

CHES gives researchers a nondestructive look at calcium stores in swallows

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Every spring, when millions of small songbirds are returning from their southern wintering grounds to begin breeding, these birds are struggling to garner as many resources as possible to allow the earliest and most prolific reproduction they can manage. Of all the resources that a laying female has at her disposal, there are three that are likely to limit egg-laying: protein, fat and calcium. An ongoing research program has been designed to study the importance of fat and protein stores to reproduction in tree swallows, a small insectivorous bird that occupies nest-boxes in open areas throughout the U.S. Although we have methods for assessing the protein and fat stores of swallows on living specimens, we have not previously been able to assess the calcium stores without sacrificing the bird.

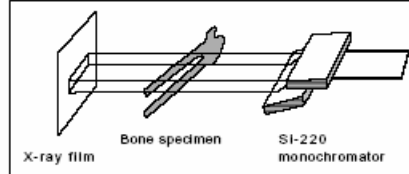
Calcium is likely to be important, because it is one of the principal constituents of egg shells. The amount of calcium that must be shunted through the laying females' system and deposited in shells every day is far in excess of the amount that she could obtain from the environment. All birds must rely on stores of calcium that can be built up before the breeding season and rapidly depleted during laying. Previous research on pigeons and chickens has indicated that the principal site for calcium storage is in the hollow interiors of their leg bones.

In a recent series of experiments on legs from collected swallows, one of us (RP) has recorded X-ray images that indicate the potential for quanti-

Lateral view of the tibiotarsal-tibio metatarsal joint from tree swallow collected during fall migration. Note that the bones are hollow in the long parallel-walled portions away from the joint. The arrow indicates small growths of material which appear to be associated with the storage of calcium for egg-laying.

fying calcium stores in live birds without harming them. The leg bones of these birds are tiny (about 1.5 mm in diameter), and the challenge has been to visualize the interiors of the bones with sufficient acuity to measure the differential development of calcium deposits within them.

The experiments have been carried out at CHES beamline D1 using X-rays at 12 keV. Utilizing an asymmetric-cut Si-220 monochromator, a beam with a large cross section and an energy resolution of $\Delta E/E=10^{-5}$ was obtained. Radiographs of the bone samples were stored on Kodak high-resolution X-ray film. Analysis is being done after digitizing the recorded information. The spatial resolution obtained is about 15 μm . For future experiments a CCD system will be used, which will allow not only a much faster data acquisition but also 3-dimensional tomography



Schematic experimental arrangement for radiography measurements at D-line.

of the samples.

The use of the synchrotron radiation at CHES offers several advantages over other sources. The collinearity and the monochromatization of the light eliminates distortions present in images made with conventional X-ray sources. Most importantly, the high intensity of the beam (appr. 10^9 photons/sec) allows short exposure times (<0.4 seconds) that can be used with living birds.

A pilot test to discriminate differences among birds that are reflected in the size, thickness and number of eggshells the females lay is being planned for spring 1994.

