

Invisible garden

Teacher resources

This activity is to get students to look more closely at invertebrate animals that they have probably already encountered in their gardens. The work sheet is intended to be used as a prompt for thinking about the biology and ecology of these animals, and as such not all questions have a single right answer. The questions are meant to give an introduction to a range of invertebrates and their ecology, and be accessible to all levels, but it may be useful to talk to the students about food webs, exothermic animals, ecology and ecosystems if they have not studied these concepts yet as part of the curriculum.

Equipment required:

- Low powered microscopes or hand lenses (x10 –x 20 magnification)
- Petri dishes (tape to secure closed if desired)
- Garden invertebrates
- Worksheet per participant or pair of participants



Preparation

Most of the invertebrates included are easy to gather from any garden or vegetated space, but the honey bees and butterflies may require preparation further in advance to obtain specimens. The subsequent notes contain information on how to gather animals, answers to the questions posed in the worksheet, other interesting facts and further reading and activities if desired. This information can be conveyed by the facilitators during the activity, or given out as an 'answer sheet' after the activity.

Live invertebrates can be kept in petri dishes with the lids taped down. They should be kept out of heat and bright light as much as possible, especially worms, woodlice and slugs, which may need spritzing with water occasionally to keep them hydrated. Invertebrates can also be kept in the fridge for a couple of days if necessary, as the cool temperature will keep them alive but relatively inactive.



Honeybee

Find it! If you contact a local beekeeper they may be able to give you some dead honeybees from their hives. The British Beekeepers Association has a list of contacts for local associations http://www.bbka.org.uk/about/local_associations/

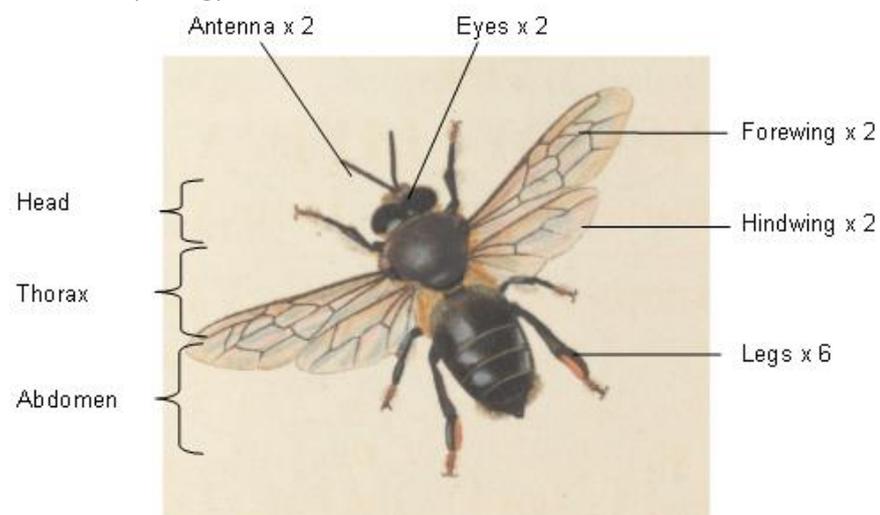
Questions

How many main body parts do insects have? How many wings? How many legs?

Honeybees are social insects – what does this mean?

Answers and other information

Insect morphology



Insects have three main body parts – head, thorax and abdomen. They have 3 pairs of legs and two pairs of wings.

Exceptions that prove the rule! In beetles the forewings are modified into 'elytra' hardened cases that protect the hindwings. In flies the hindwings are modified into 'halteres', drumstick shaped appendages that help the flies to balance and fly acrobatically.

How many legs does a caterpillar have? The answer is still six – they have six true legs which can be seen at the head end of the caterpillar, the legs further down are 'prolegs' they are temporary appendages that disappear completely when the caterpillar pupates to turn into an adult.

Social insects

Social insects are those that live in a colony and work co-operatively to raise young, with adults having different roles where only some get to reproduce. As well as honeybees some species of ants, wasps and termites are social.

In a honeybee colony one female is the queen, she lays all of the eggs. The eggs hatch out into workers, who are all sisters, and they gather pollen and nectar for the colony, build the honeycomb structure of the hive and look after the young. To start a new colony some larvae will be fed 'royal jelly' to make them turn into queens instead of workers, and some males bees will also be raised (they come from unfertilised eggs). A new queen will mate with males and go with a group of workers to a new nest site – this group is known as a swarm.

