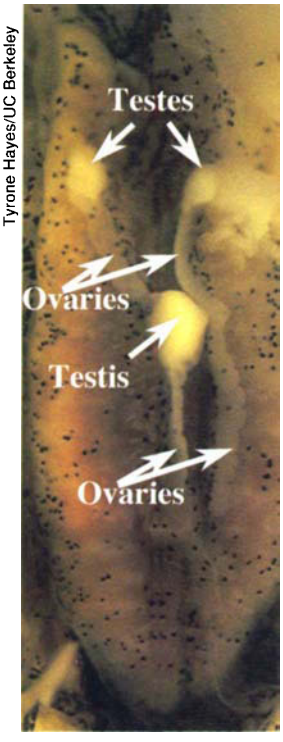


Tyrone Hayes/UC Berkeley

Abnormal gonads in a male *Xenopus* frog are the result of exposure to the herbicide atrazine. The frog has become a hermaphrodite, with both male (testes) and female (ovaries) sex organs.

Atrazine scrambles frog sex organs

Exposure to atrazine demasculinizes tadpoles and can turn them into hermaphrodites with both male and female sexual characteristics, UC Berkeley scientists have found.

In the April 16 *Proceedings of the National Academy of Sciences*, developmental endocrinologist Tyrone Hayes and colleagues report that the widely applied herbicide also can lower levels of the male hormone testosterone in sexually mature male frogs as much as tenfold, to levels lower than those in normal female frogs.

"Atrazine-exposed frogs don't have normal reproductive systems," Hayes says. "The males have ovaries in their testes and much smaller vocal organs," which are essential in calling potential mates.

The vocal chords of more than 80% of male frogs exposed to 1 part per billion (ppb) or more of atrazine were smaller than average; at concentrations of 0.1 ppb and higher, as many as 16% of the frogs had extra gonads.

Because it has been in use for 40 years in some 80 countries, atrazine's effect on sexual development in male frogs could be a factor contributing to the global decline of amphibians, Hayes says. More than 60 million pounds of atrazine were applied last year in the United States.

The laboratory tests used the African clawed frog *(Xenopus laevis)*, which is very sensitive to hormones that mimic its own sex hormones. If raised in a pond with the female hormone estrogen, for example, all *Xenopus* tadpoles turn into females. In the presence of male androgens such as testosterone, the frogs grow larger voice boxes.

"Atrazine probably does not have such severe effects on humans, because it does not accumulate in tissue and humans don't spend their lives in water the way frogs do," Hayes says. Nevertheless, the effects of atrazine on frogs could be a sign that the herbicide is subtly affecting human sex hormones.

The U.S. Environmental Protection Agency is currently re-evaluating allowable levels of atrazine in drinking water and the environment. Hayes found hermaphroditism in frogs at levels as low as 0.1 ppb, while draft regulations to protect aquatic life limit 4-day exposures to 12 ppb. Levels as high as 40 ppb have been measured in rain and spring water in parts of the Midwest, while atrazine in agricultural runoff can be present at several parts per million.

Hayes and his colleagues subsequently visited atrazine-contaminated ponds in the Midwest to see if such reproductive abnormalities occur in frogs in the wild. They turned up many native leopard frogs (*Rana pipiens*) with similar problems, and are now testing captured animals to determine whether the changes are due to atrazine. The researchers are also trying to determine how the abnormalities affect the frogs' ability to produce offspring. The National Science Foundation is supporting the studies.

In response to a new study by UC Berkeley scientist Tyrone Hayes, *above*, the U.S. Environmental Protection Agency may reconsider forthcoming rules on the use of atrazine.

Oral exposure to hormones "masculinizes" female finches

Female zebra finches that orally ingest the hormone estradiol benzoate as chicks develop "masculinized" brains and can sing if stimulated with testosterone as adults, UC Davis scientists have found.

Scientists discovered several decades ago that female finches exposed to estradiol — an estrogen commonly used in hormone replacement therapy — can sing like their male counterparts. Now UC scientists have found that giving doses of hormones to female finch chicks orally, a natural route of exposure to estrogenic chemicals in the environment, can induce "truly significant brain changes," UC Davis animal science professor James Millam says.

Exposure to estradiol benzoate also caused infertility in male finches and hindered the songbirds' ability to reproduce, according to studies by Millam and colleagues published in the December and April issues of *Hormones and Behavior*.

Male zebra finches exposed to estradiol benzoate, an estrogen, had a greater incidence of infertility and reduced reproductive ability.

"Our results indicate that songbird populations may be at risk if they are exposed to estrogenic chemicals as chicks," Millam says.

