why & how?
PRIMARY SCIENCE TEACHING TRUST

Teacher's Handbook

The Molliebird

An evolution story

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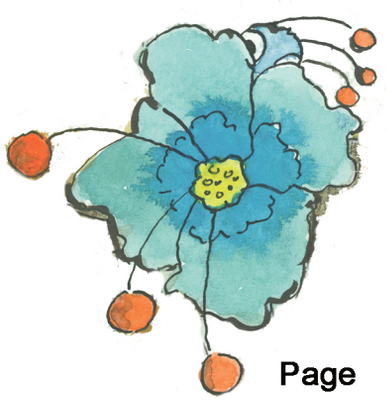
'The Molliebird': Teacher's Handbook

Foreword

Stories are a powerful way to engage children with new or complex ideas in science. Created by two PSTT Fellows, The Molliebird is a beautifully illustrated narrative poem that encourages children to think about concepts that relate to evolution. This accompanying teacher guide offers a wealth of support and suggestions to promote discussion and engagement with The Molliebird story and the science behind it. It is a brilliant resource for the primary classroom.

Alison Eley
Academic Director, The Primary Science Teaching Trust



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Introduction

Why use stories to teach science?

Can you remember your favourite story from childhood? Can you remember how it made you feel? That sense of connection with the emotions in a story can be very powerful for making a memory.

Reading a book as a launchpad for a science lesson is not a new idea. Many teachers use a story to give context, which helps children to understand how that particular science concept fits into the world around them and why is it important and useful. However, there is a greater reason to use stories in teaching: research[1] shows that our minds give 'psychological privilege' to stories so, if we learn a story with curriculum content, it is treated differently (by our brains) to an explanation of the content on its own. Stories are often easier to understand and remember than other forms of information. In particular, we tend to listen out for:

- causality (that one event causes another),
- conflict (which stops the goal being reached),
- complications (which give the story twists and turns)
- characters (who are complex).

It is often the emotional content of the story that engages us and makes the experience memorable. We think that it makes sense to use good stories, which have emotional content, to teach scientific principles.

[1]Willingham, D. T. (2004). *The privileged status of story. American Educator, Summer, 43-45, 51-53*

Chapter 1

Why use 'The Molliebird' to teach inheritance, natural selection and evolution?

'The Molliebird' has been written by two experienced primary science teachers who have noticed that children often hold on to misconceptions, even when the correct science has been clearly explained to them. It is not always obvious what these misconceptions are until you ask them to describe what they think is going on.

This book has been written to help generate discussion in the classroom, with the aim of getting children to vocalise their misconceptions. This will then allow you, as the teacher, to tackle these misconceptions with activities and discussion.

Evolution is a topic that is often discussed in very general terms, so 'The Molliebird' has been written to give a specific scenario for a class to discuss. Within that scenario, the authors have deliberately included a misconception–the bird thinks that she can choose to give birth to brown babies by coating herself in mud. She has noticed that brown mothers have brown babies who survive whilst her blue babies are eaten. So, she thinks that painting herself brown with mud will result in her babies being brown.

Children often have misconceptions about the time taken for a change to occur in a species. They think that it can happen very quickly, even within one generation. For this reason, the book tells the story of natural selection from beginning to end–the teacher can then discuss how long this process can take, thus dealing with that misconception.

By asking the right questions, you, as the teacher, should be able to identify the misconceptions held by children in your class. Often, taking part in that discussion is enough for children to work through their ideas, logically, to a better understanding of the science. You may need to reinforce this understanding with further activities, which are described later in this handbook.

Chapter 2

What science is covered in this book?

Inheritance and variety

We all inherit characteristics from our parents. This is because genetic material in the form of DNA (deoxyribonucleic acid) is passed on in the sperm from our father and the egg from our mother.

DNA is a long molecule that is made up of four types of molecule in a sequence. The sequence is like a code that tells the cells in our body how to function and how to grow. Everyone has a unique sequence in their DNA (unless you are an identical twin) and it is this sequence that makes you slightly different from every other human on the planet.

