cake and eat it too?" he asks.

Shay and Calvin Harley, chief scientific officer of Geron, respond that it may very well be. To make sure that telomerase-containing cells aren't malignant, they are doing further tests, such as seeing how many additional mutations it takes to make the cells cancerous. And as a further safeguard, Harley says, Geron plans to put telomerase on a tight leash in replacement cells for damaged tissue: Rather than using a perpetually active telomerase, the company plans to add regulatory sequences to the gene that would enable it to be turned on and off at will by drugs.

Another obstacle besides possible malignancy may limit the use of the technique, however: Telomerase may not immortalize all cell types, Weinberg and other experts say. But Harley says preliminary results suggest that the enzyme can do the job once researchers figure out how to grow the cells properly in culture.

Clearly, much more work will be needed to find out whether telomerase-expressing cells will prove useful in the clinic. But if they do, then using them to overcome tissue damage would result in more than a Pyrrhic victory. **–DAN FERBER**

Dan Ferber is a writer in Urbana, Illinois.

ORIGINS OF LIFE

RNA Study Suggests Cool Cradle of Life

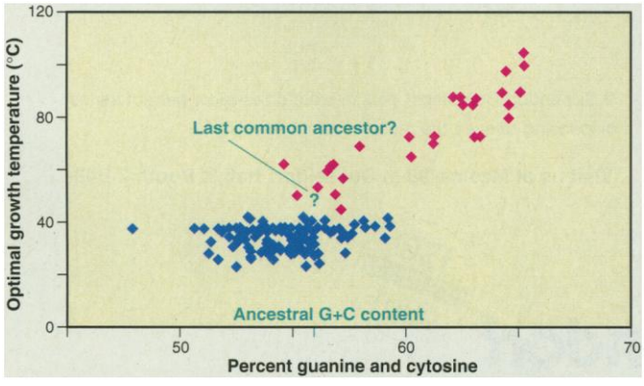
Debate on the origins of life has lately centered on a simple question: Was the cradle of life hot or cold? Many researchers argue that the first cells arose in the scalding waters of hot springs or geothermal vents, while a small but prominent band of holdouts insists on cool pools or even cold oceans. With no fossils to go by, the argument has circled a variety of indirect clues, with recent evidence favoring hotter environs. But now on page 220 comes good news for the cold camp: Evidence from the genes of living organisms suggests that the cell that gave rise to all of today's life-forms was ill-suited for extremely hot conditions.

To probe the temperature preferences of early cells, Nicolas Galtier, now of Edinburgh University in Scotland, Nicolas Tourasse of the University of Texas, Houston, and Manolo Gouy of the University C. Bernard in Lyon, France, analyzed 40 living organisms for two genes that act as a sort of thermometer for an organism's ideal growing temperature. Their work suggests that in the ancestral cell, these genes could not have withstood temperatures above about 70°C—a more moderate temperature than many have proposed. Although the evidence is indirect, other biologists say the work is a clever approach that will reinvigorate the debate about the conditions in which life began.

The notion that the last common ancestor of all life lived in very hot conditions has recently gained followers (*Science*, 2 May 1997, p. 700), in part because some of the organisms that populate the lowest, earliest branches of the tree of life live in extreme environments today—the so-called hyperthermophiles thrive between 80° and 90°C. And most geologists believe the early Earth was racked by volcanoes and asteroid impacts, which create hot environments.

Galtier decided to test this theory by tracking the evolution of two temperature-sensitive RNA molecules in the cell's protein-making factory, the ribosome. The ribosome is in part made of RNA—which is itself composed of nucleotide bases—and so depends on the bonds between the bases to work properly. But those bonds are temperature sensitive: Some withstand high temperatures better than others. For example, the bases guanine (G) and cytosine (C) form a strong bond, while adenine (A) and uracil (U) form a weaker bond. Other studies have shown that the ribosomal RNA of heat-loving organisms has more G and C than A and U, presumably because the G-C bond holds up better in the heat.

Using the two ribosomal RNA molecules, Galtier's team constructed a phylogenetic tree for 40 living organisms ranging from bacteria to mammals. They then used a computer model to find the most likely proportion of G and C in the RNA molecules of the ancestor of all 40 organisms. To their surprise, the model



Cool ancestors? Heat-loving organisms tend to have more guanine and cytosine in their RNA, but the ancestral cell apparently had only a moderate amount of these bases.

ScienceScope

Particle Projects Fused Japanese physicists hope that combining plans for two new accelerators will improve the chances of getting them built. One, the Neutron Science Project, is a linear accelerator that would break down nuclear waste by pelting it with neutrons. The other, the Japan Hadron Facility (JHF), would create the world's most powerful proton synchrotron to generate kaons and other subatomic particles for basic research.