Hormones are powerful chemicals that regulate sexual development and reproductive ability. Synthetic hormones are leaking into the environment and may

be having important impacts on wildlife, Millam says. For example, millions of women take estrogen in birth control pills and menopause treatments; estrogen is not broken down by water treatment and remains in sewage wastewater. More relevant to birds is the presence of hormone mimics in pesticides and industrial chemicals, which can be ingested by developing chicks.

The finches received a variety of estradiol doses, primarily at levels higher than those encountered in the environment (except the most polluted areas), although some reproductive impacts — such as increased egg breakage and male infertility — were identified at environmental levels. The U.S. Environmental Protection Agency funded the research.

Cloned calf "Rosie" is rosy

A cloned Hereford calf named Rosie is doing well after its birth at UC Davis on May 2.

The reddish-brown and white female is part of an ongoing study aimed at better understanding which types of adult cells are best suited for cloning cows. The researchers hope to improve the cloning technique, eventually using it to produce more healthful meat and milk products.

"We're encouraged that Rosie is feeding well and acting energetic like any other newborn calf," says Gary Anderson, professor and chair of the UC Davis animal science department. However, because young calves are especially vulnerable to respiratory, digestive and umbilical infections, scientists continue to watch her closely.

The calf was cloned from a follicle cell taken from the ovary of a 16-year-old, reddish-brown Hereford cow, and has the same coloring and markings as the cow from which she was cloned.

This is the second calf cloned and delivered at UC Davis. The first was born in August 2001 and died three days later due to multiple birth defects. Worldwide, an estimated 150 cloned calves have been born at about 10 laboratories.

The new calf is expected to remain at UC Davis for about 2 months, then go to a Northern California ranch where the cow from which she was cloned lives.

Cloning may someday enable scientists to produce replicas of individual animals that have valuable traits, such as cows whose milk is particularly nutritious. Cloning could also be used to genetically engineer cows and sheep that can produce pharmaceuticals in their milk.

The current technology used to produce clones in the laboratory, called nuclear transfer, involves removing the nucleus (with its genetic material) from the unfertilized egg cell of one cow. Then a cell is taken from somatic tissue of a donor animal of the same species and placed next to the "empty" egg. In this case the donor cell was a follicle, supportive tissue in the cow's ovary.

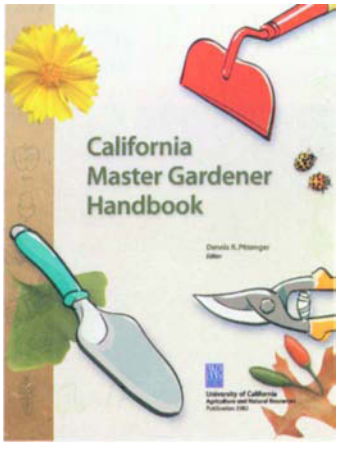
Rosie weighed about 100 pounds at birth, a bit larger than the average 75 to 80 pounds usually seen in Hereford calves. Cloned calves are often unusually large, but this calf is considered within the normal range for her breed.

An electrical charge is applied, causing the two cells to fuse together. The fused egg is placed in a lab dish with the appropriate nutrients. Eventually the resulting embryo — which is a genetic copy of the animal that donated the nucleus — is transplanted into a surrogate mother.

Master Gardeners on page and screen

Published earlier this year, ANR's *California Master Gardener Handbook* is a runaway hit, quickly selling out its first print run (an additional 10,000 more copies have been delivered). "A new bible on the block for home gardeners," one garden editor wrote.

Now home gardeners have another opportunity to learn from UC Master Gardeners: UCTV will broadcast about 20 hours of the program's certification lectures this summer and fall. Broadcasts begin the last week in July and will include classes on integrated pest management, weed identification, the home vineyard and vertebrate pest control. UCTV is a systemwide channel with programming from all UC campuses, labs and ANR; it can be found on Dish Network Channel 9412 and various locations on cable. For information, go to www.uctv.tv.



ANR's *California Master Gardener Handbook* is "a new bible" for home gardeners.

The *California Master Gardener Handbook* (ANR Publication 3382) is 702 pages, with black-and-white photos, line illustrations and a glossary of terms. It includes chapters on individual crop cultural practices and, when applicable, nutrition of edible crops, plus chapters on related disciplines such as soil and water management, weeds and insect pests, and landscape plants and design. Copies cost $30, with discounts for ANR personnel and Master Gardeners. To order, go to http://anrcatalog.ucdavis.edu/ or call 1-800-994-8849 or (510) 642-2431.

— Compiled from UC and other news sources