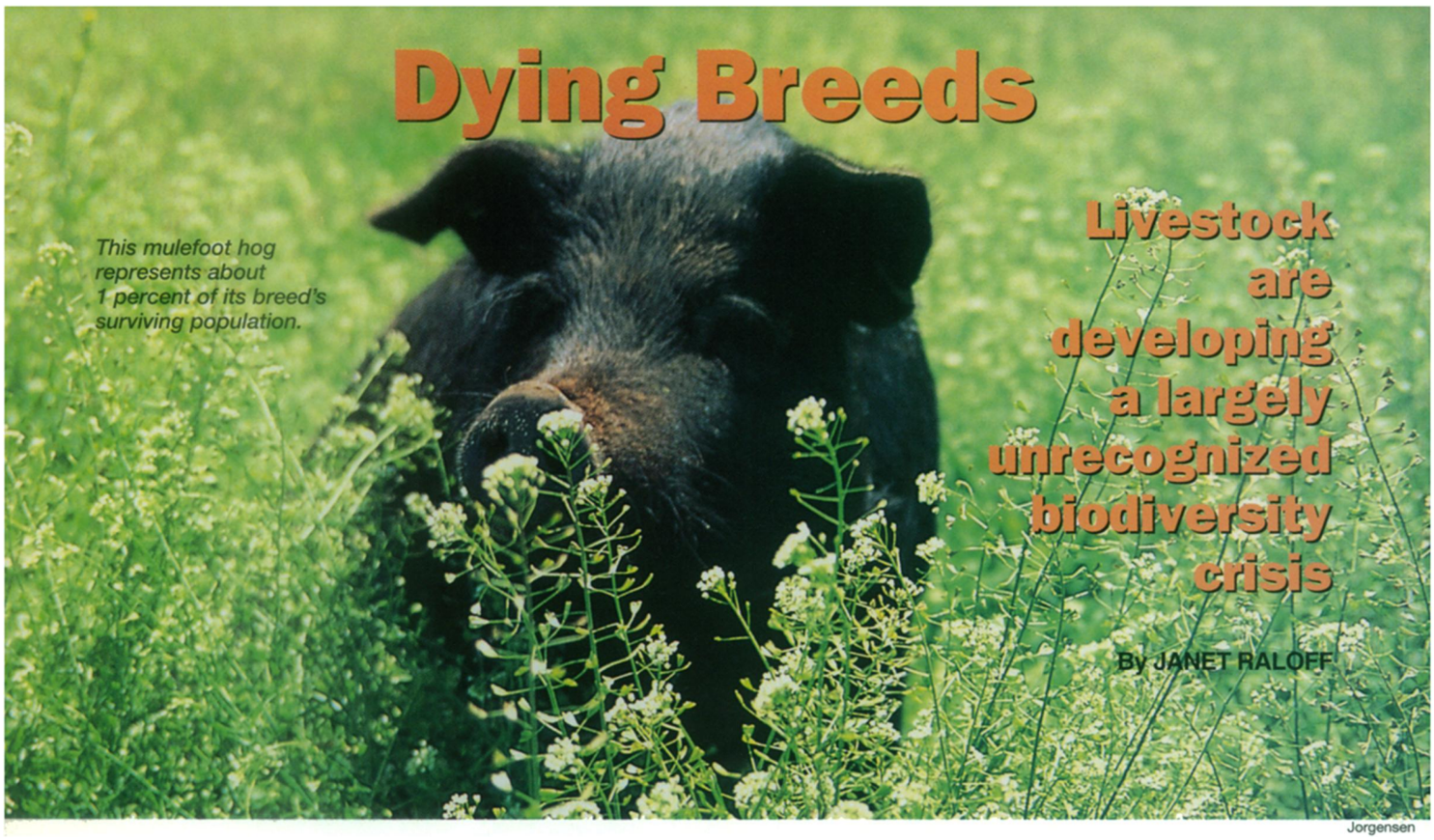
Dying Breeds



This mulefoot hog represents about 1 percent of its breed's surviving population.

Livestock are developing a largely unrecognized biodiversity crisis

By JANET RALOFF

Jorgensen

When it comes to milk production, nothing beats Holsteins. For the farmer who takes care to keep them cool, sated with high-energy chow, and milked regularly—often under the management of a sophisticated computer—these familiar black-and-white cows produce an average of 2,275 gallons of milk each per year. The average Brown Swiss, in contrast, produced only 1,820 gallons last year, and a Jersey less than 1,600.

