Some animal species can survive successfully without sexual reproduction

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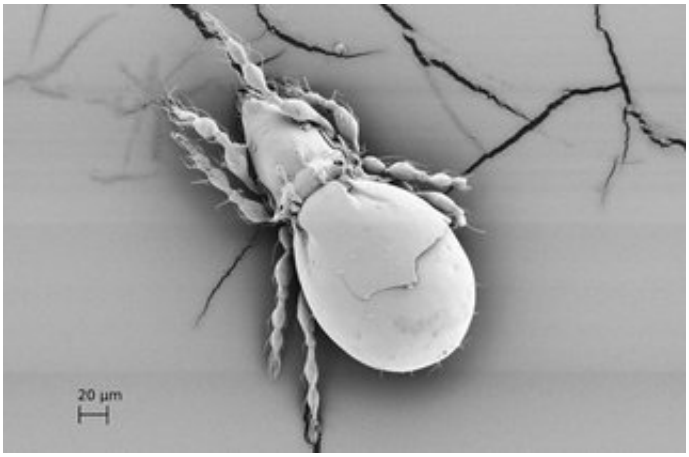

The "ancient asexual scandal" O. nova. Credit: M. Maraun and K.Wehne

In the framework of an international research project, a team of scientists have demonstrated for the first time that asexual reproduction can be successful in the long term. The animal they studied is the beetle mite Oppiella nova. Until now, the survival of an animal species over a geologically long period of time without sexual reproduction was considered very unlikely, if not impossible.

However, a team of zoologists and evolutionary biologists from the Universities of Cologne and Göttingen, as well as the University in Lausanne (Switzerland) and the University of Montpellier (France), has demonstrated for the first time the so-called Meselson effect in animals

in the ancient asexual beetle mite species O. nova. The Meselson effect describes a characteristic trace in the genome of an organism that suggests purely asexual reproduction. The results have been published in *PNAS*.

So far, scientists have seen the great evolutionary advantage of sexual reproduction in the genetic diversity produced in offspring by the encounter of two different genomes that a pair of parents can supply. In organisms with two sets of chromosomes, i.e., two copies of the genome in each of their cells, such as humans and also beetle mite species that reproduce sexually, sex ensures a constant "mixing" of the two copies. That way, genetic diversity between different individuals is ensured, but the two copies of the genome within the same individual remain on average very similar.

However, it is also possible for asexually reproducing species, which produce genetic clones of themselves, to introduce genetic variance into their genomes and thus adapt to their environment during evolution. But (contrasting sexual species) the lack of sexual reproduction and thus "mixing" in asexual species causes the two genome copies to independently accumulate mutations, or changes in genetic information, and become increasingly different within one individual: The two copies evolve independently of one another. The Meselson effect describes the detection of these differences in the chromosome sets of purely asexual species.

"That may sound simple. But in practice, the Meselson effect has never been conclusively demonstrated in animals—until now," explained Prof. Tanja Schwander from the Department of Ecology and Evolution of the University of Lausanne.

The existence of ancient asexual animal species like O. nova are difficult for evolutionary biologists to explain because asexual reproduction

seems to be very disadvantageous in the long run. Why else do almost all animal species reproduce purely sexually? Animal species such as O. nova, which consist exclusively of females, are therefore also called "ancient asexual scandals."

Proving that the ancient asexual scandals really do reproduce exclusively asexually, as hypothesized (and that they have been doing so for a very long time), is a very complex undertaking: According to first author of the study Dr. Alexander Brandt of the University of Lausanne, "There could be, for example, some kind of 'cryptic' sexual exchange that is not known. Or not yet known. For example, very rarely a reproductive male could be produced after all—possibly even 'by accident.'" Purely asexual reproduction, however, at least theoretically leaves behind a particularly characteristic trace in the genome: the Meselson effect.

For their study, the researchers collected different populations of Oppiella nova and the closely related but sexually reproducing species Oppiella subpectinata in Germany, and sequenced and analyzed their genetic information. "A Sisyphean task," said Dr. Jens Bast, Emmy Noether junior research group leader at the University of Cologne's Institute of Zoology.

"These mites are only one-fifth of a millimeter in size and difficult to identify." In addition, analyzing the genome data required computer programs specifically designed for this purpose. Hence, Brandt, Schwander and Bast consulted the experienced soil scientist and taxonomer Dr. Christian Bluhm at the Forest Research Institute Baden-Württemberg; Patrick Tran Van, a bioinformatician specializing in evolutionary genomics; and the soil ecologist Prof. Stefan Scheu from the University of Göttingen.

Their efforts were ultimately rewarded: they succeeded in proving the Meselson effect. "Our results clearly show that O. nova reproduces

exclusively asexually. When it comes to understanding how evolution works without sex, these beetle mites could still provide a surprise or two," Bast concluded. The results show the survival of a species without sexual reproduction is quite rare, but not impossible. The research team will now try to find out what makes these beetle mites so special.

More information: Alexander Brandt et al, Haplotype divergence supports long-term asexuality in the oribatid mite Oppiella nova, *Proceedings of the National Academy of Sciences* (2021). DOI: 10.1073/pnas.2101485118

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