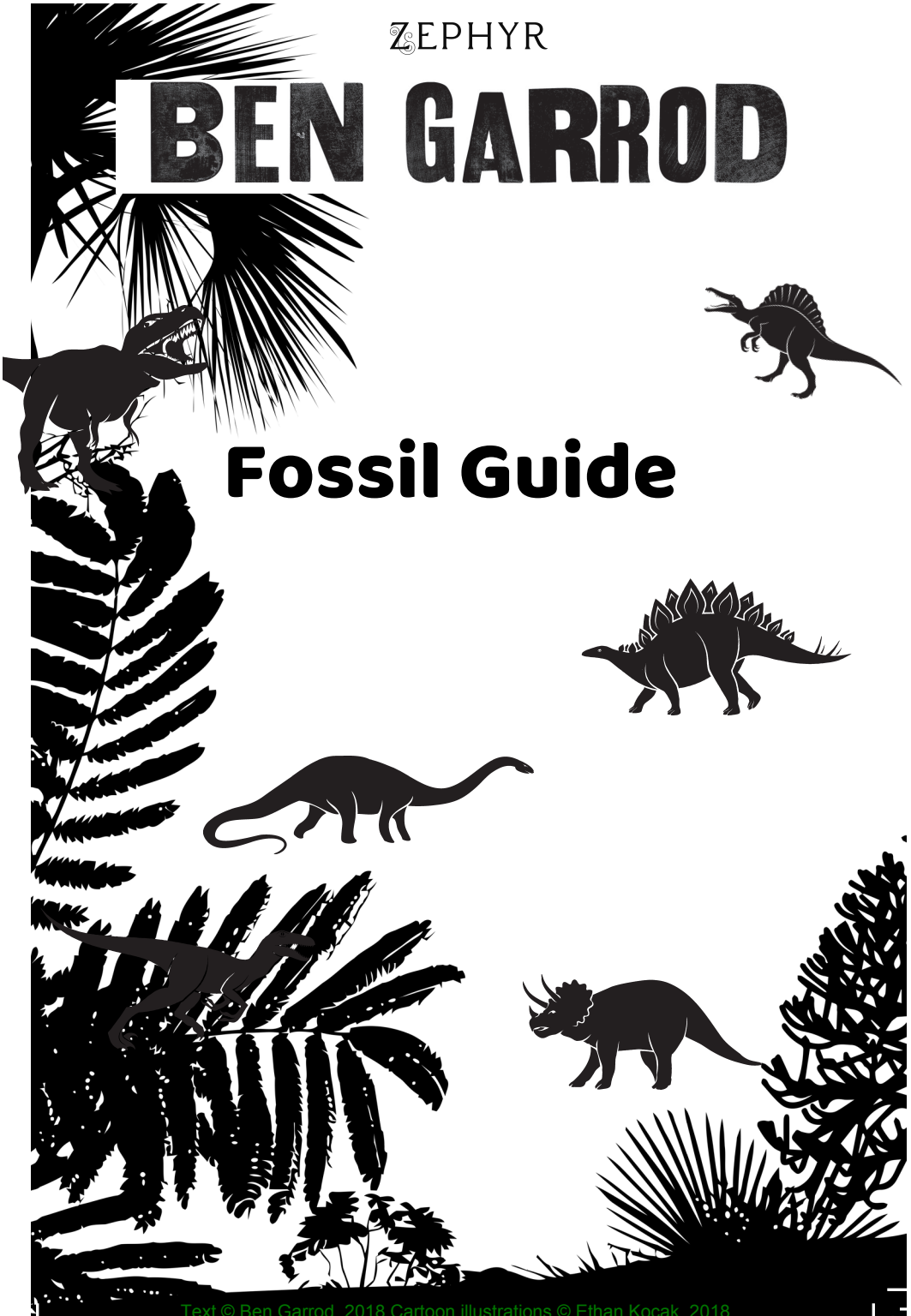
ZEPHYR

BEN GARROD



Fossil Guide

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Contents

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PRACTICAL

Section 1: Equipment and Safety

Finding fossils is fun. Here are some of the skills needed if you want to find your own fossils. It's important always to make sure you look for fossils legally, responsibly and above all, safely! The different sections in this guide will look at where and when are the best places to find fossils, how to look after them like a proper museum collection, and how to clean them.

This Fossil Finder section is the most important of all and looks at the equipment you will need and how to stay safe.

There are rules when you go out hunting for a *Tyrannosaurus rex*. Some are designed to protect you and some to protect the fossils and the landscape.

Never go fossil hunting on your own, even if you know the area well.

Always take an adult with you.

Many sites that are good for fossils are remote and you could easily get into trouble with rising tides, rocks falling from cliffs or getting stuck in mud.

