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ROYAL ENTOMOLOGICAL SOCIETY - FOUNDED 1833

A Royal Entomological Society magazine for age 7+

DISCOVER THE AMAZING LIVES OF INSECTS!

Issue No. 1

INSTAR

THE MAGAZINE FOR YOUNG ENTOMOLOGISTS

INSIDE...

WHAT DO INSECTS EAT?

DISCOVER DRAGONS

Welcome to INSTAR!

INSTAR is a magazine full of great articles about insects and how to explore their world. Perfect for young entomologists. Let's explore!

Contents

BUZZ WORD

INSTAR

Young insects have to moult as they grow because their skeleton is on the outside of their bodies – called an exoskeleton. The stage between each moult is called an INSTAR. The number of instars that a young insect goes through before becoming an adult depends on the species and insects often change colour and shape between instars.

▲ *Caterpillars go through instars 4 or 5 times before they become a moth or butterfly*

Front cover main image: Queen wasp – German Wasp (*Vespula germanica*) resting on grape hyacinth after waking © DAVID MAITLAND

The importance of insects

Insects are everywhere! They come in very different shapes, sizes and colours which allows them to live in almost every habitat. Our lives would be very different without insects – they pollinate many of our fruits, flowers, and vegetables. They are food for amphibians, reptiles, birds, and mammals, and they feed on lots of living and dead things themselves. Some insects are predators that hunt other animals, others are herbivores that eat plants, and some live as parasites on or inside other animals. Others are scavengers and eat whatever they find in their environment.

Someone that studies insects as their job or hobby is called an entomologist. Over one and a half million species (that's 1,500,000!) have been recorded and described by entomologists and there are millions more to be discovered.

• An entomologist at work

Insects are fascinating, important and there is so much more to discover about them. INSTAR is full of insects and entomologists. See what you can discover!

BUZZ WORD

SPECIES

To make living things easier to talk about scientists put similar kinds of animals and plants into groups. The most similar living things are grouped together as one SPECIES. All species have a scientific name. The dinosaur species *Tyrannosaurus rex* is an example of a scientific name. The honeybee in the UK has the scientific name *Apis mellifera*. This means that scientists around the world have a name that they can all use without worrying about which language they speak. See how many scientific names you can spot in this magazine.

INSECTS

(OR NOT?)

Beetles, flies, bees, butterflies and earwigs are all insects. Centipedes, millipedes, woodlice and spiders are not insects.

So, what makes an insect? Insect adults have six legs and three body segments (a head, a thorax and an abdomen). Most adult insects have four wings too. Many insects can look very different when they are young though, for example a caterpillar that changes (or metamorphoses) into a butterfly adult that has six legs, four wings and three body segments.

Counting the number of legs on an invertebrate can be difficult whilst they are on the move for their next meal or finding somewhere to lay their eggs.

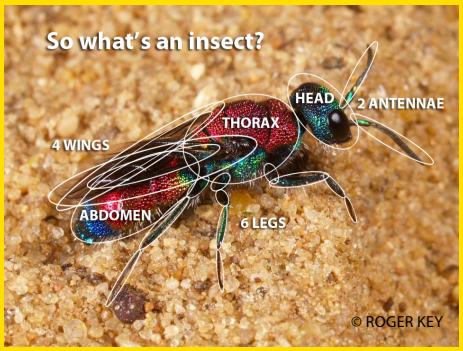
One of the simplest things you can do to look closer at insects is make a "spy-pot". Using a spy-pot can be a great way to keep a ladybird from flying or crawling away in a gentle way as you look closer. You can use it for lots of other invertebrates too, counting the legs on a centipede, for example.

To make a spy-pot, just get two clear plastic cups, carefully cut off the bottoms and replace them with cling film or some clear plastic held on with a rubber band. Gently place or scoop the insect (or is it?) into one of the cups so it is sat on the cling film or plastic bottom. Then slowly put the second cup inside the first until the animal is held softly between the two cups.

You now have a perfect container to look at the invertebrate in more detail. Give it a go, a great way to look closer. Remember that insects can suffocate if they are left in the spy-pot for too long, so let go whatever you are looking at after two or three minutes.

Insect:

Ruby-tailed Wasp (*Chrysis viridula*) showing the common features of adult insects



Not an insect:

Woodlouse

Did You Know...

The giant weta from New Zealand is the heaviest known insect species; one was found to weigh 71g.

Insects in Order

There are over 24,000 different species of insect in the United Kingdom and one and a half million species have been discovered around the world so far! Insects have been put into groups by scientists, called Orders. Here are some of the main orders...

Order Ephemeroptera
Mayflies – mainly live in water as larvae. Found near rivers and ponds. Adult mayflies have large wings and large eyes.


© ROBIN WOOTTON

Order Odonata
Dragonflies and damselflies – predators of the air. Can be very large.


© CHRIS BESTALL

Order Orthoptera
Crickets and grasshoppers – found in grass and trees. Good jumpers.


© PHILIP PERECY WT

Order Dermaptera
Earwigs – found under rocks. Usually brown, flat and long.


© WONG

Order Hemiptera
True bugs – when entomologists talk about 'bugs' these are what they mean. They have special mouthparts for piercing.


© SIMON LEATHER

Order Neuroptera
Lacewings – common predators that eat other insects. They have large wings.


© ROGER KEY

Order Coleoptera
Beetles – a very large group of insects. They have a wing case to protect their wings.


© PAUL PEARCE

Order Diptera
Flies – just one pair of wings and great fliers.


© WIKIMEDIA

Order Lepidoptera
Butterflies and moths – the larvae are called caterpillars and eat plants. The adults feed on sugary nectar.


© ANNELIESE EMMANS DEAN

Order Hymenoptera
Bees, ants and wasps – some live in big family groups called 'colonies', and many are important pollinators.


© ANNELIESE EMMANS DEAN

What happens when Yellow Crazy Ants meet Christmas Island Crabs?

Elva Robinson

Yellow Crazy Ant worker
Photos © EJH Robinson

What is a Yellow Crazy Ant?

The 'scientific' name is *Anoplolepis gracilipes*, but the proper English name for them genuinely is 'Yellow Crazy Ant'! They are called crazy ants, because of the way they move: they run around like crazy in a zigzag pattern. It makes your eyes swim just watching so many of them moving so quickly. The workers are yellowish-brown and slender, with long legs and very long antennae, so they look quite graceful when they actually stay still. They are about 1cm long. Like other ants, they live in colonies and usually nest in holes in the ground. There are around 4000 worker ants in each nest, and also about 50 queens and 50 males.

Why are they special?

