Patterns for Life MOTHS

Moths, Adaptations and Predators

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Background material for teachers

1. Student investigation of the effectiveness of moths resting against a background

For the study of identifying moths against a background we have found the following procedure works very well and gives consistent results across a wide age range, from Year 2 to adults! Ideally, you want to try this investigation in a room or laboratory that has students at different distances from the large sheet of paper: a lecture theatre is perhaps best but the effect is evident in a laboratory or even a conventional classroom.

Choose a background paper that is varied rather than plain. We have used the same one for around 10 years and it is a large sheet made from 4 pieces of gift wrap paper sellotaped together, see Figure 1. Cut out 20 – 30 moth outlines, like this one here, see Figure 2. Use some white paper, some yellow paper, some fairly close in colour to the predominant background colour (in this case red) and some from another sheet of gift wrap that is the same as the background paper. Place the paper moths on the large sheet without any conscious bias. We have placed 2 or 3 of the gift wrap moths over their `true` position on the large sheet so that, in theory, they would match the background completely. With white and yellow moths on the paper, you will find that every student sees 11 moths (the total of the yellow and white moths) and others may see from 11 – 26 (the total number on our sheet). It is rare that the maximum number of 26 is seen.

Figure 1 Suitable background gift wrap with moths

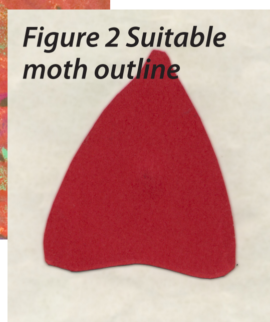

Figure 2 Suitable moth outline

For GCSE students, 20 – 30 seconds exposure time to the stimulus sheet is sufficient for them to count the number of moths they see. When you collect the data it is best to start asking for the student response from those furthest away from the large sheet of gift wrap to counter any possible conformity effect. Record all the counts for students at the same distance from the stimulus sheet in one group, so that the mean can be calculated. Then record from the next furthest group away from the large sheet and so on. A graph of mean number of moths seen against distance from the stimulus sheet almost always produces a negative correlation: students nearest the sheet see most. This outcome can be discussed in relation to predators, such as birds, searching for prey (moths) on tree trunks, fence posts, rocks, etc..

One of the best sources of moth images for British moths is Ian Kimber`s UK Moths` website - the address is www.ukmoths.org.uk/ . Ian is quite happy for his images to be used for educational purposes but for other uses contact him via the website. If you want to use the images provided by other people then you would need to contact them; these details are on the UK Moths website.

2. Research into prey polymorphism – Alan Bond & Alan Kamil

Bond and Kamil carried out a series of laboratory experiments investigating how well blue jays, *Cyanocitta cristata,* do when searching for morphs (forms) of the North American underwing moth, *Catocala relicta*. In fact the birds were trained to search for virtual moths on computer screens, see Figure 3 (and the Powerpoint slide).

[For example: Bond, A. B. & Kamil, A. C. 1998. Apostatic selection by blue jays produces balanced polymorphism in virtual prey. *Nature*, **395**, 594 – 596.]

Bond and Kamil were trying to explain why many of the moths that rest on tree trunks are polymorphic, i.e. there are several distinct forms of the same species. Invariably, it is only the forewings that are polymorphic, whereas the hindwings are remarkably similar. Polymorphism seems to be an evolutionary response to predatory success. The selective advantage of polymorphism is that predators, such as birds, find it harder and more time-consuming to search for two differently coloured prey than one. So it would pay birds to keep searching for the most common morph and switch when its frequency declined: this is called hunting by search image.

Figure 3 One of the birds (called Larry) in the laboratory set-up. [If the bird correctly sees a `moth` it pecks at it and is rewarded with a mealworm/food pellet dropping into the receptacle below its perch. If it does not find a moth it pecks at the green disk and the next pattern is projected onto the screen.]

In their studies, Bond and Kamil were able to manipulate computer images of moths and place them against backgrounds of different levels of difficulty for the birds, achieved by embedding the images into backgrounds of increasing crypticity. They found that the blue jays were remarkably good at detecting the moths, and it was only at the highest levels of crypticity that their performance declined. They also found that the birds detected more moths after a run of the same morphs than when a random selection of morphs was shown, evidence of the birds using a search image.

One of the most common moths in UK is the Large Yellow Underwing, *Noctua pronuba*. It has several morphs and four are shown below., Figure 4.

Figure 4 Four morphs of *Noctua pronuba*

Species of moths (other than the peppered moth!) illustrated in the resource

- Slide 2 Lesser Yellow Underwing (laying eggs), Emperor Moth larva, Large Yellow Underwing pupa and adult Herald
- Slide 3 Large Yellow Underwing
- Slide 4 Puss moth larva, Magpie
- Slide 5 Cinnabar, Garden Tiger
- Slide 7 Chinese Character (masquerading as a bird dropping), Large Yellow Underwing (hiding), Common Carpet (disruptive coloration) and Canary-shouldered Thorn (camouflaged as a twig)
- Slide 8 Cinnabar larva, Lunar Hornet Moth, Large Yellow Underwing, Eyed Hawk-moth
- Slide 9 Striped Hawk-moth, Large Yellow Underwing
- Slide 20 Willow warbler
- Slide 27 Glaucous Shears, Red-green Carpet

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