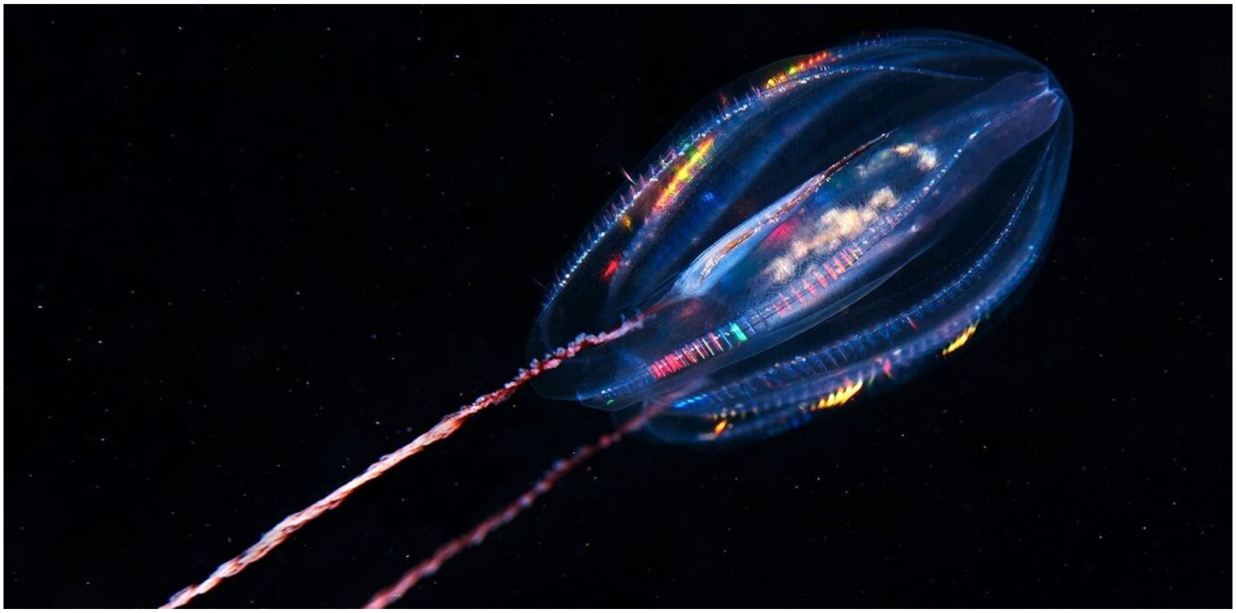
Finding a rare fossilized comb jelly reveals new gaps in the fossil record

October 4 2021, by Richard Cloutier, Christian Klug, Mike Lee



The bodies of comb jellies like Mertensia ovum are soft, meaning they rarely fossilize. Credit: (Alexander Semenov), CC BY-SA

They look like jellyfish but they aren't. They seem inoffensive but are efficient predators—occasionally, they even eat fish. They are gelatinous and very delicate—and extremely rarely do they fossilize!

Ctenophores, also known as comb jellies, are colorful, translucent animals, that drift through oceanic waters. Unlike jellyfish, ctenophores don't have stinging cells, and typically capture prey using long, sticky tentacles.

Our research describing a fossilized ctenophore from Eastern Canada, published recently in *Scientific Reports*, suggests that our creature was a very late survivor from the very dawn of animals. It also means that a very controversial idea about early animal evolution can't be rejected by the fossil record.

Common today but rare as fossils

There are approximately 200 species of living ctenophores, and many are locally abundant. Some well-known modern comb jellies include the sea gooseberry (Pleurobrachia pileus) found in the open water in the northern Atlantic Ocean, the North Sea, the Baltic Sea and the Black Sea, and the ribbon-like Venus girdle (Cestum veneris) that can be seen in tropical and subtropical oceans worldwide.

