Dinosaur death - did it die or was it killed?
Was this a Cretaceous crime scene? - using rock and fossil forensic evidence to find out

Ask your pupils to use evidence from the rocks, piece by piece, to build up a picture of how a dinosaur died - like a detective builds up a case from a crime scene.

Tell the pupils 'A large fossil skeleton has been found in rocks near your school. Did the animal die naturally or was it attacked and killed? Use your detective skills to investigate what really happened long ago.

Give the pupils: the first two pieces of evidence (pages 3 and 4).
Evidence A - photo of the remains of a dinosaur. There is damage to the thigh bone in one of the back legs. The bone is being sent to a special forensic laboratory for further investigation.

*Evidence B - artist's drawing of the animal that died***.** The remains are those of a hadrosaur; a large (about 7m long), plant-eating dinosaur which often walked on two legs.

Ask the pupils:
- What evidence in the leg bone would suggest whether your dinosaur died of natural causes, or had been attacked?
- What evidence would you look for in the rock to show what the local environment was like when it died? Look for clues in the drawing.

Give the pupils: the next three pieces of evidence.
Evidence C - photo or specimen of sandstone. Remind them that this was once loose grains of sand that have been stuck together by natural processes to form rock.

Evidence D - photo or specimen of mudstone. Remind them that this formed from wet mud that later hardened into rock.

Evidence E - photo of plant fossils found in the mudstone.

Ask the pupils:
- To 'picture the possible crime scene' by imagining what the area might have looked like at the time when the dinosaur was alive.

Give the pupils: the sixth piece of evidence after they have tried to imagine and visualise the environment.
Evidence F - artist's drawing showing a reconstruction of the environment.

Give the pupils: the seventh piece of evidence.
Evidence G - dinosaur trackway diagram. These trackways were found in mudstone the same age as the mudstone found near your dinosaur - but they were several kilometres away.

Ask the pupils:
- What evidence do the tracks show about the animals which lived at the time? Do the tracks tell you what they were doing when they walked across the soft mud?
- Is this evidence any help in trying to work out what happened to your dinosaur?

Give the pupils: the eighth piece of evidence.
Evidence H - museum drawings of skulls of possible suspects. The museum in the area where your dinosaur was found has several skulls in its collection. All these animals lived at the same time as your dinosaur.

Ask the pupils:
- Can you work out which skull (if any) could **not** have belonged to a predator. Remember your dinosaur was a large animal.
- How reliable is this evidence which comes from skulls that a local museum happens to have on view?

Give the pupils: the last piece of evidence
Evidence I - photo of the damaged thigh bone and the forensic report. This report states that the thigh bone shows damage caused by sharp, serrated instruments, in several places at once.

Ask the pupils:
- To pull together all of the evidence and work out whether your dinosaur died of natural causes or whether it was attacked and killed by a predator.
- If it was attacked, which is the most likely culprit?
- Why do you think it might have been attacked?
- Do you think there are any other possible causes of death which have not been investigated?

Teachers: If this activity is too long or requires too much printing, a shorter, simpler, alternative approach involves using Evidence A B, H and I only.

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The back up

Title: Dinosaur death - did it die or was it killed?

Subtitle: Was this a Cretaceous crime scene? - using rock and fossil forensic evidence to find out.

Topic: This activity could be used as part of studying predator/prey relationships and food webs or as a detective story to build up scientific investigational skills.

Age range of pupils: 10 - 16 years.

Time needed to complete activity: about 20 minutes, but this will vary according to the age group.

Pupil learning outcomes: Pupils can:
- gain evidence of how animals lived and died from a study of fossils;
- reconstruct past environments from a study of the rocks;
- know that more than one piece of evidence is needed in order to be able to interpret the whole story;
- use various pieces of evidence to construct a complete story;
- understand that their preferred solution may not be the only possible solution;
- build a scientific explanation;
- make predictions of possible scenarios;
- evaluate conclusions.

Context: Possible answers to the questions given to the pupils:-

What evidence in the leg bone would suggest whether your dinosaur died of natural causes, or had been attacked? *If the leg bone was broken, this might suggest that the dinosaur fell. If, however, the bone has marks that could have been made by teeth, this would suggest that the animal was attacked. The skeleton is whole suggesting that the animal was not taken away and eaten or scavenged. It looks as though it died where it was found and was quickly covered by sediment.*

What evidence would you look for in the rock to show what the local environment was like when it died? Look for clues in the drawing. *If the surrounding rock is mudstone then the dinosaur lived on a flat area, maybe a river bank. If the rock is made of gravel and pebbles all jumbled together, then maybe there was a flash flood which killed the dinosaur. If the local rock is hard and crystalline, this may explain why the dinosaur fell and broke its leg. The hadrosaur was plant-eating so there may be fossil plant remains in the rocks. Maybe the area was covered by bushes and trees?*

To 'picture the possible crime scene' by imagining what the area might have looked like at the time when the dinosaur was alive. *Evidence F, the artist's reconstruction shows the sort of environment that evidence C, D and E suggest, i.e. a muddy plain with plants growing on it and a river with a sandy bed.*

