



DARWIN
INSPIRED
LEARNING

Enquire with
Darwin

KS2

Module 4: Interdependence

Lesson plan

Interdependent life forms

Darwin's garden experiments and country walks were vital to the development of his big idea of a constantly evolving world of interdependent life forms. Opportunities to become closely acquainted with nature, in all its diversity, are as important today as they were for Victorian naturalists.

On his Beagle voyage, Darwin saw lush tropical forests but, five years later when he bought Down House, the view from his study window prompted him to consider why the visible diversity surrounding his home was quite different from that of the tropics. Darwin compiled a huge collection of observations and evidence from the natural world with which to build theories.

Today, these '*endless forms most beautiful, and most wonderful*' (Darwin, 1859) which provoked so many questions, are under threat locally and globally.

Quotation

'It is interesting to contemplate an entangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so different from each other, and dependent on each other in so complex a manner, have all been produced by laws acting around us.'

Charles Darwin wrote these words in the last paragraph of his famous book, *On the Origin of Species* published in 1859.



Above: Tangled bank.

Below: Tangled bank in close up.

Lesson outcomes

- Deciding why it is important to collect data to answer questions.
- Focusing on a set of specific invertebrate and plant relationships while investigating a local environment in detail.
- Explaining the importance of observing and questioning when trying to understand interdependence in any habitat.

Curriculum links

- To make links between life processes in familiar animals and plants and the environments in which they are found.
- Different plants and animals are found in different habitats.
- Living things and the environment need protection.

Key words

Interdependence, life cycles, invertebrate, tangled bank, pollination

Resources

Hand lenses, white trays with a selection of mosses and flowering plants from the school grounds (see Notes for teachers), Darwin notebooks, pencils, digital cameras.

Fold-out identification guides - from the Field Studies Council (FSC):
www.field-studies-council.org/publications.aspx

- one each of the following: Day flying moths; Grasses; Playing-field plants (particularly good for school grounds); Orchids (if you visit Downe Bank or another nature reserve); Butterflies; Bugs on bushes; Grassland Plants; Ladybirds; Garden birds.



Above: Bumblebee collecting nectar and pollen.

Below: Fly orchid hidden in chalk grassland.

Lesson sequence

Pre-visit lesson

Starter activity

Working as a whole class, show Darwin's tangled bank quotation (see PowerPoint slide 2) and read it aloud. Move to slides 3, 4 and 5 and ask the pupils to imagine what it might be like to sit in this special place. What might they see? What might they hear? What might they smell? How different would it be at night? If they were to lie close to the ground, what new things would they see? Why did Darwin use a magnifying lens to study the plants and animals here? Record all comments on the whiteboard and save for later reference.

Main activity

Introduce Darwin's ways of working (see slide 6). Explain that Darwin was a great observer and looking closely at living animals and plants using magnifying lenses was an important part of his scientific work. He also collected pressed plants, fossils, dead butterfly and beetle specimens, feathers, bird skins and animal bones, to help him in his research and development of ideas. Ask pupils what sort of evidence they will look for when they take plants from the tray.

Encourage collaborative, enquiry-based learning as pupils work in pairs and use their hand lenses to explore these plants and any small animals that live there. Using the resource Darwin's ways of working: close observation (page 12, slide 12) pupils record their observations, questions and make sketches.

In groups, pupils discuss the life cycle of one or more of the plants they have investigated. Everyone draws one or more life cycles in their Darwin notebooks.



Above: Blackberries in the Sandwalk hedge at Down House..

Below: Red admiral on knapweed.

Pre-visit lesson

Plenary

Share Darwin's story of red clover (see Notes for teachers and slides 7 and 8). Explain the term interdependence and the importance of interdependent relationships between plants and animals. (Both the definition and other examples can be found in Notes for teachers pages 7 and 8)

Encourage pupils to think of other interdependent relationships from their own experiences in the local environment. Prompt thinking about how they would find evidence, and make links with Darwin's ways of working (slide 6).

Extension activities

Differentiation:

- Literacy - pupils write a letter to the educator at the site they will visit explaining what they have seen and how this evidence has influenced their ideas. They can include questions they might have about their evidence.
- To develop important argumentation skills needed in secondary school science, pupils could, for example, debate the relationship between ant and aphid or bee and clover; which benefits most from the relationship and why. Observational and library research evidence would be needed to support arguments and claims.
- Keep an ant farm or, to get the whole school involved, each class studies a small area of the school garden for an extended period of time to inspire everyone to observe and record changes in habitats, behaviours and populations.
- Encourage blogging to share all findings not only in school but through internet-based school links locally or worldwide.
- The fly orchid story could start a topic on wildlife mimicry and why it aids survival (see websites).