Yellow Crazy Ants are very good at invading new areas where they have never been before. We don't know for sure where Yellow Crazy Ants come from originally, but it was probably somewhere in Asia. Now they are found in hot places all over the world: Africa, Japan, India, China, Indonesia, Papua New Guinea, Hawaii and Australia. One of the main reasons these ants are so successful is because they have an unusual way of living. Instead of just living in one nest, they spread their colony out across lots of nests. The workers from these different nests are not aggressive to each other and form what is called a 'supercolony'. Supercolonies can be aggressive to other Yellow Crazy Ant supercolonies, but some islands have only one giant supercolony. This means that the ants don't spend any time fighting each other and they can breed and spread very quickly. Because they don't fight, they can also live very close together and help each other find food. Sometimes there are as many as 10 nests per square metre. This means that there may be 285 million Yellow Crazy Ants in an area the size of a football field! That's more than 4 times as many as there are people in the UK.

Yellow Crazy Ant
Photo by John Tann (Creative Commons licence)

Christmas Island Crab
(Creative Commons Attribution 2.0 Generic license)

What do they eat?

Almost everything! The ants need protein and sugar. They get sugar from honeydew which is produced by other insects, including aphids. They also eat fruit for sugar. They have a 'social stomach' called a crop, which is extra big, so that they can bring lots of sugary honeydew back to the nest and share it with other ants. To get their protein, they are voracious predators of other insects, especially other ants, and will also scavenge on any dead animals they find. On their own, they can carry insects that are twice as heavy as they are. If they find something even bigger, they help each other carry it, so they can actually move insects that weigh a thousand times as much as they do! When Yellow Crazy Ants come into an area, their huge appetites mean that they can eat almost every ant that was there before.

Yellow crazy ants collecting food, Christmas Island. Photo by John Tann (Creative Commons licence)

What happens when Yellow Crazy Ants meet Christmas Island Crabs?

Where do the Christmas Island Crabs come in?

As well as killing off other ants, Yellow Crazy Ants can also kill off other animals. Around a hundred years ago, the Yellow Crazy Ants were accidentally brought to Christmas Island, an Australian island in the Pacific. In the last 20 years they have spread so much that they have become a devastating supercolony across the whole island. Christmas Island is home to the Christmas Island Crab, a big red land crab that is only found there. The Yellow Crazy Ants kill and eat the red crabs. We think that the ants have killed 10-15 million red crabs (25-33% of the population). Obviously, this is very bad for these unique crabs, but it also causes other big problems on Christmas Island too. The crabs are important grazers on the forest floor, eating some kinds of tree seedling. When the ants kill the crabs, the seedlings don't get eaten, so the balance in the forest is upset and some trees die out while others take over. Also, the Yellow Crazy Ants need so much honeydew that they protect the honeydew-producing insects in the trees. These insects are drinking the tree sap, and sometimes the ants encourage so many of them that the trees actually die. In some places, the trees that die are important food crops, like bananas or coconuts, so this is bad for the environment and also bad for the farmers.

Crab eaten by ants.
© Christopher Boland

Is there anything good about Yellow Crazy Ants?

Some cocoa plantations have big problems with a beetle called the cocoa weevil damaging cocoa trees. Yellow Crazy Ants eat the beetle, so this means that the ants protect the cocoa trees. Cocoa trees mean chocolate, so Yellow Crazy Ants aren't all bad!

Photo of Elva Robinson having a social (insect) tea © Julie Wilson

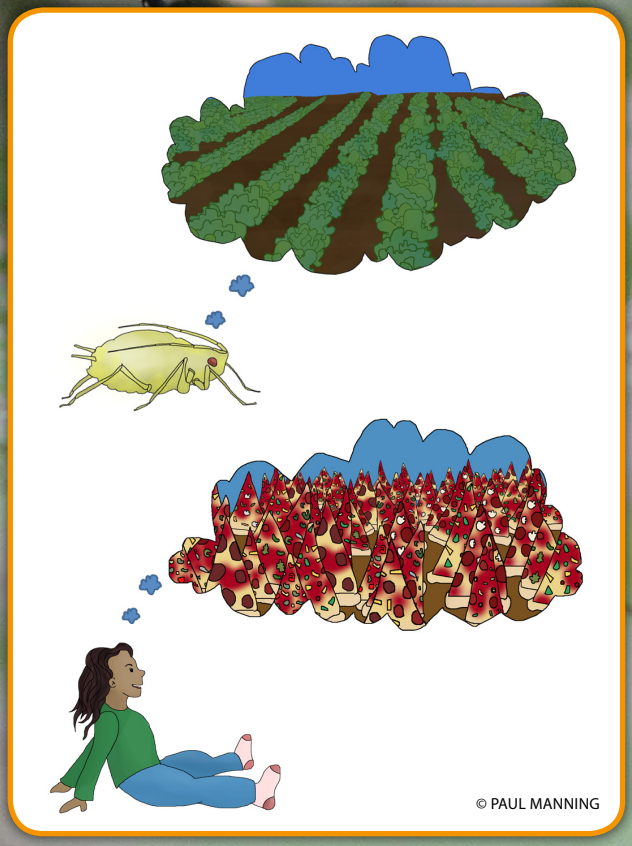
INSECTS THAT EAT OTHER INSECTS

Nathan Medd

• 7-spot ladybird and aphid – ladybirds can be used to control aphid pests

One of the many ways that insects affect our lives is that some species eat our food. This often happens when food is being grown in fields or greenhouses. We call these insects pests and a lot of time and money is spent trying to control them. If we didn't stop these insects from eating crops and stored food we would lose a lot of the fruit, vegetables and grain on which we rely.

When we grow our crops we provide insects that like to eat that type of plant with a very attractive meal. Imagine your favorite food in the whole world. Got it? Now imagine an entire field filled with that food, prepared just the way you like it and with no one to stop you eating as much as you like. That's what a pest sees when they come across a field of their food plant.



© PAUL MANNING

In nature the pests don't have it so easy. Their food does not grow in large fields by itself; it grows in small patches surrounded by other plants. In nature there are also dangers for the pest insect. Predators wait to eat pests that cross their paths, insects known as 'parasitoids' lay their eggs inside the bodies of pests, stalking silently, waiting for the perfect moment to sting their victims.

So, how do we stop pests from eating our food in fields and greenhouses? The traditional method for controlling pest insects is to spray the crop with a chemical that is toxic to insects. These chemicals, called insecticides, are very good at controlling pests. Pests can also be controlled in another way too, by using the predators and parasitoids found in nature. If we add or encourage other insects into crops to control pests this is called biological control. Biological control can be very useful for saving our food from pests and farmers all over the world use biological control to protect our crops.

BUG BOX 1: LADYBIRD

COMMON NAME Seven-spot ladybird

SCIENTIFIC NAME *Coccinella septempunctata*

ORDER Coleoptera (beetles)

ADULTS

SIZE 5-8mm

FAVOURITE FOOD aphids

LIKE TO BE on plants where there are plenty of aphids

SEE THEM April to September they hide and hibernate in cold months

FACT FILE

- Seven-spot ladybirds are the most common ladybirds in the UK and are easily spotted by the seven black spots on the wing cases and the white patches on the sides of its head.
- One of the biggest threats to a young ladybird is another young ladybird – they will eat each other!
- The bright patterns on many ladybirds are an example of warning colouration – ladybirds taste horrible!