Take a torch and some brightly coloured clothes, as well as a phone.

If you are going anywhere near cliffs, think about taking a hard hat too!

Check tide timetables if you are going to bays and coves.

Never search for fossils at the bottom of cliffs. Falling rocks are a danger so unless you are a palaeontologist, don't do it!

Stay at least 8m away from the base of cliffs.

Be careful of steep drops and never go fossil hunting in quarries.

Winter is a good time to look for fossils, because heavy rain and storms often reveal them, but make sure you keep warm and wrap up well.

Always think about your safety when looking for fossils.

You will need some equipment to collect properly, get all the information you can and prevent any damage to the fossils on your way home.

The most important tool for any fossil hunter is a notebook and pencil.

Record where you found the fossil and when.

Draw the scene – was it near the sea or in a stream bed? Was it next to other rocks and what did they look like? Writing notes and making detailed sketches will help you remember and make you a better scientist.

A camera is also a good way of recording lots of information and for you to keep a record of all your finds.

Take some newspaper to wrap your fossil in and prevent damage.

A magnifying glass is handy, to make sure you're looking at an actual fossil.

If you break rocks apart to see if there are fossils inside you'll need a little hammer and chisel and safety glasses too, remember.

It's not just you that needs looking after though . . . if you go fossil hunting, you need to be a responsible collector. We'll look at how to collect fossils responsibly in section ?. As long as it is done safely and in a way that doesn't destroy valuable fossils for anyone else, hunting for fossils is a perfect way to practice being a young scientist or naturalist. You'll learn lots about identifying species and you'll have some great adventures finding weird and wonderful specimens. Happy hunting!

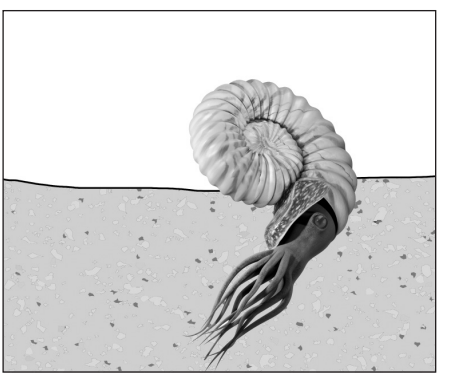
PRACTICAL

Section 2:
How fossils are formed

We all want to go out and find an amazing fossilised skeleton from a brand new species of dinosaur. But first, it helps to understand what makes a fossil, so that you can know where to look and how to make sure you preserve any fossils you find. How are fossils formed? There are a few different ways fossils can be made but here is one of the most common methods of fossilisation.

1. After an animal dies, it sinks to the seabed and is buried by sediment.

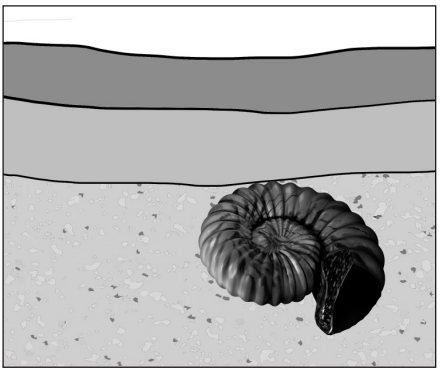
As a marine animal dies, it sinks and rests on the sea floor. All the soft parts decompose and rot, leaving the skeleton. The bones quickly become completely buried by sand and mud. This makes the marine environment the perfect place to create fossils, explaining why marine fossils are so common.



2. Over time, sediment around the bones begins to harden.

Over tens of thousands of years, more and more

sediment builds up above the bones. As the seabed is added to more and more, the pressure around the bones increases. The sediment begins to harden and turn to rock.

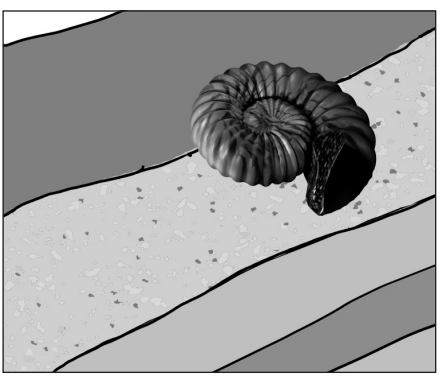


3. The bones dissolve, forming a fossil 'mould'.

With the sediment around the bones now hard, dissolved minerals within the ground dissolve the bones themselves. This leaves a 'hollow' in the sediment. This 'mould' is a perfect imprint of the original bone.

