Group 2
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What the Moths Taught Us

Part 1: A Game

In the first part of this activity, your teacher will explain and play a game with you. The game requires counting some results. Enter these into the table below.

	Number of chits on the board			Percent Remaining	
	Dark (D)	**Light (L)**	**Total**	**Dark (D)**	**Light (L)**
Start	50	50	100	100%	100%
After Round 1	50	47	97	100%	94%
After Round 2	47	47	94	94%	94%
After Round 3	44	47	91	88%	94%
After Round 4	42	46	88	84%	92%
After Round 5	40	45	85	80%	90%
After Round 6	39	43	82	78%	86%
After Round 7	37	42	79	74%	84%

In this activity, we will:

1. Learn about a **real-world phenomenon** that was similar to the game that you played
2. Analyse the results from your game, by **doing some calculations** and **drawing some graphs**
3. Think about **how colour change can occur** in groups and individuals
4. Discuss whether **games and simulations** can be used to learn about the real world
5. Try and come up with possible **alternative explanations** for the real-world phenomenon, and thus learn a little bit about how scientists have **disagreements**

Part 2: Kettlewell's Problem

Henry Bernard Davis Kettlewell was a biologist in Oxford University. He was interested in studying peppered (spotted) moths. These moths had two types of wing coloration – light and dark.

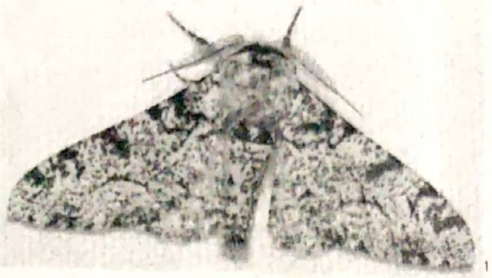

Figure 1: Light-winged (left) and dark-winged (right) peppered moths.

Until the year 1848, the number of light-winged moths was very large, making up 99% of the total moth population in the forest. However, over the course of the next 100 years, the population of the light-winged moths reduced to a mere 5% of the total moth population, whereas the dark-winged moths now represented 95% of the moth population. Dark-winged moths tended to outnumber the light-winged ones particularly near the industrial cities. Kettlewell wanted to understand why the proportion of dark-winged moths near industrial cities had changed in this way.

Kettlewell knew that peppered moths were prey to many insect-eating birds. It was also known that the moths rested on tree-trunks with their wings open. Kettlewell thought that the wings could camouflage with the background (i.e., hide from sight due to similarity) and would provide the moth some protection against predatory birds. Thus, in the past, when the tree bark and lichen growing on them was light-coloured, moths with light-colored wings were camouflaged, but those with dark wings were more likely to be visible to predators. However, in industrialised areas coal was burnt to generate power. Smoke from the burning coal killed lichens and caused the trees to darken with soot. According to Kettlewell, the light-coloured moths became noticeable against a dark background and thus became an easier prey for birds.

The phenomenon of change in colour of the moth population was called **industrial melanism**. In the term "industrial melanism", melanism originates from the word melanin. Melanin is the pigment responsible for human skin colour, and an increase in melanin leads to darker colour. Since the dark-winged moths had increased in proportion near industrial cities, the term "industrial melanism" was used to describe the change.

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Questions

Question 1

What are the similarities and differences between the game you played and the problem that Kettlewell was dealing with?

The group who played on dark sheet picked out more light chits & group who played on light sheet picked out more dark chits. There the birds are us & chits are moths.

Quantitative Analysis

Question 2

Each group of students is likely to have started with a different number of dark and light chits. At the end of the game, both dark and light chits would have decreased. Use the data you gathered while playing the game and fill in the table below.

Decrease between first and last round	Dark chits	Light chits
Actual numbers	13	8
Percentage	26%	16%

Now compare your results with those obtained by your classmates in other groups. Did the other groups get different results from yours? Which group of students saw the greatest decrease for each of the values?

