was a full-fledged political state "from the founder on up," contends epigrapher and art historian Linda Schele of the University of Texas in Austin. Throughout the 16-king dynasty, she says, the written record shows little change in the way the rulers exercised their power. Impressive ritual and political displays orchestrated by Copán's kings began with Yax K'uk'Mo, who is represented by the same glyph for "king" used to signify later rulers, she adds.

Other researchers place the emergence of statehood at Copán considerably later than Yax K'uk'Mo's reign. Fash estimates a political state took shape about 200 years after the founding of the Copán dynasty, when Smoke Imix oversaw major construction efforts and the population expanded to at least 10,000 people. Only then could the traits of a political state develop, he says. These include ranked social classes, the concentration of wealth and political power in the hands of a few people and a bureaucracy to administer the government.

But extensive surveys of Maya settlements in the Copán Valley indicate that, if Copán achieved statehood at all, it was with the 16th ruler, Yax Pac, argues David Webster of Pennsylvania State University in University Park.

For the past decade, Webster and Penn State colleague William T. Sanders have directed research into the settlement history of Copán. They and their coworkers have mapped 1,425 archaeological sites, most consisting of rural farmers' dwellings grouped around courtyards. A few sites near the Main Group contain the more elaborate homes, temples and workshops of the "nonroyal elite" – nobles, tradesmen and artists.

People began to farm the fertile bottomland of the Copán Valley around 1000 B.C. But extensive dating of obsidian, a native stone used for knives and jewelry, excavated at sites in the valley indicates substantial Maya occupation in the region began around A.D. 400 and continued until approximately A.D. 1200, Webster says. Thus, farmers and nonroyal elites preceded and ultimately outlasted Copán's Classic-era kings and their retinues.

Webster's team estimates Copán's population peaked at about 20,000 during Yax Pac's reign. At that time, settlements linked to the Main Group were mainly confined to a 5-mile stretch of the Copán River, Webster notes. Other Classic Maya cities, such as Tikal in Guatemala, held populations about twice as large and covered much more territory.

The 800-year stretch of substantial settlement at Copán demonstrates that, contrary to the views of many investigators, royal power was weak during the Classic period, Webster argues. There were numerous political interest groups that wielded tremendous power, including second-level elites who represented the extended families working the land and who underwrote the projects of the Copán dynasty. These families persisted in the Copán area for nearly 400 years after Yax Pac's demise.

Furthermore, the population collapse at Copán occurred far more gradually than previously thought, Webster maintains. Rapid population growth and intensive farming of hillsides during the 8th and 9th centuries A.D. led to massive soil erosion and food shortages, promoting the royal collapse. Indeed, preliminary analyses of Copán skeletal remains reveal signs of malnutrition and disease – even among the royalty – around A.D. 800. Continuing erosion and overfarming of a limited area eventually led the Maya to abandon the entire region around A.D 1200. Only then, according to recent pollen studies, did the forest begin its recovery.

More surprises undoubtedly await scientists who study the workings of Copán, but Grove cautions against the temptation to overinterpret new finds. With tongue only partly in cheek, the University of Illinois researcher remarks: "A little knowledge is a dangerous thing, particularly in the hands of an archaeologist." □

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nutrition, but this is somewhat suspect because improved nutrition should produce a rapid increase in size, over one or at most two generations. But the imprinting of information on the genes of one's offspring – saying, in effect, "I grew well, so you try to grow taller" – might provide a better explanation of this gradual increase in size.

David C. Hobby
New Paltz, N.Y.

Too soon to say

"New Therapies Brighten Stroke Horizon" (SN: 11/4/89, p.292) includes a discussion of our views on new forms of stroke therapy. Although the substance of the report is an accurate reflection of my opinions, one statement is incorrect. I supposedly said that some patients can expect "significant protection" against stroke-induced neuronal injury "within two years max." Although I am quite hopeful that new forms of therapy will be available within the next few years, I am unable to confidently predict a precise schedule. Clinical studies are currently in progress which appear to be quite promising, but unless we are very lucky, it is unlikely that these investigations will be completed in the next two years.

Justin A. Zivin
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We appreciate the clarification but in all fairness must add that the notes our reporter took during Dr. Zivin's scientific presentation at the Society for Neuroscience meeting show the phrases "significant protection" and "two years max" enclosed by quotation marks.

– P. Young, Editor

Quake comparison miscalculated

In "Earthquake leaves Bay area still vulnerable" (SN: 10/21/89, p.261), you state: "Because the magnitude scale is logarithmic, a magnitude 8 quake is 10 times stronger than a magnitude 7."

It is true that the Richter magnitude scale is logarithmic, but to compare the difference in strengths of, for example, two earthquakes of magnitudes 7 and 8, one should estimate the seismic energy E released by calculating:

$$\log E = 11.8 + 1.5\, M_s$$

where M_s is the surface wave magnitude. Thus a magnitude 8 earthquake is not 10 times stronger than a magnitude 7, but rather about 30 times stronger.

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Moon models

The grooves and crater chains of Mars' satellite Phobos are an interesting mystery, and the experiments of Kevin Horstman and Jay Melosh help show how such features could arise by regolith powders draining into underground fractures ("Phobos: Moonlet of the Pits," SN: 11/4/89, p.301). However, their model does not go far enough.

As I pointed out in a 1980 ICARUS paper, some craters in the chains have raised rims, showing that they did not form simply by drainage, but rather by ejecting at least some material, possibly by degassing of sublimed ice or other volatiles through the fractures. The new Phobos-2 measurement of a very low density for Phobos supports the hypothesis that Phobos' interior contains, or originally contained, volatiles and that the grooves and crater chains may have involved not only fractures but also venting.

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The grooves on Phobos may indeed be the result of a collision with Martian impact ejecta ("Martian impacts and Phobos' grooves," SN: 11/18/89, p.334). But I recall the very thin F-ring shadow on one of Saturn's coorbital moons. It would seem that Phobos, as part of a "perturbed asteroid" scenario, could also have plowed into a slightly clumpy, perhaps Jovian, F-ring analog at some point in its journey to Mars-orbit.

Anyway, it's fun to wonder, and I think the state of planetary science is such that even amateurs like me can feel part of the "knowledge accretion" process.

Jon Alexandr
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CORRECTION

In "Natural Selection for Computers" (SN: 11/25/89), the diagram on page 347 was copyrighted by the American Society of Civil Engineers and should have been credited to that organization. In "Reopening Old Wounds" (SN: 1/20/90), the credits for the two photographs on page 42 were mistakenly reversed.