Other topics to introduce:

- Pollination
- Domestic bees and honey
- Waggle dance
- Genetic inheritance and relatedness

Ladybird

Find it! In the winter and early spring ladybirds, especially harlequin ladybirds, can often be found overwintering in sheds and houses. Look in corners and little niches and you will often find some clustered together.

Questions

Ladybird larvae look quite different to the adults and undergo metamorphosis – why might they have different bodies in different stages of the life cycle?

What species of ladybird is in the petri-dish?



Answers and other information

Metamorphosis

Unlike mammals insects do not grow gradually from their young to their adult form but do it in distinct stages known as instars. This is because their hard exoskeleton means they have to moult to get bigger and develop new body parts.

There are two types of metamorphosis:

- Holometaboly – the young are known as larvae and look completely different to their adult form. They have to enter an inactive stage known as a pupa to transform and then emerge as adults. Butterflies, moths, beetles, wasps, bees and flies are all holometabolous.
- Hemimetaboly – the young hatch out and are known as nymphs which often resemble the adult but are lacking some adult features like wings and genitalia. They go through several growth stages, moulting between each until they reach the adult stage. Grasshoppers, crickets, aphids, shield bugs, dragonflies and damselflies are hemimetabolous.

Having different body forms at different life stages lets insects specialise in different activities. The young forms are usually completely focussed on feeding, whereas the adults are focussed on mating and (if female) laying eggs. This also means that the adults and young often occur in different spaces and do not compete for food. The most well-known case of metamorphosis is the very hungry caterpillar. The caterpillar (larva) does nothing but eat plant food until it pupates and then emerges as a butterfly.

Identifying ladybirds

It can be difficult to identify ladybirds because there are often different forms within the same species. For example the two-spot ladybird has one colour form that looks like it has four spots, and many species have a 'melanic' (dark coloured) version of their colour pattern. The 7-spot ladybird and the 2-spot ladybird are probably our most commonly seen native ladybirds.

One species of ladybird, the Harlequin, arrived in Britain in 2004. There have been some concerns over the invasion of this species as the adults and larvae are both voracious predators. They may have an impact on native ladybirds by eating their larvae and competing with them for food. The harlequin ladybirds are very variable in appearance but are bigger than many of our native species and are often found overwintering in groups.

The ladybird survey website has a printable ID guide at http://www.ladybird-survey.org/species_list.aspx.

More information on the harlequin ladybird <https://www.rhs.org.uk/advice/profile?PID=962>

Butterflies and moths

Find it! Butterfly specimens can be found in insect collections or tropical butterfly houses may give you some dead individuals for educational purposes. Alternatively you could trap some moths using a light trap and release them after the exercise.

http://www.mothscount.org/text/86/equipment_and_where_to_get_it.html

Questions

What are the benefits of having scales on your wings?

Butterflies and moths have much longer proboscises than bees – how might this help them?

Answers and other information

Scales

Butterflies and moths are in the Lepidoptera family, so named from the Greek words *lepidō* (scale) and *pteron* (wing). Butterflies and moths actually have scales all over their bodies including their legs. Underneath the scales their wings are transparent and membranous, like bees wings.

Scales can serve many functions:

- Insulation against cold
- Help increase lift in gliding flight
- Protection against predators
- Colours and patterns in the scales can provide camouflage or warning colouration

The scales are detachable, and are often left behind when the moths and butterflies touch surfaces. This is especially noticeable for moths whose scales are more loosely attached. This can protect them from predators, as when grabbed or stuck to a spider web they can slip out, leaving their scales behind.

The colour on wings is due to the scales, and can come either from pigments within the scale or through a process known as structural colour. Structural colour is generated when the scale has a three dimensional structure that light bounces off of in such a way so it appears coloured to the human eye. Some more information and beautiful pictures of lepidopteran scales: <http://www.vqronline.org/vqr-portfolio/scales-wings-butterflies-and-moths>

Proboscises

The mouthparts of butterflies, moths, bees and sap-sucking insects like aphids take the form of a proboscis. The proboscis is a long tube that can be used to suck up liquid food, such as nectar from flowers. Butterflies and moths can coil this tube up so it is completely hidden under their head when not in use. The length of the proboscis determines how deep a flower the insects can drink nectar from. The longest known proboscis is that of the Morgan's sphinx moth which is over 20cm long and enables it to drink nectar from certain species of Madagascan orchid that have nectaries 20-35 cm deep.



The orchid *Angraecum sesquipedale*

Bramble leaf-mining moth

Find it! Nearly any patch of bramble will have some leaves containing this tiny moth. The white winding trails are usually quite easy to spot once you start looking (see image). Leaves can be handled directly by students or put into a petri dish if you don't want to risk them getting pricked by thorns on the stems.