What evidence do the tracks show about the animals which lived at the time? Do the tracks tell you what they were doing when they walked across the soft mud? *The tracks suggest that the hadrosaur and the ostrich dinosaur were much the same size but the tyrannosaur was much bigger. Your hadrosaur is much bigger than the one indicated by these footprints. The hadrosaur in the diagram walked across the mud just after the ostrich dinosaur as one of its footprints overlies one of the ostrich dinosaur's footprints. No relationship between the tyrannosaur footprints and the other two sets can be determined from the evidence. It can be assumed, however, that they were not made at the same time, as the tyrannosaur, a predator, walked across the area and does not seem to have noticed the other two animals. The footprints do not give clues as to what the dinosaurs were doing when they walked across the soft mud. The hadrosaur and the ostrich dinosaur were probably grazing and the tyrannosaur could have been hunting. Maybe the hadrosaur and tyrannosaur were going to the river to drink and the ostrich dinosaur was returning from it?*

Is this evidence any help in trying to work out what happened to your dinosaur? *It tells us that these animals were living several kilometres away from your hadrosaur. There is, therefore, a possibility that the tyrannosaur could be a predator of the hadrosaur.*

Can you work out which skull (if any) could **not** have belonged to a predator. *The skull belonging to the ostrich dinosaur suggests that it could not have been the killer. The animal was small with a toothless beak; it could not have killed a large hadrosaur. The other animals, whose skulls are pictured, however, could have attacked your dinosaur.*

How reliable is this evidence which comes from skulls that a local museum happens to have on view? *This evidence gives us some names of animals which lived at the same time as your hadrosaur. We only know for certain, from the footprint evidence, that the tyrannosaur and ostrich dinosaur were living quite close to your hadrosaur. The museum may not contain the skulls of all the predators alive at the same time as your hadrosaur.*

To pull together all of the evidence and work out whether your dinosaur died of natural causes or whether it was attacked and killed by a predator. *The fact that the forensic report states that the damage to the thigh bone of your dinosaur was caused by sharp, serrated instruments in several places at once, does suggest that the hadrosaur was attacked by a predator.*

Why do you think it might have been attacked? *Predators usually attack other animals for food - attacks for other reasons are uncommon.*

If it was attacked, which is the most likely culprit? *The most likely culprit is a dinosaur with sharp, serrated teeth. Using the museum evidence from the skulls, the tyrannosaur is the most likely suspect. It is unlikely, however, that the tyrannosaur killed your dinosaur as the only damage to the fossil skeleton was on the thigh bone. Your hadrosaur was attacked but managed to escape and died later, perhaps of its injuries. Walking on two legs would have been difficult with a damaged thigh bone.*

Do you think there are any other possible causes of death which have not been investigated? *Was there any evidence that the thigh bone had healed after the damage? If it had, then the predator which caused the injury was not the killer. The animal might have died of old age and the thigh bone might have been bitten by a scavenger after it died. Other, more imaginative scenarios, may also have been possible (fell down a bank into the mud, ate poisonous plants etc.)*

Following up the activity:
The pupils could work out the food chain involved in this activity. They could also try to make up their own crime scene with local predator and prey animals. The Royal Tyrrell Museum staff, who originated this activity, ask pupils to do a dramatic re-enactment of what they think happened - this can be highly successful and great fun.

Underlying principles:
- There is interdependence between animals and plants.
- Predator/prey relationships can be interpreted from evidence.
- Food webs in ecosystems of the past can be determined from fossil evidence.
- Ancient environmental conditions can be reconstructed from evidence in rocks.
- As much evidence as possible must be used to build scientific explanations, make predictions and evaluate conclusions.

Thinking skill development:
- understanding the pattern of events (construction);
- using different pieces of evidence to reach a conclusion, some of which may not fit the pattern (cognitive conflict);
- explanation of thinking as each new piece of evidence is introduced (metacognition);
- relating fossil and rock evidence to a modern-day predator/prey scenario (bridging).

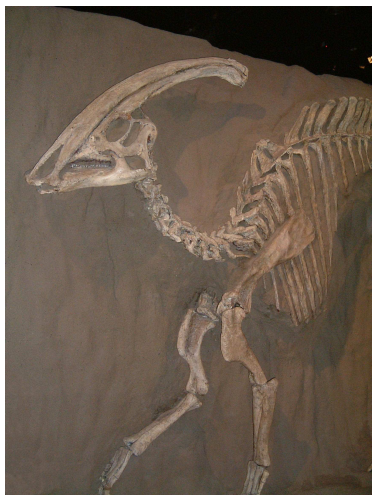
Resource list:
- Evidence A - a photograph of the dinosaur remains
- Evidence B - a forensic artist's reconstruction of your hadrosaur
- Evidence C - a photo or specimen of sandstone
- Evidence D - a photo or specimen of mudstone
- Evidence E - photo of fossil plants
- Evidence F - an artist's reconstruction of the environment
- Evidence G - a diagram of dinosaur trackways
- Evidence H - drawings of skulls of suspects
- Evidence I - photo of the damaged thigh bone and forensic report.

