Viruses. It would include some seven of the regular members of the study group, plus a half-dozen additional participants. Gallo, Montagnier, and Levy are among the proposed members. Varmus plans to solicit naming suggestions and then poll the membership for their preferences. A fourth name, unassociated with any particular group, may be the result.

There are apparently no hard and fast rules for determining viral relatedness. A variety of characteristics, including the size and shape of the viral particles, whether they have RNA or DNA as their genetic material, host range, and biological action, have been used. The ability to determine complete gene sequences, a skill which has been acquired relatively recently, adds a new consideration. According to Varmus, the same genetic principles that have been applied to defining species generally may be applicable to viruses. "Members of a virus 'species' would share genetic characteristics and allow genetic intermingling between members of the same 'species' while resisting the influx of information from other 'species,' " he explains.

Varmus expects that it will be sometime in June before the committee can come to a decision about the name of the AIDS virus. Whether it will be accepted remains to be seen. "These deliberations can be irrelevant to the way people behave," he points out. "Nothing we do is binding. If someone wants to ignore it, he can."—**Jean L. Marx**

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Periodic Extinctions and Impacts Challenged

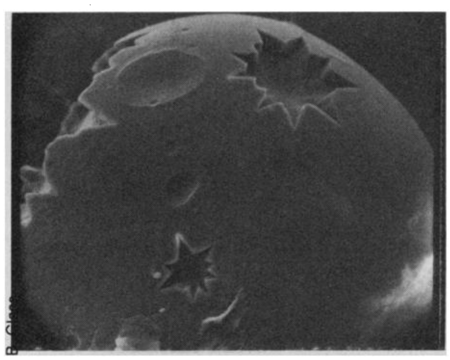
Critics are attacking the evidence that comet showers have caused periodic extinctions; proposed triggers for the showers seem unlikely as well

No one has delivered a knockout punch to the idea put forward more than a year ago that every 28 million years or so a swarm of comets batters Earth and drives as much as 70 percent of animals and plants to extinction (*1, 2*). But if it has not been knocked out, the hypothesis is certainly falling back under increasing criticism. Many geologists, paleontologists, astronomers, and statisticians who have now had a chance to study the details of the proposals find the geological evidence merely suggestive or even nonexistent and the supposed underlying mechanisms improbable at best (*3*).

Astronomers have just struck a serious blow to one periodic extinction hypothesis by demonstrating that the sun's yo-yo motion through the disk of our galaxy cannot cause the periodicities claimed for extinctions and Earth impacts. In the original proposals, each time Earth bobbed up or down through the central plane of the galactic disk during its 66-million-year oscillation, it would have a greatly increased chance of encountering one of the huge clouds of gas bunched near the plane. Having the mass of hundreds of thousands of suns, the gravitational pull of such a molecular cloud could perturb the comets encircling the solar system and send a billion of them into the inner solar system, a dozen or two of which would hit Earth over a million years or so. The largest impact or the combined effect of the comet shower would then cause the extinctions.

Patrick Thaddeus and Gary Chanan of Columbia University have shown (*4*) to everyone's satisfaction that, contrary to the galactic hypothesis, molecular clouds are simply not bunched tightly enough around the plane of the galactic disk to make much of a difference. The chance of Earth encountering a cloud near the plane is not much greater than at the extremity of Earth's oscillations where the clouds have begun to thin out.

Compiling their own observations and those of others, the Columbia group



A remnant of a large impact

A huge impact splattered this glassy microtektite across the globe about 37 million years ago (diameter about 250 micrometers).

finds that molecular clouds become half as numerous 85 ± 20 parsecs above or below the plane than they are at the plane (1 parsec = 3.26 light-years). The most distant excursion of Earth from the plane is 72 parsecs. Thaddeus and Chanan then calculated how much that amount of bunching would increase the frequency of encounters near the plane. Not much, they found, and certainly not enough to make the near-plane encounters distinctly more numerous than those away from the plane. As Frank Bash of the University of Texas notes, "There is no real significance to passing through the galactic plane." Thaddeus and Chanan calculate that a record of at least 300 extinction cycles, not the nine that are available, would be required to distinguish the few encounters attributable to plane crossings from the many that can happen at any time.

As often seems to be the case with periodic extinction hypotheses, there is a way around this difficulty, but it is one that leaves the galactic hypothesis an unlikely explanation of the reported periodicities. Richard Stothers and Michael Rampino of the Goddard Institute for Space Studies in New York, who advanced one of the original galactic models, point out that if the sun's motion perpendicular to the plane were like that of other stars its age—carrying it several hundred rather than 72 parsecs from the plane—the plane-crossing mechanism could work. Molecular cloud specialists agree, but they see little chance that a far-ranging, high-speed sun was suddenly slowed within the past 30 million years by an extremely rare encounter with a molecular cloud. Thaddeus estimates the probability at 1 percent or less. Others find it equally unlikely.