When sperm is formed, the father's DNA is split in half, much like a zip being undone, so that only half of it ends up in each sperm cell. The same happens when an egg is formed in the mother. The two halves 'zip up' again when the sperm and the egg combine to make an embryo and so half the DNA of a child is the same as that of the mother and half the same as that of the father. The DNA splits in half in a slightly different way every time an egg or sperm is made so we are similar to our brothers and sisters but never exactly the same (except for identical twins).

'Variety' is the term for these slight differences. There is always variety, even within members of one species. In the same way, no two Molliebirds would have looked exactly alike. They would have been slightly different in size, colour or beak shape–but they all belonged to one species that could mate with one another.

DNA contains the code for our eye colour, our hair colour, our temperament, even our likes and dislikes. Sometimes the DNA for one trait, e.g. brown eyes, can mask the DNA for another, e.g. blue eyes. So, a brown-eyed person may have the DNA to make blue-eyed or brown-eyed babies because the gene (a specific chunk of the DNA) for brown eyes is dominant and it masks the effect of the gene for blue eyes.

Some traits are governed by more than one part of the DNA. The Molliebird's feathers could be bright blue or dark blue or somewhere in between. Bright blue birds mating with bright blue birds would tend to have bright blue chicks. Dark blue birds mating with dark blue birds would tend to have dark blue chicks. If a dark blue bird mated with a bright blue bird, then the babies might be bright blue, dark blue or some combination of the two. This happens when no one gene is dominant–the result can be a combination of the different varieties.

Natural selection by the survival of the fittest–the mechanism for evolution

Darwin, on his famous voyages to the Galapagos Islands, made an astonishing observation: there were small birds, called finches, which were clearly related to the ones he had seen in England, but they didn't feed in the same way as the English ones. These finches had found all kinds of different ways to feed–there were those who fed on seeds, insects and even the blood of larger animals. How had this variety come about? Why was it not the same for finches everywhere? Why did these varieties exist and survive?

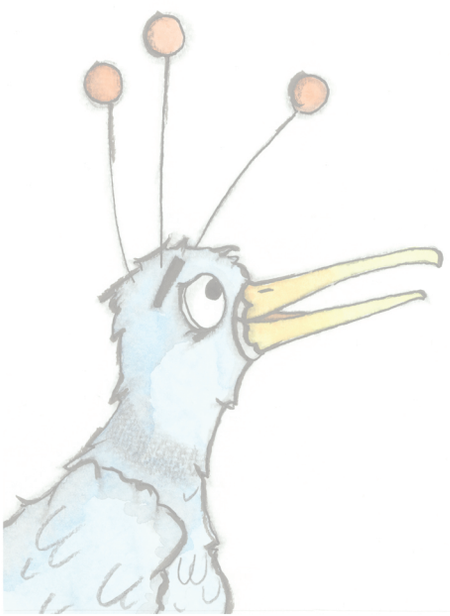
Darwin formed his idea of natural selection (by the survival of the fittest) to explain how this might happen. He suggested that there was one type of finch to begin with. As the numbers of finches rose on the island, food became harder to find. By chance, some finches were born that had slightly different beaks. If these beaks helped them to eat a different kind of food, which the others couldn't eat, those birds were more likely to thrive and live long enough to reproduce. They became 'the fittest'. Any offspring that they had (with the same slightly different beak) would also thrive and reproduce.

Thus, the new type of finch began to establish itself. There were many different potential food sources that were not being exploited by other animals so, gradually over generations, many finches that were born with different beak types by chance had the opportunity to thrive there.

There is always variety amongst animals (or plants) of the same species. Think of any animal: some are taller, some are faster, some have darker hair or are 'more attractive' to the opposite sex. In an ever-changing environment, there will be moments where one animal fares better than another because of its ability to thrive and reproduce in a particular environment. If this happens, then that animal might have an advantage and be more likely to survive to reproduce than other varieties. Thus, more of that variety might end up in a population. In extreme circumstances, where an environment changes to such an extent that only that one variety survives, a species could change from mostly one variety to mostly another. Thus, the species evolves.

