

HEAT CONDUCTION

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OBSERVATORY

Beaks, Bills and Climate



INTRODUCTION: The area (A) of a Toucan beak at left is 100 cm^2 . The Toucan's normal body temperature is 105°F . The Toucan's beak thickness (L) is 0.1 cm . The coefficient of thermal conductivity (K) of the Toucan beak is $7 \times 10^{-4} \text{ cal/cm} \cdot \text{s} \cdot ^\circ \text{C}$.

QUESTION: The exterior temperature (temperature of the air) of the environment of toucan is 95°F . Find the heat/time (in cal/s) which the Toucan's beak would be conducting out of the bird's body into the 95°F environment?

HINT: $Q = K [(\Delta T)A t/L]$ where delta T is temperature between outside and inside the beak. $\Delta C/\Delta F = 5/9$

ANSWER: 3.89 cal/s

In the 1800s, an American zoologist named Joel Allen posited that animals in cold climates evolved to have shorter appendages (limbs, ears, and tails) than those in hot climates, in order to minimize surface area and thereby minimize heat loss. The theory, known as Allen's rule, has long appeared in biology books, but scientific evidence for it has remained weak. Now a study comparing bird bills provides the most substantial evidence yet in support of Allen's rule. Researchers looked at more than 200 bird species and found that there is a **significant relationship between bill length and climate. Birds that live in hot environments, like the toucan, tend to have large bills. Those in colder environments, like the turkey, have smaller ones.**

In the case of the toucan, about 30 to 60 percent of body heat can be lost through the beak. In a hot, tropical environment, this is extremely useful. On average, birds living in cooler climates, like the turkey and the partridge, have beaks one-third to one-fourth the size of birds in warmer climates, said [Glenn Tattersall](#), a biologist at Brock University in Ontario, Canada, and one of the study's authors. This helps them retain body heat, Dr. Tattersall said. For the study, he gathered data on birds that live in Canada's cooler climate, while his co-author, [Matthew Symonds](#) of Melbourne University, focused on Australian birds that live in warmer climates. Their study will appear in a future issue of [The American Naturalist](#).