Evidence 1: Color in *Fritillaria* Plants

Fritillaria delavayi is a plant used in traditional Chinese medicines. It grows on steep, rocky slopes in the Himalayan mountains. People harvest *Fritillaria* quite heavily—when they can get to them. Some populations of the plant are simply too remote, and thus safe from harvest.

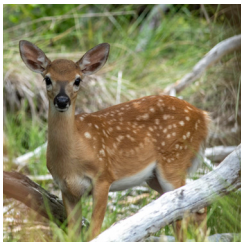
Fritillaria plants growing in remote, low-harvest areas are easy to spot as pops of bright green or yellow amidst the rocks. But in high-harvest areas near people, plants are nearly the same color as the rocks. Color in *Fritillaria* is inherited, and moving a plant from one environment to another does not affect its color.

Below are representative *Fritillaria* from populations that experience different amounts of harvesting. Look closely! There's a plant in every image.

Low Harvest ⟷ **High Harvest**

Images from Niu 2021

Evidence 2: Size in Island Species



Many species that live on islands are smaller than related species on the mainland. Size in island species comes from differences in their genes (compared to mainland species) that cause them to reach adulthood at a smaller size.

Scientists think smaller adults have a reproductive advantage on islands, where food and other resources are limited.

The table shows a few examples of weight differences between island species and related mainland species.

Island Species	Weight (kg)	Mainland Species	Weight (kg)
Island Fox	1–2.8	Grey Fox	3.6–7
Key Deer	20–34	White-tailed Deer	68–136
Cozumel Raccoon	3–4	Common Raccoon	5–26

The size differences in these species are inherited. Island species raised on the mainland are still smaller, and mainland species raised on islands are still larger.

Evidence 3: Mimicry in Butterflies

Some butterfly species taste so bad that birds and other predators learn to avoid eating them. The predators also avoid butterflies of other species that happen to look like the bad-tasting ones. That means butterflies that look like bad-tasting species are likely to survive and pass their genes to offspring. The butterflies that look different are more likely to be eaten.

The wings of the Mocker Swallowtail butterfly come in a wide variety of colors and patterns. These differences are due to variations in genes. Below are a few examples of Mocker Swallowtails from different areas, shown next to bad-tasting species that share their environment.

Mocker Swallowtails (*Papilio dardanus*) from different areas

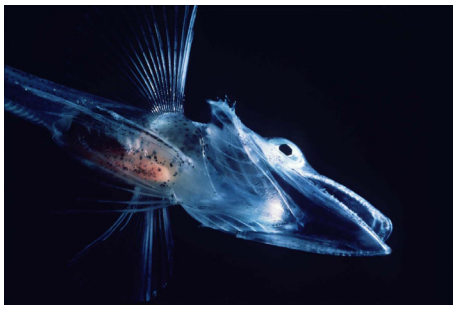
Bad-tasting butterfly species living in the same areas

Amauris echeria *Amauris niavius* *Aletis helcita*

Images from Deshmukh 2018, Fig. 1

Evidence 4: Blood in Icefish

Most fish species have deep red blood packed with oxygen-carrying red blood cells (RBCs). But not Crocodile icefish. Their blood is clear, and they have no RBCs. In fact, they don't even make the oxygen-carrying protein hemoglobin. Their hemoglobin genes are full of harmful mutations, and they no longer work. Instead, oxygen diffuses into their blood directly from the water.



Crocodile Icefish

Lacking RBCs would usually be a huge problem, but not for these weird fish! In their unusual environment, it may even be an advantage!

Icefish live in icy waters around Antarctica, where nutrients that are needed for making RBCs are rare. Since icefish don't need these nutrients, their lack of RBCs may make it easier for them to get by in this environment.

When icefish are moved to a warmer environment with more nutrients, they still can't make hemoglobin or RBCs, no matter how much it would help them.

Evidence 5: Spots in Guppies

Guppies live in pools along streams in Trinidad. Male guppies from different pools are born with differences in their coloring, which they inherit from their parents.