In 'The Molliebird' story, the environment changes drastically as a result of a forest fire. Bright blue birds are now clearly visible against the sooty backdrop and more likely to be eaten by the tree snake, which hunts by sight. The first two mates (and batches of offspring) are bright blue. But when The Molliebird mates with a bird, that, by chance, has some darker blue plumage, she has a chick that is much darker than normal. The darker chick has the advantage of better camouflage in the soot-covered forest that is regrowing with darker species of plants and so that darker chick survives. Any other chicks that The Molliebird has with this same mate might be darker too and the dark chicks may grow up and have darker coloured chicks themselves.

In a darker coloured forest, these darker chicks are more likely to end up being the type that survive the best and become the most numerous. They may end up as the most common variety of their species as all the others are easier for the tree snake to find and eat. Thus, The Molliebird's species evolves.



Chapter 3

What are the common misconceptions about inheritance, natural selection and evolution?

There are three main misconceptions that can be tackled using this book:

• **Environmental changes to the appearance of the parent (i.e. those not caused by their DNA) will be passed on to the offspring.** Children often believe that, if the features of an adult animal are changed (e.g. hair length or colour), then this change will be passed on to the offspring.

• **An animal can choose to change its features and that this will be passed on to its offspring.** Children often believe that an animal can choose to change to fit an environment rather than an animal being born with a different feature that suits that environment, by chance. (For example, they may think that dark brown bears moved north to find food and decided to make their own fur go white for better camouflage in the snow.)

• **Evolution is a very quick process.** Children often believe that evolution is almost instantaneous. They think that all the animals in the species change simultaneously, or within one generation. (For example, they may think that the dark brown bears went north to find food and all the bears went white at the same time.)

These misconceptions can be identified using 'The Molliebird' book and the questions listed in Chapter 4. Listen out for these misconceptions when you discuss the story.

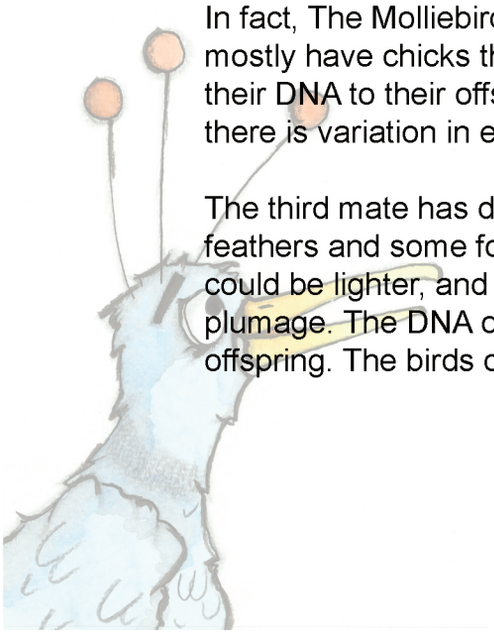
The children may say:

1. **Every chick that The Molliebird has with mate number 1 or 2 would be bright blue.**
   In fact, a different chick can be born by chance to any parent bird. Human children don't always have the same hair colour as their parents (although it is more likely).

2. **The Molliebird will make her chicks brown by coating herself in mud.**
   In fact, The Molliebird can't change her DNA for blue feathers by changing her own colour with mud. Therefore, she will pass on her DNA for blue feathers no matter how muddy she is.

3. **The Molliebird decided to have darker blue chicks so that the snake wouldn't see them.**
   In fact, The Molliebird is unable to voluntarily change the colour of her offspring. She will mostly have chicks that are similar in colour to her and her mate because they pass on their DNA to their offspring, and this will produce mostly chicks that look like them. As there is variation in every population, some of them may be darker or lighter.

   The third mate has darker patches of feathers, so he has some DNA for darker blue feathers and some for lighter blue. Some of his offspring are likely to be darker but some could be lighter, and some could be a mixture of dark and light blue, just like his own plumage. The DNA of the father and the mother will determine the colour of the offspring. The birds cannot control the colour of their offspring



4. **The Molliebird decided to mate with the darker bird to get darker chicks.**
   There is some logic in this suggestion. When we selectively breed dogs for a certain purpose, we do indeed choose dogs that exhibit the traits that we want in their babies, e.g. huskies are selected for breeding based on the thickness of their coats and their strength. A strong parent is likely to have a strong baby. Some animals even advertise how fit and healthy they are with a display of some sort, in order to get a mate. So, some animals do choose a mate based on their features.