4. Minerals collect inside the mould, making a cast.

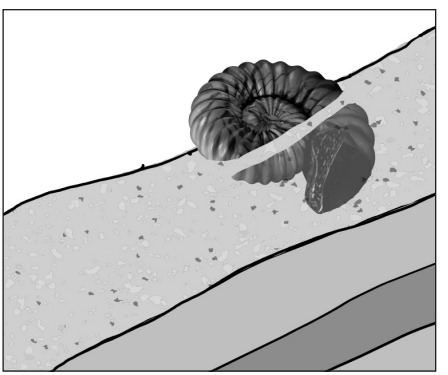
Ground water is full of minerals, which seeps into the mould, filling the cavity. These minerals are left behind in the mould and a perfect cast is formed. This cast has the same shape as the original bones, but has none of its internal features.



Other fossils form when the mineral-rich groundwater dissolves the bones and replaces it there and then with the minerals. In these fossils, the internal structures of the bones are also all preserved.

5. The fossil is exposed.

After millions of years underground, seas retreated and what was once beneath the sea is suddenly on dry land. The sediment is eroded by wind and rain. Eventually, layers of earth are removed and the fossil ends up near the surface, ready for you to find it.



Although this is a common way for fossils to be formed, they did not all start under the sea. Many animals fossilised on land and were covered by sand or soft sediment from rivers or lakes.

So, now we know what a fossil is, but if there were so many animals and plants alive during prehistoric times, why don't we find hundreds of fossils every time we take a walk through the park or visit the beach?

Well, conditions have to be just right. The decay of an animal needs to be under certain conditions to help increase the chances of fossilisation, such as low levels of oxygen – for example, when an animal sinks into muddy sediment at the bottom of the sea – or a fast burial, when an animal is buried by a sand storm.

PRACTICAL

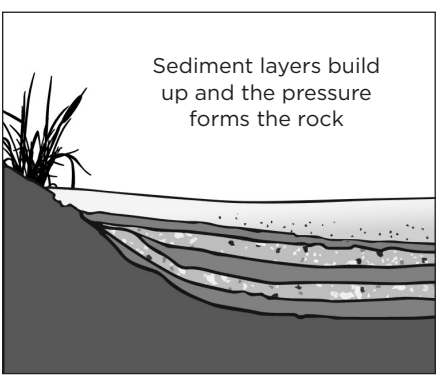
Section 3 : Where to find fossils

This might sound silly but when I was growing up, I had the idea that if I dug in my garden, eventually I'd find a dinosaur. OK, stop laughing . . . I was little! But it leads to a serious question – why is it that you only find certain fossils in certain areas and sometimes, no fossils at all?

Well, first of all, some dinosaurs and other prehistoric species lived in very specific areas. It doesn't matter how long I look for a *Triceratops* fossil in the UK, I'm never going to find one . . . simply because they lived in what is now known as North America. The other reason is because some rock types contain fossils and some don't and because you need to make sure the rock is the right age. That's right – all rock is old but there are different types of old.

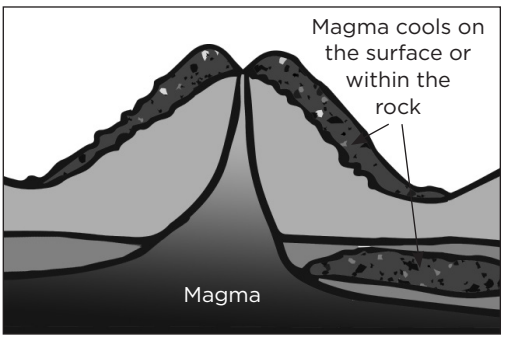
THERE ARE THREE MAIN TYPES OF ROCK:

Sedimentary rock These rocks are made when mud, sand and pebbles are laid down, layer on top of layer. Over years and years, the pressure squashes these layers together and eventually turns them into rock. Limestone and



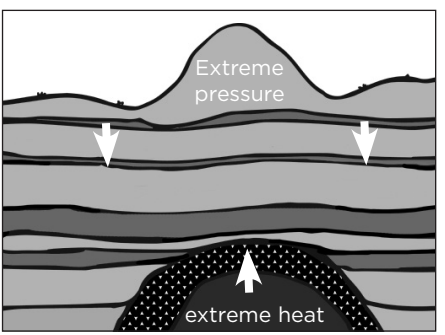
sandstone are good examples of sedimentary rocks. These rocks are great for fossils.

