
abortion alone should serve, in effect, as a political litmus test. Cardinal Joseph Bernardin of Chicago urged that the church's "pro-life position . . . be developed in terms of a comprehensive and consistent ethic of life." This, Byrnes observes, provided "a kind of moral cover" for "pro-choice" Catholic Democrats. The partisan implications of the bishops' conflicting positions, and the fact that a pro-choice Catholic,

Geraldine Ferraro, was the Democratic candidate for vice president, gave the bishops a larger role in the 1984 campaigns than they otherwise would have played. Four years later, with different candidates and different circumstances, the bishops had a much lower profile. How big a role they play in national politics in the future, Byrnes concludes, will be determined, in considerable part, by the parties and candidates themselves.

SCIENCE, TECHNOLOGY & ENVIRONMENT

Computerized Q.E.D.'s

"The Death of Proof" by John Horgan, in *Scientific American* (Oct. 1993), 415 Madison Ave., New York, N.Y. 10017-1111.

When Princeton's Andrew J. Wiles announced last June that he had solved Fermat's last theorem, his fellow mathematicians gasped in astonishment. More than 350 years ago, Pierre de Fermat claimed that he had found a proof of the proposition that for the equation $X^n + Y^n = Z^n$, there are no integral solutions for any value of N greater than two. Fermat did not disclose his proof, however. Now, Wiles claimed to have found one. And largely on the basis of his reputation, other mathematicians accepted his claim. But his proof ran to 200 pages (and could have been five times longer, if he had spelled everything out), and only one mathematician in 1,000 was qualified to evaluate it.

Unsettled situations such as this are not uncommon these days. Mathematical proofs often run hundreds of pages and can take years to be confirmed. In one case, a demonstration that was completed in the early 1980s consisted of some 500 articles totaling nearly 15,000 pages and written by more than 100 workers; only one person is said to have grasped the proof in its entirety, and he died in 1992.

The increasing complexity of mathematics, together with the rise of the computer, is bringing about profound changes in the ancient discipline, *Scientific American* senior writer Horgan reports. "For millennia, mathematicians have measured progress in terms of what they can

demonstrate through proofs—that is, a series of logical steps leading from a set of axioms to an irrefutable conclusion. Now the doubts riddling modern human thought have finally infected mathematics. Mathematicians may at last be forced to accept what many scientists and philosophers already have admitted: Their assertions are, at best, only provisionally true, true until proved false."

The computer, Horgan says, is forcing mathematicians "to reconsider the very nature of proof." Some proofs have required enormous calculations by computers, and cannot be verified by mere humans. Two years ago, Laszlo Babai of the University of Chicago and several colleagues developed a technique for "computer proofs" that offer the probability—but not the certainty—of truth. Still other investigators have been using computer graphics to produce "video proofs," which they hope will be more persuasive than traditional, formal proofs.

But computational experiments, whether involving graphics or numerical calculations, can be deceptive, Horgan notes. All the calculations that computers make are based on the manipulation of discrete, whole numbers (namely, ones and zeros). As a result, computers can only approximate numbers such as π or the square root of two, and that can result in errors. Even most of the mathematicians taking advantage of computer graphics and other experimental techniques agree that seeing by computer should not be believing. David A. Hoffman of the University of Massachusetts at Amherst, one of those mathematicians, worries about the decreased

emphasis on traditional proofs. "Proofs are the only laboratory instrument mathematicians have," he says, "and they are in danger of being thrown out."

The "New" Tuberculosis

"A Plague Returns" by Mark Earnest and John A. Sbarbaro, in *The Sciences* (Sept.-Oct. 1993), New York Academy of Sciences, 2 E. 63rd St., New York, N.Y. 10021.

Along with the rise of acquired immunodeficiency syndrome (AIDS) and human immunodeficiency virus, there has been an unexpected resurgence of tuberculosis (TB) in recent years. The newspapers report ominously that today's TB is drug resistant. Yet all but "a minuscule fraction" of the 27,000 active TB cases today are treatable, note Earnest and Sbarbaro, of the University of Colorado Health Sciences Center. The chief problem—and danger to uninfected Americans—is that a large proportion of patients almost certainly will fail to take their prescribed medicines.

When the two front-line TB drugs (isoniazid and rifampin) are combined with one or two back-up medications, most patients can be cured within six to nine months. The problem that physicians face in treating the disease is that mutation by the TB bacillus can result in organisms resistant to one or more of the drugs. "Luckily," the authors write, "mutations of *M. tuberculosis* are rare: Only one of every 100,000 organisms descended from one bacillus is resistant to the action of isoniazid and just one in a million can withstand the effects of rifampin or streptomycin."

But the treatable victims themselves often fail to cooperate, Earnest and Sbarbaro note. "Studies in the past 40 years have consistently shown that 35 percent of all people—tuberculosis patients and otherwise—do not take the medications prescribed for them." That puts others in danger, since tuberculosis needs only an exchange of air to spread. (Each contagious person, on average, infects five other people before the disease is discovered.)

A TB patient whose doctor has correctly

prescribed three effective drugs may suspect that the three medications are causing his upset stomach. Without consulting the physician, he decides to take only one of the drugs. The patient may feel fine for a while, because the lone drug still kills vast numbers of the organism. But all the bacilli resistant to that particular drug "continue to reproduce, ultimately reaching numbers sufficient to recreate the classic symptoms of tuberculosis: progressively severe fatigue, weight loss, night sweats, and coughing." At that point, the patient reaches for one of the drugs he had stopped taking, but it is too late: By the normal process of genetic mutation, a whole new generation of organisms resistant to the new drug *and* the old one has emerged. By taking just one drug at a time, instead of all of the prescribed medications together, the patient has allowed a monster of resistance to emerge.

How can TB patients be made to take their prescribed medications? The use of newly developed combination pills will help, but they are not a cure-all, the authors say. What needs to be done, they contend, is what the Denver Health Department did as early as 1965. It assigned staff members "to bring high doses of the medications to the patients (or the patients to the medication)." That approach is not cheap, of course, but it may be essential, the authors say, if the plague of TB is to be beaten back again.

Tempest In The Tropics

"The Deforestation Debate" by Richard Monastersky, in *Science News* (July 10, 1993), 1719 N St. N.W., Washington, D.C. 20036; "Tropical Deforestation and Habitat Fragmentation in the Amazon: Satellite Data from 1978 to 1988" by David Skole and Compton Tucker, in *Science* (June 25, 1993), American Assoc. for the Advancement of Science, 1333 H St. N.W., Washington, D.C. 20005.

Deforestation became a household word during the late 1980s, when rock stars, movie actors, and other celebrities cranked up a crusade to save tropical woodlands, particularly in the Brazilian Amazon. Tropical forests are indeed important.