EXPLORE THE ISSUE BEING INVESTIGATED

Catching Evolution in Action

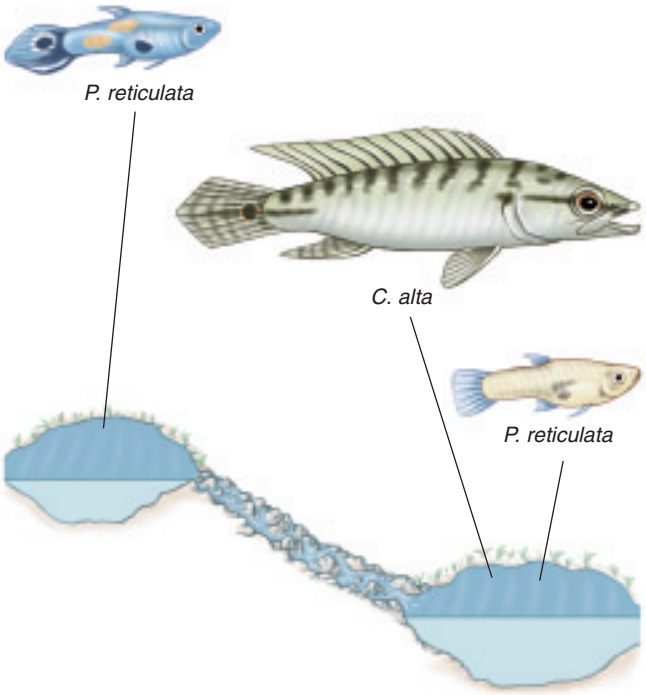
To study evolution, biologists have traditionally investigated what has happened in the past, sometimes many millions of years ago. To learn about dinosaurs, a paleontologist looks at dinosaur fossils. To study human evolution, an anthropologist looks at human fossils and, increasingly, examines the "family tree" of mutations that have accumulated in human DNA over millions of years. For the biologists taking this traditional approach, evolutionary biology is similar to astronomy and history, relying on observation and deduction rather than experiment and induction to examine ideas about past events.

However, evolutionary biology is not entirely an observational science. In recent years many case studies of natural populations have demonstrated that in some circumstances evolutionary change can occur rapidly. In these instances, it is possible to establish experimental studies to directly test evolutionary hypotheses. Although laboratory studies on fruit flies and other organisms have been common for more than 50 years, it has only been in recent years that scientists have started conducting experimental studies of evolution in nature.

To conduct experimental tests of evolution, it is first necessary to identify a population in nature upon which selection might be operating. By manipulating the strength of the selection, an investigator can predict what outcome selection might produce, then look and see the actual effect on the population.

Guppies offer an excellent experimental opportunity. The guppy, *Poecilia reticulata*, is found in small streams in Venezuela and the nearby island of Trinidad. In Trinidad, guppies are found in many mountain streams. One interesting feature of several streams is that they have waterfalls. Amazingly, guppies are capable of colonizing portions of the stream above the waterfall. During flood seasons, rivers sometimes swell, reducing the depth of waterfalls. During these occasions, guppies may be able to jump these barriers and invade pools above waterfalls. By contrast, not all species are capable of such dispersal and thus are only found in these streams below the first waterfall. One species whose distribution is restricted by waterfalls is the pike cichlid, *Crenicichla alta*, a voracious predator that feeds on guppies and other fish.

Because of these barriers to dispersal, guppies can be found in two very different environments. In pools just below the waterfalls, predation is a substantial risk and rates of survival are relatively low. By contrast, in similar pools just above the waterfall, few predators prey on guppies. As a result, guppy populations above and below waterfalls have evolved many differences. In the high-predation pools, guppies exhibit drab coloration. Moreover, they tend to reproduce at a younger age.



The evolution of protective coloration in guppies. In pools below waterfalls where predation is high, guppies (*Poecilia reticulata*) are drab colored. In the absence of the highly predatory pike cichlid (*Crenicichla alta*), guppies in pools above waterfalls are much more colorful and attractive to females. The evolution of these differences can be experimentally tested.

The differences suggest the action of natural selection. Perhaps as a result of shunting energy to reproduction rather than growth, the fish in high-predation pools attain relatively smaller adult sizes. By contrast, male fish above the waterfall display gaudy colors and spots that they use to court females (see figure above). Adults there mature later and grow to larger sizes.

Evolution does not offer the only explanation for these observations. Perhaps, for example, only very large fish are capable of jumping past the waterfall to colonize pools. If this were the case, then a founder effect would occur in which the new population was established solely by individuals with genes for large size.