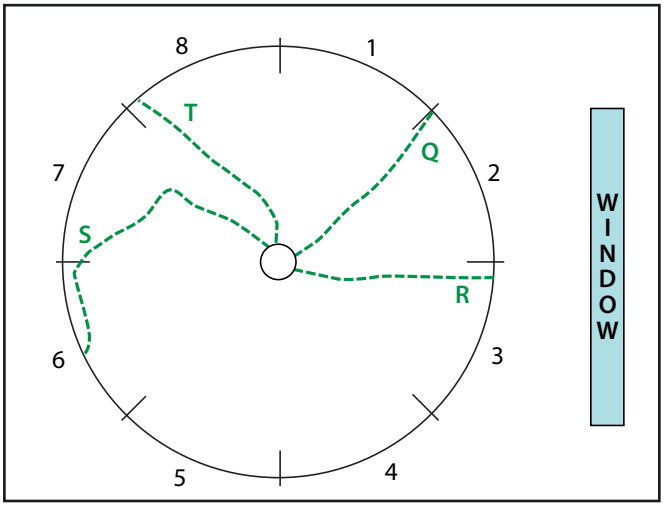


Figure 3 Four trails of crosses have been joined to show the routes taken by four large yellow underwing caterpillars.

[The children may observe that a caterpillar seems to have more than 6 legs. In fact, like all insects, they only have 6 real legs, the additional `prolegs` near the end of their body help them to move when they are caterpillars. When an adult moth emerges from its pupa it will have just 6 legs. For examples of the four stages in the development of large yellow underwing moths see Appendix, Figure 1.]

It would be instructive for the children to see the measuring technique in action so we suggest they use the first summary diagram for this. They can measure the track length taken by the first four caterpillars (A – D) and then compare these lengths to the straight line distance. A convenient way to record the distance each caterpillar moves is for two pupils to place a piece of string on the track the caterpillar follows on your whiteboard. With a metre rule they can then determine the length of its route from the centre until it crossed the perimeter of the larger circle.

The `real` straight line route is a radius of the large circle (18 cm minus 1.5 cm, the radius of the small inner circle) and a second piece of string can be cut to represent this length - this can be measured on the whiteboard. The pieces of string will thus be a physical record of the distances. The strings will need to be marked in some way to identify them. [An easy way is to wrap a piece of Scotch tape round one end and write `A` on the tape to identify that this was the first caterpillar.] This should reveal that caterpillar D followed a slightly more circuitous route than the other three caterpillars.

[A diagrammatic representation of the tracks taken by all twenty caterpillars are shown in the Appendix, Figures 2 – 6.]

The distances the children will measure will not, of course, be the `real` distances covered by caterpillars A – D. The `real` distances of the tracks taken by the twenty caterpillars are listed in the Appendix, Table 1.]

[The commentary on the DVD is provided in the Appendix and an animal cameo of the large yellow underwing is also included to provide some additional material about the moth, should it be needed. The animal cameo is taken from issue 29 of the educational newsletter Feedback, which is produced termly by the Association for the Study of Animal Behaviour (ASAB). To receive a pdf version of each newsletter simple contact the ASAB Education Officer (Charlotte Evans) at behaviour@cardiff.ac.uk]

Analysis

Provide the children with a copy of the data in Table 1 in the Appendix. The children can then be asked to study the table and make some observations. For example, they could find the shortest and longest routes and thus determine the range in distances. It might be appropriate for them to calculate the mean track distances taken by the caterpillars: it is 18.75 cm. Interestingly, only 5 caterpillars have track distances greater than the mean distance! This an example of how one particular piece of data (viz. the 28.4 cm distance covered by caterpillar S) has a marked effect on the mean value.

[Some other comments on the findings appear below Table 1 in the Appendix.]

Follow-up work

The large circle has its perimeter divided into eight sectors, labelled 1 – 8. A simple count could be undertaken to determine the number of caterpillars that left each sector. This would allow the children to answer the question – "Are the caterpillars equally likely to move in any direction from the centre of the inner circle?". A table recording these data may be sufficient (see Table 2 in the Appendix) or you may ask the children to plot the data on a graph. With 20 caterpillars in the sample we would expect two or three caterpillars (the mean is 2.5 caterpillars) to leave each sector. The graph, or the table, will reveal if the caterpillars have shown a preferred direction of movement. Since the laboratory used in this investigation had windows on just one side of the room then there would be a difference in light intensity in the room and on the table where the caterpillars were tested, so the caterpillars may, or may not, have shown a response to this.

