DNA Studies Show Microevolution in Penguins

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By comparing the genetic code retrieved from 6,000-year-old remains of Adelie penguins in Antarctica with that of modern Adelies living at the same site as their ancestors, an international team of researchers has shown that microevolution, the process of evolutionary change at or below the species level, has taken place in the population. They also speculate that the remarkable lack of genetic differentiation among Adelie populations from around Antarctica may have been prompted by changes in migration patterns caused by giant icebergs.

An international team of researchers from Italy, New Zealand and the United States conducted the research and published their findings last

week in the *Proceedings of the National Academy of Sciences*.

Although previous studies have looked at genetic changes in populations of other species, they generally have focused on changes over relatively short periods of time, such as several decades.

Comparison across thousands of years is possible because the extremely cold and dry conditions of the southernmost continent--conditions found almost nowhere else on Earth--preserved the ancient penguins' physical remains so well.

The new study shows that the alleles -- slight variations in the coding of genes -- from ancient birds differ in several significant ways from those in modern populations in the same area. The researchers found that the DNA sequences for some of the genes had become longer over time, and that the frequency of some of the different genes had changed as well.

Previous studies have shown genetic similarities across the current population in the existing Adelie colonies--which range in size from 100 to 170,000 breeding pairs of birds--even though each bird's natural instinct is to return to its natal location to breed, a behavior which would be expected over time to promote genetic differences between colonies.

David Ainley, a U.S. penguin researcher funded by the National Science Foundation (NSF), and his coauthors describe how the genetic makeup of modern Adelies was compared with genetic material collected from well-preserved penguin bones taken from a dependably dated level of soil on Inexpressible Island in Terra Nova Bay, near the site of the Italian Antarctic research station and the next colony north from Beaufort Island. These samples were compared with 48 blood samples from modern Adelies living on Inexpressible Island.

Ainley and Grant Ballard, another U.S. researcher and co-author, have

studied the Adelie penguin colonies of Antarctica for three decades, and are currently launching the tenth season of a multi-colony study of the birds. The researchers have banded, and subsequently tracked, large numbers of chicks at each colony. The bands carry imprinted numbers that identify individual birds.

Ballard and Ainley's research focuses on the Adelie demography at three colonies on Ross Island -- Cape Bird, Cape Crozier and Cape Royds -- and at a fourth colony on nearby Beaufort Island. Their work is supported by the NSF's Office of Polar Programs, which manages the U.S. Antarctic Program. Through the Antarctic Program, NSF coordinates almost all U.S. science on the continent and its surrounding waters.

In the PNAS paper, the researchers also theorize that cyclical break-offs of enormous Antarctic icebergs could be the source of a remarkable genetic similarity among contemporary penguin colonies.

The icebergs, including one known as B-15-- which was initially roughly 300 kilometers (186 miles) long and 40 kilometers (24 miles) wide, cut off some colonies on Ross Island from the migration routes that the animals have normally used to return to the colonies where they were born.

Penguins annually return to breed in the colonies where they were born, a phenomenon that scientists call "philopatry." But, Ainley argues, the ecological disruption caused by the appearance of enormous icebergs within the past five years could explain why genetic makeup across the colonies is so similar.

Research by another NSF-supported scientist, glaciologist Doug MacAyeal, indicates that the break-off of large bergs such as B-15 is likely a relatively frequent natural phenomenon on a geological time

scale. MacAyeal estimates that 20 such "mega-bergs" may have broken away from the Ross Ice Shelf over a typical 1000-year interval since the last Ice Age.

Because Adelies have colonized areas left bare by disintegrating ice shelves and glacier tongues, as continental ice has retreated since the last Ice Age, producing large icebergs, it is likely, the researchers said, that disruption of migration is an important factor in the evolution of the species.

B-15 also caused large numbers of the birds to abandon their eggs at the western ancestral colonies and others to seek colonies of easier access, where they have bred successfully.

Similar events in the past, Ainley argues, would explain the genetic similarity among modern Adelie populations. Rather than allowing the birds to become isolated into separate colonies -- each of which would be expected to become more genetically distinct over time -- the periodic disruptions could serve to mix bird populations and produce genetically similar populations.

Source: NSF