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A Short Jump From Single-Celled Ancestors to Animals

The first animals evolved from their single-celled ancestors around 800 million years ago, but new evidence suggests that this leap to multi-celled organisms in the tree of life may not have been quite as dramatic as scientists once assumed. In a *Developmental Cell* paper publishing October 13, researchers demonstrate that the single-celled ancestor of animals likely already had some of the mechanisms that animal cells use today to develop into different tissue types.

“We’re looking into the past at an evolutionary transition that was important for the origin of all animals,” explains Iñaki Ruiz-Trillo, an evolutionary biologist at the Institute of Evolutionary Biology in Barcelona, Spain. “We show that these early organisms already had some behaviors that we once thought were only in multicellular animals. From there, it would have been a simpler evolutionary leap.”

The researchers studied a single-celled amoeba called *Capsaspora owczarzaki*, which is a close relative of today’s multi-celled animals. *Capsaspora* was originally discovered living inside a freshwater snail and has been used by Ruiz-Trillo’s group to learn more about animal evolution. Ruiz-Trillo and his team sequenced the *Capsaspora* genome in an earlier project and discovered that the amoeba contained many genes that, in animals, are related to multicellular functions.

As a single-celled organism, *Capsaspora* can’t have multiple different cell types at the same time like humans can. However, a single *Capsaspora* does change its cell type over time, transitioning from a lone amoeba to an aggregated colony of cells to a hardy cystic form during its life cycle. This new study explored whether *Capsaspora* uses the same mechanisms to control cell differentiation over time as animals use to control cell development across different tissues.

Now, in close collaboration with the team of Eduard Sabidó at the Proteomics Unit of the Centre for Genomic Regulation and Universitat Pompeu Fabra, the researchers analyzed the proteins in *Capsaspora* to determine how the organism might be regulating its internal cell processes at different life stages. The genome provides the instructions to build a cell and the information provided by the proteome enables the researchers to understand how cells actually function. “Mass spectrometry-based proteomics allows us to measure which proteins are being expressed and how they are being modified,” says Sabidó. “Intracellular signaling depends on these protein modifications—so by doing these analysis, we know not only what’s in the cell, but also how the cell organizes and communicates internally.”

The researchers discovered that from one stage to another, *Capsaspora*'s suite of proteins undergoes extensive changes, and the organism uses many of the same tools as multicellular animals to regulate these cellular processes. For example, *Capsaspora* activated transcription factors and a tyrosine-kinase signaling system in different stages to regulate protein formation. "These are the same mechanisms that animals use to differentiate one cell type from another, but they haven't been observed in unicellular organisms before," says Ruiz-Trillo.

The presence of these protein-regulating tools in both *Capsaspora* and animals means that the single-celled ancestor of all animals likely also possessed these systems—and was more complex than scientists have previously given it credit for. "The ancestor already had the tools that the cell needed to differentiate into different tissues," says Sabidó. "The cells that were around before animals were more or less prepared for this leap."

"This is another example on how advanced technologies contribute to a multidisciplinary approach in the life sciences research. In this case, thanks to high-end mass spectrometry technologies we are able to add a new layer to the way we look at cells. Genome sequencing already made a difference in evolutionary biology and now proteomics provides new clues to understand not only the information contained in the genome but the proteins and actions resulting from it" concludes Sabidó.

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