   So, this could happen if The Molliebird was capable of working out that the colour of her mate could influence the colour of her offspring and that her babies would be more likely to survive as a result. In the real world, however, this is unlikely. Humans can understand the process of inheritance and make clever choices in selective breeding, but birds are unlikely to be able to do so.

   If, as happens sometimes, a male appears to be more attractive to the female then she may choose to mate with him. If the darker feathers acted in the same way as a peacock tail–signalling that the male bird was particularly fertile or strong–the female might instinctively prefer him to other mates. The Molliebird could be interpreted as doing this. It makes for a good discussion point!

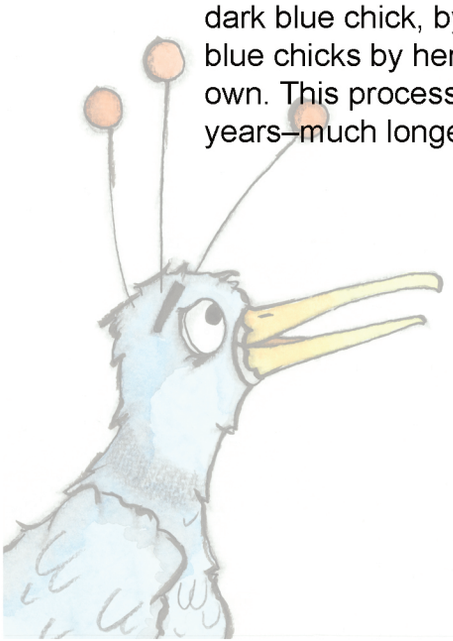
   However, as The Molliebird tries to change the colour of her babies with mud, some children will suggest that she *consciously tries* to change the colour of her babies by mating with the third male with darker feathers, which is not the case with real birds.

5. **The Molliebird's forest regrows within in a year or two.**
   In fact, a forest takes a long time to regrow. It could take as long as 100 years.

   Perhaps more importantly, the time it takes to populate the forest exclusively with dark blue birds would take a long time too. There is no sign of the original Molliebird with her bright blue plumage at the end of the book, so we know that some time has passed between the fire and the last scene of the regrown forest.

   That original Molliebird and her third, surviving, mate would have bright blue and dark blue chicks. It is likely that only the dark blue ones would survive long enough to reproduce as the snakes would probably eat the lighter blue ones.

   Most birds can only have one or two clutches of eggs per year and the chicks will take a few months, at least, to reach maturity and have their first clutch. The Molliebird's species produce around three eggs per clutch, so the original Molliebird might have one dark blue chick, by chance, each year. She could not repopulate the forest with dark blue chicks by herself. Her dark blue chicks might then have dark blue chicks of their own. This process is likely to take many, many generations and, therefore, many, many years–much longer than a year or two.



Chapter 4

How should I use 'The Molliebird' book with my class?

Before you read the book: The children will need to understand the mechanism of inheritance before they read 'The Molliebird': an organism inherits characteristics from its parents because DNA is passed on from parent to offspring in the egg/sperm or egg/pollen, for example. The sequence of molecules in the DNA is the code that passes on the characteristics of the parent organisms to their offspring.

To teach inheritance, spend some time looking at family photographs. Discuss the fact that children look like their parents. As some children will not know what their genetic parents look like, you may want to look at photos of your own family or of a celebrity so that everyone can join in with spotting the differences. There are many more examples online that you can find by searching for celebrities who look like their parents.

This can also be true for animals. Prominent markings of a parent animal will often be passed on to their offspring. Have a look online for examples.

Then read the book for the first time: Read the book to the class in whichever way best suits your style. Some teachers use a visualiser to share one book with the whole class so that they can see the pictures clearly, some sit in a reading corner. Other teachers have multiple copies of the book so that children can follow along with the story at their desks. You could even read in small groups as a guided reading session.

Read it without stopping, initially. Get a sense of the whole narrative from beginning to end. Give the reading some expression to hook the children with the emotional side of the story.