BUG BOX 2: LACEWING

COMMON NAME
Common green lacewing

SCIENTIFIC NAME *Chrysoperla carnea*

ORDER Neuroptera (lacewings)

ADULTS

SIZE 11-14mm

FAVOURITE FOOD aphids, pollen and nectar

LIKE TO BE on plants where there are plenty of aphids

SEE THEM May to September

FACT FILE

- Male and female lacewings attract each other by making a sound by vibrating their abdomens.
- You can buy lacewings to control pests.
- The larvae eat aphids and other soft-bodied insects and they eat up to 60 small aphids in one hour. The larvae will feed for many weeks before making a pupa inside a cocoon of silk.

BUZZ WORD

PARASITOID

A parasitoid is an insect that lives in or attached to another insect when they are larvae. Adult parasitoids lay their eggs in or on another insect, which we call the host. The egg hatches and the larvae eat and kill the host while they grow.

Flower power

Bees, hoverflies and butterflies are perhaps the best known of the flower-feeding insects that we call pollinators, but even insects like ladybirds will enjoy a feast of flower food if they can find one. Pollinators are one of the easiest insects to attract into your garden or watch in a park or playground.

Top tips for giving insects flower power:

Choose flowers for the right month of the year – when you are walking around have a look at what insects are landing on and eating. Different insects need pollen and nectar from flowers at different times of the year. So if you are planting flowers then try to make sure there is something for them to eat over as many months as possible. Many garden centres have labels to help you chose flowers that are good for pollinators.

Try to think like different insects – remember that insects come in many shapes and sizes, and have different length tongues and different sized bodies. Some insects like butterflies and bees can reach nectar that is deeper in a flower using their long mouths and tongues. Flowers like honeysuckle make nectar deeper in the flower. Flies and beetles have shorter mouths so need flowers that are shallower like daisies or poppies. Including lots of different shapes of flowers will encourage lots of different groups of insects.

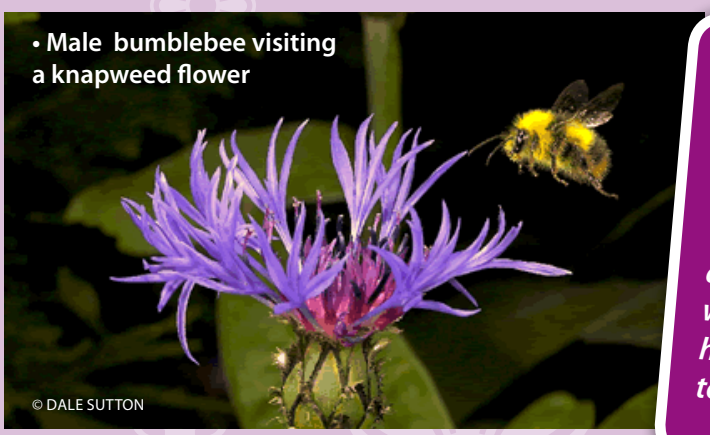
You only need a small space – some flowers are good for lots of different insects. Knapweed and cornflowers flower for a long time and their nectar can be reached by insects that are large, small, with long mouths or short ones.

• Flies pollinate flowers and feed on nectar and pollen too, just like this hoverfly

© NIGEL WIDDOWS

• Painted lady butterfly on honeysuckle

© PETER PRICE



• Male bumblebee visiting a knapweed flower

© DALE SUTTON

Did You Know...

Butterfly and moth wings have scales, as well as creating wing patterns these help control body temperature.

© PETAR SABOL

TREES FOR INSECTS

Trees are often full of insect life. You only have to look at the number of birds that feed in the trees to know that.

Tree insects can be easy to explore, if you know how.

To get started, find a tree that has plenty of leaves. The best equipment for this is a white or pale umbrella, so you can see things easily, and a thick stick or walking stick. Hold the umbrella so that the handle is pointing upwards towards the tree, like a satellite dish. Using a stick, gently tap the branches. Ladybirds, caterpillars and aphids will be knocked off into your umbrella ready for you to look at.

Why not try different species of trees to compare your catches between them? Some insects will only live on certain types of tree. If there are flowers on the trees then make sure you have a look for insects flying from flower to flower, feeding on nectar and pollen. For example, bees don't just collect nectar and pollen from flowers close to the ground, they also like the flowers up high.

BUG BOX 3: PEA APHID

COMMON NAME	Pea Aphid
SCIENTIFIC NAME	*Acyrthosiphon pisum*
ORDER	Hemiptera (true bugs)
SIZE	2-5mm
FAVOURITE FOOD	plant sap
LIKE TO BE	on plant leaves and stems, living in family groups
SEE THEM	in warmer months

FACT FILE

- The pea aphid is a common pest around the world, especially on peas, which give it its name.
- Many aphid species are 'farmed' by ants. In return for protecting the aphids from predators, the ants are rewarded with honeydew which is a sugary liquid.
- Most aphids do not have wings but some have wings that allow them to move to new areas.

Maggots and Crime

Dr Kate Barnes
University of Derby

Maggots?
Aren't they just small, smelly, wriggly creatures that fishermen use to catch fish?

Adult blow flies are found all over the world in lots of different habitats which means they are usually nearby when a crime takes place. Different species of blow flies live in different places, for example, the bluebottle species, *Calliphora vicina* prefers towns and cities but another bluebottle species, *Calliphora vomitoria* is more common in the countryside. One greenbottle species, *Lucilia caesar* is happier in woodland but another greenbottle species, *Lucilia sericata* likes warm, sunny, open spaces. If we know where blow flies prefer to live, forensic entomologists can help at crime scenes.