However, their delicate bodies generally lack hard parts, meaning very few fossil ctenophores have been preserved and discovered: only about a dozen species have been found globally. Fossilization of these soft-bodied animals requires exceptional conditions such as very rapid burial with very fine sediments in an oxygen-poor aquatic environment, which suppresses the activities of decomposing and scavenging organisms. Other environmental parameters also play an important role in the preservation.

The new ctenophore fossil, Daihuoides jakobvintheri, was found in the fine sediments from Miguasha cliffs along the Restigouche River in the Gaspé Peninsula, eastern Québec. Credit: Johanne Kerr, Author provided

Until the early 1980s, comb jellies were unknown from the fossil record. The first comb jelly fossil to be discovered came from the Early Devonian Hunsrück Slate of Germany, deposited some 405 million years ago.

Since then, records of spectacularly preserved early relatives of comb jellies were described from the 518-million-year-old Chengjiang Biota in southern China, the 505-million-year-old Burgess Shale of British

Columbia in Western Canada and other similar deposits.

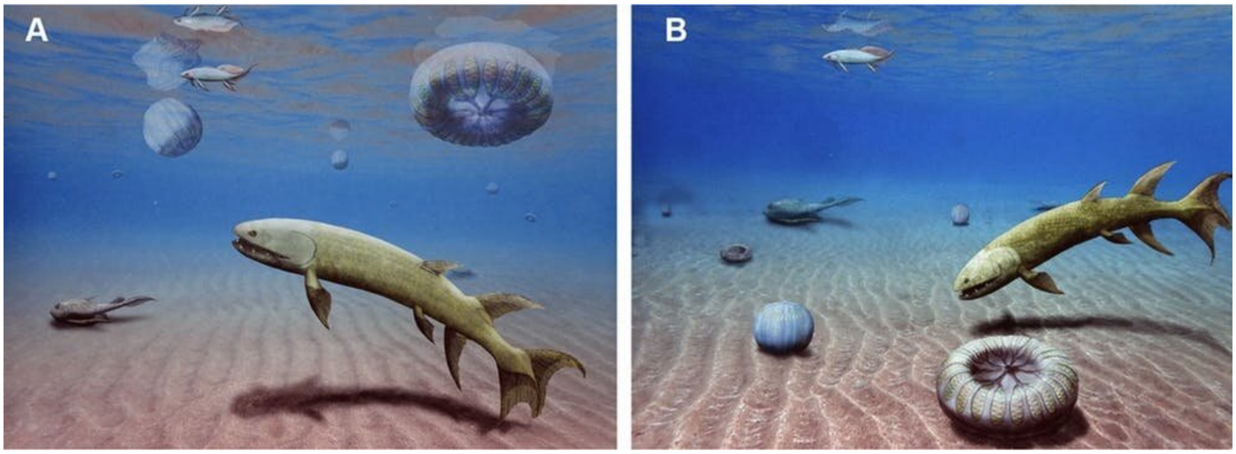
In August, two new species of Cambrian comb jellies were also reported from Utah. Our new fossil, named Daihuoides jakobvintheri, adds substantially to this scant record.

Strange anatomical symmetry

Most living ctenophores have a translucent spherical or cylindrical body, frequently showing bright-colored bioluminescence, vaguely reminiscent of colorful disco mirror balls. Most use a pair of long tentacles, armed with non-venomous sticky cells (colloblasts), to trap small prey and convey it to their mouth on the top of their body.

Ctenophores propel themselves using comb rows: beating hairs (cilia) organized into longitudinal bands. The presence, number and organization of these comb rows are taxonomically important. The single specimen of our fossil Daihuoides reveals a circular disk-shaped body (calyx), approximately six centimeters in diameter, with 18 radiating comb rows, each one distinguished by a clear zigzag pattern.

The presence of comb rows permitted us to identify this fossil as a ctenophore, but their high number was puzzling. This number is unusual in a living ctenophore, but rather common in very ancient Cambrian ctenophores. Cambrian comb jellies from the Chinese Chengjiang fauna, belonging to the genera Daihua, Xianguangia and Dinomischus, share a hexaradiate-based symmetry, meaning being six-fold or a multiple thereof, such as 18-fold.



