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Bacterial 'aphrodisiac' sends single-celled organism into mating frenzy

Researchers surprised to observe bacterial protein triggering a switch from asexual to sexual behaviour.

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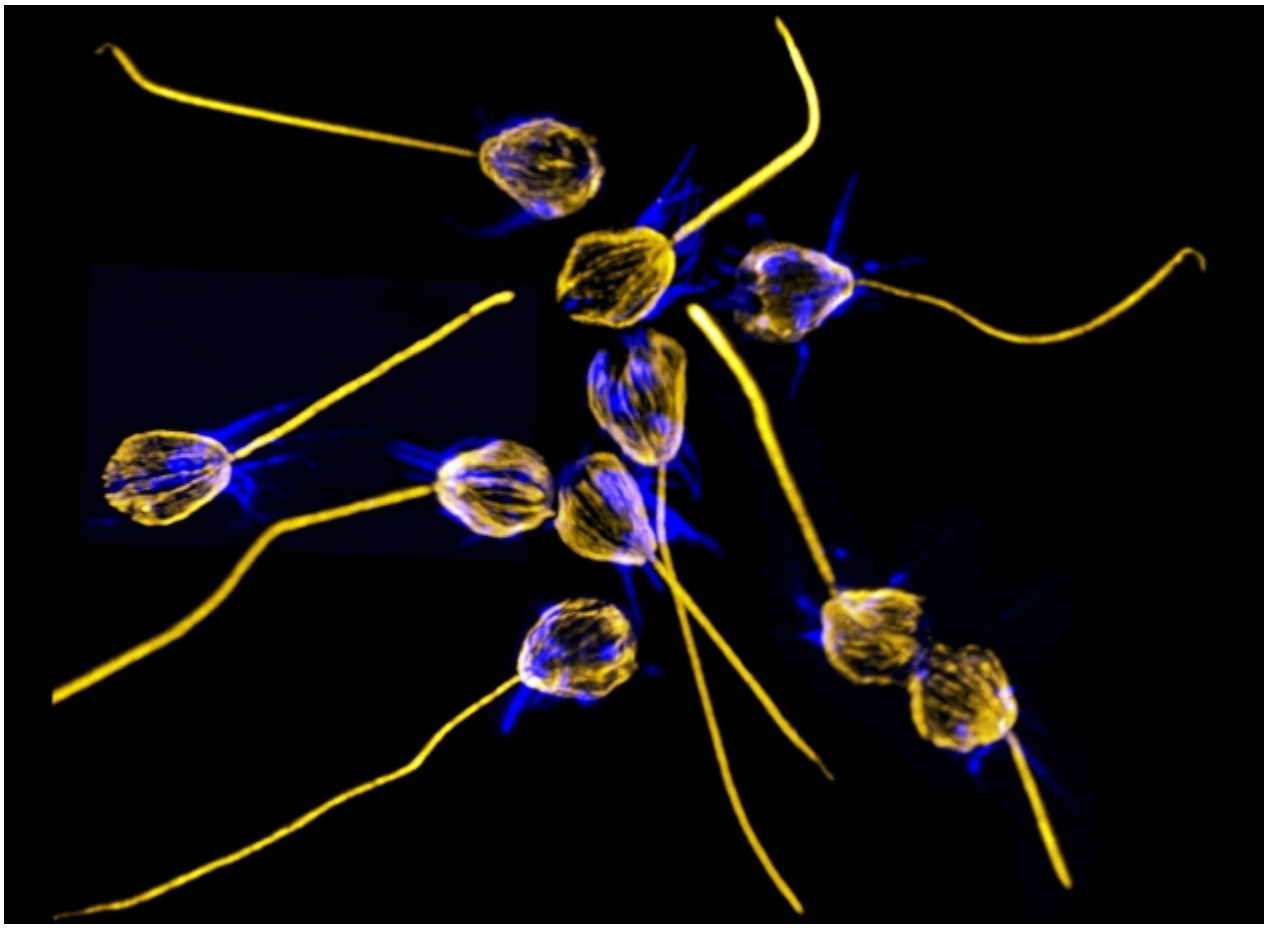

Arielle Woznica

The single-celled choanoflagellate *Salpingoeca rosetta* swarms and mates in response to a protein secreted by *Vibrio fischeri* bacteria. (This image is an edited 3D reconstruction of the original culture.)

