# Anatomical and Physiological Changes in Birds

*Christopher Neill*

Imagine the possibilities. You are practicing for an important music recital and the part of your brain responsible for listening and expressing musical notes grows larger.

Or you are about to travel to a foreign country where vegetables, rice, and beans, rather than hamburgers and French fries are the standard diet, and your digestive system lengthens to accommodate the greater percentage of roughage you will be eating. Or, in the weeks leading up to the marathon run you are training for, your stomach, liver, and kidneys shrink, reducing your weight and allowing you to put more of your energy into leg muscles.

Sounds far fetched for us, but such dramatic, short-term anatomical and physiological changes are routine in the bird world.

Scientists who study bird songs have found that birds have specific areas of their brains devoted to learning and producing songs. These locations, or song nuclei, have more neurons and larger neurons, in species that sing complex songs, like Song Sparrows and many species of wrens.

Every spring, longer days trigger the release of testosterone in songbirds' blood. This hormone increases the size of the song nuclei – birds are in effect growing new parts of their brains each spring. "Seasonal changes in neural attributes of brain nuclei that control song are among the most pronounced examples of natural plasticity in the adult brain of any vertebrate," writes G. Troy Smith, a bird song researcher at the University of Washington in Seattle.

How much these regions of the brain grow seems to be set for each species, and influenced only slightly by learning. To test this idea, Eliot Brenowitz of the University of Washington and Donald Kroodsma of the University of Massachusetts tested two groups of Marsh Wrens, one that was exposed at a young age to a variety of adult Marsh Wren song "dialects," and one group that heard only the simplest songs. They found no difference in the size of their song nuclei.

Large changes in the size of other bird organs also follow from the "need" for them at different times of year.

The length of intestines changes in response to the quality of a bird's diet. Geese are a case in point. Geese make their living by eating a large volume of relatively poor quality food, primarily grass and other plant material. Geese that eat lower quality grasses need longer intestines, and this particular piece of the goose's anatomy can change by as much as fifty-seven percent, depending on diet.

If geese are not eating, as in arctic-nesting female Snow Geese tied to incubating a clutch of eggs, their guts shrink. This was discovered by comparing incubating females with females whose nests were lost to predators.

What drives these changes? C. Davison Ankney, who studied the snow geese, argues "there must be selection for geese whose digestive organs atrophy quickly because small organs make smaller demands on a bird's metabolism."

This phenomenon may be widespread. European Starlings, the blackbirds that are common nearly worldwide, have smaller guts during the breeding season, when they are eating more insects, a much higher quality food than the plant seeds that make up most of their diet the rest of the year. Other birds, such as Eastern Kingbirds, that switch from insect to fruit diets and back each year, will likely show the same pattern.

Another key reason that these kinds of physiological changes have evolved is the reduction of weight – a very important consideration for birds.

It has been known for a long time that birds put on large amounts of fat before they migrate. But recently, Theunis Piersma of the Netherlands Institute for Sea Research and Robert Gill, Jr. of the U.S. Geological Survey in Anchorage, found that Bar-tailed Godwits, large shorebirds that migrate 11,000 kilometers directly over the Pacific Ocean from the Aleutians to New Zealand, undergo physiological changes other than storage of fat.

They examined birds that died in collisions with a radar station just after they left land for their over-water migration. They had stomachs, livers, and kidneys that were much smaller than birds that were resident on the wintering grounds.

It appears this phenomenon is not limited to Alaskan godwits. The Red Knots that pass through Delaware Bay and Cape Cod's Monomoy Island from South America on their way north in spring, can increase the size of their stomachs thirty percent in as little as three weeks, indicating that their internal organs were also reduced for intercontinental flight.

"It is consistent with the suggestion that it is unprofitable and energetically too expensive to carry a digestive machinery over thousands of kilometers of open ocean," Piersma and Gill wrote. "It seems better to get rid of such tissue even before takeoff and to rebuild the strategically reduced body parts upon arrival at the destination."

These adaptations are foreign to humans, with our evolutionary legacy of heavy, lumbering bodies, relatively stable diets, and a tendency to stick close to home.

But for birds, they are a fact of life. In Piersma's words, "Many species of avian migrants may only be able to reach the corners of the earth by virtue of their remarkable body flexibility."

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