Gary Skinner

Battle of the barnacles

Competition on the seashore

The photograph on the centre pages shows a rock wall on a British rocky shore. It is covered with various intertidal animals, mainly barnacles. Have a good look at the image; you should be able to see barnacles of two different species and, amongst them, and even sometimes in their old shells, other animals, mainly shelled ones called molluscs. This image can be used to go on a virtual tour of this part of the rocky shore, and to see – nearly first hand – some important principles of ecology.

Much of the UK coastline is rocky, and the parts washed by the sea from high to low tide are called rocky shores. The region between the tides is the littoral zone, home to many species of animals and algae (but no true plants).

A day spent searching for living creatures on a rocky shore, it is claimed, can yield creatures from over twenty different **phyla** (singular phylum; see Box 1). One of the major phyla to be found is the **arthropods** and some very obvious jointed-legged animals (*arthropod* means *jointed limb*) such as crabs, lobsters and shrimps are commonly found here. Also common on rocky shores are many different kinds of shelled animals, belonging to the phylum **molluscs**, very like the well known land snails.

One group of animals, though, seems to defy this clear cut distinction; they are jointed legged animals living in shells! These are the barnacles; arthropods which live as tiny larvae in the sea and then cement themselves, head down, on suitable rocks, build a shell, poke their legs out of the top of it and start to filter feed! Barnacles like this are called acorn barnacles, and they occur in mind boggling numbers on most rocky beaches around the world.

A British barnacle, Semibalanus balanoides, reveals its legs when the tide comes in.

Box 1
What is a phylum?

The Animal Kingdom is divided into over 30 major groups, or types of animal life; these are called phyla. Large ones include the arthropods (insects, crustaceans, arachnids including spiders), echinoderms (starfish, sea urchins etc.), molluscs (snails, slugs, squids, octopuses etc.) and many others. Our phylum is the chordates and includes mammals, fish, amphibia, reptiles and birds.

British barnacles

There are over 1000 species of barnacle known in the world, but anyone starting a study of these fascinating animals in the UK only has to cope with four, and even one of these is a foreigner! Like most tiny organisms, these do not have common names and we have to use their Binomial Latin Names (see Box 2). The native species are:

Chthamalus montagui
Chthamalus stellatus
Semibalanus balanoides

The only other commonly found littoral species is an Australian barnacle called *Elminius modestus,* first noticed in Chichester Harbour in 1945. It is now found all around Britain and parts of north west Europe.

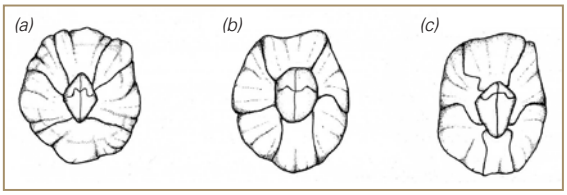
Barnacles could possibly be confused with one other group of shelled animals on the shore, the limpets. These are generally much bigger than barnacles (although young ones may not be) and do not have any sign of an opening at the top, or legs that emerge.

All adult acorn barnacles are fixed to a surface, usually rocks on a rocky shore, but also limpet shells and other solid objects. They have a conical shell, with plates that open on the top to let out the feeding legs. The shell consists of a number of calcium-based (calcareous) plates (4 or 6) with a flat top. When the tide is out, the plates close and the animal is in a box, which helps to stop it from drying out until the water comes back.

The number and arrangement of these outer plates, and the shape of the top, are used to identify barnacles. This can be done on the shore with a good hand lens (10×). The simplest way to decide which species you have is to look carefully at it and compare with good drawings and photographs.