Japan's Science and Technology Agency had championed the neutron project, while the JHF was being pushed by the education ministry. But the two bureaucracies, themselves to be merged in 2001, have joined forces to reduce the projects' combined $2 billion price tag.

Saving money will force some compromises: Neutrons will move a little slower, dragging out nuclear waste studies, and physicists must abandon plans to build the JHF in an existing tunnel at the High-Energy Accelerator Research Organization (KEK) in Tsukuba. The new plan—which promoters hope will get its first funding next year—calls for building the JHF, then the neutron accelerator, at a research center in Tokai, 150 kilometers north of Tokyo. "If this is the only way [to get funding], we have to accept it," says Sakue Yamada, a KEK director.

Short-Lived Comeback? The SOHO saga has taken a turn for the worse. On 21 December, just 3 days after earning *Science*'s Comeback of the Year award for its miraculous rescue after a June 1998 accident (*Science*, 18 December 1998, p. 2156), the Solar and Heliospheric Observatory (SOHO) apparently lost its last stabilizing gyroscope. The breakdown has put the $1 billion sun probe into sleep mode and is forcing it to burn precious fuel to remain stable. Now, engineers are racing to write software that will allow the joint European–U.S. craft to limp along without the navigational aid—all before the craft burns its remaining fuel, which could last just 6 months. Even if they succeed, SOHO will be out of action for at least a month and its reduced mobility will limit the use of several instruments, says Joe Gurman of NASA's Goddard Space Flight Center in Greenbelt, Maryland. The setback is "no fun," he says, "especially after all that's been done to save it."

Contributors: David Malakoff, David Kestenbaum, and Dennis Normile

concluded that the ancestral RNA for both molecules had only a moderate G+C content, well below that of all known hyperthermophiles and consistent with organisms that live at moderate temperatures (see figure).

To check their work, the team ran the model again with a different phylogenetic tree; the result was unchanged. To show that the model was not simply finding the average G+C content of all the organisms, they ran it again using only organisms with high G+C contents—and still found only a moderate G+C content.

Even so, it's difficult to extrapolate back billions of years, warns evolutionary biologist Norman Pace of the University of California, Berkeley, who has favored a hot origin for life. "Things get awfully murky back there," he says, calling the moderate G+C content "mud in already murky waters." And the last common ancestor of all living things must have lived some time after the very first stirrings of life.

But others welcome the result. "Statistical methods can be much more powerful than many people realize," says evolutionary biologist Ziheng Yang of University College London, who finds the analysis convincing, although he "would not take it as the last word" on the topic. Even Galtier agrees with that. But if he has his way, the evidence for a cooler ancestor will once again heat up the origins-of-life debate. **–GRETCHEN VOGEL**

PLANETARY SCIENCE

Pluto: The Planet That Never Was

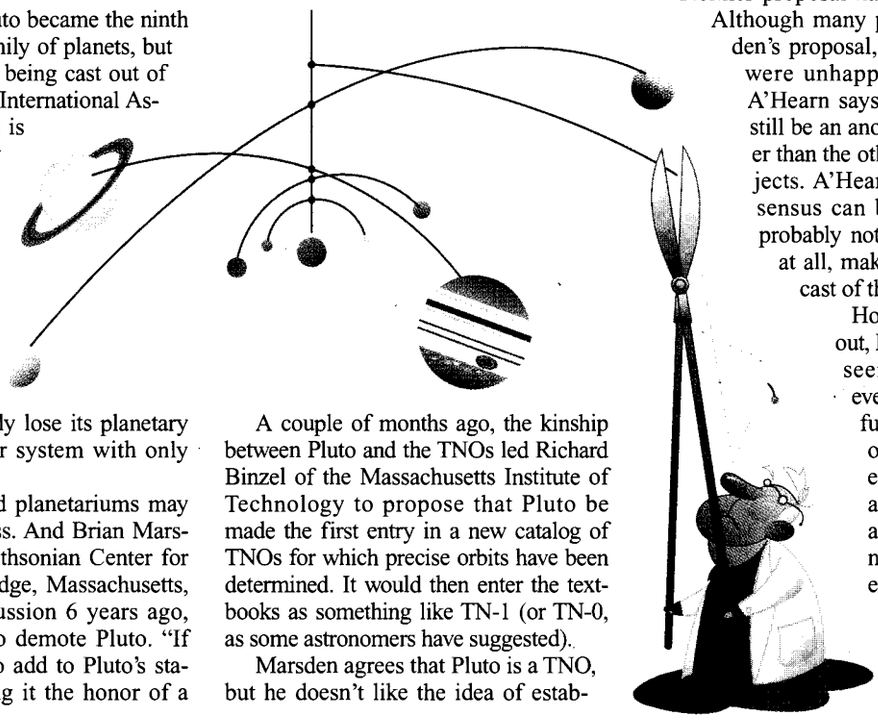
Nearly 70 years ago, Pluto became the ninth member of the sun's family of planets, but now it's on the verge of being cast out of that exclusive clan. The International Astronomical Union (IAU) is collecting votes on how to reclassify the icy body: as the first (and largest) of the so-called trans-Neptunian objects, or as the 10,000th entry in the growing list of minor bodies orbiting the sun. In either case, Pluto may officially lose its planetary status, leaving the solar system with only eight planets.