Igneous rock

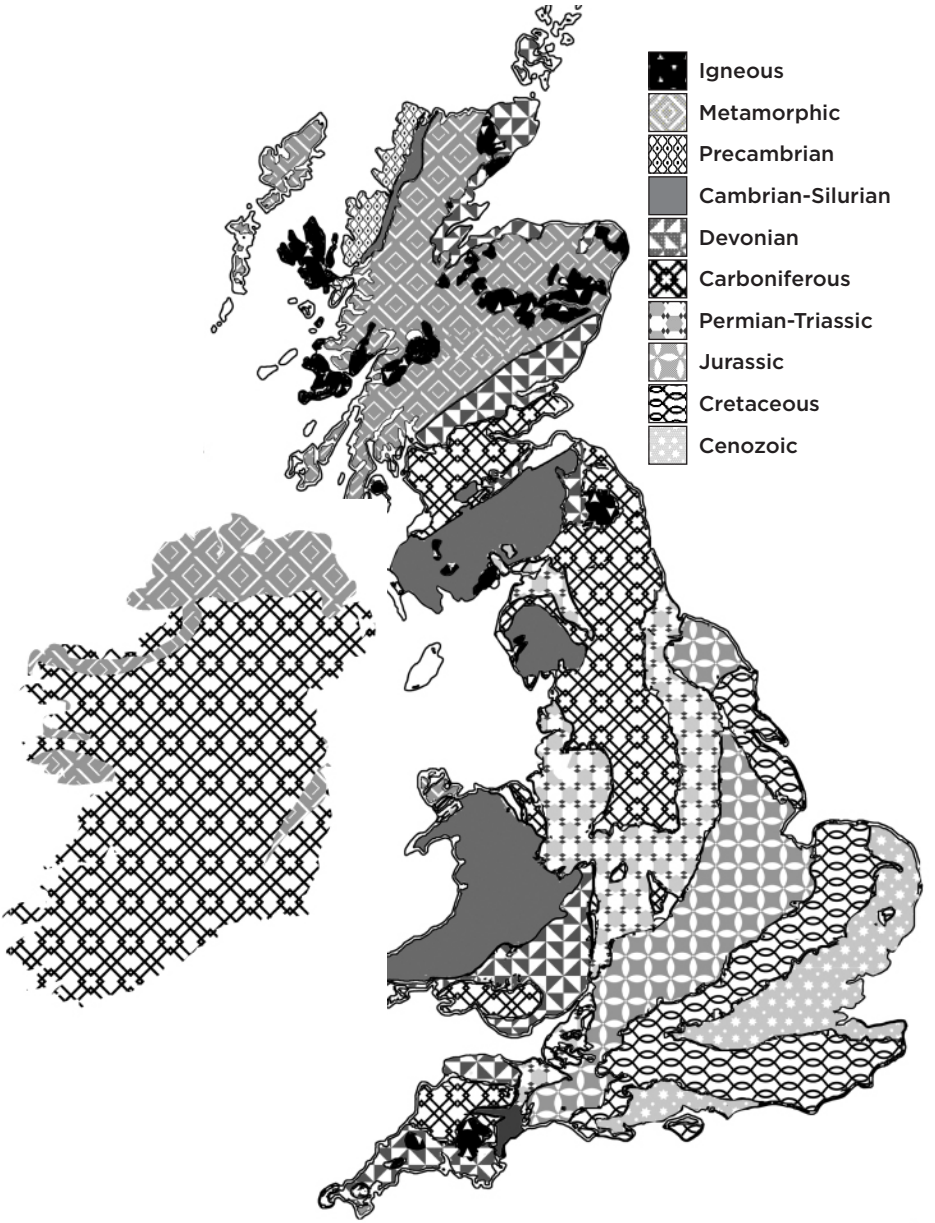


The word igneous comes from the Latin word meaning fire and this clue helps explain where igneous rock comes from. It starts off as magma, either from volcanoes or from within the Earth. This cools and hardens to make igneous rock. Granite is an example of an igneous rock.

Metamorphic rock



This type of rock is formed when either sedimentary or igneous rock are changed because of extreme heat or extreme pressure. Slate, marble and schist are all examples of metamorphic rock. Sometimes there are fossils in these rocks but they are often squashed.



Usually, fossils are found preserved in sedimentary rocks. Because of the way the rock was made and because it doesn't really change that much over time, fossils are preserved well. Sandstone is made of tiny grains of eroded rock and limestone is made up from tiny fossilised shells and skeletons from prehistoric plankton. Both these types of sedimentary rocks are great for finding fossils.

Now, all you need to do is to find which type of rock is where and how old that rock is? Where can you find Jurassic sedimentary rock that may contain giant marine reptiles like pliosaurs or rock from the Cretaceous period, full of ammonites and belemnites?

Have a look at this map – the different patterns show the different types of rock where fossils can be found. Think about the fossils you would like to find and do a bit of detective work. For instance, if you really want to find an ammonite it helps to know that they were only found in the Jurassic and Cretaceous periods. So there's no point in looking in rock from the Triassic. Also, think about how that animal lived. Ammonites, for example, were marine animals, so look in places that were covered by the sea in prehistoric periods. This means it's a great idea to look at a site that used to be

a Jurassic sea habitat and not a Jurassic freshwater river. Think about the age of the rock, the type of rock and how your fossil animal lived.