Two alternative life reconstructions of the fossil comb jelly Daihuoides jakobvintheri, (A) as a pelagic animal like modern comb jellies, and resembles a jellyfish, and (B) as a benthic animal, like many Cambrian comb jellies, and resembles a sea anemone. Credit: *Scientific Reports*, Author provided

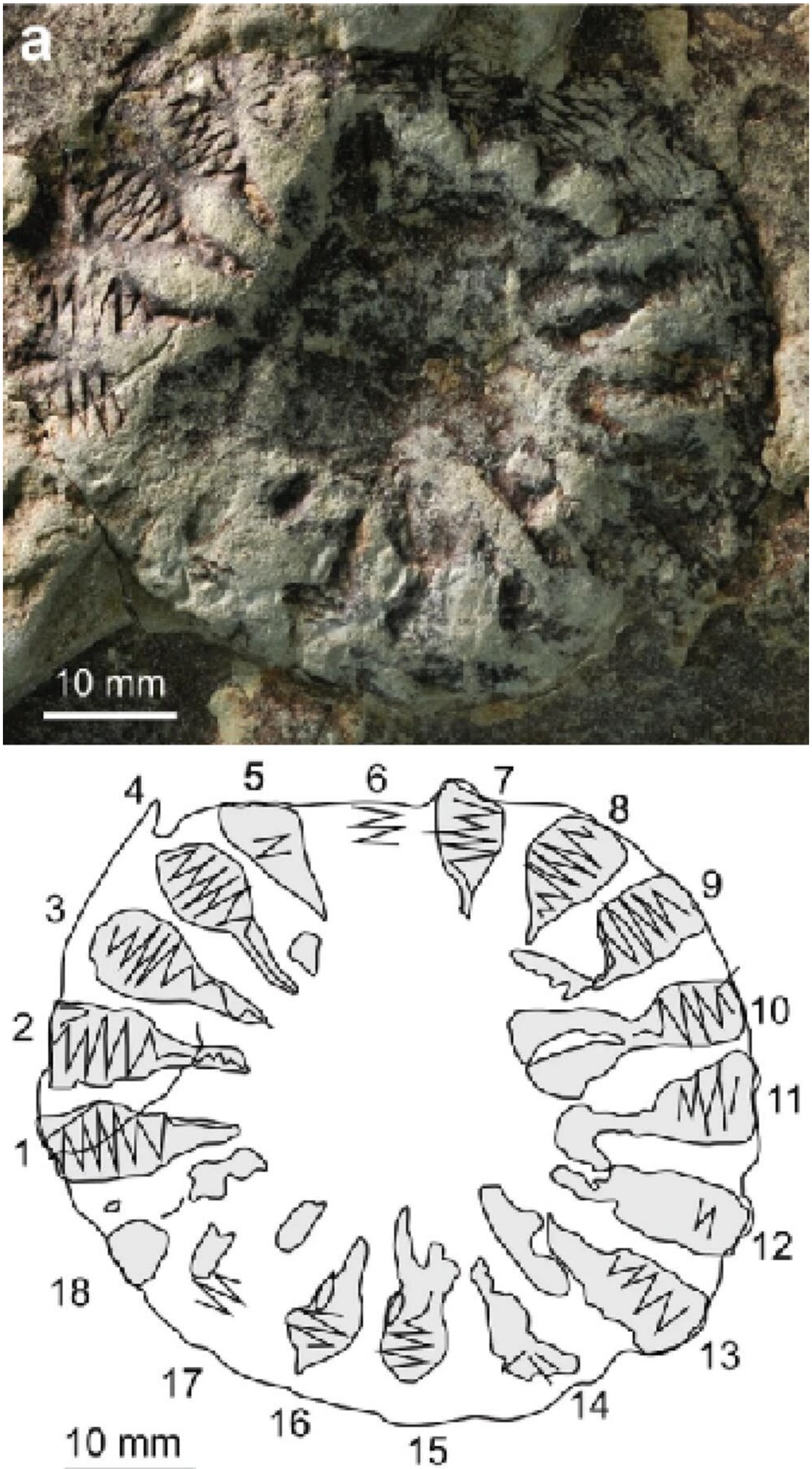
Exceptional conditions

Our new fossil comes from the well-documented Devonian fossil site from Miguasha along the south coast of the Gaspé Peninsula in Eastern Canada.

It is a UNESCO World Heritage Site because it preserves an exceptional diversity of early fishes, including a transitional form between fishes and land vertebrates (tetrapods). This trove of fossils, known as the Escuminac assemblage, is 375 million years old—and was once an estuary near the equator!