Question *The caterpillar of this moth live inside the leaves, eating the track you can see, why might this be a good lifestyle choice?*

Answers and other information

Some of the benefits of being a leaf-miner are:

- Protection from predators
- Protection from wind and rain
- Some protection from heat and cold
- Plenty of food!
- Selectively eating the inner parts of the leaves – which are less tough because they have lower levels of cellulose.



Leaf mines are formed by the larvae of an insect, and there are many species that have evolved this lifestyle. The most common ones are formed by moths, wasps and flies. More information and identification keys can be found at: <http://www.leafmines.co.uk/index.htm>

Bramble leaf-mining moth *Stigmella aurella* is very common in the UK. The adult moths lay an egg on the bramble leaf and when the larvae hatch they go under the surface of the leaf and start eating out a tunnel to form a mine. You can see how this mine starts narrow at one end and gradually becomes wider as the caterpillar grows. When the caterpillar is fully grown it cuts its way out of the mine and forms a pupa on the leaf surface. The adult moth has a wingspan of only 6mm and mostly flies at night so can be hard to spot. They emerge and fly mainly in May, although they can have multiple generations in a year and therefore be present for longer. As the winter approaches the caterpillars slow down their feeding and overwinter inside the mine, and will pupate and emerge the next May.

If you hold the leaves up to the light you can see the caterpillar's frass (faeces) inside, and if the caterpillar is still resident it will appear as a dark blotch at the wider end of the mine.

Pictures of the different life stages of this moth can be found at:

<http://www.ukmoths.org.uk/species/stigmella-aurella>

Other common leaf miners

The holly leaf miner *Phytomyza ilicis* is a fly that forms a 'blotch' mine under the surface of holly leaves.

<https://www.rhs.org.uk/advice/profile?PID=531>

The horse chestnut leaf-mining moth *Cameraria ohridella* arrived in the UK in 2002 and is now very widespread. Multiple mines can occur on each leaf and make the leaves turn brown earlier in the year.

<https://www.rhs.org.uk/advice/profile?PID=533>



Slug

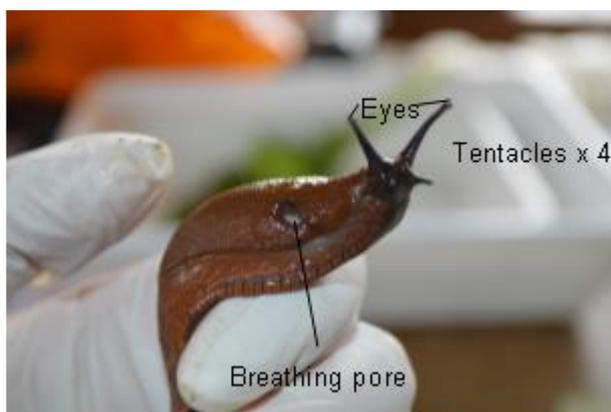
Find it! Slugs can usually be found in most gardens and outdoor spaces, check under logs and other shelters. Alternatively lay traps of cabbage leaves, hollowed out citrus fruits or plant saucers with some grain (hollow facing down) out overnight and collect in the morning.

Questions

Can you see the breathing pore?

Do slugs have shells?

Answers and other information



What is a slug?

Slugs and snails are gastropods; single shelled, soft-bodied animals in the mollusc group of animals. The name *gastropod* comes from the Greek words *gaster*, meaning stomach, and *poda*, meaning feet. All gastropods have a muscular foot that they use to move around.

A snail with a shell is the original form for a gastropod, in evolutionary terms. Slugs have a very reduced shell that often cannot be seen from the outside. Sometimes this takes the form of a small plate under the back of their mantle, and sometimes the shell is just a few granules of calcium carbonate. *So the answer is yes, slugs do have shells!*

Shelled slugs and semi-slugs still have an external shell, but it is not big enough for them to pull themselves inside like a snail. The slug in the image on the question sheet is a shelled slug (*Testacella haliotideia*).

There are more than 40 species of slug and over 100 species of snail in the UK. They have a wide range of diets including live and dead plant material, lichen, fungi and some are even carnivorous.

Some slug facts:

All slugs and most snails are hermaphrodites, meaning they have both male and female reproductive organs. This means that when two individuals mate, both can have their eggs fertilised.

Slugs and snails are largely nocturnal, so this is why you don't always see them eating plants, but just the holes they leave behind.

