

COVER ILLUSTRATION

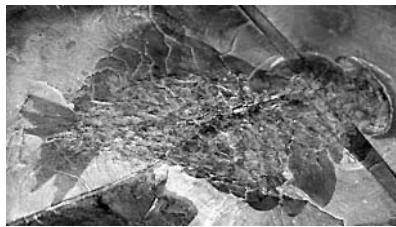
To see what you eat

With the imagination and creativity of an artist's commune, the Cambrian explosion is believed to have produced almost all the body plans on earth today within a geologically short period of perhaps 30 million years (540–510 million years ago) or less. All but one of the extant phyla, and the basic body plans they represent, had their beginnings in this period. Furthermore, in a spectacular display of metazoan bloom, evolution forged several other phyla in this same period that are now extinct, although perhaps not as many as some enthusiasts believe. It was the big bang of evolution. Curiously, the first known eyes appeared then, too, and there may be a relation.

Predation is a terrible and swift sword for prey species and there is good evidence that predation drives evolution, at least to some extent. Sensory modalities drive predation. After all, the predator must find the prey. Vision is the most far ranging and comprehensive sense and must be a principal facilitator for predation. Auditory sense must be entrained, hence cannot be as efficient or as global as vision, and although it is an excellent sensory modality, we recognise auditory predators as exceptions—for example, bats, dolphins.

So, did vision drive the Cambrian explosion? Dr Andrew Parker of the zoology department at Oxford University thinks so and describes his thesis in his book *In the Blink of an Eye*. But, it cannot be this simple an explanation, as evolution is neither directed nor compelled, especially by so single a force. There are many other factors at work including climate, geography, water currents, oxygen levels, competition, and even chance. Nevertheless, the formation of eyes, and especially the neurological processing necessary to process the image must have had a significant role in the “Cambrian explosion.”

Even the Cambrian explosion may not have been as dramatic and sudden as once assumed by some. The soft bodied fauna that must have presaged the Cambrian and betokened evolutionary creativity—the Ediacaran fauna—were probably more complicated than we realise. The pre-Cambrian fauna, whether Ediacaran or not, probably laid extensive molecular and phylogenetic groundwork for the explosion to come.



Anomalocaris.

Nevertheless, the visual diversity of the Cambrian is worth considering.

Opabinia (upper left on this month's cover) must have been a predator, and an odd one at that, with five eyes, a segmented body, and a miniature elephant's trunk for a nose. It was thoroughly described by Harry Whittington (Cambridge palaeontologist in a monograph in 1975) as one of the most remarkable creatures in the history of science, and is now considered a close cousin of the arthropods. Whittington found five eyes with two stalked pairs and one smaller central eye in an extraordinary creature approximately 50–70 mm in length. The eyes are almost spider-like in distribution, and probably provided stereopsis. Whittington dissected beneath the carapace (the stuff of genius since these are fossils compacted into slate!) and found the animal to be bilaterally symmetrical (like us, but in contrast with radially symmetrical, like a starfish). *Opabinia* had this peculiar and flexible “elephant trunk” proboscis with what were most likely grasping spines at the end of the trunk. This trunk with its prehensile spiny lips was probably designed to deliver food to the mouth on the ventral surface. Although these creatures were rare within the Burgess shale, where they were first found, it is likely that the large visual field the eyes would have produced, the streamlined segmented body, and presumed aquatic speed made for an agile, and successful predator.

If *Opabinia* was the resourceful, barracuda-like predator of the Cambrian seas, then *Anomalocaris* was the looming lord and master. *Anomalocaris* (upper right of cover and this page) was the largest predator of the Cambrian seas with some species known to be up to 2 metres in length. This widely distributed animal was much more common than *Opabinia*, and certainly less subtle. With large, laterally placed eyes,

Anomalocaris, too, must have had a wide field of view. Frontal views of the creature suggest stereopsis was possible, and stereopsis almost certainly must be present for the most efficient predators. Unlike that found in another early creature from this period, the trilobite (*BJO*, April 2002), a calcite lens system was not present, or at least not preserved, so little can be said about the eyes, although they were not found to have facets as would be seen with compound eyes. But while *Opabinia* may have been agile, *Anomalocaris* probably wasn't. It is believed that *Anomalocaris*, a protoarthropod, probably more resembled a manta ray in its swimming. With its anterior grasping forelimbs for feeding, and its circular mouth with massive teeth, it probably was accustomed to less well detented or slower, organisms, perhaps resembling sea cucumbers, or their equivalent in the Cambrian. It would not have needed stereopsis.

The Cambrian had organisms that represented extant phyla too. *Waptia* (lower left) was an arthropod, and probably had compound eyes as do arthropods today. This benthic species walked along the bottom, feeding on organic debris. Its eyes were stalked and probably more sensitive to movement than possessive of good acuity, if modern correlates are an example.

Other more evolutionarily pedestrian animals were present and probably represent direct predecessors of contemporary phyla. *Perspicularis* (lower right) was a common species in the Cambrian, and is thought to be a crustacean predecessor.

Many other creatures have been found from the Cambrian, and many of these are distant predecessors of contemporary species. And, at least one, *Pikaia*, a protochordate, represents the lineage that is distantly related to vertebrates, although perhaps a direct ancestor. But that is a story for another day.

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