diagnosing particularly tricky cases.

To produce a simpler test, Gibbs and Harrington needed to identify these proteins in small amounts of spinal fluid. Working with Gibbs, Gary Hsich, now a pediatric resident at the University of Pennsylvania in Philadelphia, developed a way to separate the proteins from spinal fluid. Then he added an antibody that latches onto the telltale proteins. The resulting protein-antibody complex appears as a dark horizontal stripe on a piece of nitrocellulose paper.

Gibbs says the method is simple and reliable. "It can be used by any diagnostic lab in the world." Almost as important, the test is relatively quick. "Now we can do 40 samples per gel in 24 hours," he asserts.

Gibbs, Harrington, Hsich, and their colleagues then used the test to demonstrate that proteins 130 and 131 are members of the 14-3-3 family found inside brain cells. The test also indicated that 14-3-3 proteins are not prion-related.

The researchers tried the test on spinal fluid from 71 people with TSEs. It accurately detected 14-3-3 proteins in 96 percent of the specimens. In 66 samples from people with viral encephalitis, stroke, brain hemorrhages, and other non-TSE neurological disorders, the test showed 14-3-3 in only a few cases. This indicates that the test is specific for TSE, the group reports.

To satisfy himself that the test is accurate, Zeidler sent Gibbs and his colleagues 16 additional specimens from patients with known or suspected CJD and 12 from people with the human version of mad cow disease—including samples from two cases that have not yet been made public. He also sent off specimens from patients with other neurological diseases. Zeidler declines to reveal the results of this comparison because he and his colleagues are preparing to submit them in a letter to LANCET.

Gibbs and his colleagues also tried the test on spinal fluid from cattle, sheep, and chimpanzees. Some of the animals had been infected with prions, some had not. The test detected 14-3-3 in 87 percent of the infected animals. In animals that were not infected, only 3 percent of the tests gave a positive result.

Pharmaceutical companies have no reservations about the value of such a test. Gibbs says they have begun queuing up to license the new technology, which was patented by NIH and Cal Tech. The researchers are preparing to simplify the test even further so that it can be administered as routinely as an HIV test.

Even before the new test becomes available, regulators in the United States have announced that they will take steps to ensure the safety of livestock feed—and ultimately of the people who dine on beef.

The Food and Drug Administration is likely to ban the use in cattle feed of all protein derived from certain animals or just that from their eyes, brains, spinal cords, and lower intestines. The banned group could include sheep, beef, other ruminants, and perhaps swine, says Bert Mitchell, director of surveillance and compliance in the FDA's Center for Veterinary Medicine.

Since the emergence of mad cow disease in the United Kingdom, the U.S. beef industry has relied on a Department of Agriculture surveillance program that each year culls cattle showing symptoms of neurological disease, slaughters them, and examines their brain tissue.

Although about 5,000 head are tested each year, none has been found to have mad cow disease—proving that the ailment has not yet emerged in the United States, says Gary Weber, executive director of regulatory affairs for the National Cattlemen's Beef Association in Washington, D.C.

Cattle farmers would welcome a simple, accurate test, says Weber. "That's where this new test from NIH could help us."

Not surprisingly, Gibbs is delighted with the outcome of years of painstaking effort. "It's a very great satisfaction," he says, "knowing that you have been able to do something that's going to help in human medicine—and veterinary medicine as well." □

Mathematics

Crop circles: Theorems in wheat fields

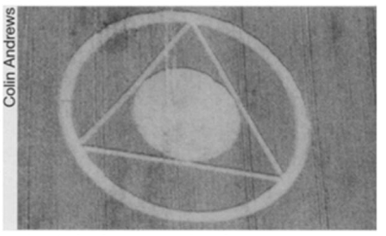
Since the late 1970s, farmers in southern England looking out on their wheat fields in the morning have sometimes been startled to find large circles and other geometric patterns neatly flattened into the crops. How these crop circles were created in the dead of night at the height of the summer growing season remains a puzzle, though hoaxers have claimed responsibility for some of them.

Several years ago, astronomer Gerald S. Hawkins, now retired from Boston University, noticed that some of the most visually striking of these crop-circle patterns embodied geometric theorems that express specific numerical relationships among the areas of various circles, triangles, and other shapes making up the patterns (SN: 2/1/92, p. 76). In one case, for example, an equilateral triangle fitted snugly between an outer and an inner circle (see photo). It turns out that the area of the outer circle is precisely four times that of the inner circle.

Three other patterns also displayed exact numerical relationships, all of them involving diatonic ratios, the simple whole-number ratios that determine a scale of musical notes. "These designs demonstrate the remarkable mathematical ability of their creators," Hawkins comments.

Hawkins found that he could use the principles of Euclidean geometry to prove four theorems derived from the relationships among the areas depicted in these patterns. He also discovered a fifth, more general theorem, from which he could derive the other four (see diagram). "This theorem involves concentric circles which touch the sides of a triangle, and as the [triangle] changes shape, it generates the special crop-circle geometries," he says.

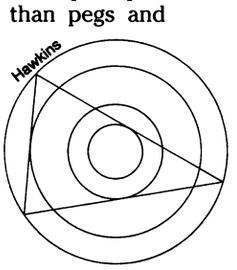
Curiously, Hawkins could find no reference to such a theorem in the works of Euclid or in any other book that he consulted. When he challenged readers of SCIENCE NEWS and THE MATHEMATICS TEACHER to come up with his unpublished theorem, given only the four variations, no one reported success.



Aerial photograph of a geometric crop-circle pattern in an English wheat field.

This past summer, however, "the crop-circle makers... showed knowledge of this fifth theorem," Hawkins reports. Among the dozens of circles surreptitiously laid down in the wheat fields of England, at least one pattern fit Hawkins' theorem.

The persons responsible for this old-fashioned type of mathematical ingenuity remain at large and unknown. Their handiwork flaunts an uncommon facility with Euclidean geometry and signals an astonishing ability to enter fields undetected, to bend living plants without cracking stalks, and to trace out complex, precise patterns, presumably using little more than pegs and ropes, all under cover of darkness.



Hawkins' fifth crop-circle theorem involves a triangle and various concentric circles touching the triangle's sides and corners. Different triangles give different sets of circles. An equilateral triangle produces one of the observed crop-circle patterns; three isosceles triangles generate the other crop-circle geometries.