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Researchers trace origin of an "altruism gene"

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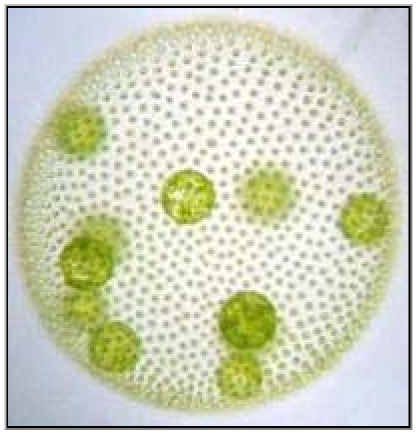
For the first time, scientists say they have traced the origin of an "altruism gene," possibly shedding light on the nagging mystery of how generosity and cooperation evolved.

The findings, they add, suggest that at least some altruism genes evolved from genes that originally served to suppress some biological activities in lean times.



Volvox carterii, a type of alga (Courtesy A. Nedelcu)

The scientists traced an "altruism gene" in *Volvox carterii,* a primitive multi-cellular creature, to its one-celled ancestor.

Volvox, thanks to its simplicity, is considered possibly the best living representative of another great evolutionary event now lost in time: the emergence of multi-cellularity.

The findings, if correct, might thus clarify how this advance drew on simple forms of cooperation between cells.

The research appears in the May 23 online issue of the research journal *Molecular Biology and Evolution*.

The origin of altruism and cooperation is an enigma because evolutionary theory seems to predict such behavior should be rare or nonexistent. Yet some forms of altruism, conscious or not, are widely documented in creatures as humble as insects and bacteria.

Evolutionary theory holds that organisms with the strongest genes for survival and reproduction do, in fact, survive and reproduce most successfully. They thus multiply their genes most widely, spreading the advantageous genes through whole populations. Ceaseless repetitions of the process can gradually transform species into totally new ones.

Such a world seems to have no place for self-sacrificing types, who presumably couldn't spread their genes very far.

Evolution, supersized

Several competing theories attempt to solve the puzzle. One is that groups with cooperative members outcompete groups with selfish ones, and thus spread their niceness genes, in a scaled-up version of the process by which genetically favored individuals trump other individuals. Variants of this notion have gained currency in the past decade, although it fell from favor earlier, as it has some trouble explaining how altruism got a foothold in the first place.

But all this addresses only why altruism evolved. Another key question is how: what actual genetic changes were involved?

There has been some progress on this. Earlier this month, for instance, scientists reported that a one-letter change in genetic code could turn microbes that habitually “cheat” their comrades into model citizens. That study involved some artificially induced genetic changes, though. It didn’t address how such mutations might have arisen in nature.

That’s the subject of the new study, by Aurora Nedelcu of the University of New Brunswick in Fredericton, Canada and Richard Michod of the University of Arizona in Tucson, Ariz.

The organism they focused on, Volvox, consists of around 2,000 cells linked to form a globule.

Taking one for the team

Volvox cells have a division of labor. All but 16 permanently renounce reproducing themselves to take on other jobs, such as moving the group around by swimming. A similar division occurs in most multi-cellular creatures: their cells are either “germ” cells—reproducers such as sperm and eggs—or “somatic” cells, all the others, which leave no heirs after the individual dies.

This can be seen as a profound form of altruism. By not reproducing, somatic cells commit evolutionary suicide to benefit the group. Something similar also occurs in insect colonies, which often have sterile “worker” castes.

In Volvox, biologists have previously found that a gene called RegA causes this “reproductive altruism.” RegA suppresses cell growth. Because a cell must grow a certain amount to reproduce, RegA also ends its reproductive career. Both germ and somatic cells have the gene, but in germ cells it’s inactive.

To trace RegA’s ancestry, Nedelcu and Michod hunted for genes similar to RegA in a one-celled creature, *Chlamydomonas reinhardtii*, believed to be closely related to Volvox’s single-celled ancestor. The most similar DNA sequence they identified was one called Crsc13. It also suppresses cell growth, they found, but apparently for a different reason—to help the cell through lean times.

C. reinhardtii, like plants, conducts photosynthesis: it uses light energy to build sugars needed to live. In darkness, the researchers found, Crsc13 goes into action. Since photosynthesis can’t occur in the dark, the gene blocks the assembly of chloroplasts, tiny compartments where photosynthesis occurs.

Crsc13 thus prevents “unnecessary investment” in temporarily useless activities, saving resources for more essential work, Nedelcu and Michod wrote.

A grander purpose

In Volvox, they added, evolution apparently co-opted the gene for the grander goal of cellular cooperation.

This transformation may have required no change in the gene itself, they argued; all that needed to change was the way it was activated and inactivated. Every organism has this ability to switch genes on and off. It's often accomplished by coating the relevant DNA with specialized molecules blocking its use.

In evolutionary terms, Nedelcu said, there may be no fundamental difference between altruism in Volvox and the generosity that inspires people to give, say, to charity. Both might ultimately stem from similar mechanisms.

"I do believe that the same principle applies," she wrote in an email. Any gene that allows someone to delay gratification for future benefits, she speculated, might be co-opted by evolution to shift those benefits to others instead.

Variable or stressful environments may encourage this process, she added. Periodic hardship frequently spurs the evolution of survival mechanisms that involve suppressing biological activities, like Crsc13. Moreover, in tough times, people often come together; so do many bacteria.

But researchers will have to write histories of more "altruism genes" in different organisms before drawing general conclusions of this sort, Nedelcu cautioned: "definitely, more studies are needed."

The Volvox finding is "exciting," said Gene Robinson of the University of Illinois at Urbana-Champaign, a specialist in the genetics of social behavior who wasn't involved in the research. "It overall demonstrates that comparative genomic analyses, done on the right sets of species, hold great promise" for charting the evolution of sociality.

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