[Some other comments on the findings appear below Table 2 in the Appendix.]

It would be relatively easy to replicate this experiment with caterpillars bought from livestock suppliers, see Figure 4. Moth and butterfly larvae are available from several biological suppliers. Two reputable sources are:

Blades Biological, Cowden, Edenbridge, Kent TN8 7DX

Tel: 01342 850242

Fax: 01342 850924

E-mail: info@blades-bio.co.uk

Website: www.blades-bio.co.uk

Worldwide Butterflies, Sherborne, Dorset DT9 4QN

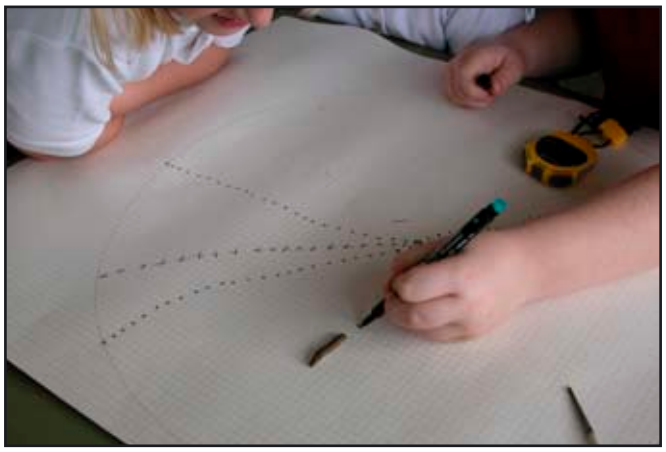
Tel: 01935 474608

Fax: 01935 429937

E-mail: sales@wwb.co.uk

Website: www.wwb.co.uk

Figure 4 Year 4 children following the track of a large yellow underwing caterpillar.



Similar work could be undertaken with other animals which might be available, such as woodlice and mealworms. Woodlice can usually be found beneath a pile of stones, logs, etc. which may be found in a corner of a sports field or perhaps a purpose-built wildlife area. Pet shops or angling suppliers sell mealworms (blowfly/bluebottle larvae) quite cheaply, these being frequently used by anglers as live bait.

Acknowledgements

We particularly wish to thank ASAB for funding this project. We are grateful to Fiona Stout for kindly supplying the commentary for the short introductory section of the DVD, Roy Leverton for permission to use the image of the peppered moth and the large yellow underwing, the UK Moths website and the Natural History Museum for giving permission for MD to photograph specimens of adult large yellow underwings from their collections. All other photographs were taken by MD. MD was also very grateful to Professor Phil Wheater (Manchester Metropolitan University) for allowing us to film the caterpillar sequences in the laboratories of the School of Biology, Chemistry and Health Science.

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Appendix

Table 1 `Real` distances (i.e. the distances shown by the tracks on the large sheet of paper used in the investigation) covered by the twenty caterpillars.

Caterpillar	Track distance (cm)
A	16.9
B	17.0
C	17.3
D	20.1
E	18.6
F	17.6
G	20.6
H	16.8
I	17.2
J	16.7
K	19.9
L	22.7
M	21.0
N	17.5
O	17.9
P	17.0
Q	16.9
R	16.8
S	28.4
T	18.1

The `shortest` route (i.e. the straight line distance) was 16.5 cm. Some caterpillars (A, H, J, Q and R) clearly moved in a more or less straight line away from the smaller circle in the centre of the paper but a few (D, G, L, M and especially S) meandered before reaching the perimeter of the larger circle. Children should appreciate that caterpillars moving in a straight line to a refuge have less chance of being seen, and therefore eaten, by a predator.

Table 2 Number of caterpillars leaving each sector of the larger circle.

Sector	Number of caterpillars
1	2
2	3
3	2
4	4
5	2
6	3
7	2
8	2
Total	**20**

The caterpillars have not shown a preference for moving in a particular direction as they leave the larger circle. The number of caterpillars that moved towards the window (i.e. sectors 1 - 4) was 11, the number moving away from the window (sectors 5 - 8) was 9. Overall, moving in a fairly straight line seems a useful strategy for a caterpillar to use, rather than, say, moving towards (the window) or away from the area of greatest light intensity.