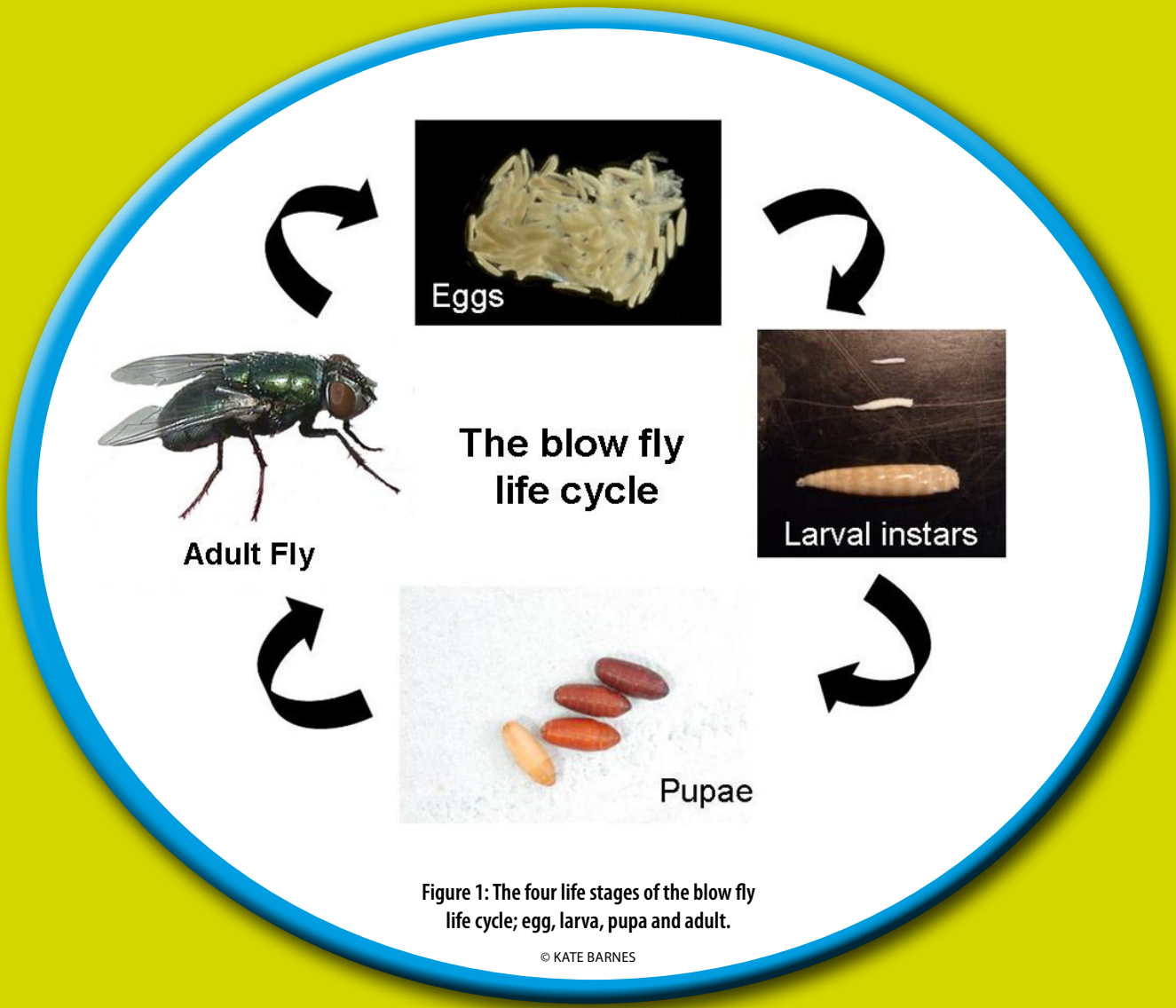


Figure 1: The four life stages of the blow fly life cycle; egg, larva, pupa and adult.

© KATE BARNES

BUZZ WORD

PUPA

The life stage of some insects in between larva and becoming an adult. A butterfly's chrysalis is a type of pupa

Maggots and Crime

For example, if a body is found in a field with only *Calliphora vicina* present it shows that the person was probably killed in a town and then moved to the field several days later.

Blow flies are usually active during the summer – you've probably seen them buzzing around on warm, sunny days or basking in the sunshine on a garden fence. Bluebottles tend to be active for longer periods of the year, starting in March and ending around October or November, however, greenbottles start to be active around May and end in September. Most blow flies spend the winter as larvae or pupae. These different times of activity mean that if a body is found in February with blow fly larvae on it then they have probably been there since last autumn. This kind of information can help the Police to tell what time of year a murder happened.

When a dead body is found and no-one knows when that person died, the Police turn to forensic entomologists to give them the answer. A forensic entomologist identifies the insects on the body and uses them to work out when the person died. Blow flies are the most useful insects to forensic entomologists because they can help time a death by acting as living clocks.

Blow fly maggots are champion recyclers, feeding on rotting animal flesh and breaking it down. This makes them ideal for solving crimes. When a person or animal dies, the body starts to rot, or decompose, and releases smells to which adult blow flies are attracted. They have sensors on their antennae which detect these smells. Once they have found the body, female flies lay eggs on it and the clock starts. The eggs need a certain amount of time and warmth to grow and eventually hatch into maggots (or larvae). Larvae are designed to be feeding machines; they have a narrow head with mouth hooks that help them hold on to their meal and a wider posterior end (or bottom) that has breathing holes. Being able to breathe out of their bottoms means they can spend all day and night face down eating! Larvae feed for days and pass through three stages (instars), getting bigger at each stage.

A greenbottle

Blow fly larvae are feeding machines with narrow heads and wide bottoms

Once the larvae have finished feeding, they move away from the body and find somewhere dark and dry to pupate (turn into a pupa), usually burrowing down into soil. Once a suitable place is found, they don't move, their outer surface (or cuticle) becomes hard and brown and the larva turns into an adult fly inside. This happens over several days and when the adult fly breaks out it hides somewhere safe for about 24 hours until its body has hardened and air has been pumped into its wings to inflate them. It can then fly away to start the cycle all over again.

So, when larvae are found on a body, a forensic entomologist asks a few questions so they can help the Police….

- What type of flies are there? (because different species spend different amounts of time in each life stage),
- What temperature is the crime scene? (because all insects grow at different speeds depending on the temperature)
- How old are the larvae? (to tell how long the body has been there)

This may sound gruesome but it helps to solve crimes. Amazing what you can tell from a maggot!

Did You Know...

Haemolymph is what insect 'blood' is called, it carrys substances around their bodies.

Get to know insects through poetry

Anneliese Emmans Dean

Have you ever wondered what it feels like to wake up and find you can fly? Or what it feels like to live for just one day as an adult? Have you ever wondered, in other words, what it feels like to be an insect?

Scientists who study insects are called entomologists. Entomologists ask 'fact and figures' questions about insects. Questions like: How? How many? How fast? But I am not an entomologist. I am a poet. And as a poet, I ask a different sort of question about insects. I ask 'What does it feel like?' questions.

Chester

Who likes chomping

Chomping's champion
Chomping's great
Leaves and leaves and
Leaves to be ate

Chomping's champion
Chomping's brill
So many leaves
Such a thrill

Chomping's champion
Chomping's ace
Leaves galore
Stuff my face

Chomping's champion
Can't go wrong
All these leaves!
All day long!

Chomping mini-break
Chomping halt
Take time off
To have a moult

Then back to chomping
Back to chomp
My chlorophyllic
Gastro-romp

Chomping's champion
Chomping's cool
Leaves and leaves and
Leaves as a rule

Chomping's champion
Chomping's fab
Pile on the milligrams
Pile on the flab

Chomping chomping
Till one day
I go to sleep…
Then fly away.

Entomologists can find out the answers to their sort of question. That's their job. But I can never know the answers to my sort of question. Instead, as a poet, I use my imagination. I imagine what it might feel like.

To find the answers to their questions, entomologists observe insects very closely. And as a poet, I do that too. Because to imagine what it feels like to be an insect, you first need to get to know it. And you get to know it by observing it very carefully.

I love observing insects. Don't you? I love watching how they move. I love watching what they eat. I love watching what they do when they're disturbed. There are so many different insects, and they behave in so many different ways.