Their blood (hemolymph) is pale blue/grey

Take part in our slug hunt: <https://schoolgardening.rhs.org.uk/Resources/Activity/Slug-it!-mapping-UK-Slugs>

Millipede

Find it! Millipedes can be found in damp dark places such as under logs, in log piles, in leaf litter or under pieces of bark.

Questions

How many pairs of legs are on each segment of the millipede's body?

Millipedes are detritivores, what does this mean they eat?

Answers and other information

Millipedes have two pairs of legs on each segment of their body, in contrast to centipedes which have only one pair of legs per segment. Both of these animals belong to the myriapod family. Although millipede means 'thousand feet' the most found in nature is a Californian species (*Illacme plenipes*) with 750 feet (325 pairs). Most species have between 34 and 400 legs. When the young hatch they usually have only three pairs of legs, and they add new segments each time they grow and moult.

There are around sixty species of millipede in the UK, some of which can be seen at:

<http://www.naturespot.org.uk/taxonomy/term/19543>

Detritivores eat rotting material, this could be dead plants or dead animals. They perform a very important function in the ecosystem to help recycle nutrients. This recycling is also carried out by many species of fungi and bacteria, which are known as decomposers. Millipedes mostly eat rotting wood and dead plant material, but sometimes eat soft live plant material such as seedlings and fruit.

Woodlouse

Find it! Same places as millipedes.

Questions

How many legs does a woodlouse have?

Can you see the uropods (small tube like tails)?



Answers and other information

Woodlice have 14 legs. They belong to the isopod family of crustaceans – so they are more closely related to crabs and lobsters than to insects or myriapods. Like millipedes they are detritivores.

The uropods have multiple uses, they can be used as sensory organs, to excrete a liquid that is repellent to predators and to draw up water into their anus.

Woodlice have a number of interesting behaviours, you could try keeping some as pets to observe them. When woodlice young first hatch from their eggs, the females keeps them inside a 'brood pouch'. Unlike most invertebrates that have a hard exoskeleton they do not moult their cuticle all at once, but instead shed the back half first, and then the front half a few days later.

There are around 35 species of woodlice in the UK, some of which can be seen at:

<http://www.uksafari.com/woodlice.htm>

Earthworm

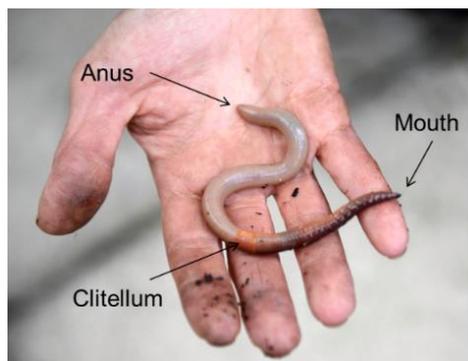
Find it! Go out with a trowel or spade, or if you're lucky turning over a log might be enough

Questions

Can you see the worm's setae (tiny bristles that help them move)?

Why are worms good to have in your garden?

Answers and other information



Worm morphology

Earthworms are long tube-shaped animals, with their digestive system running through their entire length. They have neither an exoskeleton like insects nor an internal skeleton like mammals. They keep their shape with fluid filled chambers and muscles going around and along the body allow them to move.

Setae are bristle like hairs on each segment of worm bodies, they are used to grip surfaces to help them move.

Adult worms have a saddle or belt like structure known as a clitellum, it produces the egg capsules after the two worms (which are hermaphroditic) mate.

Worms in the garden

Worms help with nutrient cycling in the same way that millipedes and woodlice do, by eating decaying plant material, digesting it and excreting it, thereby recycling nutrients into the soil. Worms also help improve the structure of the soil because of their tunnelling. There are lots of different species of earthworms, and they prefer different habitats.

Some earthworms live deep in the ground, they emerge at night to feed on dead plant material on the surface, and will pull fallen leaves and other plant debris into their tunnels. This helps bring carbon and nutrients down into the soil and mixes the soil by bring soil up from the deeper layers. These are often the worms that leave visible worm casts on the surface.



Surface-feeding earthworms live on or near the surface of the soil and they help break down leaf litter. Others live in the top 20 cm of soil, and their burrowing helps to aerate the soil and make it less compact.

Some species such as the brandling worm live in compost heaps, you can even buy some of these worms to add to your compost heap to make it work better

Identify common earthworms: <https://www.opalexplornature.org/earthwormguide>

Further worm activities:

Worms up close <https://schoolgardening.rhs.org.uk/Resources/Activity/Worms-up-close>

Earthworm watch <http://www.nhm.ac.uk/take-part/citizen-science/earthworm-watch.html>

Make a wormery <https://www.rhs.org.uk/advice/profile?PID=726>