Useful links:
Related Earthlearningideas -
'What was it like to be there - in the rocky world' published on 14th January 2008.
'The meeting of the dinosaurs - 100 million years ago' published on 3rd March.
'What was it like to be there - bringing a fossil to life' published on 11th August, 2008.

Useful websites:
http://www.tyrellmuseum.com/pdf/087%20booklet_r.pdf
http://www.enchantedlearning.com/subjects/dinosaurs/glossary/Hadrosaur.shtml
http://www.nps.gov/akso/ParkWise/Students/ReferenceLibrary/Paleontology/Hadrosaurs.htm

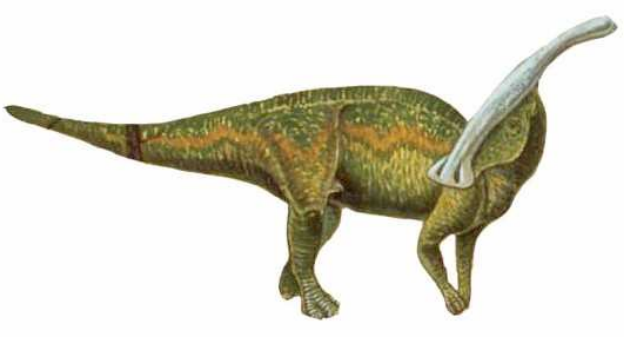
Source: Developed as part of an Earth Science Education Unit 'Creative Science' workshop by Susannah Lydon, Lucy Green, Marianna Jarai and Nikki Edwards. The activity was inspired by a 'Cretaceous Crime scene' activity devised by staff at the Royal Tyrrell Museum, Alberta, Canada. We are also grateful to Dr Martin Whyte, Sheffield University, for information regarding skeletons and trackways.

Evidence A



Fossil of Parasaurolophus
Photo by Susannah Lydon

Evidence B



Artist's reconstruction of a hadrosaur
Drawing by Brian Regal,
reproduced with permission from the artist

Evidence C

Sandstone *Photo: Peter Kennett*

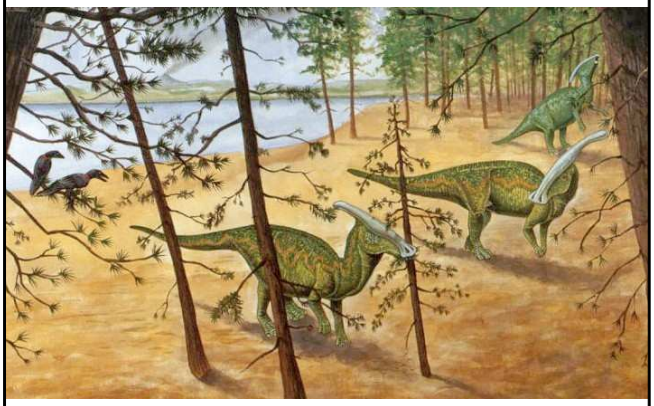
Evidence D

Mudstone *Photo: Peter Kennett*

Evidence E

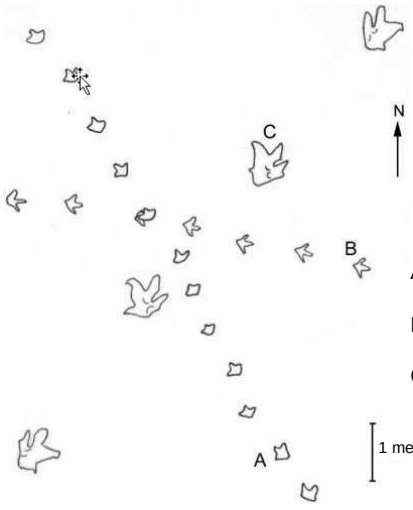
Zamites gigas (top) and *Ptilophyllum pecten*
Bennetitales (Cycad-type plants), Yorkshire, UK
Photographed, with permission by Elizabeth Devon
from the Alan Bentley Collection, Bath, UK

Evidence F



Artist's reconstruction of the environment
Drawing by Brian Regal,
reproduced with permission from the artist

Evidence G



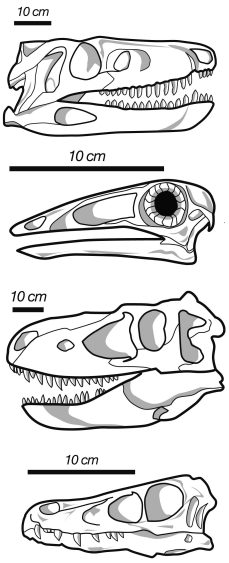
A hadrosaur

B ostrich dinosaur

C tyrannosaur

Drawing by Peter Kennett

Evidence H



1 Crocodile
- sharp, conical teeth with no serrations
- walked on four legs

2 Ostrich Dinosaur
- toothless beak
- walked on two legs

3 Tyrannosaur
- serrated, dagger-like teeth
- walked on two legs

4 Dromaeosaur
- small, dagger-like teeth
- walked on two legs

Drawings: Earth Science Education Unit, Keele University

Evidence I

Forensic Report:
Thigh bone shows damage caused by sharp, serrated instruments, in several places at once.

Photo: Susannah Lydon