Here's a helpful list of some of the best fossil sites around the UK and the type of rock you can find there.

Palaeogene – Quaternary period
65–0 million years ago

Bouldnor (Isle of Wight)
Herne Bay (Kent)
Walton-on-the-Naze (Essex)
Warden Point (Isle of Sheppey, Kent)

Cretaceous period
145–65 million years ago

Beachy Head (East Sussex)
Durlston Bay (Dorset)
Hunstanton (Norfolk)
Littlehampton (West Sussex)

Jurassic period
200–145 million years ago

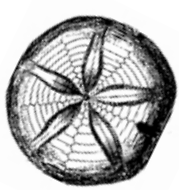
Charmouth (Dorset)
Dunrobin (Sutherland)
Kimmeridge (Dorset)
Lyme Regis (Dorset)

Carboniferous period
359–299 million years ago

Crail (Fife)
Kingsbarns (Fife)

Silurian and Devonian periods
444–359 million years ago

Marloes Sands (Pembrokeshire)



PRACTICAL

Section 4:
How to prepare fossils

This section gives you a beginner's guide on how to prepare fossils, once you've found them. There are lots of different ways to prepare fossils, and experts take years and years to learn the skills, but there are some quick and easy techniques you can use to start preparing fossils for yourself.

You can find all about what equipment you'll need to collect fossils and where to look for them in the previous sections, but the most important rule is always to take an adult with you when you go fossil-hunting and to ask an adult to help you when you are preparing any fossils you find.

Here are two easy ways you can start preparing fossils:

Physical preparation of ammonites

This first bit is usually best done on the beach where you find the fossils, so take a hammer, chisel and safety glasses with you. There's no point in taking lots and lots of rocks home with only one or two fossils. You'll have a bad back from lifting useless rocks.

Often, ammonites are preserved in limestone and can be found in what we call limestone ‘nodules’. These nodules look like big round blobs of rock and can be found mixed in with other rock or lying on the beach. When you see one, you’ll recognise it straight away. It helps to have a good look at the nodule to see if there are any signs that a fossil might be inside before you start whacking it with a hammer.

When you have your nodule, look for any signs of weakness, such as a crack in the rock. If you see a crack, gently tap it with a geological hammer (or a small DIY hammer will do).

Don’t just hit it as hard as you can. If you do this, you’ll probably injure yourself and damage the fossil. If it doesn’t open after a few gentle taps, place the chisel along the crack and tap that instead. Once the nodule has split open, you will probably be left with the actual fossil on one half and the imprint (or the ‘trace fossil’) on the other half. Usually, the ammonite will be beautifully exposed but if it needs to be cleaned any further, use a brush and a cocktail stick to clear away any tiny bits of rock left over. This can be done when

you're at home. This should be enough to provide you with a cool fossil for your collection. Any more complicated than that and you will need some high-tech equipment.

In the UK, fossils can be collected as long as you don't cause any damage or break any laws. It is illegal to collect on some beaches and some places are called Sites of Special Scientific Interest (SSSIs) and collecting is not usually allowed there either. It may be tempting to collect fossils at these places but remember, you are a young scientist and as scientists, we should make sure fossils get to a museum, where they can be studied and appreciated by as many people as possible.

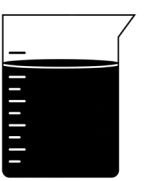
When out collecting, don't pull nodules and fossils from cliffs. Not only is this a really complicated thing to do but it can also cause damage to the surrounding area.

Acid preparation of microfossils

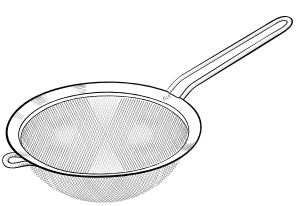
Lumps of natural chalk can often be found on beaches. This white crumbly type of sedimentary rock is made up from ancient shells, crushed together.

Acid can be used to prepare small fossils like these. Although it can take a long time, it's a very good way to remove these tiny fossils, called microfossils. This method also means less risk to the fossils. Many palaeontologists use a special chemical called acetic acid to dissolve the chalk. You may never have heard of this acid but you have probably had it on chips . . . it's the proper name for vinegar.

Place the chalk in a container with a diluted mixture of vinegar and water. To start with, use a ratio of 1:10, which means you need ten times more water than vinegar. Leave it to soak for between 1-3 days.



