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Yeast suggests speedy start for multicellular life

Single-celled organism can evolve multicellularity within months.

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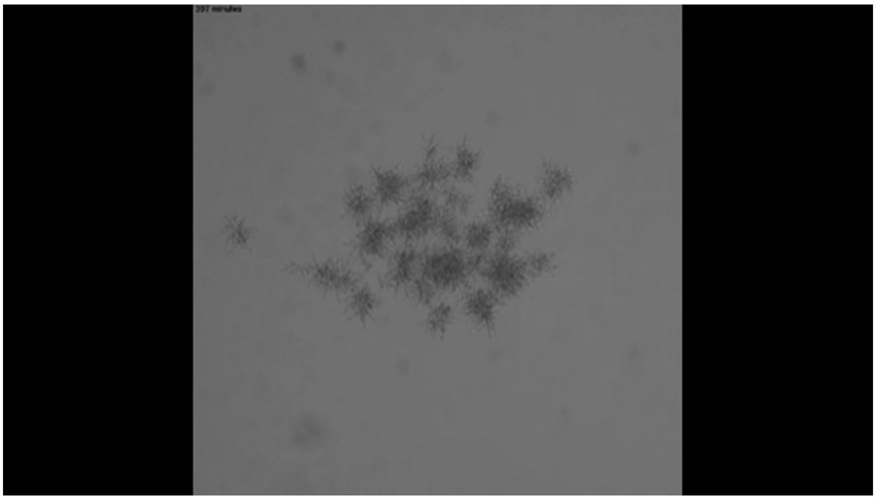
The origin of multicellular life, one of the most important developments in Earth's history, could have occurred with surprising speed, US researchers have shown. In the lab, a single-celled yeast (*Saccharomyces cerevisiae*) took less than 60 days to evolve into many-celled clusters that behaved as individuals. The clusters even developed a primitive division of labour, with some cells dying so that others could grow and reproduce.

The study, by William Ratcliff and his colleagues at the University of Minnesota in St Paul, is published online today in the *Proceedings of the National Academy of Sciences*[1]. Referring to the origin of multicellularity, Richard Lenski, an evolutionary biologist from Michigan State University in East Lansing who was not involved in the study, says: "This has long been viewed as difficult transition, but these experiments show it might not be quite as difficult as assumed."



Ratcliff came up with the concept for the experiment with his colleague Michael Travisano. "We were talking about the coolest work that we could do," says Ratcliff. "We ruled out the origin of life as too difficult, but thought that evolving multicellularity would be feasible."

Multicellular life has evolved independently at least 25 times, but these transitions are so ancient that they have been hard to study. Ratcliff adds, "It's nearly impossible to look at living multicellular organisms and infer the ecology of their very different, very deep ancestors."

Instead, Ratcliff and Travisano wanted to see if they could evolve multicellularity in a single-celled organism. They used gravity as the selective pressure. In a tube of liquid, clusters of yeast cells settle at the bottom more quickly than single cells. By culturing only the cells that sank, Ratcliff selected for those that stick together. After many rounds of selection over 60 days, the yeast had evolved into 'snowflakes' comprising dozens of cells (see video, above).

Safety in numbers

Many single-celled organisms, including yeast, often form clumps of genetically distinct cells. But Ratcliff's snowflakes were made up of genetically identical cells that had budded off and stuck together. Many other multicellular organisms may well have evolved through a similar 'divide-and-stick' process.

The snowflakes behaved like true multicellular organisms. They had a simple life cycle with a juvenile stage, when they grew unimpeded, and an adult one, when they reached a certain size and split into a large parent flake and a smaller, daughter flake.

Ratcliff could even tune these stages. If he cultivated only those snowflakes that settled faster, he ended up with larger ones that grew bigger before splitting. This confirmed that natural selection was acting on the entire flake, rather than on the individual cells within it. "They survive as a whole, or they die as a whole. Selection shifts to the multicellular level," says Ratcliff.

The snowflakes split because some of their component cells sacrifice themselves, allowing pieces to snap off. These individual cells die for the good of the whole, allowing the parent flake to continue growing and produce many offspring. This mirrors the split seen in more complex multicellular organisms, with body cells that die off every generation and germline cells (sperm and eggs) that carry over into the next one.

Other studies have shown that single cells benefit from staying together because they are less susceptible to being eaten by predators[2] and better at foraging for nutrients[3]. But Ratcliff's study is one of the few to show how clusters of cells could become true multicellular individuals. “They have done a very good job of seeing what happens after multicellularity has evolved,” says Homayoun Bagheri, who studies the evolution of multicellularity at the University of Zurich in Switzerland.

“I think this paper marks the beginning of a really important body of work that may take many years to play out — not only dissecting the genetics of what's happened so far, but asking just how far the yeast can go in terms of a multicellular lifestyle,” says Lenski.

Yeast evolved from multicellular ancestors, so it is possible that they had an easier time of recreating their ancient lifestyle. However, Ratcliff notes that yeast became single-celled organisms billions of generations ago, and would probably have lost the genes for multicellularity. Even so, he now wants to repeat his experiment with single-celled organisms that do not have a multicellular past, such as species of green algae from the genus *Chlamydomonas*.

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References

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