Since 1842, more than 21,000 fossil fish belonging to 20 different species have been found. Many of these fossils represent near-complete skeletons with most bones still in place.

In contrast to the plethora of fishes, invertebrates are rare and less diverse. In fact, only 10 species have been found. Most of them only known from a handful of specimens, and are primarily arthropods (hard-bodied invertebrates with jointed legs, represented today by things such as crabs and insects).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The fossil comb-jelly Daihuoides jakobvintheri, showing 18 radially-arranged comb rows. Credit: *Scientific Reports*, Author provided

The base of the tree of life

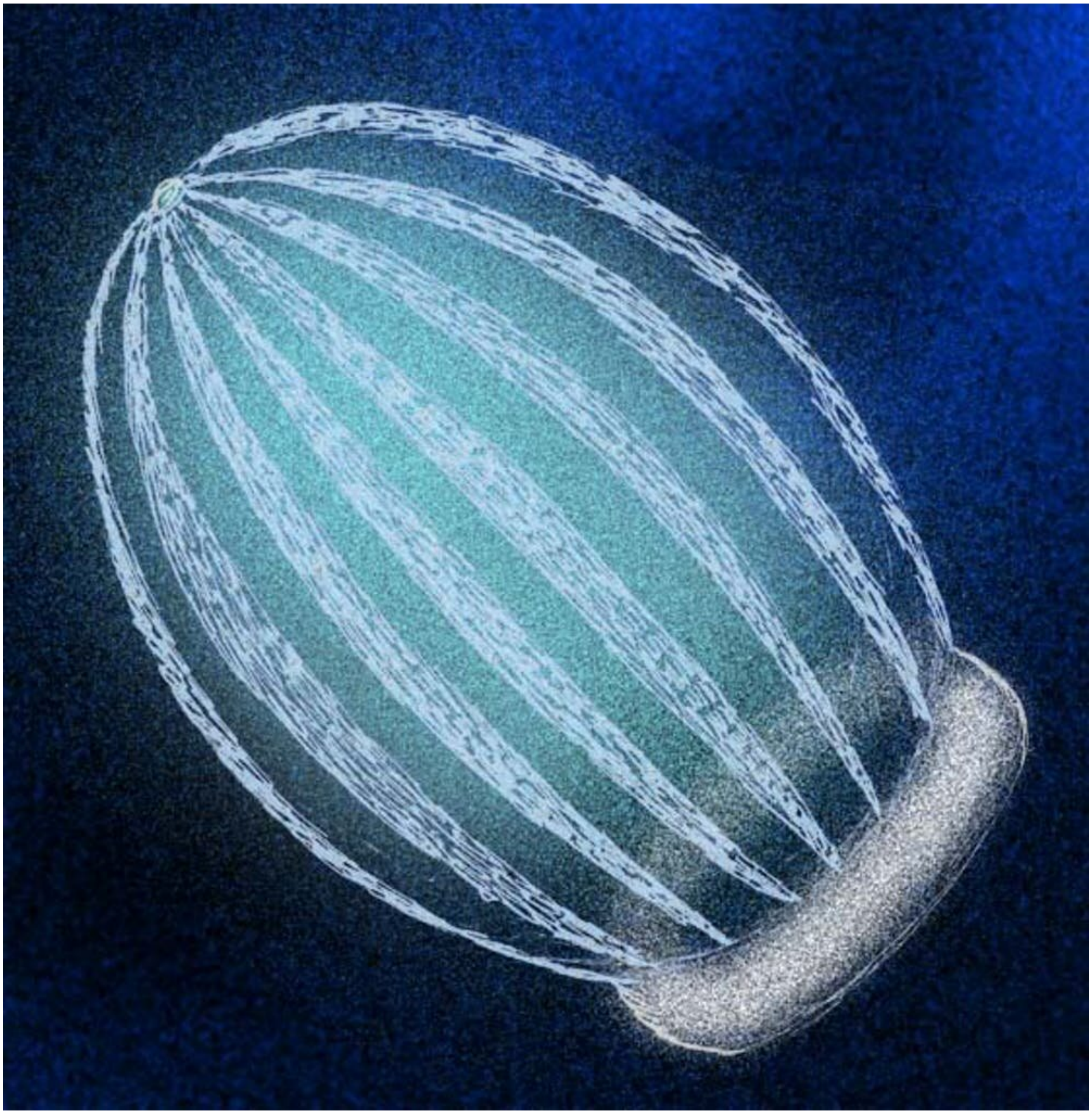
The Cambrian Explosion refers to the near-simultaneous appearance of the major groups of animals in the fossil record, between 540 and 520 million years ago.