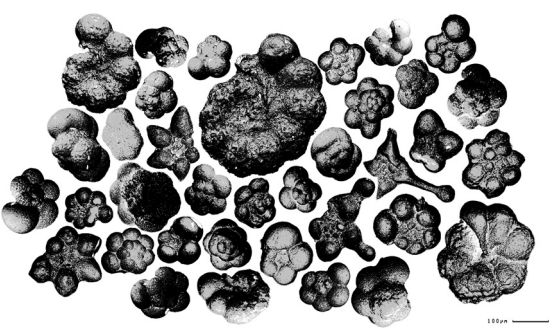
Use a sieve with a 2mm mesh and pour the acid solution away, trapping the 'sludge' in the sieve. Then soak the sludge in water for a day, to stop the effects of the acid.



Sieve it again and pour the sludge on to a tray. Either let it dry naturally for a day or two, or heat it in the oven for around an hour at 80°C. Don't sieve it down a sink – you'll probably block it and you won't be very popular at home for a while!

If you are lucky enough to own a light microscope, that's great but if not, ask your teacher whether you can take the dried white powder to school. Keep it safe in a jar or envelope and take a little bit out to look at under the microscope. Get your teacher to show you how to do this.

Put a thin layer of the white powder on a microscope slide and have a look. There should be hundreds if not thousands of tiny fossils. There will be lots of different types of fossils too. For example, your sample should have lots of 'forams' (short for

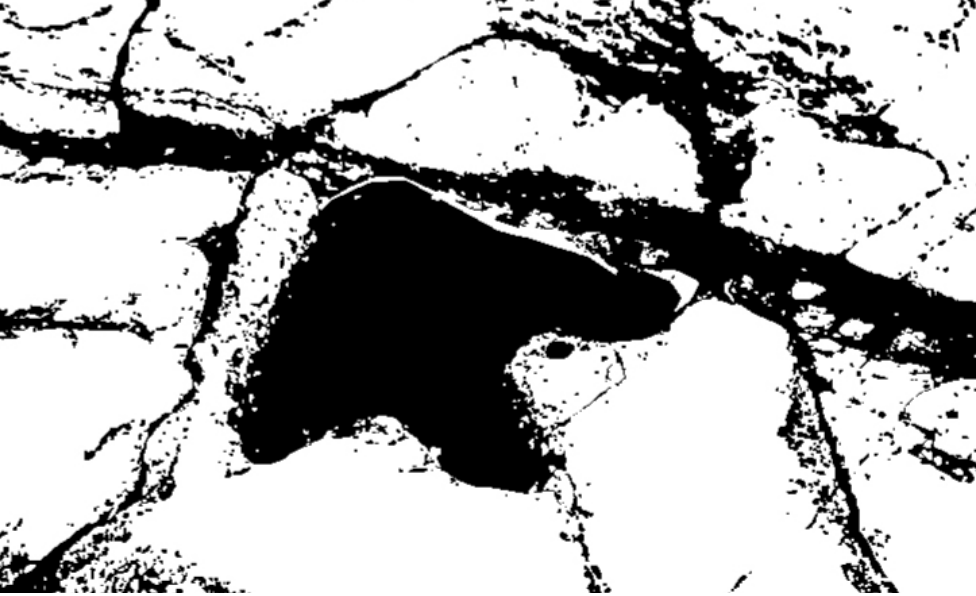


foraminifera), which are single-celled organisms, with a little shell and ostracods (or ‘seed shrimps’), which are tiny relatives of crabs and shrimps.

If you want to prepare your fossils using acid like this, then vinegar is great to use. Make sure you don't get it in your eyes and try to use white vinegar where you can, as it won't stain the fossils a funny colour.

PRACTICAL

Section 5: How to study fossils



As you'll know from the previous sections, fossils come in all shapes and sizes and you can have great fun collecting them. Just make sure it's safe to do so and you collect in an area that won't damage the environment. Some fossils you can pick up and hold, such as bones, teeth and ammonites but there are other types of fossils too. Trace fossils are a really important type of fossil but usually you can't just pick them up. Trace fossils are a record not only of bones, skin and feathers but of behaviours. They can tell us how a dinosaur walked or ran, whether it lived on its own or in groups and how it behaved. Most often, trace fossils are footprints and burrows but can also include coprolites (fossilised poos). Understanding the behaviour of an animal that died more than 66 million years ago may seem impossible, but trace

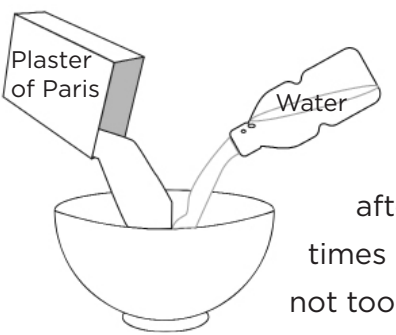
fossils can help us understand more about dinosaur behaviour.