Figure 1 Stages in the development of large yellow underwing moths.

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Figures 2 - 6 Tracks taken by the 20 caterpillars

Figure 2

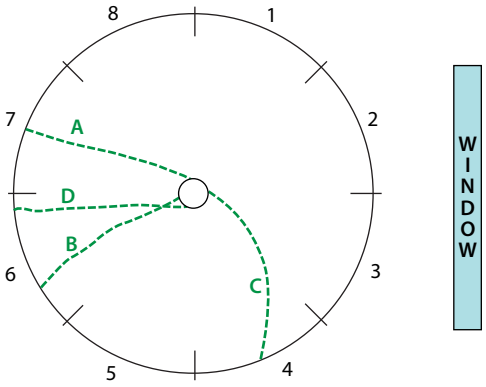


Figure 3

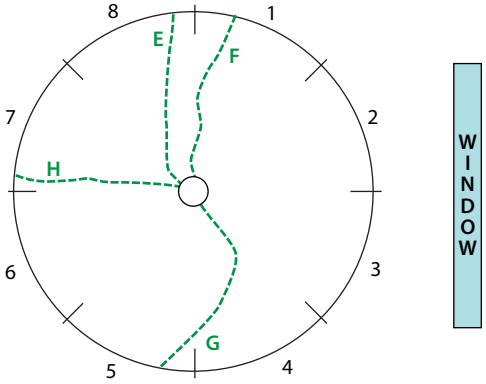


Figure 4

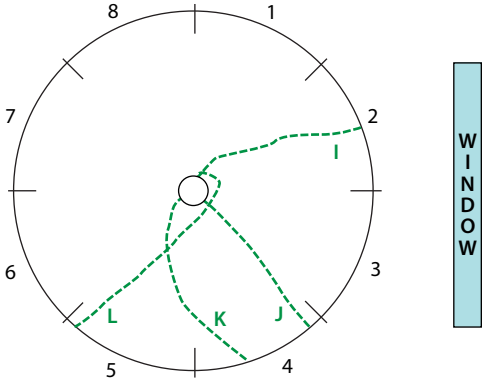


Figure 5

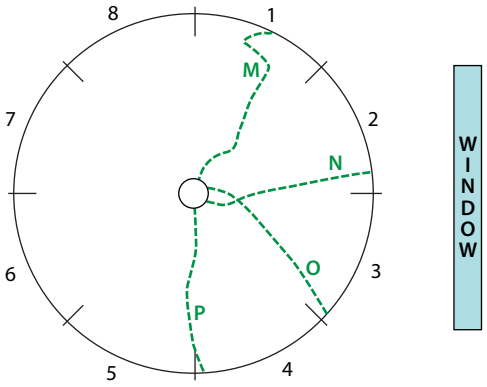
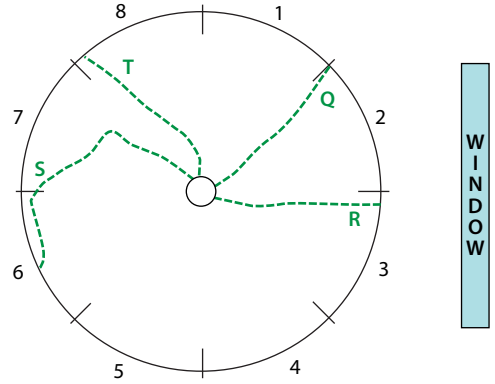


Figure 6



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Commentary for Crawling Caterpillars DVD

The large yellow underwing is one of the most common moths in the British Isles and can be found in many different habitats. It is a medium size moth, with adults having a wingspan of 50 – 60 mm.

Like all other moths and butterflies, a large yellow underwing goes through four stages in its development: egg, caterpillar or larva, pupa and adult. Females lay their eggs on grasses and other low vegetation in late August and September and about 10 – 12 days later caterpillars emerge. They feed on grasses and plants, such as dandelion and dock, and grow until they are about 50 mm long. In April they pupate and the adults emerge in late June and fly until September/October.