Then read the book for the second time and pause on each page to ask these questions:

Can you see The Molliebirds?

How many can you see?

What is the monster?

How has the forest changed?

Can you see The Molliebird now?

Why are the chicks bright blue?

If she had more chicks with this mate, what might they look like? Would they all look like that?

Do you look like your siblings?

How many birds have been eaten? How do you know? (Hint:How many lumps are there in the snake?)

Why do some of the birds get eaten?

Why didn't The Molliebird get eaten?

What is The Molliebird thinking in this picture?

How did The Molliebird try to solve the problem?

What do you think of that idea?

Is there anything The Molliebird could have done that might have worked better than coating herself and the eggs in mud?

If The Molliebird had more chicks with the third mate, what might they look like?

Did The Molliebird choose to have darker chicks?

Which birds might live long enough to have chicks of their own?

Why are there lots of darker chicks at the end?

The book says that The Molliebirds lived with their brothers and sisters and cousins and aunts. What would the brothers and sisters look like?

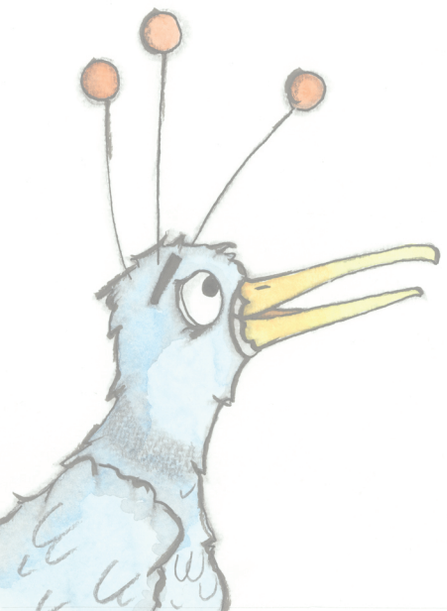
How has the forest changed from the beginning to the end of the book?

Darwin talks about natural selection by the survival of the fittest. What does ‘the fittest’ mean in this scenario?

What natural event has happened to make them the ‘fittest’?

Higher level questions you might like to ask:

• What might happen if the number of snakes doubled?
• In this book, the snake hunts by sight. This is rare in the snake world. Most hunt using scent and heat and vibrations. If a new snake that hunted by scent arrived in the jungle, what might happen?
• The baby bird is physically different from his mother. He might behave differently too. How might that help the birds to survive?



Chapter 5

What activities could I do after reading 'The Molliebird' with my class?

A) Variety Activities

Make model birds to demonstrate variety

You will need:
• 20g plasticine per child–some red and some blue

Give out 20g of plasticine to each child.
Give most children 15g blue and 5g red.
Give a few children all red and a few children all blue.

Give only one instruction–make a small bird. Look at the variety of birds created at the end. Allow the children to mix/use the colours in whatever way they like. Discuss how this is like nature–small differences lead to variety.

Imagine a scenario where the forest is invaded by a new species of red flower. What might happen to the number of each variety of bird?

Look for variation in the classroom

You will need:
• Paper
• Pencils
• Mirrors

Ask the children these questions and ask them to record their answers to each question in order.

Can you roll your tongue? Y/N

Y N

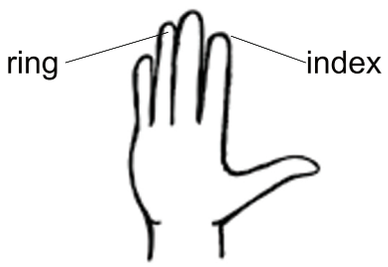
Have you got a 'widow's peak' hairline? Y/N

Y N

When you fold your arms, is your right arm on top? Y/N

Y

Is your ring finger longer than your index finger? Y/N



Y

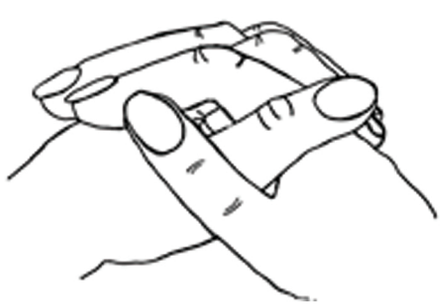
Is your earlobe attached at the bottom? Y/N

Y N

Does your thumb bend backwards at the tip? Y/N

Y N

Clasp your hands together – is your right thumb on top? Y/N



Y

Look at your sequence of answers.
Are they the same as anyone else's in the classroom?