Above: Bumblebee on clover.

Below: Ants.

Visit

Visit a local nature reserve or, if possible, visit Downe bank (Darwin's Orchis Bank), managed by Kent Wildlife Trust. Spring, Summer and early Autumn are the best times to visit most nature reserves. To extend the potential to work out-of-doors, take short, '10-minute field trips' on dry winter days. The activity is more powerful if the school grounds or local environment can be visited regularly and changes over the year observed.

Encourage pupils to observe and identify some of the plants and animals they see using the FSC fold-out sheets. Also ensure all pupils take digital images of the environments they visit. They will need to link the images to notes in their Darwin notebooks so that they can produce a slide show and stimulate recall in the post-visit plenary.

Post-visit lesson

Main activities

Ask groups of 3 pupils to make a 3-slide PowerPoint presentation that will illustrate something each one saw that either surprised them or they had not seen before. Encourage groups to share their feelings about the place they visited, as well as their ideas and/or observations. In this way they share some key features of the plant / animal / habitat they investigated.

Plenary

Working in mixed ability groups, complete the Playing field mystery (see Resource materials page 15, slide 15). Find, print and laminate images and use them to make food chains and add these together to make a food web for the playing field (include all relevant organisms in the table; the dog is the odd one out). Differentiate with food chains of lesser or greater complexity.

Assessment of progression

Extend the Playing field mystery activity. The playing field is closed when a new one opens with better facilities. Half of the field is fenced for sheep pasture. Pupils work in groups to explain what effect this change would have on the habitat and their food chains. How would the half of the field without sheep be affected?



Above: Gatekeeper butterfly on ragwort.

Below: Fly on bindweed.

Notes for teachers

Pre-visit lesson

Main activity

Pupils will need to understand the concepts of life cycles and food webs before starting this unit. Revise in particular how plants are pollinated. It will also be helpful to revise hand lens technique with the class before practical sessions. It may be helpful to develop a mini-beast code for use with specimen trays or on visits.

Pupils could write a story about life on Darwin's tangled bank from the perspective of a snail, ant, mouse, owl, bat, moss, flowering plant, ladybird or aphid. These stories could then be developed into a play about interdependent life on a tangled bank inspired by Tennyson's lines '*Nature red in tooth and claw*' *In Memoriam* canto 56. (This poem was published in 1850, before *On the Origin of Species* in 1859 but this phrase, was taken to exemplify the process of natural selection and used by those in favour of the theory of natural selection and by those opposed to it.)

Encourage pupils to do personal research on the life cycles and habitats of their chosen animal. A local museum may provide schools with a handling collection of taxidermic specimens of British wildlife; useful as a thinking stimulus for pupils who respond to kinaesthetic learning environments.

E.O. Wilson said in an interview for *Time Magazine* in 1986: '*When you have seen one ant, one bird, one tree, you have not seen them all.*' Show slide 11. There are still undiscovered species in the world. As Darwin discovered, there are also ways to discover more about the known species. His hand lens was an essential observational tool that helped Darwin to see things differently. A hand lens can support pupils' disregard for human size scale, and help them consider the diverse and abundant organisms that dwell at our feet.



Above: Toadflax.

Below: Taxidermic specimens.

Pre-visit lesson

Specimens need to be collected on the day of use. It would be helpful to include all parts of the plant and some soil around any roots. Keep in a cool, dark place and mist sprayed to keep them fresh. Pupils might write a reaction to their new view of the world in the style of Rachel Carson's 1998 book *The Sense of Wonder*: 'A lens-aided view into a patch of moss reveals a dense jungle where insects as large as tigers prowl amid strangely formed, luxuriant trees'.

Definition: A dynamic model based on each species' resource exchanges with other species in a habitat; identifying each species' niche within a given ecology and successive increases in complexity as species evolve direct and indirect dependence on other species for resources.

Many plants depend on animals to pollinate them and have evolved interdependent relationship in which plants and pollinators benefit. A plant needs to make less pollen than if it is wind pollinated (much pollen is unused). Instead, insect-pollinated plants produce coloured flowers, nectar, and/or fragrance as well as pollen. Some plants have flowers that attract lots of different pollinators but other plants, for example, red clover and orchids, attract just one pollinating insect.

A good example of an interdependent relationship is the link between bumblebees, field mice and cats. Show slides 7 and 8 making sure that the pupils see the long tongue (proboscis) of the bumblebee inside the flower tube; it is the only bee that can pollinate clover because the flowers have a long narrow tube with nectar at the end. There are fewer bees if a field mouse raids nests locally and eats the eggs, larvae and honey. There are more bees where cats eat field mice.