Chthamalus montagui

Semibalanus balanoides



(a) Semibalanus balanoides
(b) Chthamalus stellatus
(c) Chthamalus montagui

Three British barnacle species; note that, in ***Chthamalus****, the central lines cross at right angles.*

Fish J.D. and Fish S. A Student's Guide to the Seashore (2nd Edn) Cambridge, 1996

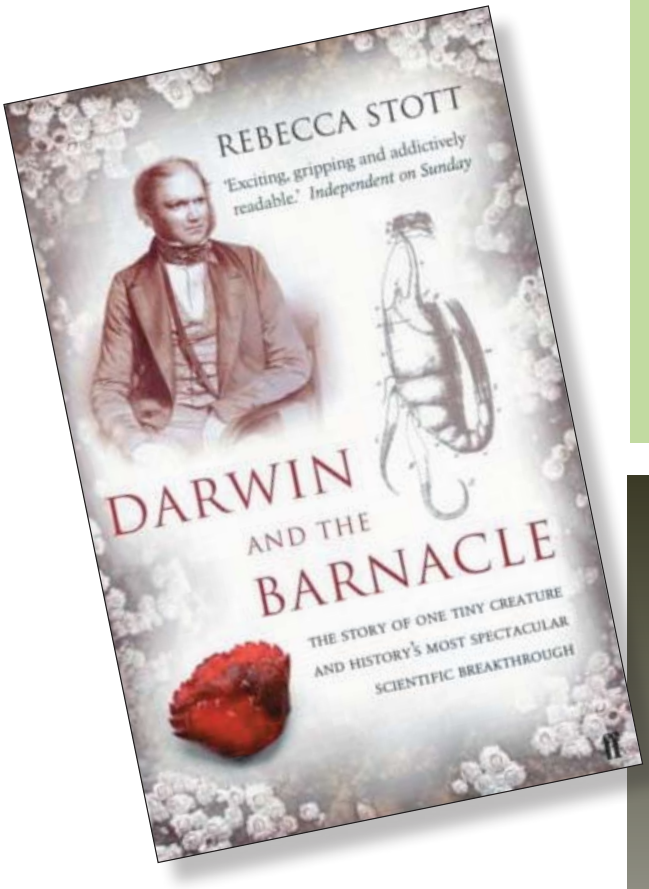
Box 2
Binomial names

All living things belong to a genus (humans are in the genus *Homo*) and within that, a particular species, humans are sapiens, so *Homo sapiens*. Both names are always printed in italics (or, when written, underlined), and the genus name must be capitalised, the species one lower case, as shown. Try to find out the binomial names of a few familiar animals and plants; this should be easy on the internet.

What barnacles can teach us

One fascinating fact about rocky shore species is that they are distributed in bands or zones on the shore and, as such, show very simple and easily understood patterns of distribution. Studies of patterns of distribution in relatively simple habitats like this have been very helpful in finding out the sorts of factors controlling why animals and plants live where they do. When oil spills have affected rocky beaches, knowledge of the biology and ecology of the species living there has proved useful in understanding how to best manage the spillage.

Because people have been interested in these fascinating animals for a long time, they are also now useful for scientists looking for climate change effects. A long set of data, collection starting in the 1950s, exists about barnacle distribution around British shores, and these are now being looked at again and compared with the present day pattern. There are many indications in the data that warming is taking place, for example the warm water species *Chthamalus montagui* is found in more places in Scotland than it used to be. The favouring of *Chthamalus* by the warmer seas has released it from competition with *Semibalanus*, which is therefore suffering. These studies show that, no matter how sophisticated our instrumentation gets, living things are still often the most sensitive way of finding out what is going on in the environment.



Charles Darwin was fascinated by barnacles. He spent eight years observing, dissecting and classifying them before he started his main work on the ***Origin of Species.***

Barnacle patterns

One of the best understood patterns found is that of the mid-shore barnacles, the two *Chthamalus* species and *Semibalanus balanoides.* Joseph Connell, working on the Scottish island of Cumbrae, surveyed the distribution of barnacle species, and from his observations came up with some hypotheses. He observed that *Chthamalus* occurs higher on the shore than *Semibalanus*, and suggested that it was stopped from living further down by competition with *Semibalanus*.