Some groups got ~~whi~~ light & some got darks shets. The dark chits were left more on dark sheet & light chits were left more on light sheets.

Question 3

For the information above, is it better to compare the groups using whole numbers or percentages? Why?

It is better to compare by percentage because the chits taken by every group is different

Question 4

Draw a graph showing the number of dark and light chits left behind on the board after each round. Looking at your graph, what do you think will happen to the number of dark and light chits if the game is played further? Why?

According to the graph, after a period of time the black chits will disappear.

Group and individual colouration

Let's think about how the colour of the "moths" changed in the game.

Question 5

Think of each moth separately. Did the colour of the individual moths change? (Y/N) ✓

Question 6

Now, think of the moths together, as a group. Did the colour of the group of moths change? (Y/N) ✓

Question 7

If your answer to question ~~6~~ 8 was "yes", then why or how do you think the change occurred?

In a group as a whole if we observe when there are more light moths, group will appear light. With time the dark moths increased & the ~~ro~~ group appeared dark.

Question 8

Based on the game, do you think the colour of individuals needs to change in order for the colour of a group to change? Why?

No, because the colour of moths can't change because its their genetic formation. the reason is that ~~th~~ dark moths survived more as compared to light moths.

Learning about the real world using simulations

Question 9

We played the game and used it to come to some kind of understanding about Kettlewell's problem. We also drew some conclusions about the moths based on our game. Which of these conclusions would hold in the real world? Which of the conclusions would not?

The kettlewell theory showed that how things camouflage in surroundings. It also showed how ~~spiecis~~ spiecies adapt with time through evolution.

Part 3: Kettlewell's data and other scientists' disagreement

Kettlewell thought that there might be fewer light-winged moths near industrial areas, because white-winged moths would be more easily visible to predator birds. But he needed to test this guess using an experiment. To do so, he **marked** the underside of the wings of some moths and **released** them at sundown in a polluted forest near the city of Birmingham in England. In the following week, every evening, the marked moths were **recaptured** using various traps. Such an experiment is called a mark-release-recapture experiment. The following table represents the number of moths recaptured:

	Polluted Forest (Birmingham)
Light Wings	18/137
Dark Wings	136/493

The numbers in the table indicate the number of moths recaptured out of the number of moths marked and released. For example, 18/137 indicates that out of 137 moths marked and released, 18 were recaptured.

Questions

Question 1

Calculate the percentage of light and dark-winged moths that were recaptured:

Percentage of light-winged moths that were recaptured: 13.13% (approx)

Percentage of dark-winged moths that were recaptured: 27.3% (approx)

Which type of moth was more likely to be recaptured?

Dark-winged moths were recaptured more likely.

Question 2

Look at the percentages that you calculated in your game. Were they similar to those found by Kettlewell? Why or why not?

Our result was different as we performed on light sheet but it followed kettlewell's theory because in last white chits were left more

Question 3

What do you think happened to the moths that were not recaptured?

The moths that weren't recaptured must be preyed by birds

Question 4

Kettlewell's fellow scientists were not convinced by some parts of what he was saying about the moths. They agreed with some of Kettlewell's points, but disagreed with some other points. The reasoning by these two groups are represented by empty boxes in *Other Biologists'* column shown below:

Kettlewell	Other Scientists
There are moths on the trees	There are moths on the trees
↓	↓
Birds prey on the moths	Birds prey on the moths
↓	↓
Birds are able to see white moths more clearly	
↓	↓
Birds prey more on the moths which they see clearly	
↓	↓
Fewer white moths survive	Fewer white moths survive

The other scientists thought that there could be other reasons why fewer white moths survived. What line of reasoning can you think of that leads to the same result – survival of fewer white moths?

There could be a reason that light-winged moths doesn't survive in polluted areas as their were less no. of moths in industrial areas.

Question 5

What experiments could Kettlewell have conducted to convince his scientist colleagues that he was right?

Kettlewell performed mark-release-capture experiment & also showed that their are less white moths in polluted areas.