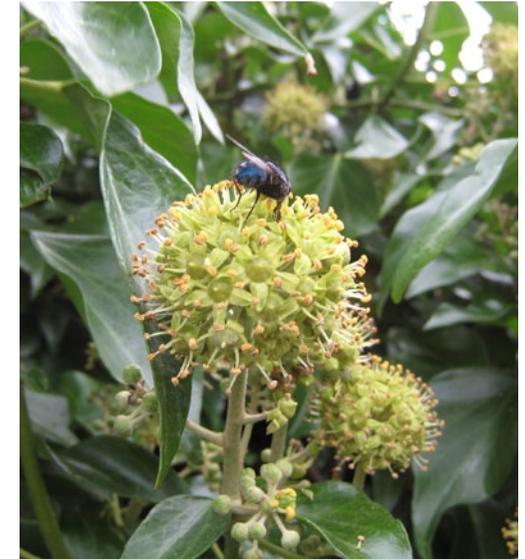
Above: Moss growing on a tree stump.

Below: Crab spider attacks a hoverfly.

Pre-visit lesson

Make a drawing of similar connections between aphids and ants. Aphids suck huge amounts of sap from plants to get nutrients, and honey-dew is the waste product they excrete. Ants are attracted to the sweet honey-dew and some even 'milk' the aphid to get it. Ants look after aphids and may even make protective plant structures or carry the aphids physically to feeding sites. However, ants will eat aphids if their population grows too large! Ray North (see references page 11), states that honey-dew forms 62% of a wood ant's diet while insects make up 33%, plant sap and tree-resin 4.5%, fungi and carrion 0.3% and seeds 0.2%. He notes that in temperate climates honey-dew is an important food source in early spring because there is little insect prey available. These percentages could be shown graphically in numeracy-linked work.

In 1860 Darwin began to make important discoveries about orchids. He wrote '*The contrivances by which orchids are fertilised are varied and almost as perfect as the most beautiful adaptations in the animal kingdom.*' The flowers of the bee, spider and fly orchids look very much like the insects. (see fly orchid on slide 9). It is called a fly orchid but male solitary wasps pollinate it. Pupils might ask why the wasp goes to another flower when the first one was unresponsive. Each plant produces a scent that is slightly different and the wasp hopes that the new flower will satisfy him. Male wasps mating with a fly orchid happens before the female insects have emerged from pupation. Once the females emerge, the males stop visiting the flowers.



Above: Fly on ivy.

Below: Bee orchid in chalk grassland.

Visit

A risk assessment will be necessary. Spring, Summer and early Autumn are the best times to visit most nature reserves. Visits to Downe bank (Darwin's Orchis Bank) near Down House in Kent in late May or early June can be organised with Kent Wildlife Trust. It is a species-rich chalk grassland filled with floral diversity, including native orchids, and an exceptional range of bees, wasps, hoverflies, butterflies, caterpillars and moths. A preparatory visit is essential, and Kent Wildlife Trust can provide a warden-guided talk if enough notice is given and a booking made. Visits to other nature reserves will need similar preparation. www.kentwildlifetrust.org.uk/reserves/north-west-kent-downs-area/downe-bank/.

A map to locate other reserves is available: www.wildlifetrusts.org/

Sites may close to the public in winter. 10-minute field trips in the school grounds or locally can be extended into dry winter days or summer night events / sleep-overs. In an urban school without green space, tiny tangled banks are found between paving stones, on brick walls and the weedy edges of playgrounds. Use hand lenses, collect images and evidence.



Cracks between paving stones are a habitat.

Post-visit lesson

Display slides from the field-trip experience, and encourage pupils to recall what they saw and felt. The slides can also stimulate questioning and further individual research.

Plenary

Print and laminate images to make food chains. Differentiate with food chains of lesser or greater complexity. Add the food chains together to make a food web for the playing field (include all relevant organisms in the table; the dog is the odd one out). Playing field mystery answers (in order across and down) are: grey squirrel, dog, earthworm, hedgehog, thrush, goldfinch, bats, blackberry, chaffinch, mole, snails, field mouse, swallows, kestrel, ladybird, woodlice, fox, ivy, bee orchid, bumblebees, blackbird, cat. Other animals are mentioned e.g. rabbit, slugs, vole, wasps, butterflies, aphids and spiders, that could also be part of one or more food chains.

Sheep, as the dominant grazer in a field, are better than mowing as the grass is removed over several weeks allowing insects to move away and ensure mounds like ant hills are not damaged. Birds can go on visiting. Sheep also find some plants tastier than others, so grazing removes different plants at different rates; mowing removes everything at once. Grazing also ensures aggressive weeds such as nettles and brambles don't take over. Orchids are less likely to be disturbed when people are kept out of a site. Droppings change the fertility; wildflowers thrive on poorer soil. Droppings also affect the acidity of the soil in the longer term.



