

A Breakthrough for Turkey Growers

Biological Basis for Broodiness

If you think selecting and cooking the traditional Thanksgiving turkey is a chore, consider the trials of the turkey producer.

First, the turkey is hardly the most fecund of barnyard creatures.

A turkey hen typically doesn't begin laying eggs until she's 30 weeks old and then produces only 90 eggs over a 25-week laying season. That's a poor showing against meat-type chickens, which begin laying at 23 weeks—or egg-type hens, which will lay for a year or more and produce as many as 285 eggs annually.

To add to the turkey grower's woes, there's broodiness—a sort of reversion to behavior of birds in the wild, when the turkey decides she wants to sit and hatch her eggs, instead of continuing to produce more.

That's where John Proudman comes in. "The problem is a hormone called prolactin," explains Proudman, a poultry physiologist with ARS' Germplasm and Gamete Physiology Laboratory at Beltsville, Maryland.

"When a good turkey layer is producing an egg a day, prolactin levels in the bird's blood are perhaps 150 nanograms (billionths of a gram) per milliliter of blood. But when a bird goes broody, prolactin levels may be up to 10 times as high, and egg production drops to zero.

"We've calculated that if we could get around this problem and increase turkey egg production by just 10 eggs

per hen, it would be worth another \$30 million a year to the turkey industry," says Proudman.

Turkey eggs are far from a sure bet to become gobblers, at any rate. U.S. growers raise about 4 million turkey breeder hens annually, which in turn produce 308 million turkey poults (chicks), of which only 292 million make it to market.

The turkey hen with lower levels of prolactin may visit her nest once or twice a day, spending the bulk of her time elsewhere. But the broody bird stays on the nest all day long, warming her hoarded eggs.

Driven by Brain Chemistry

That prolactin is the culprit is not in question. Studies by University of Minnesota scientists have shown that if a bird is physically primed to lay eggs but is injected with prolactin, that bird will go broody.

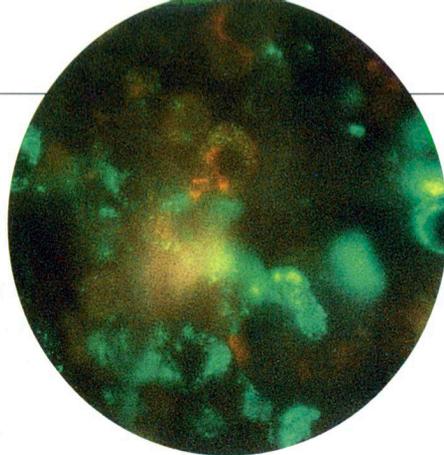
Nature provides turkeys with prolactin via the pituitary gland. Certain cells in the hypothalamus region of the bird's brain produce a natural chemical called vasoactive intestinal peptide, or VIP. This VIP travels to the pituitary gland, where it stimulates cells called lactotrophs to produce prolactin.

The turkey pituitary gland is also home to cells called somatotrophs, responsible for production of growth hormone. Unlike the human pituitary gland, where lactotrophs and somatotrophs are intermingled, in the turkey pituitary the two types of cells normally keep to their own territory—lactotrophs up front, somatotrophs mostly in the rear.

But if the lactotrophs and somatotrophs don't share neighborhoods, they do share something more surprising: function.

"As hens become broody, you can see some of the same cells producing both growth hormone and prolactin,"





Turkey pituitary cells were stained to identify growth hormone (green) and prolactin (red). Photomicrograph by John Proudman.

reports Proudman. “The lactotrophs no longer keep to their own territory; the cells in the rear begin producing prolactin where growth hormone was previously produced.

“Studies about 10 years ago with rats showed that such cells could alter function during physiological changes such as pregnancy. But this is the first time this change in cell function has been seen in birds. It could help explain the large increases in prolactin present in some birds.”

Proudman and other scientists hope to curtail the potential flood of prolactin in the broody bird in several different ways.

In collaboration with poultry physiologist Wayne Kuenzel at the University of Maryland, Proudman is studying the pituitary to see what triggers a cell to switch jobs from growth hormone production to prolactin production—perhaps a natural “on-off” switch in the genes that dictates a cell’s assignment.

Interrupting the Message

The researchers are looking for the receptors where prolactin congregates to wield its influence.

“We know there must be prolactin receptors on the turkey’s ovary because if you give a bird prolactin, its follicles regress and it stops producing eggs,” says Proudman.

“But there are undoubtedly receptors in other tissues as well. We’ve cloned and worked out the DNA sequence for the prolactin-receptor gene. And we’ve gone on to find the messenger RNA that would carry the code to a cell to be a receptor in tissues in the ovary, kidney, and pituitary gland,” he says. “If the RNA for a receptor protein is present in the tissue, we know that tissue is likely to bind prolactin.”

The scientists will also tackle the question of what stimulates VIP production in the bird’s brain, triggering the chain of events that leads to a surfeit of prolactin in the broody turkey.

One potential solution is antisense technology—finding the gene that carries the *sense* of the code for production of prolactin, then creating another gene that carries an opposite message, or *anti-sense*, to block prolactin production. Just such a gene has been developed by molecular biologist Eric Wong of Virginia Polytechnic Institute and State University at Blacksburg, Virginia.

Proudman has collaborated with Wong, Bernard Wentworth of the University of Wisconsin, and Mohamed El Halawani of the University of Minnesota to produce turkeys that carry this antisense gene. The true test will come when those turkeys’ offspring reach egg-laying age and are at risk for broodiness.

“We did in vitro work with pituitary cells that showed you can use antisense RNA to block the prolactin stimulation normally seen with VIP, without suppressing the base levels of prolactin,” says Proudman.

Research has also revealed another piece of the puzzle: prolactin protein variations known as isoforms, which can be sorted on the basis of their molecular weight and electric charge.

“There are different amino acids that make up prolactin molecules and have different natural electric charges, positive or negative,” says Proudman. “When we tested blood from broody birds, concentrations of some prolactin isoforms were apparently so low that we couldn’t detect them.

“We might be able to trace the genes involved in producing different types of prolactin molecules and then

KEN HAMMOND



Using a pipette, poultry physiologist John Proudman draws off samples from tissue culture for radioimmunoassay of turkey hormones, such as prolactin. (K7000-1)

perhaps use those genes as markers for broodiness when we select birds for breeding.”—By **Sandy Miller Hays, ARS.**

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