

How many Beany Beetles? - the evolution game

Investigating evolution by adaptation and natural selection

Ask the pupils what they think evolution means.

As new groups of animals and plants are born or develop, they may be a little different from their parents. This change over time and the natural processes that caused it, is called evolution.

Explain that there are several processes by which evolution can occur, but this game will focus on adaptation and natural selection.

Adaptation is a **trait** or characteristic which helps an organism survive and reproduce more successfully than other members in the same population of that species. For example, in the game, the green Beany Beetles are better camouflaged on green paper than the brown, so are not eaten by the birds in such great numbers. The green colour will be inherited and the inheritance of this colour will help the new generation of Beetles to survive. It is an advantageous trait. The green Beany Beetles have **adapted** to their conditions and those adaptations have been **naturally selected** and can (if chance permits) continue to evolve over time.

Divide the pupils into groups.

- Give each group a piece of coloured sugar paper and the rest of the equipment needed.
- Place a starting population of 20 Beany Beetles on to the sugar paper. 15 should be a contrasting colour to the paper (e.g. brown) and 5 the same colour as the paper (e.g. green), i.e. camouflaged.
- For each round, each group of pupil 'birds' throws the dice three times. Each time -
EITHER - if they throw a number between 2 and 6 they 'eat' (remove) that number of brown Beany Beetles,
OR -if they throw a 1, they 'eat' (remove) one green Beany Beetle.



The game with modelling clay Beetles
Photo: Elizabeth Devon

- Fill in the **Results Table** (page 3) as the game proceeds.
- After the third dice throw, it is time for the survivors to reproduce. For each survivor, add one new Beany Beetle of the same colour. These are the new generation of Beetles.
- Start a new round of three dice throws
- Complete at least four rounds unless one population gets completely eaten before then.
- Optional - repeat the game with different starting population ratios, backgrounds etc.

When the games are finished and the results have been compared, **ask the pupils:-**

- Which population increased?
- Can camouflage be considered an advantageous or disadvantageous trait?
- Did the camouflaged population increase or decrease in proportion to the more visible population?
- To discuss the reasons for the findings.

The back up

Title: How many Beany Beetles? - the evolution game

Subtitle: Investigating evolution by adaptation and natural selection

Topic: This game provides an introduction to the theory of evolution and is a useful activity for cross-curricular work covering science, geography, literacy, numeracy and art.

Age range of pupils: 8 - 14 years

Time needed to complete activity: 30 minutes but it depends how many games are played

Pupil learning outcomes: Pupils can:

- appreciate that, because the green Beany Beetles are better camouflaged than the brown, they will be less likely to be eaten by the birds;
- suggest that by being green, the Beany Beetles have adapted to their environment;
- realise that this adaptation will be inherited by future generations of Beany Beetles;

- appreciate that chance plays a part in evolution. In this game the number one means that a green Beany Beetle is eaten. If the one occurs more times than usual, then the green colour will not be such an advantage;

Context:

The game results usually show that the number of surviving brown Beany Beetles decreases and the number of surviving green Beany Beetles increases even though the ratio at the beginning was 5:1. Pupils quickly understand that being camouflaged gives the green Beany Beetles an advantage over the brown. Chance sometimes plays a part and then fewer than expected green Beany Beetles survive.

Following up the activity:

Pupils could investigate the lives of famous scientists.

Charles Darwin and **Alfred Wallace** were two great naturalists living and working in the mid 1800s. They travelled extensively around the world collecting a vast number of living and fossil samples and a huge amount of evidence from a large variety of different animals and plants to support their theories. By using the evidence available through the fossil record to living species, they explained the adaptations which led to the divergence of species from a common ancestor to the endless variety of living organisms seen today. Darwin and Wallace published their work on the theory of evolution in 1858/59 and firmly established the then controversial idea as the scientific idea that underpins most of biology today.

Underlying principles:

- Evolution is the name given to changes in the characteristics of descendants (successive offspring) of populations of organisms and the natural processes that caused such developments.
- Evidence shows that all modern species of plants and animals are descended from earlier species. They all share a common ancestor in the very distant, geological past and some have changed or evolved, over that long time period into the great variety of living things which we see in the world today.
- All species are related in some way through a huge, branching evolutionary tree.

- Any changes to the physical characteristics, or traits, of an organism which improve its chances of survival is called adaptation
- Natural selection or survival of the fittest (where 'fittest' refers to organisms that are better suited to survive and successfully reproduce than others) is a complex process where the whole environment governs whether members of a species survive to reproduce and pass on their genes to the next generation.
- Chance plays a part in evolution; the better adapted organisms may not survive to reproduce because of other reasons such as major external stresses or environmental changes or the introduction of a new predator to which they become prey. All these factors reduce their fitness (their ability to survive and reproduce).

Thinking skill development:

As the game progresses, a pattern emerges. Discussion of what is happening involves metacognition. Cognitive conflict is caused when chance plays a part in the results. Relating the game to the real world involves bridging skills.

Resource list:

- large sheets of paper, e.g. sugar paper
- dried beans of two colours or two colours of modelling clay to make cylindrically shaped 'beetles'
- enough dice for each group
- copies of the Evolution Game Results Table
- pencils.

Useful links:

http://darwin200.christs.cam.ac.uk/pages/index.php?page_id=j

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The Evolution Game Results Table

Round	Brown Beany Beetles		Green Beany Beetles	
Starting population	15		5	
	Calculations	Totals	Calculations	Totals
Example round	15		5	
Eaten (subtract)	3+5	8	1	4
Survivors	15-8	7	5-1	4
Offspring (add)	7+7	14	4+4	8
Total population for next round		14		8
Round 1				
Eaten (-)				
Survivors				
Offspring (+)				
Total population				
Round 2				
Eaten (-)				
Survivors				
Offspring (+)				
Total population				
Round 3				
Eaten (-)				
Survivors				
Offspring (+)				
Total population				
Round 4				
Eaten (-)				
Survivors				
Offspring (+)				
Total population				