Masters Research Script

Reconstructing a new Species from the Burgess Shale, British Columbia: A Means of Translating Phylogenetic Research for an Informal Learning Setting

Sabrina Cappelli

This is the Earth 600 million years ago. 4 billion years have passed since its formation and the land is barren and devoid of any plants or animals. Life has been entirely confined to the oceans where the most complex organisms are simple sponge-like animals . But for reasons still not fully understood something remarkable and unexpected is about to happen. Towards the beginning of a period known as the Cambrian, which spanned 53 million years, a rapid diversification of animal life began within the oceans. By the end of the Cambrian, evolution had established most of the major animal body plans that exist today. This sudden burst of new life is known as the "Cambrian explosion" and it has inspired and puzzled scientists for decades.

At the top of the Cambrian food chain was a group of marine creatures known as the radiodonts, the largest of which was *Anomalocaris*. Reaching up to 1 meter in length, *Anomalocaris* was the undisputed terror of the Cambrian seas. Members of the radiodont group are defined by circular jaws consisting of multiple plates, a pair of jointed appendages at the front of the head, and large compound eyes. These features suggest a predatory lifestyle and imply that a complex ecosystem appeared rapidly during the early Cambrian.

Paleontologists are confident that radiodonts are related to arthropods, a large group which includes many extinct organisms as well as modern day insects, arachnids, and crustaceans. The main features of this group include: the presence of a tough exoskeleton, body segmentation, compound eyes, and joints in the appendages. Scientists hypothesize that radiodonts branched off from the arthropod lineage prior to the split between major modern groups, however, their precise placement within the arthropod evolutionary tree is hotly debated. As such, identifying new members of this group is helping paleontologists gain a better understanding of these earliest arthropods and how key arthropod features evolved.

While records of the Cambrian explosion can be found worldwide, a few fossil sites preserving the tiny and delicate soft-tissue remains of these early animals have proven to be particularly important for our understanding of this phase in Earth's history. The Burgess Shale of British Columbia is the most well-known location where these rare and exceptionally preserved fossils are found. Here, Cambrian animals were preserved by rapid burial in mud which prevented decay. These sedimentary layers accumulated over time, compressing the animal's remains into thin films of carbon. Unlike the fossilized skeletons of more recent animals like fish, reptiles, and mammals, the Burgess Shale fossils preserve all parts of the organism, from eyes to internal organs. Fossil specimens like those of Stanleycaris are helping to shed light on the origin of Radiodonts.

Within the Radiodont group, two main body forms can be distinguished. Some species, like *Anomalocaris,* had long grasping appendages and streamlined bodies which they used to chase down mobile prey. Others, like *Hurdia,* had large shell-like carapaces covering their heads and comb-like appendages which they likely used to scoop up buried organisms. Paleontologists debated how these two body plans evolved and what their common ancestor might have looked like. Their hypotheses were recently put to the test when ROM researchers discovered new fossils of a radiodont named *Stanleycaris*. With appendages that were similar to *Hurdia* and a streamlined *Anomalocaris*-like body, *Stanleycaris* appears to be the missing link paleontologists had been looking for. Based on where *Stanleycaris* fits in the radiodont tree, paleontologists now believe that the common ancestor of this group was a fast and active hunter.

The continued discovery of many complete fossil specimens like these provides snapshots of the organism from different angles. Using 3D modelling and animation, we can now reconstruct these organisms, bringing the Cambrian world to life. Although much is still unknown about this ancient world, the ongoing discovery of new organisms like *Stanleycaris* will enable paleontologists to fill in gaps in the story of the evolution of life on earth.