In pools with no predators, most males have multiple bright orange and blue spots. In pools with lots of predators, most males are a drab brown with just a few spots. And in pools with a few predators, males are somewhere in between.

Scientists hypothesized that two opposite forces shape the color of males in each pool: Brightly colored males are more attractive to females, and thus more likely to reproduce. But drab males are less visible to predators, and thus more likely to survive.

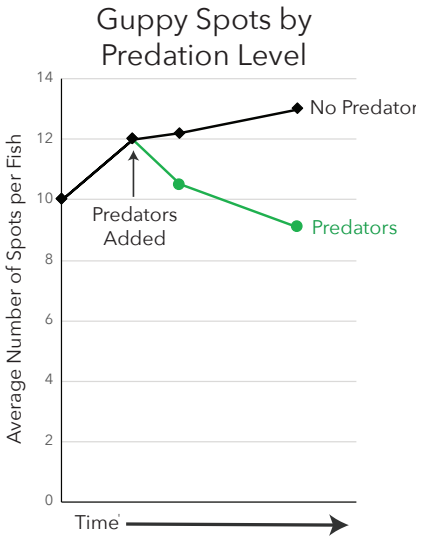
Scientists tested their hypothesis. They set up two identical ponds of guppies where males varied in their spots. First, the guppies were allowed to reproduced freely with no predators.

After 6 months, predators were added to one pond but not the other. The effects of both conditions on male spots is shown to the right.

Data based on Endler 1980, Fig. 1

Photo by Harald Olsen

Male (top) and female (bottom) guppies



Evidence 6: Tail White in Juncos

Most dark-eyed juncos live in the mountains. The breeding season is short, and birds here raise 1–2 sets of offspring a year. Females are picky: they prefer to mate with males that have more white tail feathers.

A small population of juncos lives on the California coast. The coastal breeding season is long, and birds can raise 4 sets of offspring a year. Females here are not picky about their mates, and males here have less tail white than their mountain relatives.

Photo by

Adult male dark-eyed junco

Scientists wanted to find out if tail white is heritable (due to genes) or acquired (due to the environment). They hand-raised chicks from each group in identical conditions. Then they measured the percent of white in male tail feathers. The results are below.

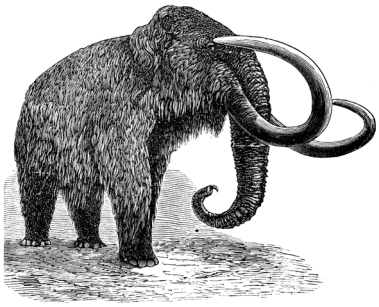
Percent of white in male tail feathers

Population	Wild birds	Hand-raised birds
Mountain dark-eyed juncos	45% tail white	44% tail white
Coastal dark-eyed juncos	36% tail white	34% tail white

Data based on Yeh 2004, Fig. 4

Evidence 7: Woolly Mammoth Extinction

Most woolly mammoths went extinct at the end of the last ice age. But on a Siberian island, a small population survived for another 6,000 years.

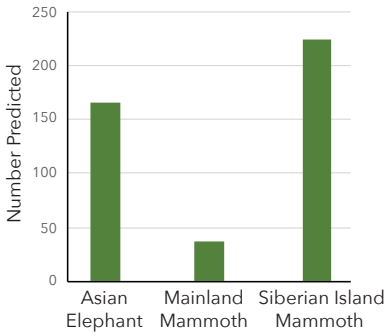


These survivors had a problem though: their traits didn't vary much. This can happen when a population is descended from just a few individuals. And with this group, it looks like many of their trait variations were harmful. It appears the surviving mammoths had little sense of smell, low fertility, and maybe even a high risk for diabetes!

Scientists learned all this by studying the mammoths' genes and predicting which variations were likely to be harmful. They counted the number of predicted harmful gene variations in DNA from Siberian island mammoths, mainland mammoths, and Asian elephants (mammoths' closest living relative). The data is on the right.

Since the population was small, it's likely that most adults had a chance to reproduce. The harmful traits passed, through genes, from parents to offspring for many generations.

Harmful Gene Variations



Data based on Fry 2020, Table 1