also used the trees a great deal."

Meanwhile, *K. wickeri* shows tantalizing similarities with modern apes. "We're looking at *Equatorius* on one side of the divide and *wickeri* on the other," says Ward. His team sees links in *K. wickeri* to Eurasian fossils, in particular, a still-unnamed 14-million-year-old ape found at a site called Paşalar in Turkey. That link may mean that *K. wickeri* was "a participant in the [early] radiation out of Africa," says Ward.

This new view of *Kenyapithecus* has "very important implications for the whole picture of [ape] evolution," says Carol Ward (no relation to Steve) of the University of Missouri, Columbia. Comparing two genera allows researchers to study the arrow of evolution from primitive to derived traits, she says.

But not everyone agrees with all of Steve Ward and colleagues' interpretations. Begun, for example, thinks that *Equatorius*, rather than *Kenyapithecus*, may resemble the ancestral ape that migrated out of Africa. He is now preparing a report on a 16-million-year-old German fossil of an ape called *Griphopithecus*, which looks much like *Equatorius*. That would suggest that the first ape to migrate out of Africa was a much more primitive, earlier branch. "It's really *Equatorius* that shows the earliest connection [to Europe]," argues Begun.

Meanwhile, the crucial question of which ape made it through the Miocene to give rise to the living great apes and humans remains a mystery. Indeed, by erasing *K. africanus*, Ward and his colleagues have reduced one contender, *Kenyapithecus*, to little more than the handful of teeth that Leakey found at Fort Ternan. "It's tempting and tantalizing to think of *Kenyapithecus* as an early member within the great ape clade, but we really can't say that at this point. The material at Fort Ternan is just too limited," says Kelley. For that, paleontologists will have to wait for Kimeu or some other sharp-eyed fossil hunter to find more complete fossils, skeletons whose parts may eventually let them make sense of the whole. **–CARL ZIMMER**

Carl Zimmer is the author of *At the Water's Edge*.

RESEARCH RISKS

California Probes Prison Teens Study

BERKELEY, CALIFORNIA—A study in California of an antiviolence drug given to incarcerated teenagers, which was recently hailed as a model for work with such a rarely studied population, is now under attack for possibly violating laws to protect inmates involved in medical research. The investigation centers on whether the research met legal requirements that all inmates in a study have a reasonable chance of benefiting from their participation.

In 1996 Stanford University psychiatrist Hans Steiner set out to measure whether divalproex sodium (Depakote), an antiepilepsy drug that is already widely used to treat violence in teenagers, is actually effective for that use. Steiner conducted the study at the O. H. Close Youth Correctional Facility in Stockton, where he has worked with youths for 15 years. Seventy teenaged boys whose aggressive violence fit a psychiatric condition called conduct disorder were divided into two groups and given different doses of the drug for 7 weeks. Steiner says boys in both groups showed a "reduction of distress" during the trial, and the high-dose group had a moderately increased ability to control violent urges. The study was funded by Abbott Laboratories and the California Youth Authority (CYA), which runs the facility.

Studies like Steiner's, in which drugs are tested on teenaged inmates, are "very, very rare," says Markus Kruesi, a child and adolescent psychiatrist at the Institute for Juvenile Research of the University of Illinois, Chicago. Kruesi hailed Steiner as a pioneer last fall when he introduced Steiner's work at the annual meeting of the American Academy of Child and Adolescent Psychiatrists (AACAP) in Anaheim, California. Steiner says he hoped his presentation would encourage more colleagues to follow in his footsteps. "Child psychiatrists are remarkably absent in these institutions," he says. "I think it's a mistake."

The still unpublished work caught the eye of new CYA director Greg Zermeño in March after Steiner applied to do a follow-up study on its long-term effects. Zermeño opened an investigation after declaring that there had been a breakdown in his office's review process when the project was approved. Governor Gray Davis has ordered the state inspector general to investigate, and the CYA has asked the state attorney general's office to help with its review. Kathy McClelland, Stanford's research compliance director, says the study protocol was approved by the university's institutional review board, and Stanford assumed that CYA had done its own review. Thomas Puglisi, director of human subject protection at the National Institutes of Health, says his office is following the progress of the state investigations but has no plans to do its own. Puglisi noted that Steiner appears to have gone beyond legal requirements for informed consent by obtaining parental approval and assigning advocates to the boys.

