Study of giant viruses shakes up tree of life
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A new study of giant viruses supports the idea that viruses are ancient living organisms and not inanimate molecular remnants run amok, as some scientists have argued. The study reshapes the universal family tree, adding a fourth major branch to the three that most scientists agree represent the fundamental domains of life.

The researchers conducted a census of all the protein folds occurring in more than 1,000 organisms representing bacteria, viruses, the microbes known as archaea, and all other living things. The researchers included giant viruses because these viruses are large and complex, with genomes that rival – and in some cases exceed – the genetic endowments of the simplest bacteria, Caetano-Anollés said.

"The giant viruses have incredible machinery that seems to be very similar to the machinery that you have in a cell," he said. "They have complexity and we have to explain why."

Part of that complexity includes enzymes involved in translating the genetic code into proteins, he said. Scientists were startled to find these enzymes in viruses, since viruses lack all other known protein-building machinery and must commandeer host proteins to do the work for them.

In the new study, the researchers mapped evolutionary relationships between the protein endowments of hundreds of organisms and used...
the information to build a new universal tree of life that included viruses. The resulting tree had four clearly differentiated branches, each representing a distinct "supergroup." The giant viruses formed the fourth branch of the tree, distinct from bacteria, archaea and eukarya (plants, animals and all other organisms with nucleated cells).

The researchers discovered that many of the most ancient protein folds – those found in most cellular organisms – were also present in the giant viruses. This suggests that these viruses appeared quite early in evolution, near the root of the tree of life, Caetano-Anollés said.

The new analysis adds to the evidence that giant viruses were originally much more complex than they are today and experienced a dramatic reduction in their genomes over time, Caetano-Anollés said. This reduction likely explains their eventual adoption of a parasitic lifestyle, he said. He and his colleagues suggest that giant viruses are more like their original ancestors than smaller viruses with pared down genomes.

The researchers also found more evidence that viruses are key "spreaders of information," Caetano-Anollés said.

"The protein structures that other organisms share with viruses have a particular quality, they are (more widely) distributed than other structures," he said. "Each and every one of these structures is an incredible discovery in evolution. And viruses are distributing this novelty," he said.

Most studies of giant viruses are "pointing in the same direction," Caetano-Anollés said. "And this study offers more evidence that viruses are embedded in the fabric of life."

**More information:** "Giant Viruses Coexisted With the Cellular Ancestors and Represent a Distinct Supergroup Along With Superkingdoms Archaea, Bacteria and Eukarya,"

www.biomedcentral.com/1471-2148/12/156/abstract

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