The Holstein's milk generation has become so legendary that the roughly 9.2 million of them in the United States now represent an estimated 91 percent of the nation's dairy stock. Not surprisingly, Holsteins have achieved almost as daunting a dominance of dairying in many other Western nations, notes Richard H.L. Lutwyche of the Rare Breeds Survival Trust in Stoneleigh Park, England.

However, what's good for the individual farmer may not reflect what's in the best long-term interest of the animals or even dairying, argues H. Peter Jorgensen, a founder and former director of the Institute for Agricultural Biodiversity at Luther College in Decorah, Iowa. The focus on a single breed is eroding the bovine gene pool, he argues, creating increasingly clonelike generations of all too genetically similar animals.

Were a disease to develop for which Holsteins carried some particular inherited susceptibility, U.S. milk production could crash. Or if faltering economic conditions made low-tech, grass-fed dairying the only affordable approach, farmers might again want animals that can produce a lot of milk without coddling. Kerrys, Dutch Belted, and Milking Devons may carry genes for some of these traits. However, being among the world's rarest dairy breeds, their ability to supply such features would disappear if they were allowed to die off.

Jorgensen

Highland cow and calf, of which there are fewer than 2,500 in the United States and fewer than 10,000 globally.

Dairy cows aren't the only livestock whose genetic diversity is waning rapidly. Of 15 breeds of swine raised in this country just 50 years ago, 8 are now extinct and most of the remaining purebred types are seriously imperiled, according to the American Livestock Breeds Conservancy (ALBC) in Pittsboro, N.C. The organization's most recent North American livestock census identifies hosts of other once-popular horses, goats, sheep, and asses poised on the brink of extinction.

Worldwide, at least 1,500 of the roughly 5,000 domesticated livestock breeds "are now rare—represented by less than 20 breeding males on the planet or less than 1,000 breeding females," explains Keith Hammond, senior officer for Animal Genetic Resources with the United Nations Food and Agriculture Organization (FAO) in Rome.

For the past decade, his department has been coordinating surveys and status reports on livestock breeds in FAO's 180 member nations. Its latest data suggest that 5 percent of those highly endangered breeds disappear from the face of the Earth annually—which, Hammond notes, comes to an average of more than one a week.

Overall, he told SCIENCE NEWS, "a larger proportion of genetic resources is in danger [of extinction] in the animal sector than in any other area of agrobiodiversity."

All domesticated livestock today belong to one of some 80 species. However, only about 14 of these play an important role in food and agriculture.

Farmers have worked with these animals over the centuries to develop highly specialized breeds that embody distinct combinations of traits. The French alone developed 200 different breeds of cattle during the 18th and 19th centuries within the two domesticated bovine species, Jorgensen notes, and the British developed 40 different breeds of sheep.

From arid regions have emerged hardy cows able to weather heat and drought. Siberia produced a breed of cattle that tolerates winter temperatures as low as

-60°C (-76°F). Elsewhere, breeds have arisen with especially strong resistance to disease and parasites, superior mothering qualities, prodigious strength for draft applications, or a tendency to lay down predominantly lean tissue.

However, since World War II, agriculture has been undergoing a transformation—moving from a family enterprise to big business. This change, which the ALBC describes as industrialization, has had a profound effect on which breeds remain popular.

Farmers once had perhaps 30 cows, each of which had a name. Today's herds typically number hundreds and sometimes thousands of nameless animals. Accompanying the change in scale has been the introduction of technology to gauge production efficiency.

"When my dad was farming," Jorgensen recalls, "he would put a scoop of feed in front of each cow and hay in the manger. We didn't have the technology to precisely measure what went in and out of each animal," a requirement for quantitative comparisons of breeds. Today, as cows enter stalls in the dairy barn, a sensor identifies each individual from the computer chip in her ear. Then software analyzes the cow's recent milking performance and triggers a feed dispenser to meter out precisely how much she will need.

Robert Hawes traces the dawn of a similar revolution in chicken husbandry to

Colonial Williamsburg Foundation

Dominique chicken, now bred largely for show.

competitive egg-laying tests that the Agriculture Department began offering in the 1920s. The compelling results convinced farmers that they could reliably expect more eggs—and money—from particular breeds, says Hawes, a poultry expert at the University of Maine in Orono.

Before long, many of the more than 60 breeds that had been raised in the United States were abandoned in favor of just a handful of high performers. Today, Hawes says, five breeds supply almost all of the chicken meat and brown eggs sold as food. White eggs now come almost exclusively from a single breed, white leghorns.

Though bird fanciers still raise other species, Hawes says their emphasis is on producing pretty chickens, often at the expense of utilitarian traits, such as an ability to lay many eggs or eggs with firm shells.