Another mechanism for driving periodic extinctions by creating comet showers, a newcomer invoking an unseen tenth planet to disturb the comet cloud, has been taking its lumps as well. Even as their model first appeared in print (*5*), Daniel Whitmire and John Matese of the

University of Southwestern Louisiana were making changes in it to accommodate criticisms. The problem now, according to other researchers, is that although Planet X could scatter comets toward Earth it could not produce a sharp burst of them that would be recognizable as a shower at Earth.

Production of a comet shower would depend on Planet X clearing a gap where it orbits in the comet cloud and occasionally encroaching on the gap edge. The encroachment is slow, being due to the continual reorientation of the planet's inclined elliptical orbit, so the gap edge must be very sharp in order to make the encounter of the two produce a sharp burst of comets. But Scott Tremaine of the Massachusetts Institute of Technology points out that the gap-clearing mechanism would require that Planet X be massive enough to clear the gap of comets while being small enough to avoid jostling the comets lying just beyond the edges back into the gap. No single mass can meet both requirements, he says. "As far as I can see," he concludes, "Planet X won't work."

One means of disturbing the comet cloud—a close approach of an unseen companion of the sun—seems to have weathered recent criticism reasonably well without significant adjustments, although it too may not be very probable. A major question has been whether the sun could hold onto a companion—a small, cool star or a star so small that its nuclear fires never ignited. It would now be orbiting barely within the sun's gravitational grasp at an average distance 90,000 times that of Earth. From the beginning, Marc Davis and Richard Muller of the University of California at Berkeley and Piet Hut of the Institute for Advanced Study in Princeton assumed that their proposed companion formed in a smaller, much more stable orbit closer to the sun and slowly drifted outward to its present orbit under the gravitational pull of passing stars.

Hut (*6*) as well as others have now closely checked the stability of a companion's orbit under the influence of passing stars and the gravity of the galaxy. A companion in the proposed present orbit would most probably be stripped away from the sun in a billion years or less, but there seems to be no insurmountable problem with sheltering the companion closer to the sun earlier on. There are many known binary stars separated from each other by one-quarter the distance of the proposed sun-companion system, notes Tremaine, and these must inevitably drift farther apart until they eventually part forever at greater distances. "It's not a special binary system," says Tremaine. "It is a very reasonable sort of system." The only problem is that the probability of a companion now being in such an ephemeral orbit is only about 10 percent, Tremaine says. That is not a fatal flaw, he notes, but it is not an encouraging circumstance either.

Eugene Shoemaker of the U.S. Geological Survey in Flagstaff has perhaps even stronger reservations after including in his calculations what he considers a conservative estimate of the effect of molecular clouds on the stability of the companion's orbit. That and the use of a slightly larger present orbit that he prefers leads to a 1 percent probability that the companion, no matter where it formed, could survive 4.5 billion years since the solar system's formation, and "that's a generous estimate," he says.

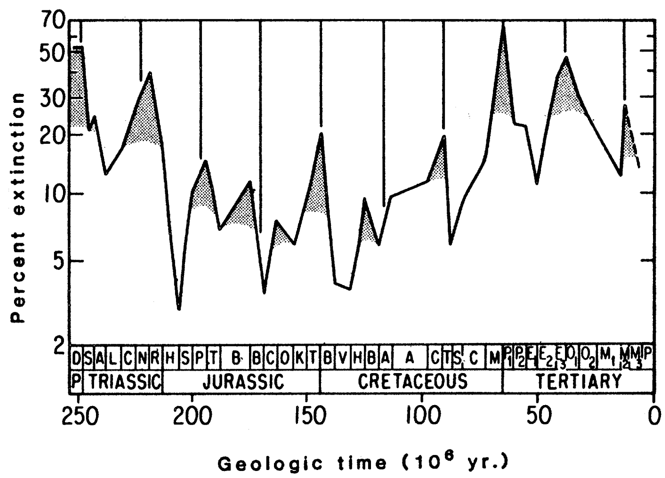
While most hypotheses for the creation of periodic comet showers fall back under a barrage of new criticisms, the observations and their interpretations that originally prompted these speculations are coming under increasing attack. The analyses suggesting that extinctions have recurred about every 26 million years during the past 250 million years have passed some tests, however. It does not seem to matter what particular measure of the rate of extinction is used; the same apparent periodicity shows up. And David Raup and John Sepkoski of the University of Chicago, who first pointed out the possible periodicity, have rerun their analyses on a complete set of data, including the extinction data that they had excluded in an attempt to produce a more representative data set. The periodicity remains. But criticisms of the analyses and the data themselves are becoming stronger.

Some statisticians see the analyses made so far as only a beginning. Searching for periodicities is "an area known for a long time to be fraught with pitfalls," notes Stephen Stigler of the University of Chicago. "The statistical evidence [gathered so far] does not support the existence of a period." The statistical tests made to date are valid ones, he says, but they fall far short of what is required.

Recent considerations of the original statistical analyses have tended to weaken the significance of the claimed periodicities. Tremaine believes that "the extinction data simply don't have any reliable evidence for periodicity." Carrying out their own Monte Carlo tests to determine how often an apparent periodicity might appear due to random events, Tremaine and Julie Heisler found a confidence level of less than 90 percent compared to Raup and Sepkoski's original confidence level of 99.74 percent. Raup and Sepkoski have recently reduced their number of reliably identified mass extinctions of the past 250 million years from 12 to 8, which reduces the confidence level to only 50 percent, according to Tremaine and Heisler's calculation. Shoemaker can find no evidence of extinction periodicity either. He pares the number of mass extinctions from 12 to 4 because he believes that the rest are either not certain to exist or are not dated precisely enough.