Researchers have stumbled on a surprising aphrodisiac for a single-celled organism: a protein secreted by a bacterium. They suggest it’s the first time that bacteria have been found to have a hand

in controlling the sexual behaviour of eukaryotes — the domain of life that includes fungi, plants and animals.

The organism involved belongs to the choanoflagellates: sperm-like creatures that are among the closest living single-celled relatives of animals. Biologists study them to understand how unicellular organisms evolved to become the earliest multicellular animals.

Choanoflagellates usually divide asexually. Until now, scientists had only managed to coax them into mating by withholding their food.

A team led by microbiologist Nicole King of the University of California, Berkeley, was studying how certain bacterial signals induce asexual division in the choanoflagellate *Salpingoeca rosetta* when they discovered something surprising: adding a marine bacterium called *Vibrio fischeri* to the culture caused *S. rosetta* to swarm into a mating frenzy and reproduce sexually.

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“It was completely unexpected,” says Jon Clardy, a biochemist and study co-author at Harvard Medical School in Boston, Massachusetts. “To be honest, we were using *V. fischeri* as a control, because we knew that it wouldn’t induce multicellularity.” The work was published on 31 August in *Cell* [1].

Protein perk up

Further experiments revealed that the bacteria secreted a protein — which the researchers dubbed EroS, after the Greek god of sex — that caused the swarming behaviour. The choanoflagellates clustered in groups of up to 35 and fused head-on before duplicating and recombining their DNA and then dividing into genetically distinct offspring.

“It’s the first time that I see bacteria inducing mating in a eukaryotic cell,” says Vanessa Sperandio, a microbiologist at the University of Texas Southwestern Medical Center in Dallas. Sperandio points out that bacteria could be influencing the behaviour of multicellular animals more than we know. When a

new signalling pathway is discovered, she says, chances are that similar discoveries will follow in other groups of organisms.

“It’s odd to rely on bacteria to induce your mating,” agrees Nick Brown, a cell biologist at the University of Cambridge, UK. He says that in further work, he’d like to know whether and, if so, how choanoflagellates are able to trigger their own sexual behaviour.

The researchers now think that the mechanism they observed might be how *S. rosetta* usually reproduces in the wild. It lives in the same coastal habitats as *V. fisheri*, and natural concentrations of the bacterial aphrodisiac could cause the choanoflagellates to gather in large numbers, making it more likely that two cells will come together for sexual reproduction.

Study author Arielle Woznica of the University of California, Berkeley, suggests that choanoflagellates may have adapted to use *V. fisheri* as an indicator that environmental conditions call for sexual reproduction.

Mating mechanics

Why bacteria would control sex in choanoflagellates is not yet clear. But the researchers have a few theories as to how the protein induces mating. EroS is an enzyme that cuts up a compound found in *S. rosetta*’s extracellular matrix, a collection of structural molecules surrounding the cell. The compound that it targets, called chondroitin sulfate, is made from sugar molecules — so it’s likely that *V. fisheri* secrete EroS to feed on this molecule, the authors say.

Clardy suggests that chewing up the extracellular matrix may physically ‘soften up’ the cells, so that two choanoflagellates can fuse. King is investigating a different lead: she thinks that chondroitin sulfate may be a signalling molecule that becomes active only when cleaved by EroS.

The finding is one of a growing number of examples of ‘cross-kingdom signalling’ — a process in which one group of organisms picks up cues from another. It has implications for the richness of chemical ecology that remains to be discovered, says Rosie Alegado, a microbiologist from the University of Hawaii at Manoa. Other microbes thought to be asexual might be convinced to give sex a try — if they're exposed to the right conditions.

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References

1. Woznica, A., Gerdt, J. P., Hulett, R. E., Clardy, J., King, N. *Cell* http://dx.doi.org/10.1016/j.cell.2017.08.005 (2017).