Rare Breeds Survival Trust

Meat from this Hebridean ram possesses little cholesterol and unusually low concentrations of saturated fat.

Swine and several other species are losing genetic diversity in response to another trend: crossbreeding.

Though virtually all purebred swine are pigmented and sport bristly hair, most children picture the pig only as the pink movie star Babe. Such unpigmented and frequently hairless pigs—which usually result from a crossing of several different breeds—constitute the majority of pigs raised in the United States and Britain, notes Lutwyche.

Promoted by vertically integrated hog operations—industrial firms that not only mass-rear hogs but also slaughter them and package the meat for supermarkets—these pigs have been bred to bulk up quickly on a high-protein diet, laying down fairly lean meat. In Britain, Lutwyche notes, any pig that doesn't match this profile encounters "enormous bigotry by the butchery trade and supermarkets," which have argued that the public "won't buy meat from a pigmented animal."

So effective has their lobbying been, he says, that Britain's Meat and Livestock Commission has devalued such meat. "Now, even when farmers bring in the most perfect carcass," he told SCIENCE NEWS, "they're immediately docked 25 pence a kilo [18 cents per pound] if it came from a [pigmented] pig."

Increasingly, these industrialized livestock operations are also wresting control of livestock genetics from those who raise the animals, points out ALBC's Carolyn J. Christman. For instance, ever fewer farmers raising pigs, turkeys, and chickens mate animals but instead are acquiring them from breeding facilities.

Just four or five companies control all the genetic stocks for commercially reared broiler chickens in North America and Europe. "If these folks are accountants and don't know much about biology or are looking for the short-term gain," she says, "they can quickly throw away a large share of the animals' genetic variability."

This business approach to livestock management is also compartmentalizing what had once been multipurpose breeds into distinct functional niches. For instance, while Holsteins rule the dairy world, they are nonplayers in the premium U.S. beef market, where Angus, Herefords, and Simmentals reign.

Optimizing for a niche, Lutwyche argues, "leaves no room for breeds like the Longhorn or Gloucester cattle—those all-purpose breeds that are neither the heaviest milkers nor animals with the preferred beef conformation [ratios of lean to fat and of meat to bone]."

Hoping to slow the genetic erosion that accompanies any loss of livestock varieties, several organizations have begun working to conserve the so-called heritage breeds through a broad range of programs. The Rare Breeds Survival Trust, for instance, has begun accrediting butchers who offer meat from pure heritage breeds. This awarding of what amounts to its seal of approval, Lutwyche says, "is proving extremely successful in helping rescue certain sheep, cattle, and pigs."

His group has also publicized data showing that meat from certain "very primitive" sheep—such as the Hebridean, Soay, and Manx Loughtan—contains very little cholesterol and an usually high ratio of polyunsaturated to saturated fats. This has permitted farmers who raise such breeds to develop health-conscious specialty markets for their meat.

The Institute for Agricultural Biodiversity has taken a different tack. In 1992, it purchased 10 mulefoot hogs, the most endangered U.S. swine, and placed small breeding groups of them in foster care with livestock farmers. Today, those animals, now numbering around 50, represent about half of the once-popular breed's global population.

Safeguard for Agricultural Varieties in Europe (SAVE), a group based in Germany, has been active in coordinating a number of similar projects in war-torn and economically ravaged areas of Eastern Europe. One of its projects involves

Grünenfelder/SAVE

Turopolje pig, one of only a few dozen to survive the Bosnian conflict.

the Turopolje pigs of Croatia. While remaining under their owner's loose control, these hardy, free-ranging swine normally spend 10 months a year in meadows and forests.

The breed was already severely endangered when civil war swept through the pig's native range 6 years ago. None of these animals would likely have survived the war without some outside intervention, says Hans-Peter Grünenfelder of SAVE's St. Gallen, Switzerland, office. His organization lobbied the Croatian government to provide about $120 per sow to help defray the extra costs incurred as farmers were instructed to move their pigs into barns for year-round feeding and protection from poachers.

Three years ago, SAVE also collected three young boars and three sows to begin a breeding program at the Zagreb Zoo. As hostilities worsened, these animals were eventually evacuated to Vienna. Today, as a first step toward the management of Turopolje breeding to preserve what genetic diversity remains, SAVE is coordinating efforts for DNA testing of the 40 or so pigs known to remain.

Heroic as SAVE's efforts are, most of them take place out of the public eye. To build an appreciation for what the world risks losing, it helps to have representatives of these animals firmly in view, says Elaine Shirley, a livestock conservator at the Colonial Williamsburg (Va.) Foundation, the nation's oldest and largest outdoor living-history museum.