Thank you to Dr Alex Sinclair and St Mary's College, Twickenham for generously allowing us to use this activity.

B)Camouflage Activities

Investigate camouflage by drawing your own forest and birds

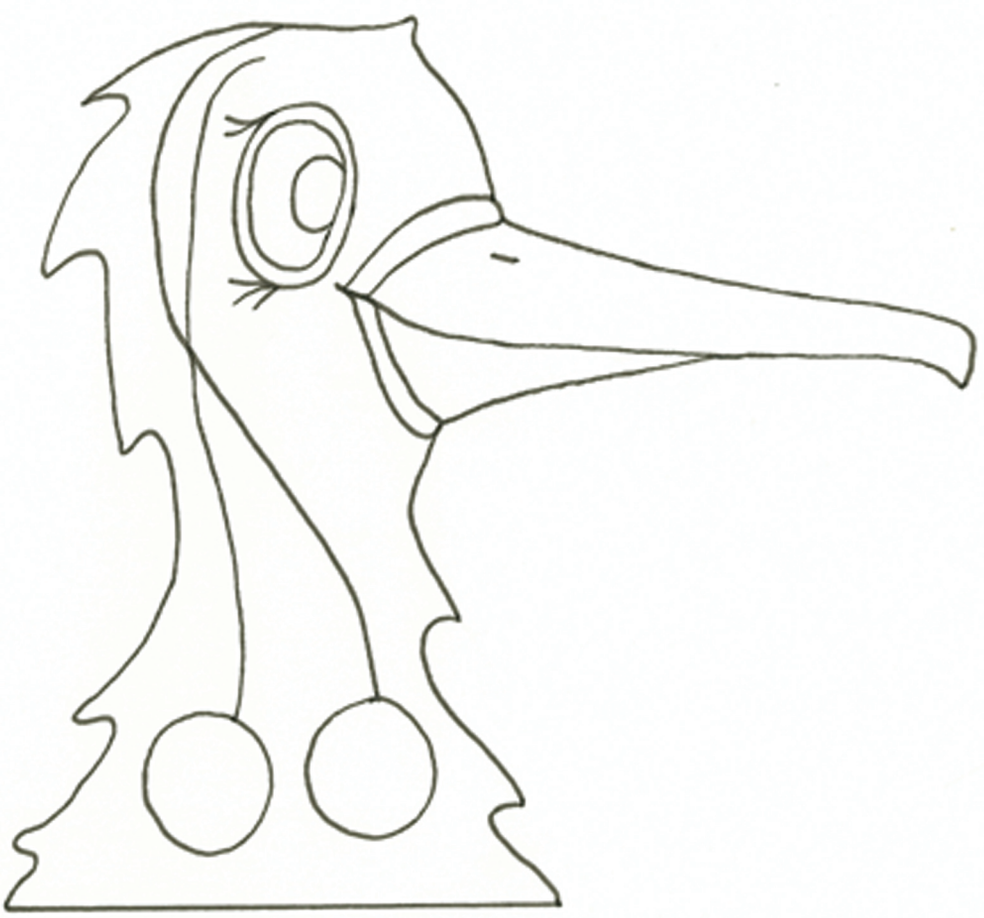
You will need:
• Paper
• Paint or pens
Ask the children to draw a forest. Then, draw a bird that would be well camouflaged there. Ask what its offspring might look like. Which chicks would fare better? Which would fare worse?

Investigate camouflage by colouring Mollie Lollies

You will need:
• Photocopies of Mollie Lollies template (below)
• Lolly sticks
• Colouring pens and pencils
• Tape

Ask the children to colour in the photocopied templates with one colour of their choosing. Cut out each template and tape it to the top half of a lolly stick. Position them in an outdoor area by pushing the lower half of the lolly stick into the ground. Stand back and observe the area. Count how many of each colour are visible.

