Shell shake – survival of the toughest
Why is the fossil record incomplete?

Show pupils a good example of a rock containing plenty of fossil marine animals, or show them the photographs.

Photo 1: A limestone with fossil brachiopods, corals, bryozoans and a trilobite cephalon ("head"). Coin = 2 cm. (Photo: *Peter Kennett*)

Photo 2: A limestone with fossil crinoids (1cm divisions on scale bar) (Photo: *Peter Kennett*)

What do the pupils think the animals might have eaten when they were alive? Is there any evidence of this in the rock?
The answer is usually, "No", because either:

- *the food consisted of very tiny particles, or*
- *if the food was larger, weak organisms might have been broken up by the action of a rough sea, or*
- *larger food organisms were destroyed later as the sediment became turned to rock.*

(See note under "Underlying principles" below)

To demonstrate how weaker organisms can be broken up, use a variety of common sea shells, similar to those shown in the photograph.

Photo 3: Shells from left to right are: winkle, mussel, cockle, carpet shell, limpet, slipper limpet, razor shell. (Photo: *Peter Kennett*)

Pupils should take two of each type, note down the names of the shells, and predict which ones they think will best survive a battering by being shaken hard together. Then place the shells (quietly!) in a plastic pot, with a couple of small pebbles. On a given signal, each group of pupils should shake its pot of shells vigorously for 20 seconds or so.

(Cartoon: *Dominic Greenall*)

When the dust has settled (people with respiratory problems take care!), tip out all the contents of each pot into a tray and examine the shells to see which ones are still recognisable. Note these down and then replace all the material in the pot and repeat the shaking exercise two or three times, until some of the weaker shells have broken down beyond recognition.

Photo 4: A pupil doing her best to destroy her shells!
(Photo: *Elizabeth Devon*)

Compile a list from the class to show which shells were the strongest and which were the weakest. If they were to examine a rock made of the broken fragments from their investigation, would they know that the weaker shells had ever existed? (*In reality, sea shells such as these consume tiny particles of food which have fallen to the sea floor. They do not prey on weaker examples of their own kind, but the activity will enable pupils to realise that there must be a lot missing in the fossil record*).

With reference to a good slab of fossiliferous rock, or photos 1 and 2, ask the pupils:

- how they could tell whether the animals were buried as they had lived, or were broken up after death (*only one shell of a pair may be preserved; bits of the structure may be missing, when compared with a fresh specimen; corners may have been rounded off by abrasion; fossils may be jumbled up*);
- how they could tell if the environment was a quiet or a violent one (*answers such as the above would suggest a violent environment. In a quieter environment, fossils would be more complete and may well lie in the positions in which they grew);*
- to explain why some shells are much better preserved in the fossil record than others (*good preservation depends upon rapid burial of the dead organism; lack of wave action to break it up, or predators/scavengers to eat it; together with favourable processes for lithification).*

The back up

Title: Shell shake – survival of the toughest

Subtitle: Why is the fossil record incomplete?

Topic: Pupils deliberately smash a variety of seashells to see which ones are strong enough to remain recognisable, and which ones are so weak that they would leave little or no evidence of their existence. This leads pupils to realise that the fossil record is often biased.

Age range of pupils: 8 – 14 years

Time needed to complete activity: 15 minutes

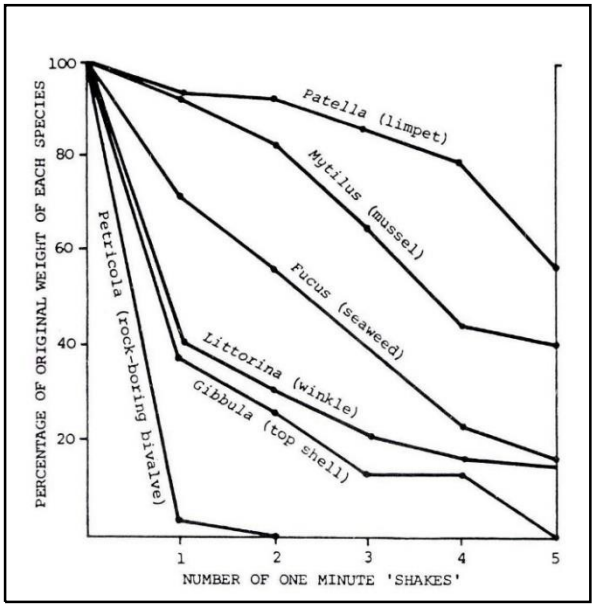
Pupil learning outcomes: Pupils can:

- work safely, with an awareness of the problems of creating dust;
- note a range of shell types;
- predict which shells will survive a battering, to simulate wave action;
- realise that when they study an assemblage of fossils there may have been more organisms alive at the time than are recognisable in the assemblage.
- recognise that the fossil record may be incomplete because of the mechanical destruction of some organisms;
- appreciate the difference between an assemblage of fossils where the animals are preserved more or less in the positions in which they lived, compared to one where considerable movement has taken place after the death of the organism.

Context:
Many organisms are destroyed by being eaten or by being broken up into tiny fragments by moving water, or by processes of lithification of the host sediment. This lesson demonstrates that a slab of apparently well-preserved fossils may not present a true record of all that lived there, so caution is needed in reconstructing the ancient environment in its entirety. A fossil assemblage may contain evidence about the environment in which the organisms lived, and what happened to them after their death.

Following up the activity:

- Ask what would happen in nature to the shell powder left behind by the smashing (*It would form the matrix to the remaining fossils and would turn to limestone when lithified).*
- Pupils could make an “artificial fossil assemblage” by mixing all the debris from their shaker with Plaster of Paris in a disposable plastic beaker, and leaving it to harden.
- An alternative approach to the whole activity is to separate all the recognisable shell fragments after each round of shaking and weigh them, species by species. If this is repeated several times, a graph may be drawn to show the relative resistance to erosion of each species.



Graph showing the reduction of recognisable shell fragments (plus some dried seaweed) with successive shaking of the plastic pot (Note: the shells are not all the same as in Photo 3)

Underlying principles:

- The introductory question on page 1 has deliberately been left open-ended, but teachers may wish to use a published diagram of a marine food web to prompt more focussed discussion.
- The fossil record usually only preserves the more robust organisms.
- Soft bodied organisms and tiny food particles may leave no trace in the rocks.
- The state of preservation of a fossil in the rocks can give many clues about the environment of deposition.
- The fossil record is biased, and this must be borne in mind when drawing conclusions from a fossiliferous rock.
- Pupils should be encouraged to observe the state of preservation when collecting fossils (where this is allowed), and not discard specimens which are less than perfect, since this may give clues to the environment in which they lived and died.
- Careful observation of the detailed state of preservation may enable a scientist to say whether the assemblage of fossils shows the relationships between the organisms in the situations where they actually lived (a *life assemblage*), or if they have been moved after their deaths (a *death assemblage*).

Thinking skill development:

Recognising patterns of probable shell strength, before shaking the shells, involves processes of construction. Cognitive conflict frequently arises when shells prove more or less resistant than pupils had predicted. Relating the outcome to other examples of fossil assemblages involves bridging skills.

Resource list:

- a variety of expendable shells, of varying resistance to erosion by shaking, preferably two of each type per group of pupils
- a strong plastic pot and screw lid, with a wide enough neck to take the shells
- a few small pebbles
- a tray to contain the debris after each shake
- Optional – a balance

Useful links:

http://www.nationalstemcentre.org.uk/elibrary/resource/730/life-from-the-past-introducing-fossils
Earthlearningidea activities *Sea shell survival: how are common sea shells adapted to their habitats?* and *Trace fossils – burrows or borings: what evidence do living organisms leave behind in rocks?*

Source: Written by Peter Kennett of the Earthlearningidea team and originally published in *Palaeoecology*, 1983, Kennett, P. and Ross, C.A., Longman Group.