The 173-acre center, which preserves—and recreates through activities—pre-Revolutionary America, has long made livestock a part of its programs. But for years, there had been no effort to use breeds that had been raised during the colonial period. For instance, "the sheep we had were basically a crossbreed that looked like sheep in paintings and drawings of the 18th century," Shirley says. "While they had the right look, heaven knows what their [genetic constitution] was."

Colonial Williamsburg Foundation

This pair of American Cream draft horses constitutes about 2 percent of the breed's global population.

Fifteen years ago, she says, a decision was made to begin raising authentic 18th century breeds. "And while we're at it, we decided, let's work with the animals that need the most help." Within 3 years, their first heritage breeds arrived—extremely endangered Leicester Longwool sheep and Milking Devons (which have died out in Great Britain but number about 150 throughout North America). Since then, they've added some chickens, and they plan to acquire appropriate horses.

Unlike farmers, who may be best suited to raising these animals, Shirley says, museums and zoos have enough time and resources to educate the public about the growing rarity of such breeds and about the potentially valuable genetic resources they carry. In fact, ALBC observes, agriculture's "unwanted breeds" increasingly hold much of the genetic diversity in livestock. As such, "their conservation is an insurance policy necessary for agriculture to face the challenges of an unknown future."

While Jorgensen agrees, he would argue that they should be conserved as more than an insurance policy. "They are just as important a historical artifact as any movies, paintings, or Frank Lloyd Wright house that we go to great expense to preserve. As living artifacts of the greatest agriculture in the world, they deserve at least some little corner where they can be appreciated by our descendants." □

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Biology

Hidden virus suspected in diabetes

A genetic remnant of a viral infection in humanity's distant past may underlie type I diabetes, the autoimmune disorder in which the body's immune cells somehow destroy the insulin-producing cells in the pancreas. In 1994, investigators seeking the cause of this betrayal implicated a superantigen, a protein or protein fragment with the ability to stimulate the activity of a large number of normally quiescent immune cells. Yet the evidence for this theory stemmed from just two people with diabetes, and it was indirect. The identity of the superantigen remained a mystery

Some of the same researchers think they have finally fingered the culprit.

In the July 25 CELL, Bernard Conrad of the University of Geneva Medical School and his colleagues argue that the superantigen is part of a protein used to construct the outer surface of a virus. Moreover, the virus under suspicion appears to be an endogenous retrovirus, a virus that infected people long ago and incorporated its genes into the human genome.

Though usually dormant, some genes of this endogenous retrovirus were active in all 10 people recently diagnosed with type I diabetes whom Conrad's group had examined. The researchers didn't find similar viral gene activity in a group of people without the disease.

Conrad and his colleagues speculate that the production of superantigens by the activated endogenous retrovirus triggers the immune system to attack the pancreas. Still, it's unclear what stimulates the viral genes. Moreover, their activity may just serve as a marker for a hidden cause of type I diabetes.

"These results are exciting. [They] do not yet prove a direct role in diabetes for the retroviral superantigen, but it will not take long until we know whether such retroviruses are responsible for some or many of the cases," says Hans Acha-Orbea of the Ludwig Institute in Epalinges, Switzerland. —*J.T.*

A flowery toxin reveals its petals

Now that physicians have grudgingly conceded that the bacterium *Helicobacter pylori* is responsible for most ulcers, and probably for some stomach cancer as well, the next step is to determine how it wreaks such havoc. In the spotlight is VacA, an *H. pylori* molecule with proven toxicity to cells in test-tube experiments. It causes large, fluid-filled spheres, called vacuoles, to appear in the cells.

While VacA's involvement in ulcers remains unclear, it does appear to be most active in acidic environments, which may help explain why *H. pylori* is destructive to the stomach. With the aid of a technique called deep-etch electron microscopy, developed by John E. Heuser of Washington University School of Medicine in St. Louis, investigators have recently analyzed the structure of VacA and its response to acid.

VacA normally assumes a flowerlike shape consisting of petals joined to a circular ring. In an acidic solution, however, the toxin breaks up into a dozen teardrop-shaped subunits, Timothy L. Cover of the Vanderbilt University School of Medicine in Nashville and his coworkers report in the Aug. 25 JOURNAL OF CELL BIOLOGY. According to their model of VacA, the toxin consists of two interlocked, six-petal rings. The researchers have not yet determined whether VacA's acid-induced toxicity results from the petals themselves or from their reassembly into some altered configuration. —*J.T.*