Mollie Lollies template:



C) Inheritance and natural selection activities

Discuss pets that look like their owners

Check that the children have fully understood the process of inheritance in the following way:

Find pictures of pets that look like their owners–there are a surprising number of websites with content such as this! Show the pictures to the children and ask them if this is caused by inheritance! Hopefully, they will quickly tell you that the pet and owner do not pass on DNA to one another, so any similarity is purely coincidental or possibly caused by the owners' personal preferences. (It is interesting to note here that about 84% of our DNA is the same as dog DNA, almost 99% is the same as chimp DNA and 60% is the same as a banana! So, the part that makes us human, and indeed individual humans, all rests in about 1% of our DNA.)

Read other books about natural selection and evolution

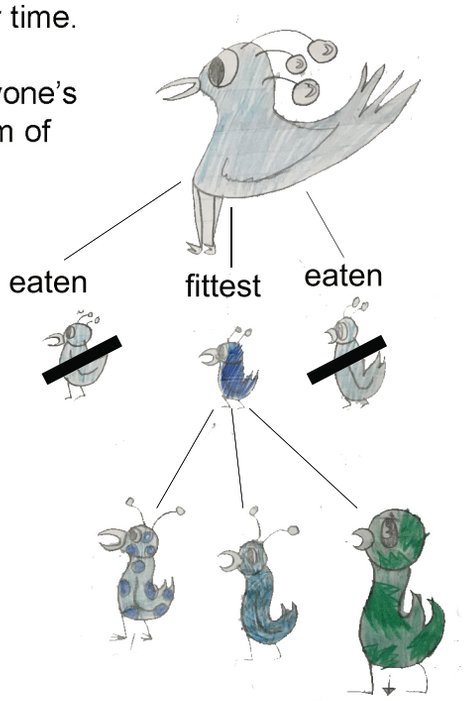
e.g. 'Moth' by Isobel Thomas (Bloomsbury Children's Books, 2018)

The peppered moth is a moth that is camouflaged on lichen-covered trees. In some areas during the industrial revolution, the trees became covered in soot. Only the darkest moths were camouflaged on these darker trees. The birds ate the ones that looked like lichen. So, the darker ones were the 'fittest' in that changed environment and there were many more dark ones in the population. As the air became cleaner, and the trees less sooty, this process reversed. It is beautifully explained in the narrative non-fiction book 'Moth'.

Create a Molliebird family tree

Ask the children to draw a family tree (like the one drawn by a Year 6 child below) with The Molliebird and her third mate, showing the two bright blue chicks and one darker one. Ask them to cross out the two bright blue ones as they were eaten by the snake before they could reproduce. Imagine and discuss the babies that the darker chick might have. Decide which ones would live and which would be eaten by the snake. Ask the children to continue the family tree for the chicks that lived. Discuss how the darker plumage might not be the only thing that changed over time.

See how different everyone's final bird is at the bottom of the family tree.



"This one is the fittest because it can easily camouflage into some leaves." Year 6 child

Imagine how an animal might evolve

Check that the children understand the idea of one animal being 'fitter' than another in a particular environment with the following activity:

Ask the children to find a picture of an animal. Then, ask them to redraw the animal with one feature changed. Discuss how this change to the feature might help. Relate this to the evolution of a giraffe or polar bear.

Play Clippy Island

You will need:
- Beans
- Bulldog clips
- Pots
- Trays
- Full instructions from the BBSRC website

This is a game that is free to download on the internet. It demonstrates what happens to the populations of different varieties of an imaginary bird species (beakies) in a series of different environmental conditions.
Visit https://bbsrc.ukri.org/engagement/schools/keystage3/natural-selection/

Create a timeline for evolution

You will need:
- A long piece of paper (or a long space on the playground)
- Pens or pencils (or chalk on the playground)
- Measuring tape

Mark metres along your paper (or playground) starting at the right-hand end and working towards the left. Each metre along shows 1 billion years passing. Measure out a line that is 4.56 metres long.
Write 'Now' at the right-hand end.
Write 'The Earth formed' at the left-hand end. This represents 4.56 billion years ago.

