CHESS 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 fullest 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 in 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 supplied 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 are highly dependent on stores of calcium that can be built up before the breeding season and rapidly deployed during laying.

In a recent series of experiments on eggs from collected swallows, one of us (RP) has recorded X-ray images that indicate the potential for quantifying 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 CHESS beamline D1 using X-rays at 12 keV. Utilizing an asymmetrically cut Si(220) monochromator, a beam with a large cross section and an energy resolution of 0.12 keV was obtained. Radiographs of the bone samples were recorded 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 of the samples.

The use of the synchrotron radiation at CHESS 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 (above 10^7 photons/sec) allows short exposure times (<0.1 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.