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Haploid female mites

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Abstract

Brevipalpus phoenicis, the false spider mite, has been shown to exist only in the haploid state.

Significance and context

Haplodiploidy, a state where males are haploid and females are diploid, is seen in many insect species, but so far no organism has been found to exist exclusively in the haploid state. Weeks and colleagues report that females of a mite species exist exclusively in a haploid state. *Brevipalpus phoenicis*, a minute phytophagous mite found in tropical and subtropical regions, is considered to be one of the major pests of many economically important crops such as citrus, coffee and tea. The false spider mite *B. phoenicis* and its close relatives *B. obovatus* and *B. californicus* reproduce by parthenogenesis. In the field, *B. phoenicis* is found almost exclusively in the female state. Both the eggs and adult cells of these female mites contain two chromosomes, but it has been difficult to unravel whether this represents a haploid or diploid state. Weeks *et al*. have shown that these two chromosomes are genetically distinct and that the female mites are haploid.

Key results

Weeks *et al*. used cytological and genetic studies to show that *B. phoenicis* is a haploid female parthenogen. They found that only one of the two chromosomes contains a nuclear-organizing region (NOR). If the two chromosomes were homologous, they would carry copies of the same genes in the same locations, thus, the presence of only one NOR suggests that the chromosomes are distinct and *B. phoenicis* is haploid. In addition, Weeks *et al*. used fluorescent *in situ* hybridization to locate the ribosomal DNA (rDNA) in the metaphase chromosomes. The *B. phoenicis* 18*S* rDNA probe hybridizes at the tip of both sister chromatids of one chromosome in a metaphase mitotic division and no hybridization signal was seen on the second chromosome. The results showed only one carries an 18*S* ribosomal DNA gene. The authors also screened 45 clonal lines of *B. phoenicis*for genetic variation at seven polymorphic microsatellite loci and found no differences at any locus.

During the investigation large numbers of endosymbiotic bacteria were found to be associated with these mites. Weeks *et al*. attempted to discover whether these bacteria were involved in female haploid parthenogenesis. By sequencing bacterial 16*S* rDNA amplified from mites, the bacterium was identified

as an endosymbiote that is also found in the tick *Ixodes scapularis*. To establish whether the bacteria are involved in causing parthenogenesis, *B. phoenicis* females were treated with the antibiotic tetracycline, which eliminated the bacteria, and were then allowed to lay eggs. Significantly more male offspring were produced after tetracycline treatment than without, suggesting that female haploid parthenogenesis is caused by bacterial infection which results in feminization of genetic males.

Conclusions

Brevipalpus phoenicis exist only as females in the haploid state. The two chromosomes of this species are genetically distinct. Feminization of haploid genetic males results from infection by an endosymbiotic bacterium.

Reporter's comments

This is the first report that feminization by an extra-chromosomal factor has been found outside of heterogametic reproductive systems. Weeks *et al*. have shown that feminization can involve bacteria other than *Wolbachia* - a bacterium that is known to induce feminization by blocking the formation of the androgenic gland. Studying the possible infection mechanism by which these bacteria induce feminization will shed more light on the sex-determination process of these mites.

Table of links

Science

References

1. Weeks AR, Marec F, Breeuwer JAJ: A mite species that consists entirely of haploid females. Science. 2001, 292: 2479-2482. 0036-8075