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Palm Trees and Lake Fish Dispel Doubts About a Theory of Evolution

By CARL ZIMMER

Sooner or later, everyone encounters a kentia palm. Its ability to grow in low sunlight has made it one of the world's most traded houseplants.

"If you've been to a wine bar or to Starbucks, there may have been one in there," said William Baker, a botanist at the Royal Botanic Gardens in Kew, England.

"Whether you realize it or not, you're familiar with this palm," he said.

As ordinary as this houseplant may be, however, Dr. Baker and colleagues have found that it has an extraordinary story to tell about evolution.

The kentia palm (Howea forsteriana) is found in the wild only on a single remote island in the South Pacific. Based on a recent study, Dr. Baker and his colleagues have concluded that roughly two million years ago, an ancestral species of palm tree living on the island split in two, and one became the kentia palm.

The idea that members of a species living side by side can split into two species is controversial. Some scientists have presented evidence that the process has produced several species of plants and animals, but their ideas have met with intense skepticism.

Two new studies in the journal Nature — one on the kentia palm and a second on fish in a Nicaraguan lake — are impressing some leading skeptics, however.

One reason for the skepticism is that another way for forming new species is well supported by evidence. When a population becomes isolated by a geographical barrier, it can evolve into a new species.

Birds swept to a remote island, for example, may reproduce only among themselves and not with the rest of their species back on the mainland.

Over generations, the birds can acquire a unique set of mutations. They may evolve to be so different from the mainland birds that the two populations can no longer interbreed. They may sing different courtship songs, for example. They may be able to mate, but their hybrids may prove to be sterile. Based on a vast

amount of research, scientists agree that this process — called allopatric speciation — drove the evolution of many species.

But some scientists have suggested that some species evolved without geographical barriers and that a new species could emerge from an old one even when all its members were living side by side. The key was for some individuals to begin to mate with one another and not with the rest of the species. If this tendency could be inherited, then two genetically distinct populations could emerge. Ultimately, they would become two separate species.

Mathematical models have suggested this process — known as sympatric speciation — can happen under certain conditions. And scientists have discovered a handful of cases in which, they argue, sympatric speciation took place. Fruit flies from a species that originally lived on hawthorns in the United States, for example, have shifted to apples in the past 150 years. Their DNA suggests that they are diverging from the hawthorn population.

But sympatric speciation has drawn fierce criticism. Skeptics have argued that many cases of sympatric speciation could just as easily have been produced by allopatric speciation. Two species sharing an island may well have evolved allopatrically elsewhere, for example, only later moving to the island in two separate invasions.

The two studies published this month in Nature are among the best ever published, in the opinion of some of sympatric speciation's toughest critics.

In one study, Axel Meyer of the University of Konstanz in Germany and his colleagues examined two species of fish that live in Lake Apoyo, a volcanic crater lake in Nicaragua. One species, the Midas cichlid (Amphilophus citrinellus), has a big body and uses powerful jaws to crush snails at the lake bottom. The slender arrow cichlid (A. zaliosus) lives in the open water, where it eats insect larvae.

Lake Apoyo formed less than 23,000 years ago when its volcano became extinct and filled with rain water. Dr. Meyer's team studied the DNA of the two cichlids and compared it to that of fish in neighboring lakes. They concluded that the Midas cichlid originally invaded the lake, perhaps swept in during a hurricane. The arrow cichlids then branched off the Midas cichlids, evolving a distinct body and no longer breeding with their parent species.

The origin of the arrow cichlids did not take long, geologically speaking. "It was less than 10,000 years, but it could be as short as 2,000 years," Dr. Meyer said.

Dr. Meyer suspects that the arrow cichlid evolved from slender Midas cichlids and shifted from a diet of snails to a diet of insect larvae. They enjoyed more reproductive success if they mated with other slender cichlids, because their offspring could swim efficiently in the open water. Over time, the fish may have evolved the mating preferences that now help keep the two populations distinct.

Dr. Baker and his colleagues present a similar picture of the kentia palm. The kentia palm grows only on Lord Howe Island, 350 miles east of Australia. The island is home to a similar species, Howea belmoreana. The kentia palm grows about 50 feet high, while Howea belmoreana reaches only about 20 feet. Kentia palms thrive on exposures of soft sedimentary rock, while Howea belmoreana grows mostly on soils formed from volcanic rock.

By studying the palm's DNA, Dr. Baker and his colleagues found that the two Lord Howe species are much more alike than either is to any other living palm. Based on the mutations accumulated in each species, they estimate that an ancestral palm arrived on the island long after the island formed about seven million years ago.

About two million years ago, the sedimentary outcrops began to be exposed on the island. This was also the time when kentia palm split off from Howea belmoreana. Dr. Baker and his colleagues propose that the kentia palm evolved from palms that colonized the new outcrops. They were still close enough to the other palms to interbreed. But growing on the sedimentary soil may have changed the growth of their flowers.

The scientists have found that the kentia palm flowers seven weeks earlier than Howea belmoreana, making it almost impossible for them to interbreed.

"It's hard to imagine a more watertight case," Dr. Baker said.

Critics have raised a few possible alternative explanations for each study. It is possible, for example, that the palms might have evolved through geographic isolation on other islands. Their descendants then colonized Lord Howe Island, and then the other islands sank underwater. (Lord Howe is expected to disappear in 200,000 years.)

But even these critics consider these alternatives a bit of a stretch.

"I've read these papers fairly carefully, looking for weak points," said Douglas Futuyma of the State University of New York at Stony Brook. "But I can't find any."