So how do you study them? Imagine a *Tyrannosaurus rex* footprint in a fossilised streambed in Montana or the print of a beautiful new species of ammonite in a huge rock on the Jurassic Coast. You should not try and take them with you (unless you are a professional palaeontologist) and a photograph won't always show the detail well. Scientists now have access to high-tech lasers, which can be fired at the trace fossil to make a CGI copy. But before we had fancy lasers, scientists took casts of the fossils and studied them. Here's how to take a cast of a trace fossil, so that you can keep a permanent record.

How to make a fossil cast

You will need some plaster of paris (which you can get from most DIY and craft shops), water, a shiny strip of paper or card, some paper clips and some modelling clay like plasticine. Then you'll need to find a trace fossil that you can take your cast from. If you can't find a fossil of an ammonite or *Iguanodon* lying around, then try making a cast of your own footprints on the beach or in some damp soil.

When you have found your fossil, first make a loop with the shiny card or paper and secure it in a circle with the paper clips. The circle needs to be bigger than the fossil, so that the fossil fits inside. If there are gaps between the paper circle and the rock, make a circle of clay around the fossil and then push the paper circle into the clay so that the mixture doesn't escape. Now mix the Plaster of Paris and water in a bowl. You will need a spoon or stick to mix it and to remove any lumps. There is no magic recipe here – you will become an expert after you have done this a few times – but the mixture should be not too runny or too thick.



If the mixture is too thin, the cast will take ages to set and will break easily. If it is too thick, then it will set too quickly and won't record the details on the fossil. The mixture should be as thick as custard or thick cream.

Make sure the fossil is clean either by blowing or brushing away any dirt. Once it is clean and you have the perfect mixture, slowly pour it on

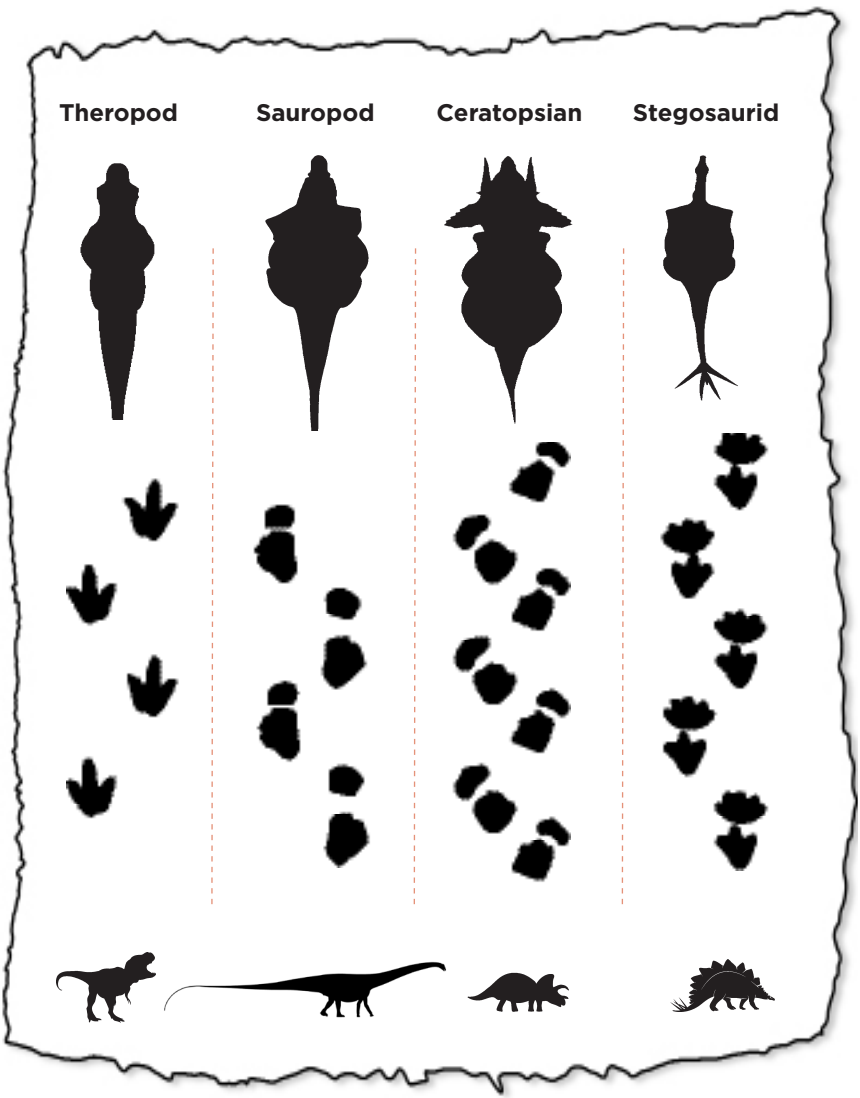
the trace fossil or into the footprint. Pour the mixture into the fossil directly so that every bit is covered. The mixture should be at least 2cm thick when you pour it into the paper circle, so that it doesn't break easily when it dries. The plaster will take about ten minutes to dry properly.