Now ask the children to find the answers to these questions and mark them on the line.
1. When was liquid water first found on Earth? (e.g. about 4.3 billion years ago)
2. When was the earliest life form found on Earth?
3. When was the first cell with a nucleus found on Earth?
4. When were the first land animals found on Earth?
5. When were humans first found on Earth?

Different websites and books may give differing answers depending on how up to date they are. Find one that you trust and go with that. The main point that you are trying to make is that modern humans are relatively new to the Earth and that they took a long time to evolve from when the first cells were formed.

D) English Activities

Explanation role play

This will give your children the chance to practise explaining the process of inheritance and natural selection as an oral activity. This kind of oral rehearsal helps the children to order their thoughts before they write them down:

Role play the Molliebird explaining to the second mate (who is brilliantly blue) why she is covering the eggs in mud. The brilliantly blue bird challenges this idea. Write an explanatory text, from the point of view of the brilliantly blue bird, explaining to the Molliebird why painting herself will have no effect on the colour of the baby birds.

Nature documentary role play

Again, this will give your children the chance to practise explaining the process of inheritance and natural selection as an oral activity:

Take on the role of David Attenborough (or another nature documentary presenter) and report on the story of the forest. Comment on the fact that, before the fire, the birds are bright blue, whereas, generations after the fire, the birds are mostly dark blue. Use scientific terms such as natural selection, changes in the environment, inheritance and DNA in your explanations.

Write a playscript

This will help your children to internalise the story and connect with the emotional journey of the Molliebird. This may well help the learning to be remembered.

Write the story of the Molliebird as a play. Focus on the emotional aspects of the tale, pausing for dramatic effect when the bird loses her chicks, etc.

Write another natural selection story

Use the following story-making script to help your children generate ideas for a new story about another animal, which, by chance, has a baby that is different and thus escapes extinction:

Let's say you could create your own forest.
What would it be like?
What animal would live there?
Let's give your animal a name.
What would it eat?
Where would it make its home?
What is distinctive about your animal?
Let's say there are only a few of your animal left in the forest.
Why are there so few?
What has made life so difficult for that animal?
Let's say that there is a way for your species to avoid extinction.
Let's say by chance a baby is born that is different from the parents in some way. This difference helps that baby to thrive in this difficult environment. How is this animal baby suited to these difficult conditions?

E) Art Activities

Camouflage in Henri Rousseau paintings

Encourage the children to think about colours and patterns that help to camouflage animals in their natural environment:

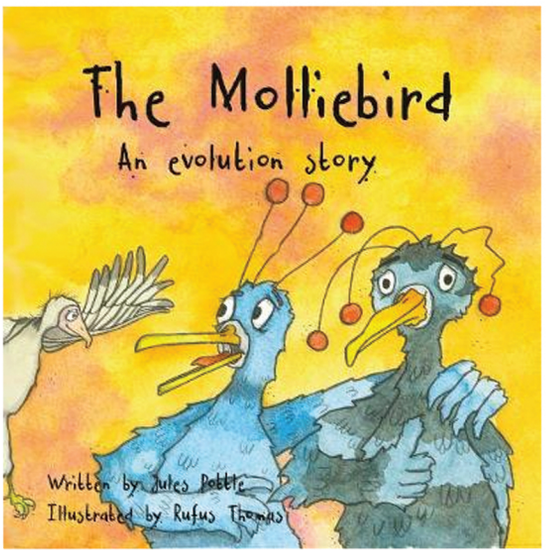
Ask the children to look at the forest- and jungle-themed paintings by Henri Rousseau. Can they see all the animals? Did they see them all immediately?

Research the foliage in a particular forest/jungle and the animals that live there. Spend time composing a painting of animals hidden within the foliage.

How to buy a copy of The Molliebird picture book

This teacher's handbook (free to download from www.pstt.org.uk/resources/curriculum-materials/the-molliebird) has been written to accompany The Molliebird picture book which provides a highly engaging fictional context for discussion about evolution. The story skilfully supports teachers with how to identify and address children's misconceptions about inheritance and changes within species.

To buy a copy of The Molliebird, please visit https://shop.pstt.org.uk/collections/frontpage/products/the-molliebird



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