Before then, animals were very simple and largely microscopic, but in the geological blink of an eye, most of the modern phyla of animals (metazoans) appeared, including arthropods, molluscs and vertebrates. Ctenophores have long been thought to be near the base of the animal tree of life, resembling other primitive forms such as cnidarians (corals and jellyfish). Sponges look primitive because they lack a nervous system and organized tissues, and they only have a few cell types.

Ctenophores and cnidarians, despite their relative simplicity, are much more complex than sponges, so it was traditionally assumed that sponges were at the absolute base of the animal family tree—the "sponges-first hypothesis."

However, some recent genomic studies have proposed that comb jellies are actually even lower on the family tree than sponges, a "ctenophores-first" hypothesis. This radical idea remains highly controversial because sponges have been assumed to be more primitive than ctenophores for more than 150 years.

If true, it could mean that many of the traits ctenophores share with typical animals (such as a nervous system, gut and complex muscles) might have evolved twice: once in comb jellies and separately in all other animals.



Reconstruction of a fossil ctenophore from the Cambrian Period, Ctenorhabdotus capulus, which is some 140 million years older than Daihuoides but still very similar. Credit: Apokryltaros/Wikipedia, CC BY

Comb jellies would be true evolutionary aliens compared to all other animals.

In the light of our discovery, we tested whether the anatomy of fossil ctenophores better supports the sponges-first or ctenophores-first hypothesis. Surprisingly, and contrary to a previous study, the fossils were equally consistent with both ideas.

Lazarus fossil

According to the Bible, Jesus restored Lazarus of Bethany to life four days after his death. In paleontology, a "Lazarus taxon" is an organism that disappears from the fossil record for a lengthy period, only to reappear much later.

Our new fossil ctenophore, Daihuoides, is a perfect example of such a Lazarus taxon and postdates its Cambrian relatives by over a hundred million years. Our creature resembles a primitive type of ctenophore with 18 sets of organs radially arranged. These forms were known from the Cambrian (over 500 million years ago) and then assumed to have gone extinct soon afterwards.

Daihuoides shows that these primitive comb jellies survived for a further 140 million years, into the Devonian, approximately 375 million years ago. This discovery demonstrates the huge gaps in the known fossil record, and implies many wonderful fossils are yet to be discovered.

Provided by The Conversation