The controversy, first reported in the *Los Angeles Times* on 16 August, centers largely on the issue of whether subjects receiving the low dose could reasonably have

CREDIT: NICK COBBING

ScienceScope

Saber-Rattling In a move that one researcher calls a "crude attempt to intimidate," an environmental group is warning British scientists and biotech executives that they could be personally liable for damages caused by genetically modified (GM) crops. Friends of the Earth (FOE) chief Charles Secrett last month sent letters to officials at more than 30 companies, research centers, and universities, warning that they could be "legally liable" for allergies or other problems caused by GM crops.

But in a public response, one of FOE's targets last week said the threat is misdirected. Accusing the group of "deep ignorance," Donald O'Nions, administrative head of the John Innes Centre in Norwich, said that his institute does basic research, not plant development.

Still, FOE believes that individual researchers "should not be able to hide behind a corporate veil," says Secrett. Whether FOE can make good on its threat, however, is in doubt. In general, European laws do not hold employees personally liable for damages caused by their companies.

Testing, Testing The debate over animal testing in India took a new turn this week when a court gave permission for a biotech company to resume testing of its immune-system drug on a new batch of monkeys. The ruling comes 2 weeks after an earlier test was disrupted by the government-sanctioned release of 50 monkeys from a national facility that failed to meet new animal welfare rules (*Science*, 13 August, p. 997).

Shantha Biotechnics in Hyderabad claims it lost $25 million due to the 9 August raid, which freed monkeys from the National Center for Laboratory Animal Sciences (NCLAS). The High Court of Andhra Pradesh in Hyderabad has now ruled that the tests can resume with new animals—and "no interference" from animal welfare organizations.

Varaprasad Reddy, Shantha's managing director, says he is "relieved and happy" with the order. But he says it fails to address a government split which pits the Animal Welfare Board against the Indian Council of Medical Research. And the Blue Cross Society, which was instrumental in the raid, says it is not opposed to testing if NCLAS improves living conditions for the monkeys.

Contributors: Erik Stokstad, Pallava Bagla

expected to benefit, as the law requires. The newspaper reported that Steiner, in his presentation at the AACAP meeting and in a recent interview with the *Times*, said he chose a dose so low as to have no effect. If that is true, it might be considered a placebo, which would generally be seen as not providing subjects with a reasonable chance to benefit.

Steiner vigorously denies designing a sneak-placebo, although he says a placebo would have made the analysis more powerful. But even the low-dose arm could well have had a therapeutic effect, he says, citing the experience with other psychoactive drugs, including Haldol and commonly used antidepressants, which were found to be effective at levels much lower than what had once been given. Psychiatric experts will weigh those arguments during the state's review.

The use of a low-dose arm as a placebo "would certainly fail to meet the intent of the regulations," says bioethicist Jeffrey Kahn, director of the University of Minnesota Center for Bioethics. But Kahn says that juvenile inmates can also lose out if the laws protecting them are so strict as to prohibit potentially beneficial research from being done. One could argue, he says, that juvenile and adult prisoners are no more compromised in their ability to make informed choices than seriously ill hospital patients who routinely serve as study subjects, and that inmates are selectively being denied "the benefits of research participation ... because of the current law."

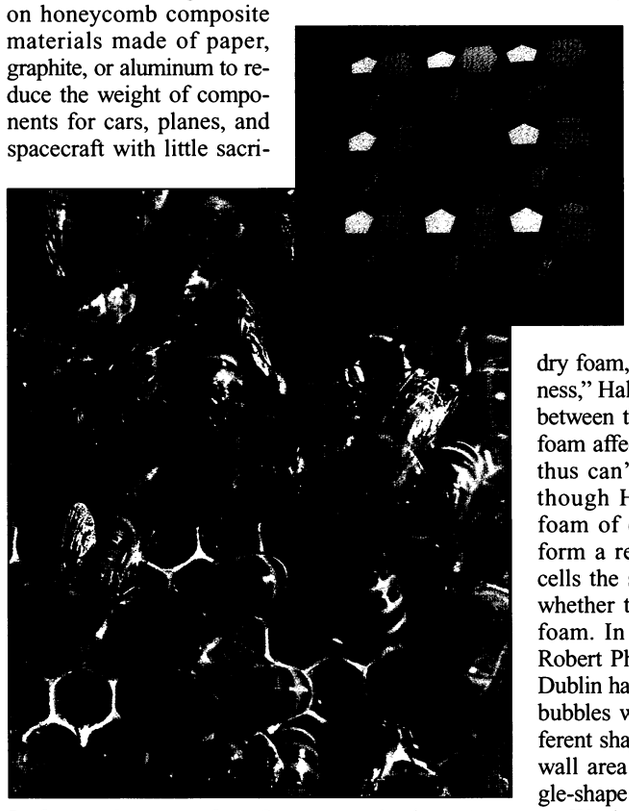
Larry Stone, executive medical director of Laurel Ridge Hospital in San Antonio, Texas, and a past president of the AACAP, supports that view. "Certainly prisons are the places where ... we should be experimenting with a number of things for rehabilitation," including medications, he says. "My concern is that good, solid researchers who are trying to do that do not get persecuted and tried in the media because of some quirk in the system."

