Correcting each other's mistakes—why cells stuck together in early evolution

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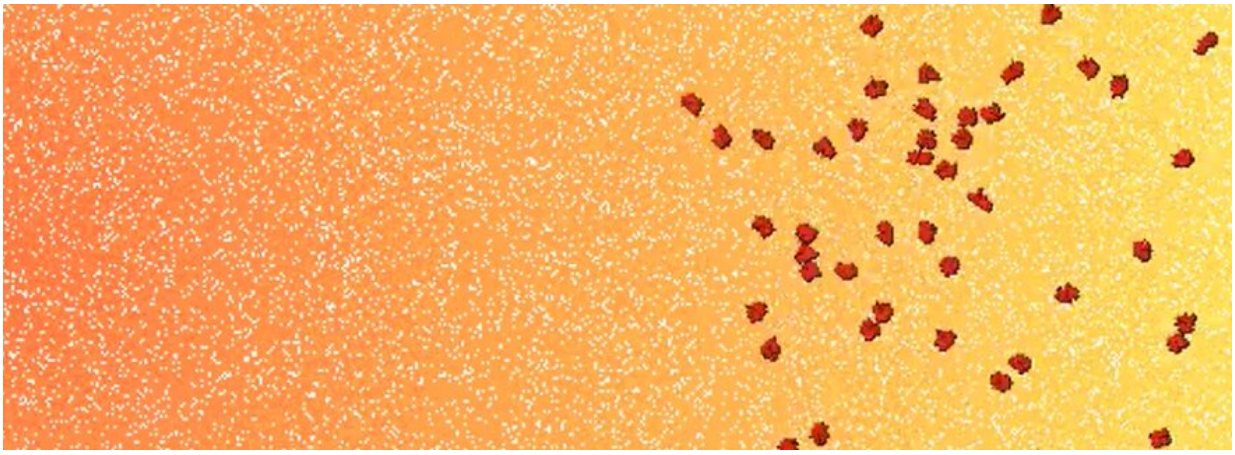

Single cells on the right are unable to sniff the reproduction place, indicated by the darker gradient on the left. Credit: Colizzi et al.

Modern animals—including humans—are stunningly complex organisms made of many billions of cells that work together. These complex multicellular organisms evolved from much simpler organisms, and those, in turn, evolved from single-celled ancestors. According to genomic and fossil data, the transition from single-celled organisms to multicellularity happened several times independently during evolution. What drove this transition to multicellularity? Researchers from Leiden University and the University of Amsterdam published a possible explanation for this transition in scientific journal *eLife*.

Finding the right spot

Enrico Sandro Colizzi is a postdoc at the Mathematical Institute at Leiden University. In this study, he worked together with Renske Vroomans from the University of Amsterdam and Roeland Merks, Professor of Mathematical biology at the Institute of Biology Leiden and the Mathematical Institute at Leiden University. They are all affiliated with the Origins Center, a platform for the study of origins and evolution of life, planets and the universe, which was financed by the Dutch Research Agenda. Together, they developed a mathematical model in which digital single cells evolve. Colizzi: "In our model, the cells have to find a suitable place to replicate. The cells had to find this place by following a chemical trail. This is very common in living cells, the cellular slime mold Dictyostelium discoideum does it, for example." The researchers found that, when the chemical trail was very faint, cells were not able to find the reproduction spot very efficiently.

Sticking together

The researchers then changed the settings in their model to allow the cells to stick together to form a primitive multicellular organism, a "blob" as Colizzi calls it. What happened next was remarkable, says Colizzi: "This blob was surprisingly able to sniff the trail of the resources and located them speedily, even when the trail was faint."

When the cells were in a multicellular group, they could collectively do something that individual cells could not. Colizzi thinks this happens because cells can correct mistakes when in large numbers: "If a single cell cannot find the trail it will get lost, but if a cell in a group cannot find the trail it will follow the cells that can."

Evolution simulated

Next, the researchers put the cells through evolutionary simulations. In these simulations, cells could stick together or stay single-celled. And again, multicellularity evolved because that was a more efficient way of finding a suitable reproduction place. The researchers wondered what would happen if that location changed so often that a multicellular blob could not find it. Colizzi explains: "When it was impossible for a blob to find the reproduction spot, multicellularity did not evolve. The cells remained unicellular."

Colizzi thinks that by remaining unicellular, cells can disperse and although they cannot find suitable spaces by sniffing them, some cells will find them by sheer luck. "Most life on Earth is unicellular. But multicellularity can evolve because groups of cells are faster than single cells at locating the right places. It was a pleasant surprise to see this happen."

More information: Enrico Sandro Colizzi et al. Evolution of multicellularity by collective integration of spatial information, *eLife* (2020). DOI: 10.7554/eLife.56349

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