

As part of Darwin200, you can join in a mass experiment to record the UK's banded snail population - see www.evolutionmegalab.org.

ON

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THE ORIGIN OF SPECIES

BY MEANS OF NATURAL SELECTION,



Celebrating Darwin

Charles Darwin is the old man with a beard on the back of our 10 pound note. Aside from the royal family, Darwin's face has also appeared on British stamps more than any other person's. He was born 200 years ago on 12 February 1809 and 2009 sees commemorations of the bicentenary of this famous scientist.



Royal Mail Darwin commemorative stamps

Celebrations include workshops to create poems inspired by Darwin, a mass experiment to record the banded snail population, exhibitions about Darwin's life and work, contemporary art shows based on his ideas, new music composed in his honour, walks retracing his footsteps and experiment kits sent to every school in the UK.

The reason he is so well known is because he was the first person to explain why there are so many different types of plants and animals all over the world. He wasn't the first to put forward

the concept of evolution – the idea that species gradually change into new species. But Darwin, and his co-discoverer Alfred Russel Wallace, were the first to describe the mechanism for how evolution occurs – a process called natural selection. Darwin wrote out his explanation in his bestselling book, *On the Origin of Species*. When the book was first published 150 years ago, these ideas were shocking because Darwin challenged the accepted views of the time that all plants and animals were created by God and had never changed, and that humans were separate from other creatures.

Key words
mutation
evolutionary tree
natural selection

Darwin essentials

Darwin's core ideas remain as simple as they are elegant. He realised that organisms produce many more offspring than are necessary to maintain a population. He noticed these offspring were not all identical, but they varied slightly, often due to random mutations. He observed that over time organisms with slight advantages for survival would live long enough to reproduce, concluding that, over many generations, this provided a mechanism for species to evolve in response to selection pressures into new forms and varieties. He also deduced, from the examination of geological structures, that the Earth was far older than many, including religious people, thought.



This tarantula has many offspring, each slightly different from its siblings. This is the variation necessary for natural selection to operate.

Box 1 Getting experimental

To celebrate Darwin's genius, every secondary school in the UK will be sent a free experiment kit to demonstrate the principles behind evolution and genetics. Each Survival Rivals kit contains three experiments enabling every student to get practical experience of how evolution works.

I'm a Worm, Get Me Out of Here for 11-14-year-olds explores natural selection by using different-coloured 'worm' baits that are selected and eaten by birds. The 'worm' bait for the experiment is spaghetti coloured with food colouring and students record which coloured bait gets eaten by the birds, and 'breed' the spaghetti according to which colours don't get eaten and so survive.

Brine Date for 14-16-year-olds explores sexual selection by studying brine shrimps in detail, looking at their mating habits and testing hypotheses.

The X-Bacteria for post-16-year-olds looks at antibiotic resistance in bacteria. In the experiment, two strains of bacteria, each resistant to a different antibiotic, are mated. The mated cells are then tested to find out if the antibiotic resistance has been transferred from one strain to the other.

The concept of evolution by natural selection is now stronger than ever, having never been falsified despite 150 years of intensive scientific research, and it has implications well beyond the realm of science. Darwin's ideas have become the framework of modern biological science, reinforced by our more recent understanding of DNA, genes and gene theory, and population genetics. Evolutionary theory now shapes our understanding of contemporary issues as wide-ranging as understanding the consequences of biodiversity loss across the world to modelling the emergence of new strains of the bird flu or Ebola viruses. At its most controversial it has challenged the place of humans in nature, the notion of a Creator and our authority over nature.

Early days

Charles Darwin was born in Shrewsbury to a wealthy and well-respected family. As a boy he hated school but loved playing outdoors and collecting beetles. Charles and his brother Erasmus did chemistry experiments in a shed in their garden which they called the 'lab'. His father, who was a doctor and wanted Darwin to become a doctor when he grew up, once said to him, 'You care for nothing but shooting, dogs and rat catching and you will be a disgrace to yourself and all your family'.