–MARCIA BARINAGA

MATHEMATICS

Proving the Perfection Of the Honeycomb

Why do bees build their honeycombs out of hexagonal cells? As early as the first century B.C., Marius Terentius Varro—Rome's answer to Isaac Asimov, the most prolific science writer of his day—speculated that it had to do with the economy, rather than the symmetry, of the design. From Varro to the present, scientists have assumed that a hexagonal lattice allows bees to store the most honey in a single layer of equal-sized cells, while using the least beeswax to separate them. Until this summer, however, no one could prove that a honeycomb was the sweetest solution. Now, a mathematician has removed all doubt: Bees do it best. The result also confirms the intuition of human engineers, who have relied on honeycomb composite materials made of paper, graphite, or aluminum to reduce the weight of components for cars, planes, and spacecraft with little sacrifice in strength.



Perfect and near-perfect. Bees use optimal construction for a two-dimensional foam; Weaire and Phelan's foam (*inset*) remains unbeaten in three dimensions but is not known to be optimal.

Last month, at the Turán Workshop in Mathematics, Convex and Discrete Geometry in Budapest, Thomas Hales of the University of Michigan, Ann Arbor, presented his proof that a hexagonal honeycomb has walls with the shortest total length, per unit area, of any design that divides a plane into equal-sized cells. (The proof has also been available on the Web since June.) Hales says that he began working on the honeycomb conjecture just last year, after solving a similar conjecture on the packing of spheres (*Science*, 28 August 1998, p. 1267). That problem, called the Kepler conjecture, stated that the densest packing of spheres is a face-centered cubic lattice, the pattern a grocer makes when he stacks apples. The proof had taken years. "After the Kepler conjecture, I expected every problem to be very difficult," Hales says. "In this case, I feel as if I won the lottery."

Both questions, Hales explains, can be viewed as versions of the same physical problem: how bubbles of equal volume are distributed in foams. "In a really wet foam, the faces of each cell are not surfaces but have thickness," Hales says. Because a sphere uses the smallest possible surface area to hold a given volume, the bubbles acquire a spherical shape, with the foam material filling up the interstices. Minimizing the amount of extra foam translates to maximizing the number of spherical bubbles per unit volume—the problem Hales solved last year.

A honeycomb is more like a dry foam. "In a dry foam, the walls have zero thickness," Hales explains. With no space between them, the bubbles in a dry foam affect one another's shape and thus can't all be spheres. And although Hales showed that a wet foam of equal-sized bubbles will form a regular lattice, with all its cells the same shape, no one knew whether the same is true for a dry foam. In 1994, Denis Weaire and Robert Phelan of Trinity College in Dublin had found an arrangement of bubbles with equal volume but different shapes, which used 0.3% less wall area than the best known single-shape arrangement.

Weaire and Phelan's discovery led to renewed scrutiny of the honeycomb—in effect, a two-dimensional foam, because bees build just a single layer of cells. Mathematicians realized they still didn't have an adequate explanation for why the cells in a honeycomb had the same shape. Could an optimal honeycomb, like Weaire and Phelan's foam, have cells of different shapes, with some being pentagons or heptagons, say, or having curved sides?

Any individual bubble can improve its perimeter-to-area ratio by rounding its sides out to circular arcs, or by adding more sides (because a heptagon is rounder than a hexagon). But that improvement comes at a cost to its neighbors. As mathematicians have long known, the topology of the plane forces the average number of sides to be six, so any heptagon must be balanced, for example, by a less efficient pentagon somewhere else. Similarly, one bubble's outward-curving arc will curve inward to the adjacent bubble and make its perimeter-to-area ratio too large. The question was how to calculate these trade-offs to find out whether one bubble's gain outweighs its neighbor's loss, making the overall arrangement more efficient.

"Hales's bright idea was that no single

CREDITS: WILLIAM J. WEBER/VISUALS UNLIMITED