Once I've watched an insect carefully, I look up in my insect books to find out a bit more about it. I like to find out how and why it does some of the fascinating things I've observed. Knowing these things helps me to understand the insect better. And the better I understand it, the better I can imagine what it might feel like.

So, what does it feel like? Well, to answer that question I start using my imagination. How do you imagine best? Sometimes I imagine with my eyes closed. Sometimes I imagine by staring into space. Other times I gaze at the insect.

BUG BOX 5: COMMON WASP

COMMON NAME	Common Wasp
SCIENTIFIC NAME	*Vespula vulgaris*
ORDER	Hymenoptera
SIZE	20-25mm
FAVOURITE FOOD	sugary food and meat
LIKE TO BE	almost anywhere
SEE THEM	June to October

FACT FILE

- Common Wasps are social insects. They live together in large nests that contain a queen and up to several thousand females called workers.
- Wasps form their nests from a type of paper that they make by chewing wood and mixing it with their saliva.
- In the 1700s a French scientist called Réaumur watched wasps doing this and realised that we humans could copy them and make our paper from wood and water too. Which is what we now do.

BUG BOX 4: RUBY TIGER MOTH (CATERPILLAR)

COMMON NAME	Ruby Tiger Moth (caterpillar)
SCIENTIFIC NAME	*Phragmatobia fuliginosa*
ORDER	Lepidoptera
SIZE	Up to 35mm
FAVOURITE FOOD	leaves
LIKE TO BE	on leaves
SEE THEM	summer and autumn

FACT FILE

- Caterpillars have been called eating machines. They eat and eat, and grow and grow.
- As they grow, they get too big for their skin, so they moult. When they moult, they shed their skin and grow into a new, bigger one. They generally do this four times.
- Caterpillars eat so much because they need enough nutrients to transform into full-sized adult moths (or butterflies) whilst they are pupating.
- During pupation, the Ruby Tiger Moth caterpillar transforms into an adult moth that is brick red.

Whatever way I do my imagining, I always have a pencil and paper nearby so I can write down any good ideas I have. Because I've now reached the bit I really, really enjoy. And that's playing with words to create a poem, a poem that conjures up what it might feel like to be this insect.

To come up with my poem I try out lots of different words and I use poets' tricks like rhythm and rhyme and alliteration. (Alliteration is when nearby words start with the same sound.) I want the poem to be fun to read – especially out loud – and although it's made up, although it's from my imagination, I want my poem to tell you something about the creature that's true.

You can read two of my insect poems here. They are from my minibeast poetry book *Buzzing!*

My poem 'Chester' was inspired by a Ruby Tiger Moth caterpillar I watched eating leaves in my garden. Caterpillars have to eat masses of leaves so they have enough energy to pupate and turn into butterflies or moths. I imagined what it must feel like to eat and eat and eat the same thing all day long, and wrote this poem.

Fitz

Who is pressed for time

Twenty-four hours
Is all I've got
This time tomorrow
That's my lot

The whole of a life
To pack into one day
Excuse me now
Must be on my way

I'm in need of a river
In need of a wife
Without them there won't be
A point to my life

I've no time to linger
No time for food
No time to natter
I'm not in the mood

Just show me the water
Beck, river or stream
So I can fulfil
My lifetime's dream

If I mate, leave a legacy
I'll not complain
My life will not have been
Lived in vain.

I was inspired to write my poem 'Fitz' by watching mayflies by a canal. I then found out that an adult mayfly sometimes only lives for one day and doesn't eat anything, but just looks for a mate. I imagined what it would feel like to have to cram the whole of your life into one day. I thought you'd be in a terrible hurry to get everything done. This poem works best if you read it quickly, as if Fitz is in a rush.

BUG BOX 6: BROWN MAYFLY

COMMON NAME	Brown Mayfly
SCIENTIFIC NAME	*Ephemera vulgata*
ORDER	Ephemeroptera
SIZE	12-20mm
FAVOURITE FOOD	nothing
LIKE TO BE	near still or slow-moving rivers, streams etc.
SEE THEM	May to September

FACT FILE

- Brown Mayflies spend most of their lives (up to two years) as larvae living in water, where they eat algae and other small creatures.
- Adult mayflies live out of the water – sometimes for just one day.
- Adult mayflies have no mouthparts, so they can't eat anything!
- Mayflies get their scientific name from the Greek ephemeros, which means 'short-lived'.

Over to you!

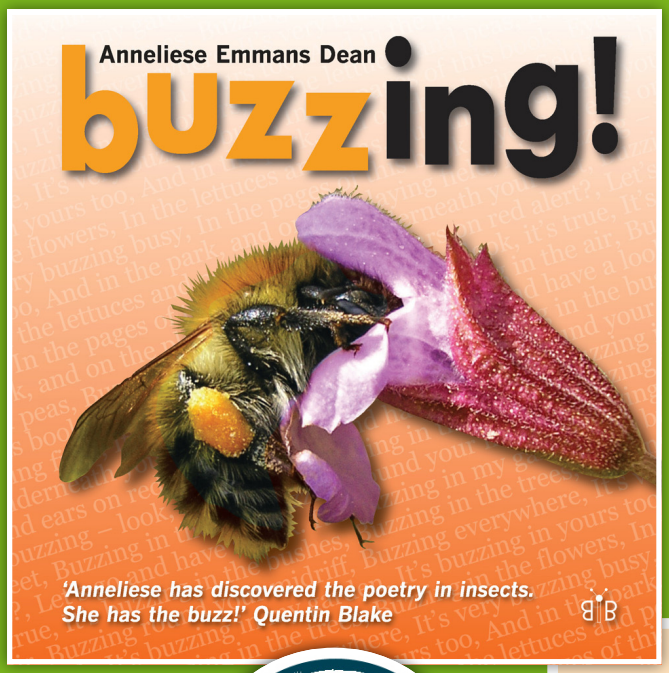
What do you think? Do you think, like me, that caterpillars enjoy eating leaves all day long? Or do you think they get bored and wish they were doing something more interesting?

And do you think that mayflies are in a mad rush? Or do you think they are very laid-back and relaxed? Maybe you think they don't know they've only got one day to live. Or maybe you think one day would seem like a very long time to them.

Why not write a poem yourself about what you think it feels like to be a caterpillar? Or a mayfly. Or a completely different insect. There are lots and lots to choose from!

Your poem might rhyme, or it might not. It might be long or it might be short. Happy or sad. Funny or serious. It's your poem, so you get to decide what it's like.

Go on – have a go. Writing poems is fun. It's a great way to get to know insects better and – best of all – there are no right or wrong answers. You just use your imagination. And you never know where your imagination – and your poem – might take you!



SHORTLIST
ROYAL SOCIETY YOUNG PEOPLE'S BOOK PRIZE 2013

Anneliese Emmans Dean is an award-winning poet, photographer and performer. She runs poetry workshops and performs her minibeast poetry show *Buzzing!* in schools, theatres and festivals nationwide. 'Chester' and 'Fitz' are from Anneliese's book *Buzzing!*, which contains 67 of her minibeast poems, over 170 of her close-up minibeast photos and masses and masses of minibeast facts. *Buzzing!* was nominated for the Carnegie Medal, shortlisted for the Royal Society Young People's Book Prize and won the 2015 NS Teachers' Book Award for Poetry. It is a National Insect Week recommended children's book.

