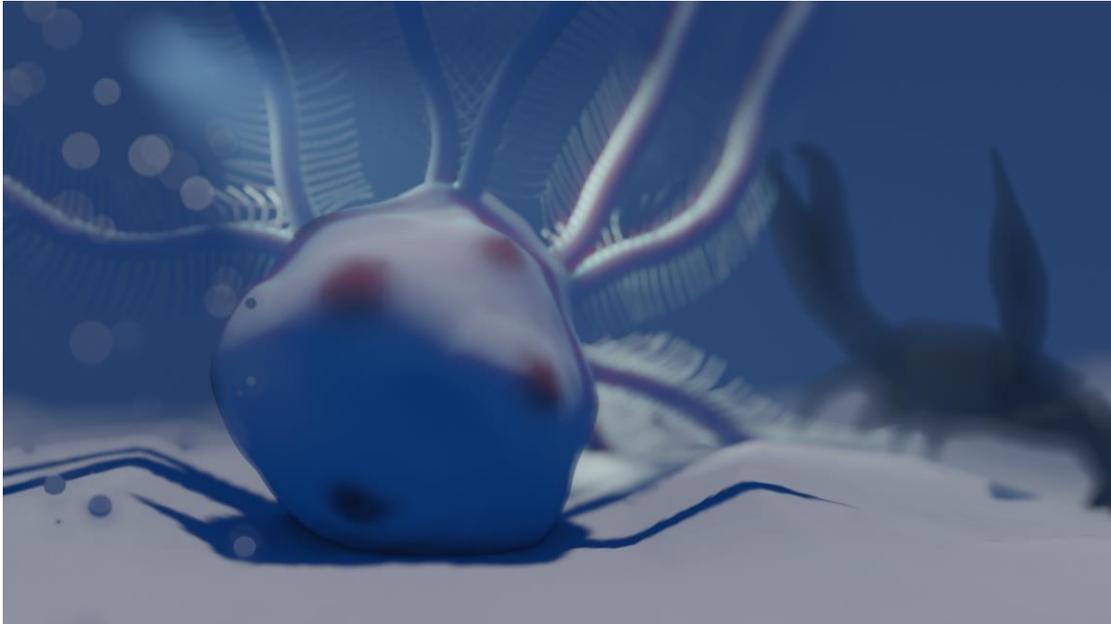


Fossil 'Buckyball' structures found in Cretaceous crinoids

Fossil Buckminsterfullerene-type structures, colloquially known as 'buckyballs', have been discovered by Cambridge palaeobiologist Jennifer Hoyal Cuthill and Aaron Hunter in stemless crinoids of Cretaceous age preserved in the collections of the Sedgwick Museum. Quantitative analysis of two species of these aberrant echinoderms, commonly known as sealilies, reveals that their hollow ball-shaped tests, built of numerous calcareous plates, have structural similarities to fullerene-type structures, more commonly associated with complex carbon molecules.



Reconstruction of the Cretaceous crinoid *Marsupites testudinarius*
Image credit: J Hoyal Cuthill

Buckminsterfullerenes or 'buckyballs' are a particular kind of geometrical structure named after the American architect Buckminster Fuller who invented the thin-shelled but structurally rigid geodesic dome. This has a strong, self-supporting fullerene-type structure of interconnected pentagons and hexagons used in iconic structures such as the Eden Project in Cornwall. The possibility of creating such hollow spheres at the molecular scale using carbon atoms was first hypothesised in the late 1960s, then synthesised and finally found to occur in natural materials from soot to cosmic dust and viruses.

Now for the first time, macroscopic 'buckyball' structures have been found in two species of 80-million-year-old fossils crinoids, *Uintacrinus socialis* and *Marsupites testudinarius*, which belong to a superfamily of extinct stemless crinoids called the Uintacrinoidea. These strange, vaguely plant-like animals are actually echinoderms related to starfish and sea urchins, as can be seen from the vestiges of their five-fold body symmetry. The most characteristic features of these uintacrinoids are their long feeding arms and football-shaped calyx, constructed from calcium carbonate plates.

Of the two species, *U. socialis* has the more expanded calyx with numerous small plates with between 4 and 8 sides. This expanded calyx is thought to have functioned either as a stabiliser on the soft chalk

muds of the seafloor, or as a buoyancy chamber, which allowed the crinoid to float in the seawater. In comparison, the calyx in *M. testudinarius* has fewer (16) but relatively large plates, each with 5-6 sides.

Geometrical analysis has been carried out by Jennifer Hoyal Cuthill, now a research fellow at the University of Essex and Aaron Hunter, an adjunct Research Fellow at the University of Western Australia. Their analysis shows that the resulting plate structure of the calyx in *M. testudinarius* is identical to a stable and strong carbon fullerene. In contrast the structure of *U. socialis* does not allow such a stable configuration and was more prone to buckling and therefore predation.



*An exceptionally preserved slab of fossils of the Cretaceous crinoid Uintacrinus socialis held in the Sedgwick Museum of Earth Sciences, Cambridge
Image credit: J Hoyal Cuthill*

The analysis further suggests that this strong buckyball-like structure provided an evolutionary advantage in the increased calyx strength and stability seen in *M. testudinarius*, compared to the increase in plates and calyx size but reduced stability seen in *U. socialis*. However, this advantage was to prove temporary, since both uintacrinoid species became extinct by Late Campanian times when new marine predators, such as crabs, evolved.

The research used uintacrinoid specimens from the collections in the Sedgwick Museum, where they are on display.

Douglas Palmer, Sedgwick Museum

Ref Hoyal Cuthill, Jennifer and Hunter, Aaron; [Fullerene-like structures of Cretaceous crinoids reveal topologically limited skeletal possibilities](#). *Palaeontology*.