Caption: Genotype and allele proportions in two wolf populations: one from a small island (Isle Royale) and one from the mainland (Minnesota). Genotypes and alleles were categorized as either “damaging” (harmful) or “benign” (not harmful).

Figures A and B represent the proportions of a wolf’s sampled nucleotide positions that have heterozygous or homozygous genotypes, respectively. Figure C represents the proportions of the wolf’s derived alleles (alleles with relatively “new” mutations). Each diamond represents an individual wolf, and the shaded bars represent means for each population. *** indicates a significant difference between the groups (P < 0.001), and NS indicates a difference that is not significant.

OBSERVATIONS, NOTES & QUESTIONS
BACKGROUND INFORMATION

In small and isolated populations, individuals have fewer choices for mates. This may lead to inbreeding: producing offspring with a close relative. Inbred offspring may have genetic conditions that reduce their ability to survive and reproduce, which is called inbreeding depression.

One example of inbreeding depression is from the gray wolf population on Isle Royale: a small and isolated island in Lake Superior, off the coast of Minnesota. This population was started in the 1940s by two or three wolves from the mainland, who crossed the lake when it was temporarily frozen. Since the Isle Royale population was small (only about 50 wolves max) and almost never had new wolves from the mainland, inbreeding was common. Many of the inbred offspring had physical conditions that reduced their survival and reproduction, such as crooked bones, extra bones, and cataracts. By 2018, most of the Isle Royale wolves had died out.

What caused inbreeding depression in the Isle Royale wolf population? Two hypotheses are:

1. Inbreeding depression was caused by an increase in the frequency of certain alleles — specifically, derived alleles: alleles with mutations that are relatively “new” on an evolutionary timescale. An allele was considered derived if it was not found in the wolves’ close evolutionary relatives: the gray fox and the golden wolf.

2. Inbreeding depression was caused by an increase in the frequency of certain genotypes — specifically, damaging homozygous recessive genotypes: genotypes with two recessive alleles. Since some of these alleles have negative effects, homozygous recessive genotypes may be “damaging” by causing certain diseases or even death.

To test these two hypotheses, scientists compared the DNA of Isle Royale wolves to that of wolves from mainland Minnesota. The figure shows some of their results.

BIG IDEAS, NOTES & QUESTIONS