BE SAFE

You may want to take a cast of your hand but it can be very dangerous to put your hand in plaster mixture for a long time. The plaster becomes very, very hot and can cause burns. It's okay to get it on your fingers and hands when mixing it but do not place your hands *in* the mixture *when* it's drying. If you want to mould your hands, there is special mixture from craft shops.

After ten minutes, tap on the surface of the mixture. It should be solid now. If you can press your finger into it, it's not quite ready yet. When you're sure it's dry, gently lift the whole cast from the fossil or footprint and remove the paper circle. Remember that the cast you have made is a 'reverse print' of the trace fossil. Clean your fossil cast with a brush, to remove any sand or dirt. If you really want to, you can use some paint to highlight parts of the cast (I prefer to just leave it).

All trace fossils tell us something about the animal that created it. What do these prints tell you about these dinosaurs?



Because you are a young scientist, you need to record all the details you can. On the back of the cast, use a pencil to write the date and location where you made the cast and if you can, what species the cast is from.

You could even have fun and use some big dinosaur toys to make prints in sand or mud and then take your own casts.

PRACTICAL

Section 6:
How to curate fossils

Through the different sections in this Fossil Finder Guide you've learned how fossils are formed, where to look for different fossils, how to stay safe when collecting and even how to take casts and use 'acid' to clean them, but then what? What do you do once you have your fossils? That's up to you. Either you can have them as a nice collection on a shelf or in a drawer just because it's cool. Or maybe you can start to collect like a real scientist and to do that, you'll need to take notes. Lots of them.

All scientists and museum curators keep detailed notes on every one of their specimens, from when and where it was found to the species identification. If you can do this, then you will be preparing yourself to be an actual scientist or museum curator. And, if you discover that one of your fossil finds is actually very important and you either loan it or give it to a museum, then you will be able to give them all this info, rather than just, 'Erm, I found it either three or six years ago and it was definitely from western Scotland. Or maybe southern England.' See how annoying that would be? And believe me, you might remember now but when you have several hundred fossils or when you're older, you will start to forget these little details.

You'll need a notepad, a pen or pencil, a compass and maybe a camera (this is a nice extra but not essential).

First of all, you need all the information (we call it 'data' in science) from where and when you found your fossil.

Let's imagine you've found an ammonite and it looks like this one.

I've made a template below that you can start to use in your notebook. If you want to add bits or change stuff, that's great. Let's imagine you filling out the form after your fossil find.

Everything you collect must have a **fossil ID code** and each one should be different. You can use a system in your number to help you. Maybe it tells you the date and person who found it, as well as the number. Maybe the code for this fossil is 18BG001. This is what the code might mean. The first two numbers could stand for the year. So 18 could

18BG001

Fossil ID code _____

Fossil species: _____

Found (date): _____

Found (location): _____

Formation: _____

For sketches:

Description:

mean the fossil was found in 2018. The next bit of the code could be the initials of the person who found the fossil. So, BG would be me, Ben Garrod. The last three digits might show the number of fossil found in that year – 001 would tell me that this is the first fossil found in that year, 2018.

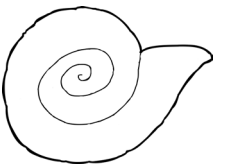
Next, when you are looking for the **fossil species**, go through books and online identification guides to help you get the right ID. Make sure your fossil species is actually found in the area you've found your fossil. For example, there won't be any *Spinosaurus* bones in the UK, no matter how hard you look and how much they look like them. Maybe it's something similar. Many species look similar, so check the small details.

The **date** is easy but important. Include the full details. Next, the **location**. Imagine you've found your ammonite on the north eastern coast of the UK. Where exactly though? Can you narrow it down? Well, you can say the nearest town or village. Let's imagine it's the seaside town of Whitby (famous for its Jurassic fossils).

The next bit is slightly more tricky but will test your skills as a young scientist. What is the **formation** like? Is it Jurassic or Cretaceous, for example? Is it limestone or

mudstone, maybe? You'll have to do some research but this will really help your understanding of your collection.

Finally, make some **sketches**. You might not be very artistic but that doesn't matter. You just need to look at the details and copy them. If you find an ammonite, don't be tempted to draw something like this:



This sort of drawing doesn't tell you much. It sort of looks like a snail or an ammonite. Look more closely at your find. Does it have lumps and bumps? Are the little ridges close together or far apart? Make sure you label your drawing with size and colour.

Then maybe draw the area where you found the fossil. Was it near rocks or in the water? A quick sketch can help you find more in the future.

By taking detailed notes like these each time, your collection will be much more scientifically important and useful.