Analyses of the record of impact craters on Earth are faring a bit better, but here too initial conclusions have been weakened. Walter Alvarez of the University of California at Berkeley and Muller originally identified a periodicity of 28.4 million years in the ages of 11 impact craters selected according to certain age and size criteria. All but one of the 11 craters seemed to be associated with periodic pulses of cratering.

Shoemaker, starting from scratch, has compiled his own list, which consists of 20 craters including three young ones that Alvarez and Muller specifically ex-



A record of extinctions

The proposed 26-million-year cycle of extinction (vertical lines) is superimposed on the record of extinctions as analyzed in 1983 by Raup and Sepkoski. The relative heights of the younger peaks are exaggerated by this analysis. [Reproduced from Proc. Natl. Acad. Sci. U.S.A. **81,** *801 (1984)]* cluded but now accept as appropriate. Shoemaker finds that if the impacts are assumed to be periodic, the best period is about 32 million years and the last event would have been 2 to 4 million years ago. But at most half of the impacts would be associated with showers, and the significance of any true periodicity seems to be reduced in comparison to that of the list of 11. This "suggests a periodicity," says Shoemaker, "but it also suggests very strongly that there is a background component" of random impacts.

Everyone agrees on one thing—statistical analyses will never decide the question. Muller and his colleagues have just begun a search of the skies for a solar companion, but geochemists have been searching for several years for new layers of iridium-rich sediments that might mark other major impacts besides the one now generally accepted to have occurred 65 million years ago. The search has not been all that productive, so far.

The geological search's single clear achievement has been the confirmation of two impact-related layers only a few tens of thousands of years apart that are about 37 million years old. One layer contains millimeter-size globules of glass called microtektites. These carry no excess iridium, but other evidence indicates that such particles are scattered across the globe by large impacts. The second layer, first noted by Billy Glass of the University of Delaware in 1974, contains tiny, partially crystalline spherules that do contain enough iridium to link them to an impact of an extraterrestrial object, as discovered independently in 1981 by Frank Asaro of the Lawrence Berkeley Laboratory and his colleagues and by R. Ganapathy of the J. T. Baker Chemical Company.

Reports of other microtektite layers 30 to 40 million years old (*7*), some of which may have associated iridium anomalies, are being hotly debated. However, marine paleontologists, including Bruce Corliss of Woods Hole Oceanographic Institution and his colleagues (*8*), agree that even if a comet shower struck then, the major extinctions of that time were not catastrophic, as predicted by the periodic extinction hypothesis, but gradual and apparently linked to progressive climate change. Geochemical searches around the times of other major extinctions besides the one 65 million years ago have thus far failed to produce any clear-cut evidence of large impacts. Reported iridium anomalies have not yet been confirmed by a laboratory having a good track record, have been contradicted by independent analyses, or are associated with fossil bacteria that could have concentrated the iridium from their surroundings.

Frank Kyte of the University of California at Los Angeles has searched a single core of central North Pacific red clay from 1.5 to 4 and 32 to 66 million years ago and found only the iridium layer of 65 million years ago, although much smaller anomalies could have gone undetected. More significantly, Kyte finds no evidence of the surge in iridium deposition expected when a comet shower floods the inner solar system with dust, some of which must settle to the sea floor. So far then, there is little if any undisputed evidence linking periodic impacts and extinctions.—**RICHARD A. KERR**

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Fifteen Years of African Drought

The well-publicized 1972 sub-Saharan drought never went away, but, despite its magnitude and persistence, it is neither a human creation nor unique

When it began, back in the 1960's, the impending drought appeared to be simply a return to more normal weather after the wet decade of the 1950's. From the perspective of 1985, however, the sub-Saharan drought of the past 15 years is seen to have been the worst in 150 years, and the past 2 years were the driest of the century. The exceptional persistence, severity, and broad expanse of the drought suggest that man's role in the disaster has been limited to aggravating human suffering; nature, not man, created the drought. It may be years before this one ends, and it will happen again.

The catastrophe of the sub-Saharan drought began innocently enough toward the end of the 1950's when nearly a decade of unusually wet weather ended and precipitation amounts more typical of the first half of the century returned. But the drop in rainfall did not stop there. A 5-year pulse of dryness peaking in 1972 brought misery and international attention. By 1975, some climatologists thought the drought might be over, but the weather in the sub-Sahara does not always work that way. Once it dries out, it has a tendency to stay dry.

Another, sharper pulse of drought peaked in 1977, equaling the intensity of the 1972 pulse, according to rainfall records for sub-Saharan West Africa compiled by Peter Lamb of the Illinois State Water Survey. In 1979, after once again approaching but failing to reach normal, annual precipitation began falling year

R. Lewin

Drought takes its toll in Africa.