He tested this idea by taking rocks with *Chthamalus* from high on the shore and screwing them to rocks lower down, amongst the *Semibalanus*. Over the next year or so he observed what happened, removing any *Semibalanus* that came near the *Chthamalus* in some cases, leaving them in others. He found that, where *Semibalanus* were removed, the *Chthamalus* did perfectly well. Figure 1 shows one of his many graphs of this experiment.

Connell's studies were amongst the first where, instead of just observing animals and plants in nature, a scientist experimented on them where they lived. This is **experimental ecology**.

Figure 1
One of Joseph Connell's graphs, showing the effect on ***Chthamalus*** *barnacles when* ***Semibalanus*** *barnacles were removed from nearby.*

Look here!

Find out what factors (other than competition) Joseph Connell thought might be affecting where barnacles live; he talks about his famous paper here: **www.garfield.library.upenn.edu/classics1981/A1981LP44800001.pdf**
All the photographs in this article, plus many more, together with virtual tours of rock shores and other habitats can be found at: **www.britishecologicalsociety.org/education2/index.php?cat=17**and click on habitats/rocky shores or sand dunes. The work to produce these websites was funded by the British Ecological Society

British Ecological Society

Try This

Surveying barnacles

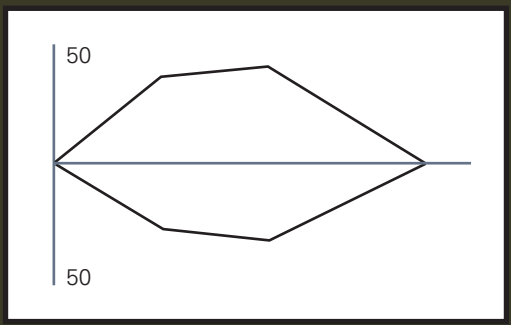
The rocks where the large photo was made.

Before visiting a rocky shore, try surveying the barnacles on the large photo (centre pages).

- Make a quadrat by cutting a 10 cm square hole in a sheet of card.
- Place your quadrat at different points along a vertical line on the photo, count the barnacles of each species in the quadrat and record your results in a suitable table.
- Plot a kite diagram (Box 3). Look for where *Chthamalus* is found and where *Semibalanus*. What pattern do you see?

Box 3
Drawing a kite diagram

Draw x- and y-axes as shown. The x-axis represents distance along the transect line. Mark the y-axis up to half the highest number of barnacles found on either side of the x-axis. Now plot half the result on each side, as shown. Finally, join up the points, again as shown. This is not easy to do with Excel, but there is software (called Field Studies) to do it; you may have this at school. The diagram represents results where no barnacles were found in the first quadrat, about 80 in the second, 90 in the third and none in the fourth.



Quadrats are placed at intervals along a line called a transect.

Comparing results

If you look into the research about the distribution of barnacles on a shore you will find lots of results from around the world. Try to look for British examples, or else you will be dealing with different species and you will be confused by this. Figure 2 shows a typical example, in this case from a rocky shore in Devon.

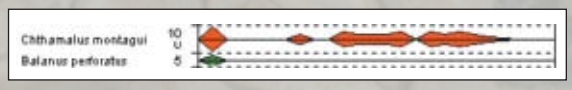


Figure 2 A kite diagram for two barnacle species, surveyed on a rocky shore in SW England.

What are its most important features of this graph? Do your results fit with it? Do you agree with Joseph Connell?

Gary Skinner teaches biology and is biology editor of CATALYST.

How the photograph was made

The image on the centre pages was made using a very high resolution digital camera (10 million pixels), taking 14 overlapping images down the rock wall. These were then 'stitched' together using special software (PhotoVista). This gives a huge image of nearly 100 Mb, and thus immense detail of the tiny animals seen.

Acorn barnacles on a vertical rock face. From this image, more than one species can be identified and their distributions mapped. Photograph by Gary Skinner

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www.sep.org.uk/catalyst