Above: Cat and mouse.

Below: Sheep in a field.

**Website links, videos,
interactives, references**

Mimicry in flowers

<http://twig-it.com/films>

Plants and animals

www.bigwildlifegarden.org.uk/tips/see_full_list

www.plantlife.org.uk/campaigns/saving_our_magnificent_meadows/

www.plantlife.org.uk/campaigns/ghost_orchid_declaration/

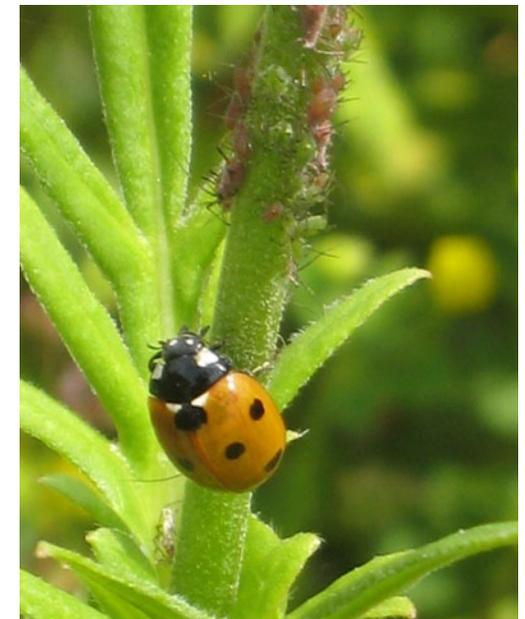
References

Carson, R. (1998) *The Sense of Wonder*, London: Harper Collins new edition with photographs by Nick Kelsh

North, R. (1996) *Ants*, Stansted: Whittet Books (out of print ISBN: 1873580258)

Keynes, R. et al. (2009) *The Darwin Guide to Recording Wildlife*, London: National Biodiversity Network. Downloadable from <http://www.opalexplornature.org/DarwinGuide>

Quotation from E. O. Wilson is from an interview published by:
Murphy, J. and Dorfman, A. (1986) 'Environment: the quiet apocalypse', *Time Magazine*, 13 October <http://www.time.com/time/magazine/article/0,9171,962542-1,00.html>



Above: Pollinator of fennel.

Below: Ladybirds eating aphids.

Resource materials

**Darwin's ways of working:
close observation**

Observations and sketches:

Notes and questions

Resource materials

Darwin inspired thinking: feeding relationships

'... worms crawling through the damp earth...'

What animals eat worms?

What could happen if the worms die out locally or become extinct?

Why could some animals struggle if one plant took over in the chalk grassland?

Resource materials

***'Nature red in tooth
and claw'***

Alfred, Lord Tennyson, *In Memoriam*, 1850

Resource materials

Playing field mystery

A grey animal with a big furry tail, eats or buries hazel nuts from the hedge.

Families bring an animal to the field. Off the lead it chases rabbits.

Where the grass is short there are small piles of earth that look as though they have been squeezed out of a tiny tube.

A prickly animal snuffles around on summer nights looking for worms and slugs. It has no tail and little black feet.

In the field, a brown spotty breasted bird flies away from a flat stone covered with pieces of snail shell.

Birds with a red patch on the eye and golden feathers cling to thistles in the winter and eat their seeds.

In summer, night-flying insects attract, small flying animals that swoop over honeysuckle in the hedge.

In the hedge, a prickly plant with black berries attracts wasps, flies and butterflies in late summer.

A bird with a pink breast and blue head searches under the hedge for fallen seeds.

Four dome-shaped piles of earth appear in the grass and earth is flung out of one of them.

There are silver trails on stones and brown striped shells on plants with tall stalks.

A reddish-brown furry animal with a long tail has made a tiny hole under the hedge.

In summer, birds that are arrow shaped fly low over the field to catch insects.

Some days a brown bird hovers over the field and swoops down to pick up a mouse or vole.

Red insects with black spots live on nettles and their larvae eat hundreds of green aphids.

Lots of little hard-shelled creatures scuttle around the dead wood under the hedge.

A reddish-brown furry animal with a bushy tail makes large holes under the hedge, a musky smell and howls on spring nights.

An evergreen climber in the hedge has triangular leaves, late flowers and black berries. There are spiders' webs here.

A very rare flower that looks like a bee grows on the edge of the field furthest from the path.

Red clover in the grass attracts flying insects that are black and yellow with white/buff tails.

A bird with a yellow beak and black feathers collects worms to feed its young in the spring but eats fruits and berries the rest of the year.

Marmalade, grey- or black-coloured furry creatures prowl the field and catch small birds or mice to kill later.

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