Darwin set off to follow in his father's footsteps when he went to study medicine at Edinburgh University at the age of 16, but he was horrified at the pain patients suffered when operated on without an anaesthetic, and dropped out after two years. He went on to study theology at Cambridge University with the intention of becoming a country vicar so he could continue enjoying nature. But on completing his degree, when he was just 22 years old, he had the opportunity to travel around the world, working as a naturalist on a ship called the *Beagle*.



The route of the Beagle

The voyage lasted five years and changed the course of his life. The ship travelled around the coast of South America, stopped at the Galápagos Islands, sailed along the southern coast of Australia and across to Mauritius, then around the southern tip of South Africa before returning to Falmouth. Along the way he was intrigued by, and collected, thousands of exotic plants, animals and fossils that had never been seen before in Victorian Britain. It was when he was visiting the Galápagos Islands, off the coast of

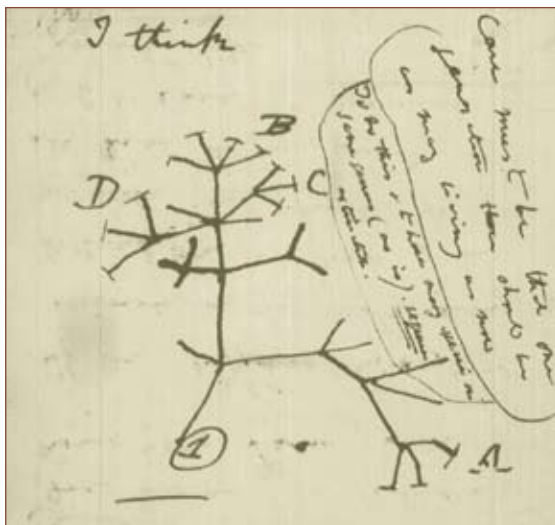
South America, that he noticed the similarities and differences between the mockingbirds on different islands. (He later wrote about the famous Galápagos finches which he only found out about on his return to England.) This set him thinking about how new types of animals evolve.



Three species of mockingbird from the Galápagos Islands. Darwin sought to explain how separate species like these could have evolved from a common ancestor.

Sketching thoughts

Just six months after returning from the voyage, Darwin first sketched his idea that all living things are related and have a common ancestor with a diagram of an evolutionary tree under the words, 'I think'. He spent the next 20 years studying the specimens he had collected on the voyage and accumulating evidence until he was confident that he could go public and announce his theory to the world.



Darwin was a scientist but he never worked in a laboratory as he did all of his experiments in his home and garden in Kent. And he often let his many children – he had 10 although only seven survived to become adults – help him. He tested his ideas with a variety of simple but innovative experiments. He soaked seeds in salt water to see if they would still grow into healthy plants if they had floated across the sea from one island to another. He grew seedlings through pegs to measure the strength of their shoots and scrutinised climbing plants to understand how they moved. Darwin studied domesticated animals to find out how characteristics were passed on to new generations and he kept fancy pigeons in a shed in the garden so that he could record which features they passed

on to their young. He even played the bassoon to earthworms kept in pots of earth in his study to see if they moved towards the music.



The greenhouse at Down House in Kent where Darwin carried out many experiments on plants, worms etc.

Darwin facts

- Darwin in north Australia was named in his honour by two of Darwin's former shipmates who led the Beagle's next voyage.
- 'Survival of the fittest' was not a phrase coined by Darwin. He borrowed it from the economist Herbert Spencer, on Wallace's advice. It does not appear in *On the Origin of Species* until the fifth edition.
- Despite being best known for his contribution to biology, Darwin was also a keen geologist.
- He forged his reputation as a biologist in a paper about the entire group of living and fossil barnacles – the product of eight years' study – after he was inspired by specimens he collected off the coast of Chile (see CATALYST vol 18 issue 3).
- Darwin was a prolific letter writer. In his lifetime, he sent around 14 500, including many to respected scientists including Joseph Hooker, Charles Lyell and Asa Gray.
- Darwin cultivated 54 varieties of gooseberry and many varieties of peas, cabbages and beans for his research on the diversity of species.

Katie Edwards designs exhibitions at the Natural History Museum, London.

Look here!

Find out what's going on in Darwin200 year:

www.lifesci.ucsb.edu/~biolum/

See all of his works online:

darwin-online.org.uk

