Chapter 9

Evidence of Evolution

9.2 How New Species Form

We have seen how evolution through natural selection and other mechanisms causes populations to change over time. Can evolution also explain how different kinds of living things came to live on Earth? How does evolution produce new species?

A **species** is a group of organisms whose members can breed with one another but not with members of other species. Notice that this definition works well for organisms that reproduce sexually. For asexually reproducing organisms, species are recognized primarily by their similar characteristics and ways of life. The formation of a new species is called **speciation**. For sexually reproducing organisms, an important key to speciation is the evolution of *reproductive barriers* that prevent two groups of organisms from interbreeding.

There are two kinds of reproductive barriers: ones that work before fertilization and ones that work after fertilization. These are called prezygotic and postzygotic reproductive barriers. (A *zygote* is a fertilized egg, so *prezygotic* means "before fertilization" and *postzygotic* means "after fertilization.")

Prezygotic reproductive barriers prevent individuals of different species from mating in the first place or prevent fertilization from occurring if they do mate. There are many types of prezygotic barriers—organisms may differ in when they breed, where they breed, or in the details of their courtship rituals. Their sex organs may not fit together properly, preventing successful sperm transfer, or other factors may prevent fertilization if sperm is transferred. Figure 9.3 shows an example of a prezygotic reproductive barrier.

FIGURE 9.3

During courtship in red-crowned cranes, the birds dance around each other, bob their heads, stretch their necks, extend their wings, and leap straight into the air, singing in unison. Unless you can perform all these behaviors just right, you have little hope of convincing a red-crowned crane to mate with you.

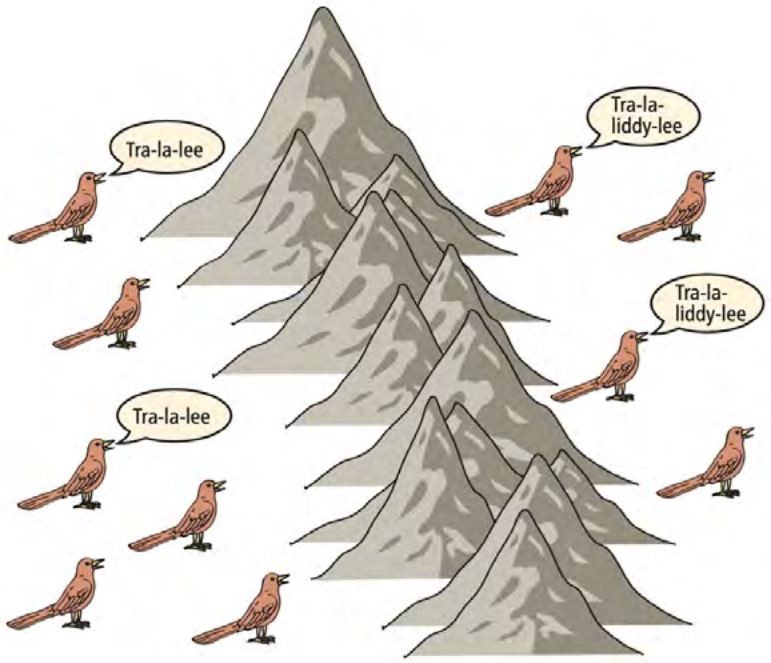
FIGURE 9.4

This is an example of a postzygotic reproductive barrier—the liger, a lion–tiger hybrid, is sterile.

Postzygotic reproductive barriers act after fertilization has taken place. Postzygotic barriers occur when mating produces hybrids that either don't survive or are sterile—unable to breed themselves. The mule, the offspring of a horse and a donkey, is sterile and cannot reproduce. Likewise, a liger (Figure 9.4), the product of the mating of a lion and a tiger, is sterile.

FIGURE 9.5

Geographic barriers isolate populations and allow them to evolve independently. Sometimes, a reproductive barrier will evolve, resulting in allopatric speciation. In this example, the courtship song of birds divided by a mountain range diverges, resulting in a prezygotic reproductive barrier.



Now let's consider how reproductive barriers—and therefore new species—evolve. In *allopatric speciation*, new species are formed after a geographic barrier divides a single population into two isolated populations (Figure 9.5). A geographic barrier could be a mountain range, a river, an ocean, a canyon, or—for aquatic organisms—a piece of land.

Once two populations are geographically isolated from each other, they evolve independently. Over time, natural selection and genetic drift may contribute to the evolution of key differences that prevent interbreeding. If a reproductive barrier evolves, the different populations become separate species.