Find out more about Anneliese and her *Buzzing!* poetry at: **www.theBigBuzz.biz**

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ULTIMATE FLYING MACHINES

Prof. Robin Wooton

To see a perfect flying machine, look at the air above a flowerbed on a sunny summer day. The little hoverfly in Figure 1 is as near to perfection as one can imagine. It can hover stock-still even if the wind is gusting, and suddenly, without turning its body, shoot off in any direction at accelerations close to that of a space-shuttle at take-off. If another hoverfly approaches, they will briefly perform astonishing aerobatics until one flies off. All this is achieved by tiny, hardly detectable adjustments to the movements of the wings, which are beating around 200 times a second. Beat that, engineers!

Figure 1. The Marmalade fly, *Episyrphus balteatus* © GEOFF FOALE

Insects are astonishing flying machines. They were the earliest – they first flew around 350 million years ago, long before pterosaurs or birds – and evolving flight was the best thing they ever did. Flight allows them to move around easily and quickly to find food, to escape attack, to get to inaccessible places. Some locusts, moths, butterflies and dragonflies migrate huge distances. Others are carried about by the wind. Dragonflies and some flies and wasps catch prey on the wing. Many bees, flies and moths hover to feed at flowers. Flight is used in courtship and mating, in aerial battles between competing males, in defending territories, etc, etc. The possibilities are endless. Insects exploit them all.

HOW TO FLY

All flying machines need three things: **wings**, to support their weight in air; a **motor**, to keep them going; and a **control system** to stabilize the flight and allow manoeuvring. Taking these one by one…

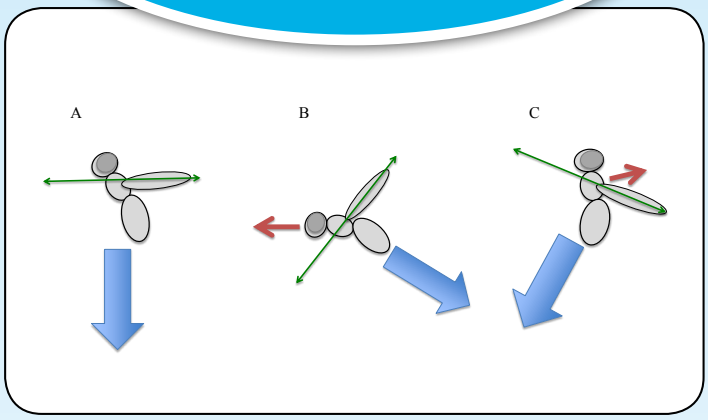


Figure 2. The directions of the wings, the accelerated air and the insect. Explanation in the text.

WINGS, AND HOW THEY WORK

Insect wings are unique. They are brilliant examples of engineering; ultralightweight frameworks of fine tubes supporting a thin, tough membrane. They are flexible because they sometimes have to bend automatically as they flap and they have no internal muscles. You can see how wings move in some superb slow-motion videos on YouTube. The best are by UltraSlo: dragonflies, butterflies, bees, ladybirds. Search for 'UltraSlo and enjoy – and notice the differences and similarities in the movements of the wings. There are also beautiful sequences in some of the BBC David Attenborough series, particularly 'Life in the Undergrowth'.

The main job of wings is to accelerate a mass of air, partly downwards. The air pushes back on the wings, supporting the insect's weight – think of treading water to keep afloat in a swimming pool. If the air is driven straight down the insect hovers or rises, if backwards as well as downwards it flies forward. Figure 2 shows this as a diagram. The thick blue arrow shows the average direction in which the air is being accelerated, the red arrow shows the direction of flight.

2A shows hovering; the air is supporting the insect, but the insect is going nowhere. 2B shows forward flight. 2C shows what happens when the insect is flying backwards. The narrow green arrows show the directions that the wings are beating back and forth. Notice how this and the angle of the body change as the flight direction changes. Most bees fly like this – see the YouTube videos – and so does the Hummingbird Hawkmoth in Figure 3, feeding at a flower with its body leaning back and its wing-stroke nearly horizontal. Flapping with an almost horizontal wing-stroke is the commonest way of hovering and flying slowly. If the wings also twist (remember they are flexible!) they drive air downwards on both downstrokes and upstrokes.

Studying insect wings has given engineers a lot of new ideas and insects use a lot of different tricks to accelerate enough air to fly.

Figure 3. Hummingbird Hawk Moth (*Macroglossum stellatarum*) © CHARLES TYLER

Figure 4. Great Green Bushcricket, *Tettigonia viridissima*.
© JOHN BRACKENBURY

THE MOTOR – THE FLIGHT MUSCLES

In most insects the flight muscles are not attached to the wings; they are enclosed in the springy, box-like thorax, and flap the wings by changing the shape of the box. This happens many times a second – several hundred times in the smallest insects. The smaller the insect, the faster it needs to flap, and tiny insects can only fly because of a unique kind of muscle that can contract at very high frequencies. Try flapping your arms and see what frequencies you can manage – and how tiring it is.. Insect flight muscle uses a huge amount of energy.

THE CONTROL SYSTEM: SENSORS AND NERVES

The head, body and wings of insects are packed with sensory hairs and strain-detectors that monitor airflow and stresses. The eyes, with their hundreds of lenses, are excellent at detecting the speed and distance of passing objects. The nervous system – the insect's central computer – processes information from these sensors and gives instructions to the muscles that control and finely adjust the movements of the wings. Everything depends on these movements: as well as supporting and propelling, the insect wings are the only surfaces that control the flight. Only in insects do the wings do all three jobs.

SO – OBSERVE!

Now you know what to look for, watch insects to see the different ways in which they fly. Grasshoppers, and the Great Green Bushcricket female in Figure 4, can't fly slowly; they use fast, direct flights – often to escape. Very small insects, like aphids and small flies, can *only* fly slowly, often much more slowly than the air currents that carry them around. The most varied and interesting flight is to be found among medium-sized and large insects. Watch dragonflies hovering, then accelerating dramatically to catch prey or chase off a rival. Watch bees and day-flying moths moving fast between patches of flowers, and slowing down and hovering to feed; wasps hunting for prey; mayflies rising and falling in their mating flights over water. Notice the extraordinary escape reactions of house flies and bluebottles, and the perfectly controlled, erratic flight of butterflies.

And especially, enjoy those hoverflies!

