Bird Bones May be Hollow, But They are Also Heavy, Biologist Says

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(PhysOrg.com) -- For centuries biologists have known that bird bones are hollow, and even elementary school children know that bird skeletons are lightweight to offset the high energy cost of flying. Nevertheless, many people are surprised to learn that bird skeletons do not actually weigh any less than the skeletons of similarly sized mammals. In other words, the skeleton of a two-ounce songbird weighs just as much as the skeleton of a two-ounce rodent.

Bird biologists have known this for a long time, but it took a modern bat researcher, Elizabeth Dumont of the University of Massachusetts Amherst, to explain how bird skeletons can look so delicate and still be

heavy. The answer is that bird bones are denser than mammal bones, which makes them heavy even though they are thin and sometimes even hollow.

Her findings, supported by bone density measurements, are published in the March 17 issue of Proceedings of the Royal Society B. As Dumont explains, "The fact that bird bones are denser than bones in mammals not only makes them heavier for their size, but it may also make them stiffer and stronger. This is a new way to think about how bird skeletons are specialized for flying and solves the riddle of why bird skeletons appear so lightweight and are still relatively heavy. This has never been explained fully and so has never gotten into the textbooks. I'd like to see that change."

Dumont measured the density of the cranium, the upper arm bone or humerus and the thigh or femur bones in song birds, rodents and bats by measuring bone mass and volume. "I found that, on average, these bones are densest in birds, followed closely by bats. Many other studies have shown that as bone density increases, so do bone stiffness and strength. Maximizing stiffness and strength relative to weight are optimization strategies that are used in the design of strong and stiff but lightweight man-made airframes," she points out. Density is a measure of mass per unit of volume; dense bones are both heavier and stronger, much as a titanium toothpick would be stronger than a wooden one.

Over time bird bones have evolved specializations that maximize stiffness and strength, Dumont says. These specializations include high bone density, a reduction in the total number of bones, fusion of some bones, and changes in bone shape. For example, a long history of studies have shown that the main bone in the bird wing, the humerus, is quite round in cross-section. This makes it stiffer in the same way that a round toothpick is harder to snap than a flat one.

Galileo described bird bones as lightweight in 1683, Dumont says. Her new data help to dispel the common misconception that bird skeletons are lightweight relative to body mass. Instead, bird and bat skeletons only appear to be slender and delicate—because they are dense, they are also heavy. Being dense, strong and stiff is one more way that birds' and bats' bones are specialized for flight.

Provided by University of Massachusetts Amherst

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