Numerous instances of allopatric speciation have been recorded. For example, the rise of the Isthmus of Panama, 3 million years ago, divided the Caribbean Sea from the Pacific Ocean, splitting hundreds of types of marine organisms into separate Caribbean and Pacific populations. Most of these populations subsequently speciated by evolving reproductive barriers, including the wrasses in Figure 9.6.

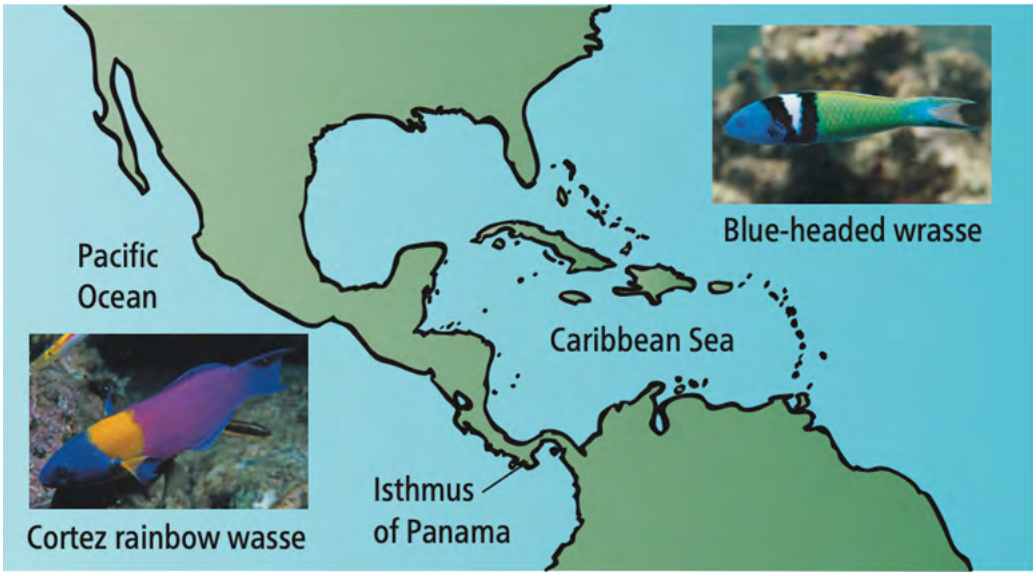


FIGURE 9.6

The formation of the Isthmus of Panama 3 million years ago isolated Pacific and Caribbean marine populations, producing numerous instances of allopatric speciation. The blue-headed wrasse (Caribbean) and the Cortez rainbow wrasse (Pacific) are descended from a single ancestral species that formerly spanned Pacific and Caribbean waters.

Adaptive radiations are spectacular examples of allopatric speciation where many new species, each adapted to a distinct way of life, evolve from a single ancestor. Many adaptive radiations have occurred on island archipelagos, which have abundant opportunities for geographic isolation. Examples of adaptive radiations include Darwin's finches and the Hawaiian honeycreepers,which include more than 30 species that differ in plumage, beak shape and size, and diet (Figure 9.7).

FIGURE 9.7

The Hawaiian honeycreepers represent an adaptive radiation consisting of more than 30 bird species. The honeycreepers differ in plumage, beak shape and size, and diet. Unfortunately, many species are extinct or endangered because of habitat destruction and the introduction of nonnative species such as rats, pigs, mongooses, cats, and mosquitoes.

Sympatric speciation is speciation that occurs without geographic isolation. Sympatric speciation is less common than allopatric speciation and often results from a sudden chromosomal change. One such chromosomal change is *polyploidy*, which occurs when organisms inherit more than the usual two sets of chromosomes, usually as a result of errors during meiosis. Sympatric speciation can also result from hybridization. *Hybridization* occurs when two species interbreed and produce fertile offspring. In both polyploidy and hybridization, chromosomal differences between the new species and the parent species prevent interbreeding. These types of speciation are more common in plants than in animals.

READING CHECK

1. **A small river forms, dividing a group of moles into two isolated populations. After many years, a biologist puts together moles from opposite sides of the river and finds that they will not mate. Has speciation occurred? If so, what type of speciation was it?**
2. **Do you think the same river would cause a population of birds to become two separate species?**
3. **Two species of frogs do not interbreed because one species breeds in the spring and the other breeds in the fall. Is this a prezygotic or postzygotic reproductive barrier?**

CHECK YOUR ANSWERS

1. The moles on the two sides of the river now represent two different species because they don't interbreed. This was allopatric speciation because it occurred after a geographic barrier (the river) separated the populations.
2. Probably not, since a small river is not much of a geographic barrier for flying animals.
3. Prezygotic, because it prevents mating.

You can read more about speciation here:

https://www.nationalgeographic.org/encyclopedia/speciation/