So large yellow underwing moths spend most of their life as caterpillars. Many birds, such as blue tits and blackbirds, eat caterpillars as they are easily digested and full of protein. Chicks grow rapidly on a diet of caterpillars. So you will not be surprised to learn that caterpillars hide during the day when birds are looking for food. Some caterpillars rest on the branches of trees, some hide under leaves and some, like the large yellow underwing, spend the day in the soil or under leaves on the ground. Almost all caterpillars keep still during daylight as birds are much more likely to notice them if they move. So, if they are in the open during the day you would expect them to move quickly to a safe place, or refuge.

In this investigation you are going to see whether caterpillars, placed in the centre of a large circle drawn on a sheet of paper, move to the perimeter in a straight line or if they meander around before crossing the perimeter.

This experimental work was carried out in a university laboratory. The large sheet of paper was Blu-tacked to the table which kept the paper in the same position throughout the investigation. The table was positioned beneath a group of fluorescent lights in the ceiling of a room that had windows only along one side.

You will shortly be looking at the first four caterpillars as they move from a small circle in the centre of a sheet of paper to the perimeter of a larger circle. You will see the hand of a scientist mark the point where the caterpillar moves from the perimeter of the smaller circle until it reaches the perimeter of the larger one. By connecting these marks the track of the caterpillar is revealed – the length of the track can then be determined using a piece of string/cord. You will be able to do this on the whiteboard in the classroom and your teacher will explain how to do this. This will allow you to answer the following question – "Do moth caterpillars move in a straight line when they seek a refuge?"

The perimeter of the larger circle was also split into eight equal sectors, labelled 1 – 8. This will enable you to count how many of the twenty caterpillars leave each sector. This will allow you to answer the question – "Are the caterpillars equally likely to move in any direction from the centre of the inner circle"? Perhaps they may show a preference for moving, say, away from or towards the window. Again, your teacher will explain what you have to do.

Enjoy watching the crawling caterpillars!

The large yellow underwing moth (*Noctua pronuba*)

The large yellow underwing is one of the most common moths in the British Isles and has a very widespread distribution. It is often the dominant moth found in a moth trap in summer.

Large yellow underwing females lay their eggs in low vegetation, such as grasses, from late August to September. The larvae emerge after about twelve days and are about 1 - 2 mm long. They feed at night on a variety of plants, such as cocksfoot grass, dandelion and dock, They continue feeding during the winter, growing until they are about 50 mm in length. In April they pupate and adults emerge from June. Large yellow underwings are single brooded, with the adults flying from June to September/October, The adults are quite large, with a wingspan of 50 - 60 mm. They are nectar feeders and feed on a variety of plants. They also come to `sugar stations`, artificial sources of food which are usually a concoction of treacle, alcohol and other additives. This liquid is painted on wooden surfaces, such as a tree trunk or fence post. Compared with many moths, the adults are quite long lived, one study found that males may live for 2-3 months and females upto 4 months. The females, however, have a period of summer aestivation or dormancy when their reproductive system is developing, after which they become active again. Although the two sexes are similar in size it is a sexually dimorphic moth: those with lighter coloured forewings are female, darker ones are male. The hindwings of both are orange-yellow with a dark-brown/black border.

During the day, large yellow underwings rest on the ground with their wings folded. Their forewing colours are muted and the moths merge with their general background colours (crypsis). If disturbed, they open their wings quickly - this `flash` is thought to alarm a predator so the moth can escape. If they are chased in flight, by a bird perhaps, they dive to the ground. The sudden loss of the strong yellow signal from the hindwings makes it difficult for the predator to find it. They also lose their wing scales easily, This lets them shake free from a web and makes them slippery and difficult for humans to handle. This is another adaptation to help them during their risky lives!

Should you wish to see a live large yellow underwing adult in your house in the summer, just put all the lights on in one or two rooms at night and open the windows - you will almost certainly have *Noctua pronuba* as a visitor!

Five fascinating facts

1. Large yellow underwings are readily attracted to the mercury vapour lamps in moth traps and some 'mothers' have recorded more than a thousand in a single trap in one night!
2. Females lay their eggs in compact batches on the underside of the leaves of the foodplants - they can lay over 1000 eggs.
3. Large yellow underwings can use the moon, stars and a magnetic sense when flying!
4. They are very strong flyers - one American record suggests a moth flew over 150 km in one night.
5. *Noctua pronuba* has actively colonised North America in the last four decades: the first moth reached Nova Scotia in 1979 and by 2002 they were in California!