WANT TO KNOW MORE? READ PROF. WOOTTON'S BOOK

BUG BOX 7: MARMALADE HOVERFLY

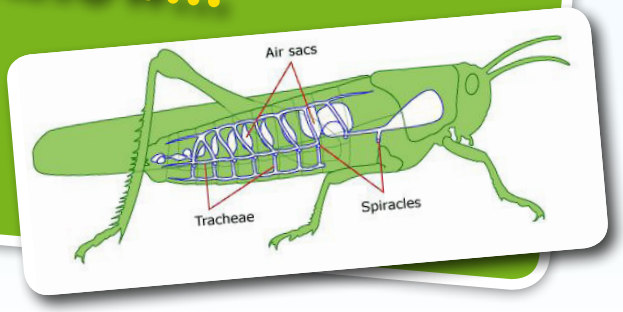
COMMON NAME	The marmalade hoverfly
SCIENTIFIC NAME	*Episyrphus balteatus*
ORDER	Diptera (Flies)
ADULTS	
SIZE	9-12mm
FAVOURITE FOOD	nectar
LIKE TO BE	hovering around flowers
SEE THEM	most of the year but more common in warmer months

FACT FILE

- Hoverflies can fly in bursts of up to 40 km per hour.
- Male hoverflies have eyes that meet at the top, female hoverflies have separated eyes.
- Adult hoverflies eat nectar but the larvae are predators and like to eat aphids and other soft-bodied insects.

Did You Know...

Insects breathe through spiracles, abdominal openings to air spaces within the insect body.



INSECT ECOLOGY

Adam Hart

The insects in your garden are chewing on plants, pollinating flowers, eating each other, being eaten, mating, laying eggs, dying and decomposing. Just like all the animals and plants in the world, whether they live in the darkest Amazonian rainforest or in your local park, insects have all sorts of relationships. Ecology is the study of relationships.

Plants can make their own food by using the energy of the sun in a process called photosynthesis. Animals can't make their own food so all animals have to eat something. Some animals eat plants while some eat other animals. If you take all the animals in a habitat and join them up if they eat each other then you end up with a food web.

Animals that eat plants are called herbivores. Some insect herbivores eat leaves, like the caterpillars of many butterflies and moths. Some insects, like aphids and shield bugs eat plant sap, using their special mouthparts shaped like a hollow tube to pierce the plant.

Some herbivorous insects eat the plants that we grow for our food and they can be serious pests. When they feed on plants they can also pass on diseases. Insects like mosquitoes can also pass on diseases, like malaria, when they feed on our blood.

Bees are also herbivores, but they eat pollen and nectar produced by flowers and collect them to feed their young. Other insects, including some beetles, flies, moths and butterflies also collect nectar or pollen. When they visit flowers they can transfer pollen from other flowers of the same type. This causes the plant to be pollinated and leads to the production of seeds and fruits, like apples, pears, strawberries and melons.

Insects are eaten by all sorts of animals. Bats eat moths, birds eat caterpillars and many spiders eat flies. Even some plants eat animals. Venus fly traps, sundews and pitcher plants are called carnivorous plants and they get nutrients by trapping and digesting insects. Insects play a very important role by providing food for so many animals. It takes 500 caterpillars to make a blue tit from a newly hatched chick!

Insects can get their own back though. Many insects are predators. Wasps hunt caterpillars, dragonflies hunt mosquitos and mantids will even hunt dragonflies.

Mantid eating a dragonfly.

© ADAM HART

NICHE BUZZ WORD

Ecologists call where and how animals and plants live their "niche". Different species have different niches and understanding these differences is another important part of an ecologist's job.

Another important relationship is called parasitism. Parasites usually live on or in other animals, their hosts, and cause the host harm. Fleas and head lice are insect parasites that make us their host, feeding on our blood. In hotter countries bot fly larvae can develop within people's flesh!

Some insects, especially some wasps, lay their eggs on other invertebrates. These eggs hatch and the larvae start to eat the living host. These insects are a bit like parasites but unlike parasites they usually end up killing their host and so they are called parasitoids. Some wasps, the tarantula hawks, even lay their eggs on spiders. The largest wasp in the world is a tarantula hawk wasp from South America called *Pepsis*.

Bot fly larva.
© ADAM HART

Tarantula Hawk Wasp.
© GAVIN BROAD/DJ CRAIG

When one insect eats another then one of them loses out – big time! But relationships don't have to be nasty. Mutualisms are relationships where everyone gains. Leafcutting ants farm a fungus in their nest for food but the fungus gets a safe place to live. Other ants herd aphids up and down trees, protecting them from predators but also "milking" them for the honeydew they exude when they are feeding on plant sap.

Leafcutter ants.
© AYUB KHAN FROM AMINART

INSECT ECOLOGY

Some insect relationships are with members of the same species. Male and female insects have to get together to mate and they can attract each other with colourful displays or with special chemical messages called pheromones. After they have mated, many insect parents do not spend any more time together. Often the mothers lay eggs in a suitable place and leave the young on their own, but some insects are very attentive parents.

Earwigs mothers care for their young when they are very young.
© JANINE WONG

BUG BOX 8: COMMON EARWIG

COMMON NAME	Common Earwig
SCIENTIFIC NAME	*Forficula auricularia*
ORDER	Dermaptera (earwigs)
ADULTS	
SIZE	10-15mm
FAVOURITE FOOD	plants and fungi
LIKE TO BE	damp places
SEE THEM	spring, summer and autumn

FACT FILE

- It is not true that earwigs can crawl through your ear and lay eggs in your head.
- Most earwig species are omnivorous, which means they will eat a wide range of plants, fungi and other insects.
- The oldest fossil earwig is over 200 million years old. They were around with the dinosaurs.
- Female earwigs often guard theirs eggs and young using their pincers (cerci) to defend their family.

BUG BOX 9: EMPEROR DRAGONFLY

COMMON NAME	Emperor dragonfly
SCIENTIFIC NAME	*Anax imperator*
ORDER	Odonata (dragonflies and damselflies)
ADULTS	
SIZE	60-90mm
FAVOURITE FOOD	small insects like mosquitoes
LIKE TO BE	perching and hunting by a pond
SEE THEM	summer

FACT FILE

- In some countries, dragonfly nymphs are used to control mosquitoes; dropping a nymph into a water container can remove up to 90% of the larvae.
- Some damselfly males will demonstrate the flow rate of water in his territory by floating downstream for a few seconds. This is a risky thing to do since he might be eaten by fish. This may show his intended mate that he is strong enough to escape.
- Dragonflies are strong fliers and can reach speeds of up to 35 kilometres an hour – the FIGHTER PILOTS of the insect world.

