Spider mites shed light on evolution of reproductive barriers

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Credit: University of Tsukuba

They may be tiny, but mites have shown that we have something to learn from them. Researchers from Japan have discovered that mites can aid in the understanding of the evolution of reproductive barriers.

In a study published this month in *BMC Ecology and Evolution*, researchers from the University of Tsukuba and Ryutsu Keizai University have revealed that their research on a particular kind of spider mite supports the predominant view of how species diverge.

Speciation—the process by which populations become distinct species—is driven by reproductive isolation, which allows closely related groups to diverge by limiting gene flow. The evolution of reproductive isolation is therefore key to understanding speciation. Existing studies have focused on diploid animals (i.e., those that have paired chromosomes, one from each parent), and support the predominant view that reproductive isolation evolves gradually via accumulated genetic changes. The view is supported by comparative studies of various taxonomic groups that have shown a positive relationship between genetic distance and the extent of reproductive isolation.

"To understand speciation, a range of different types of organisms needs to be studied," says lead author of the study, Professor Yukie Sato. "Haplodiploid animals are expected to add further insight to this evolutionary story. But few studies have examined whether this is the case—this is what we investigated."

Haplodiploidy is a sex-determination system where males are haploid (i.e., have only one set of chromosomes) and develop from unfertilized eggs, and females are diploid and develop from fertilized eggs. The research team investigated populations of the spider mite Amphitetranychus viennensis by measuring genetic distance via the differences in their mitochondrial DNA, and by conducting crossbreeding experiments between the population samples. They examined how lack of fertilization rate, in addition to non-viability and sterility in hybrids, changes with genetic distance.

"Among cross combinations, we found that the extent of reproductive isolation differed," explains Professor Tetsuo Gotoh, senior author. "Additionally, there was a positive relationship between genetic distance and all three measures of reproductive isolation."

The researchers also found asymmetries in reproductive isolation. Combined with the varying degree of reproductive isolation, these asymmetries underscore the importance of strengthened reproductive isolation at an early developmental stage via reproductive incompatibility, and the importance of interactions within cells, e.g., between mitochondrial and cell nuclear genes, for reproductive isolation in haplodiploid spider mites.

"Our results support the prevalent view on the evolution of reproductive isolation," says Professor Sato.

The outcomes of this study are important for understanding how reproductive isolation evolves in haplodiploid animals. The team's findings will also enable comparisons between major model organisms and other taxonomic groups to reveal factors underlying evolutionary differences.

More information: Yukie Sato et al, Patterns of reproductive isolation in a haplodiploid mite, Amphitetranychus viennensis: prezygotic isolation, hybrid inviability and hybrid sterility, *BMC Ecology and Evolution* (2021). DOI: 10.1186/s12862-021-01896-5

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