

A Tale of Two Species

Highlight the key points from the reading as you go, answer the questions at the end, and then discuss the story with your group in order to prepare for sharing with the class.

The Hawthorn Maggot and the Apple Maggot

Though they are grown all across the United States today, apples were once completely absent from North America. All of the delicious apple varieties we enjoy today were actually originally bred from a wild variety native to central Asia. When apples were eventually brought to North America in the 18th century, there were no native fruit flies to infest them or damage the crop. But we now have several species that lay their eggs in apples, allowing their larvae to feast on the sugary goods and ruining fruit before they make it to market. Where did these darned flies come from?

Though many pests migrate to new continents on boats, planes, etc., the apple maggot fruit fly has a different story. Some fruit flies were already here in North America infesting a native apple-like plant called the hawthorn. Following the introduction of apples, some hawthorn flies managed to make the transition to apples, which it turns out was not an easy feat.

What's tricky about switching foods is this: timing is everything!

Fruit flies have a complicated life cycle. Eggs are laid inside ripened fruit by females. These eggs hatch into larvae called maggots, which kind of look like tiny white caterpillars. The maggots have only one job: eat, eat, and eat. If you've ever encountered a rotting piece of food, you may have been the unfortunate witness to their munching.

When these maggots have reached a certain size, they turn into a pupa that lives inside a hard outer case, the equivalent of the cocoon stage for butterflies and moths. The pupa remains in the fruit as it drops to the ground and decays. As the fruit disappears, the pupae are left behind. This stage is extremely tough and can survive all sorts of environmental conditions, including the harsh, snowy winters found in most parts of the country where apples and hawthorns grow. When the pupa's casing opens the next year, out crawls the adult fruit fly. The adult only lives about 4 weeks in the wild, and during that time, must mate and lay eggs in an appropriate food source so the cycle can continue.

Emerging from your pupal case ready to lay eggs in a different food source like an apple involves a bit of a switch in timing. Apples generally produce fruit in the middle of the fall, about three weeks earlier than hawthorn trees. Three weeks may not seem like a very big time change to a human being, but for a fruit fly mom, this is likely more than half her lifespan. If she has evolved over millions of years to lay eggs in hawthorn, she's likely to emerge from her pupal casing too late to take advantage of apples.

As European settlers planted more and more apple orchards in the British colonies that pre-dated the United States, hawthorn flies were missing out on an abundant food source that closely mimicked their usual fare. If individual flies could make the shift to emerging a bit earlier in the season, they would have a huge advantage: abundant food for their offspring! In populations of fruit flies near apple orchards then, there was strong selection for an earlier emergence from the pupal stage, and over time, populations associated with apples emerged days to weeks earlier than those found near wild

hawthorn populations.

These early-emerging flies of course mated with other early-emerging flies, because, well, they were available. (Flies aren't super picky it turns out.) Adult flies of this genus rarely manage to travel more than one mile. Since most all early emerging flies were found near apple orchards, apple orchard flies were mating with other apple orchard flies. Their eggs were deposited in apples, and their young also tended to prefer apples, emerge early and prefer mates associated with apple orchards. Likewise, later-emerging hawthorn flies mated with hawthorn flies near native stands of wild hawthorn. Their young emerged later, lived among hawthorn stands, and produced young with other hawthorn flies. As such, these populations diverged.

In the centuries passing, this separation has been reinforced time and again. If taken into the lab, the two kinds of flies actually still produce hybrid young that themselves produce offspring capable of mating and producing young. However, this almost never happens in the wild since the different kinds of flies never come into contact.

Geneticists have tested hawthorn maggot flies and apple maggot flies to see if the two have become genetically distinct species. So far they've found some interesting results. There is strong evidence of genetic modifications called inversions. Sections of the DNA have essentially been modified by being "inverted", just like taking a piece of a puzzle and putting it back in backwards. This is a particular form of genetic mutation we are finding to be more common than originally thought. Some of these inversions may be associated with changes in the fly's degree of attraction to different kinds of fruit. Others may have to do with the timing of the fly's development. Scientists are still working on uncovering the genetic changes that created the shift in behavior that has led to a single species beginning to look a lot more like two.

Title: [What organisms are you looking at?]

Summary: [1-2 sentences summarizing what is happening in the system]

Focus trait: [what trait is keeping the species separate?]

Scientific Articles:

Feder, Jeffrey L. "The apple maggot fly, *Rhagoletis pomonella*." in *Endless forms: species and speciation*. Oxford Univ. Press, New York (1998): 130-144.

Feder, Jeffrey L., et al. "Evidence for inversion polymorphism related to sympatric host race formation in the apple maggot fly, *Rhagoletis pomonella*." *Genetics* 163.3 (2003): 939-953.