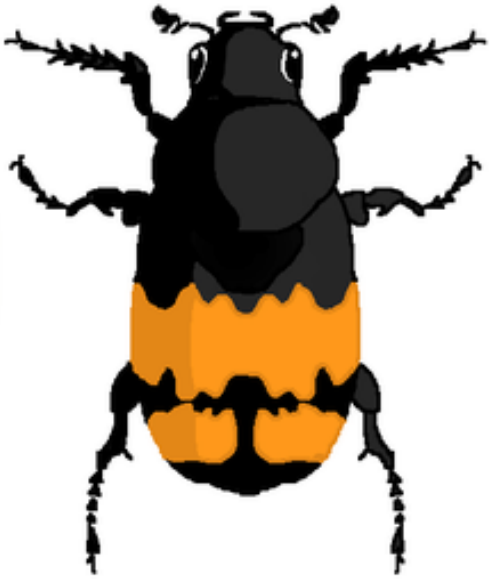
Animals create all sorts of waste. When they are alive they produce poo! And when they die, they leave behind a corpse. Animal dung and dead animals contain nutrients and some insects have evolved to take advantage of them. Dung beetles make balls of dung and bury them, laying eggs on the balls that develop into a larva which can feed on the dung. Some beetles, like sexton beetles bury dead mice and other small mammals to act as a larder for their young. Even old, dry skin and horns from weeks-old lion kills can provide food for enterprising insects like hide beetles!

Did You Know...

The scientific term for insect poo is 'frass'.

BEAUTIFUL BRITISH BEETLES

The sexton beetle (Nicrophorus vespilloides)



This beetle and its relatives receive their name from their habit of burying + feeding on the corpses of small mammals and birds. Adult beetles can smell a meal from kilometers away! After arrival, beetles will remove the fur or feathers using their mandibles, and bury the corpse in the soil. After the eggs hatch both parents will help care for their young by regurgitating pre-digested flesh directly to the larvae.

© PAUL MANNING

Get sweeping!

If you want to catch a few insects at a time to look at, then why not make a sweep net?

Homemade sweep nets are great for swishing through grass and catching small insects, although not really suitable for butterflies or moths. Insect sweep nets can be bought of course but they can be expensive, so this method is definitely cheaper and great to practice with.

To make a sweep net you just need a coat hanger, a bamboo cane (no more than 1m long) and a wide carrier bag or old pillow case – white or pale is best so that you can see what you catch.

Pull out the coat hanger to make a circle but don't untwist or cut it. Straighten out the hook and slot it into the bamboo cane and secure with some tape. Attach the carrier bag or pillow case to the coat hanger using strong tape and there you go. A sweep net!

Homemade sweepnet

BUG BOX 10: COMMON FIELD GRASSHOPPER

COMMON NAME	Common field grasshopper
SCIENTIFIC NAME	*Chorthippus brunneus*
ORDER	Orthoptera (Crickets and grasshoppers)
ADULTS	
SIZE	15-24mm
FAVOURITE FOOD	grass
LIKE TO BE	in long grass
SEE THEM	March to December

FACT FILE

- The locust, *Schistocerca gregaria*, is one of the world's most important pests and a type of grasshopper.
- Grasshoppers have ears on their bellies.
- Grasshoppers are powerful jumpers and strong fliers too.

Find an area of long grass on a warm day and walk through it whilst moving the net gently from side to side in a 'S' shape, making sure that the mouth of the net hits the grass first so that the insects go into your net.

When you have moved the net back and forth 10 or more times, it's time to inspect your catch. Leave the net open for a few seconds before emptying to allow any bees or wasps you have caught to escape before you take a look. Empty the net into a shoe box or sweet jar (a white tray is best of all) by reversing it through the coat hanger frame.

Discover dragons and damsels

Dragonflies are an ancient group of insects; they are found as fossils over 300 million years old. Fossils of enormous dragonflies with wingspans of at least 70cm have been found. Dragonflies and damselflies are closely related but you can tell the difference by watching them resting. The damselflies are generally smaller and hold their wings vertically above their body when resting, or partly open. The dragonfly will always rest with its wings spread out.

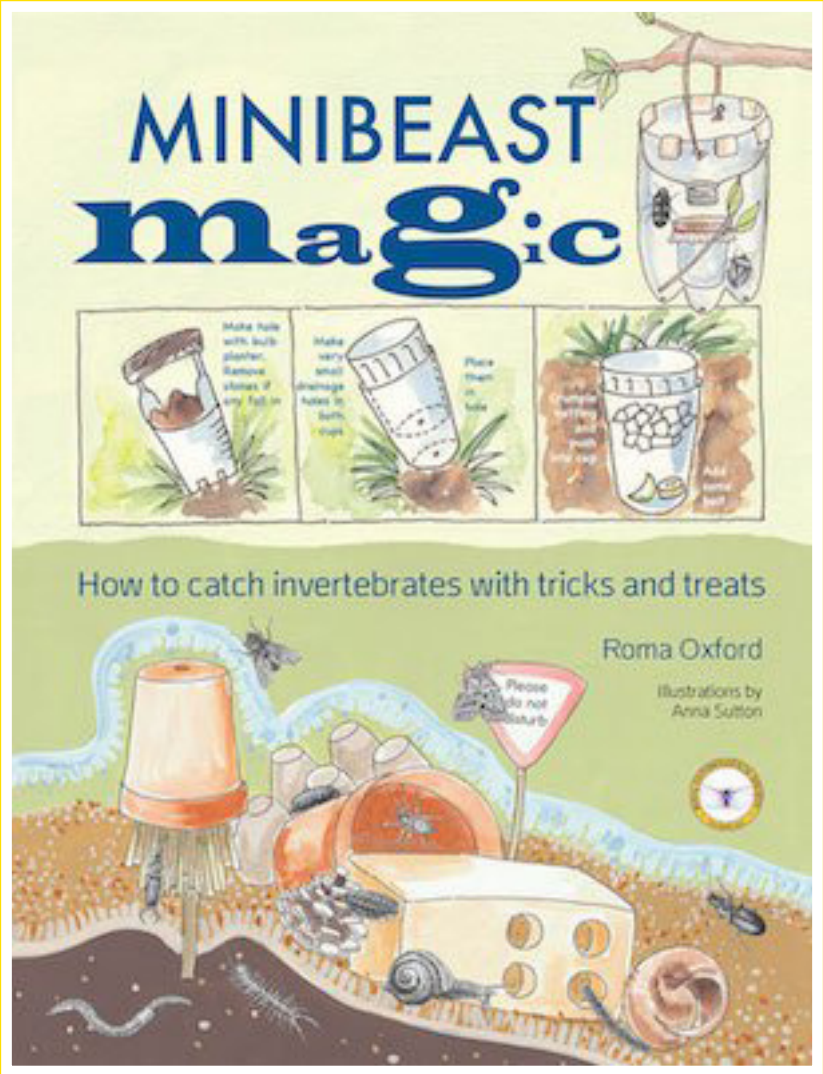
Both the water-dwelling young and the flying adults are predatory, eating other insects and small vertebrates.

Southern Hawker emerging as an adult from freshwater.
© SAM BAYLIS

Four-spotted Chaser perching.
© TAIM DAISH

Common Blue Damselfly with its lunch.
© RORY MORRISEY

Broad-bodied Chaser (*Libellula depressa*) rests in the golden sunlight.
© RUTH CARTER



If you would like to learn more about how to catch invertebrates then look for 'Minibeast Magic' by Roma Oxford and Anna Sutton – available from the Field Studies Council (**www.field-studies-council.org**)

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