Why Did Penguins Stop Flying? The Answer Is Evolutionary.

1. Life in the Antarctic biome is tough, even for a penguin that has adapted to live there. How would the life of a penguin have been made easier in its environment if these species were still adapted to fly?

2. What wing adaptation was more advantageous for the penguin to best survive in its environment?

3. What other bird species have adapted a similar trait?

4. How did the bone structure of penguins adapt as they became a flightless bird?

5. When did penguins evolve in the fossil record?

6. Why do adaptations occur in nature?

7. What major pre-historic event observed in the fossil record could have been a factor in causing penguins to evolve as they have?

Why Did Penguins Stop Flying? The Answer Is Evolutionary

Penguins' swimming prowess cost them their ability to fly, a new study says

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for National Geographic

Penguins lost the ability to fly eons ago, and scientists may have finally figured out why. A new study suggests that getting off the ground eventually just took too much effort for birds that were becoming expert swimmers.

Flight might make some aspects of penguins' Antarctic life much easier. The grueling march of theemperor penguins, for example, might take only a few easy hours rather than many deadly days. Escaping predators like leopard seals at the water's edge would also be easier if penguins could take flight, so scientists have often wondered why and how the birds lost that ability.

A popular theory of biomechanics suggests that the birds' once-flight-adapted wings simply became more and more efficient for swimming and eventually lost their ability to get penguins off the ground.

More efficient diving, on the other hand, increased the opportunities to forage for food at depth. A modern emperor penguin can hold its breath for more than 20 minutes and quickly dive to 1,500 feet (450 meters) to feast. (Related: "First Human Contact With Large Emperor Penguin Colony.")

The new study of energy costs in living birds that both fly and dive provides critical evidence to back up this theory.

"Clearly, form constrains function in wild animals, and movement in one medium creates tradeoffs with movement in a second medium," study co-author Kyle Elliott, of the University of Manitoba, said in a statement.

"Bottom line is that good flippers don't fly very well." (Related: "Giant Prehistoric Penguins Revealed: Big But Skinny.")

Sit, Swim, and Fly

The thick-billed murre or Brünnich's guillemot (*Uria lomvia*) uses its wings for diving much like penguins, but it also flies. Scientists theorized that its physiology and energy use may closely resemble those of the last flying penguin ancestors.

Other swimming birds, pelagic cormorants (*Phalacrocorax pelagicus*), propel themselves through the water with their feet. Elliott and colleagues assert that these birds can be considered biomechanical models for the lifestyle energy use of an ancient penguin ancestor that was the last of its line to take flight.

The thorough technical and isotope analysis of how guillemots burn energy reveals why today's penguins are grounded. Guillemots dive more efficiently than any other flying bird and are bested in diving only by penguins themselves, according to the study.

Flight, however, costs them more energy than any other known bird or vertebrate and has become difficult to maintain.

The team examined thick-billed murres at a colony in Nunavut, Canada, and pelagic cormorants at Middleton Island, Alaska. They injected the birds with stable isotopes of oxygen and hydrogen to serve as tracers to mark the physical costs of their activities. The team also fitted them with time-budget devices that track those activities—recording movements, speeds, and other data much like pedometers do.

"Basically the birds do only three things: sit, swim, and fly. So by measuring lots of birds and combining their time budgets with the total costs of living from the isotope measures, it is possible to calculate how much each component of the budget costs," explained study co-author John Speakman, who leads the Energetics Research Group at the University of Aberdeen, Scotland.

"The assumption is that [penguins] evolved from an auk-like ancestor," Speakman continued.

"This would involve a progressive reduction in wing size, which makes diving more efficient and flying less so. Penguin bones also thickened over the ages, as lighter bones that make it easier for birds to fly gave way to more dense bones, which may have helped make them less buoyant for diving." But Speakman believes the wing changes were the primary adaptation.

Elegant Explanation

"These results make a lot of sense," said University of Texas at Austin'sJulia Clarke, who studies bird evolution and how the flight stroke was co-opted for underwater diving.

"There have been different scenarios explored for the origin of penguins but little relevant data. These new findings from other diving birds like murres provide an elegant explanation of a key step in the wing-to-flipper transition."

Katsufumi Sato, a behavioral ecologist at the University of Tokyo's Ocean Research Institute and a National Geographic Society Emerging Explorer, added that the work indicates an important reason why penguins stopped flying and evolved larger body sizes—they needed an edge in the water.

"An interesting example is the little penguin, which is smaller than some Alcidae [a family of birds]," and weighs only about two pounds (one kilogram), said Sato. "[The] dive cost of the murre is similar to that of the little penguin, which means little penguins cannot survive against the murre, which can dive and fly."

Bigger bodies boost dive efficiency and allow for longer dives, which may be why rapid evolution produced so many bigger-bodied penguins soon after the animals lost the ability to fly.

Penguins Grounded by Taste for Fish?

Comparing multiple species, in the way this study does, points to a compelling pattern, said Chris Thaxter, a seabird ecologist with the British Trust for Ornithology.

"When wings are used both above and below water, there may be an evolutionary tipping point beyond which flight is too costly and unsustainable." Clarke, Sato, and Thaxter were not involved in the study, which was published in the May 20 edition of the journal*Proceedings of the National Academy of Sciences*.

Scientists don't have fossils of flighted penguin ancestors, and the earliest known penguin dates to just after the Cretaceous-Tertiary boundary (58 to 60 million years ago).

"It is tempting to speculate that the evolution of penguins happened in that explosive radiation [of mammal species] that happened just after the K-T event," when many species went extinct, Speakman said. "However, there is no direct evidence to support this, and it could have happened any time during the late Cretaceous."

In nature such adaptations happen for good reason, typically related to survival and reproduction. So a convincing case might be made for why penguins would have given up flight while taking to the seas.

"What we do know is that in the radiation of the mammals after the K-T event, there suddenly [in geological terms] appear a whole load of mammals that would have been serious competitors for aquatic resources [like] cetaceans and pinnipeds," Speakman said.

"So this new competitive environment may have placed a greater benefit on being more efficient swimmers and divers for aquatic seabirds. That push toward being more efficient in the aquatic environment may have been enough to tip them over the edge into flightlessness."