Children's books and planetariums may not acknowledge the loss. And Brian Marsden of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts, who launched the discussion 6 years ago, says no one is trying to demote Pluto. "If anything, we're going to add to Pluto's status," he says, "by giving it the honor of a very special designation."

Cold comfort for Pluto, maybe, but its reclassification will at least end a long identity crisis, which began soon after its 1930 discovery at Lowell Observatory in Flagstaff, Arizona, by Clyde Tombaugh, who died in 1997. Pluto turned out to be much smaller than all the other planets (according to recent estimates, its diameter is only 2200 kilometers), and its orbit is strangely elongated. It didn't belong with either the Earth-like rocky planets or the gas giants.

A clue to its true nature came in 1992, when David Jewitt of the University of Hawaii, Honolulu, and Jane Luu, then at the University of California, Berkeley, discovered a small, icy object beyond the orbit of Neptune. Provisionally cataloged as 1992 QB1, this ice dwarf measures a mere 200 kilometers in diameter. Since then many more trans-Neptunian objects (TNOs) have been detected, some of which move in very Pluto-like orbits around the sun. These "supercomets" populate the Kuiper Belt, named after Dutch-American astronomer Gerard Kuiper, who predicted its existence in the early 1950s. "Pluto fits the picture [of the solar system] much better if it's viewed as a TNO," says Luu, who is now at Leiden University in the Netherlands.

At present, more than 70 TNOs are known, and apparently, Pluto is just the largest member of this new family, which explains why it was found over 60 years before number two. If astronomers had known about the other TNOs back in the 1930s, Pluto would never have attained the status of a planet, Luu says: "Pluto was lucky."



CREDIT: TERRY E. SMITH

A couple of months ago, the kinship between Pluto and the TNOs led Richard Binzel of the Massachusetts Institute of Technology to propose that Pluto be made the first entry in a new catalog of TNOs for which precise orbits have been determined. It would then enter the textbooks as something like TN-1 (or TN-0, as some astronomers have suggested).

Marsden agrees that Pluto is a TNO, but he doesn't like the idea of establishing a new catalog of solar system objects, arguing that astronomers already have a perfectly serviceable list of numbered minor bodies (mostly asteroids). "The question is: Do we want to recognize [trans-Neptunian objects] with a different designation?" he asks. He points out that the Centaurs—TNOs that have been nudged well inside Neptune's orbit—have been classified as asteroids and says he sees "no reason for introducing a new designation system for objects of which we have representations in the current [catalog of minor bodies]."

Instead of making Pluto the founding member of a new catalog, Marsden wants to add it to the existing list. "The current number is 9826," he says. "With the current detection rate, we should arrive at number 10,000 somewhere in January or February." He notes that asteroids 1000, 2000, 3000, and so on have all been honored by the IAU with special names, including Leonardo and Isaac Newton. "What better way to honor Pluto than to give it this very special number?"

But the prospect of lumping Pluto with the solar system's riffraff outrages supporters of a new TNO category. "It's the most idiotic thing" she's ever heard, says Luu. Pluto is certainly not an asteroid, she says.

To try to settle the issue, Mike A'Hearn of the University of Maryland, College Park, is collecting e-mail votes from 500 or so members of IAU divisions on the solar system, comets and asteroids, and other relevant topics. "I wanted to arrive at a consensus before Christmas [1998]," he says, "but it may take a while, since the community as a whole doesn't seem to have a consensus." Neither proposal has attracted a majority: Although many people opposed Marsden's proposal, a comparable number were unhappy with Binzel's idea, A'Hearn says, because Pluto would still be an anomaly, being much larger than the other trans-Neptunian objects. A'Hearn says that if no consensus can be reached, Pluto will probably not end up in any catalog at all, making it the ultimate outcast of the solar system.

However the debate settles out, Pluto's career as a planet seems to be ending, and even astronomers are wistful at the prospect. "No one likes to lose a planet," says Luu. A'Hearn agrees. "It will probably always be called the ninth planet" by the general public, he says.

–GOVERT SCHILLING

Govert Schilling is an astronomy writer in the Netherlands.