

## Brachiopods prove tougher than previously thought

A remarkable 120-year record of resilience to environmental change in the world's oceans has been uncovered within a group of marine organisms called brachiopods. Although they are not well known today, brachiopods have had considerable importance in the evolution of seabed life.

It has been predicted that brachiopods might be especially vulnerable to environmental change. But Emma Cross and Liz Harper from the Department of Earth Sciences and other Cambridge colleagues from the British Antarctic Survey have found that a species of brachiopod, called *Calloria inconspicua*, has successfully combatted a significant level of warming and acidification in ocean waters over the last century and more.

Modern times have seen rising carbon dioxide concentrations leading to global warming, which is impacting upon the oceanic environment and the organisms that live there. The extent to which ocean dwelling organisms can cope with such changes in temperature and acidity is of considerable concern for biodiversity and ecology of the marine environment, which accounts for some 70% of Earth's surface.

Current understanding of biological responses to these environmental changes is largely based upon relatively short- to medium term (days to months long) laboratory and field experiments. Their value is inevitably limited in the evaluation of the processes of long-term adaptation, which might confer resistance to such changes.

From amongst the huge diversity of marine organisms subject to climate change, brachiopods provide one of the best models because they have a global distribution in all ocean depths. They are also one of the most calcium carbonate-dependent groups of marine invertebrates with their calcareous skeletons comprising more than 90% of the dry body weight. Consequently, brachiopods have been predicted to be peculiarly vulnerable to ocean acidification.

Emma Cross, Liz Harper and colleagues have been able to test this prediction in one New Zealand species (*Calloria inconspicua*) using a unique museum based collection of 389 specimens collected over the last 150 years. Measurement and evaluation of their shell characteristics shows that six out of eight key characteristics remained unchanged over this period and thus have not been affected by environmental change. However, one significant characteristic has changed. Their shells have been reinforced by an increased density of some 3.4% through deposition of calcium carbonate and the formation of narrower punctae. These latter are tissue filled microscopic perforations of the shell, which are spaced about 45 microns apart. Over 150 years their mean width has decreased by some 8% from around 20.5 to 19 microns.

The resilience of these brachiopods to environmental change is in marked contrast to other marine invertebrates such as corals, echinoderms and molluscs in which significant dissolution of their shell carbonate has been measured in recent decades. However, Emma Cross, Liz Harper and her colleagues question the future ability of these brachiopods to survive ocean warming and acidification without threatening the integrity of their shell structure.

## **Brachiopods**

Every geologist at some stage in their career will have heard of brachiopods and know how to tell the difference between a brachiopod and a bivalve mollusc. However how many geologists or even palaeontologists will have ever seen a live brachiopod? Surprisingly, brachiopods are still very much 'alive and kicking' with over 300 species and a global distribution.

Brachiopods are essentially centimetre-sized seabed dwelling filter feeders, which are initially attached to a substrate by a fleshy stalk that many lose as they become adult. Their somewhat minimal body tissue has a delicate feeding and respiratory structure called a lophophore which projects into a water-filled space enclosed by two protective shells. Opening and closing of the valves is achieved by sets of opposing muscles. Most brachiopods can be divided into those with calcium carbonate shells, which are articulated by teeth and sockets and those with calcium phosphate shells without articulating teeth.

Brachiopods have an ancient history which stretches back to early Cambrian times. Beachcombing in Palaeozoic times would have presented the collector with more brachiopod than bivalve shells. Exactly why such an ancient and successful group became eclipsed or out-competed by the more adaptable bivalves has been of interest to palaeontologists in recent decades. Unlike so many bivalves, which have evolved a variety of forms of locomotion from burrowing to swimming, most brachiopods are unable to actively move away from predators or hostile environments.

Even in Mesozoic times, brachiopods were still present in the seas and oceans of the world. Today, brachiopods are not common and are hard to find unless you live in New Zealand and know where and what to look for.

However, the Sedgwick Museum has extensive displays of fossil brachiopods from throughout their evolutionary timespan.

Reference: Cross, E.L., Harper, E.M. and Peck, L.S. 2018. A 120-year record of resilience to environmental change in brachiopods. *Global Change Biology*, DOI: 10.1111/gcb.14085

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