earth to 1.6×10^{-9}, the earth's cross-sectional area divided by the solar-system area inside 1 astronomical unit. The expected number of impacts per passage of Muller's swarmlet of 4×10^7 comets is

$$4 \times 10^7 \times 1.6 \times 10^{-9} \times 4 \times 2 = 0.5$$

This is a factor of 5 lower than the estimate given by Muller because he incorrectly added a 16/3 multiplier to allow for additional returns, a factor already included (the factor of 4) in the Davis *et al.* estimate (*6*). Muller states that the smallest comets in his swarm produce craters with a diameter of 10 km. At a mean cometary impact velocity of 52 km per second, craters of this size correspond to comets with radii of only 0.15 km and, at a density of 2 grams per cubic centimeter, to masses of 2×10^{13} grams. Even if one increased the size of the swarm by a factor of 5 in order to yield 2.5 impacts per passage, during most swarm passages the mass of the largest impacting comet will be $<10^{14}$ grams, four orders of magnitude smaller than that needed to produce a mass extinction event.

What would be the geological record of the passage of this swarmlet through the inner solar system? Not resolvable is the answer. Muller's swarmlet yields three craters with diameters $\geq$10 km every 30 million years. According to Wetherill and Shoemaker (*7*), impacts capable of creating craters with diameters of $\geq$10 km occur each 10^5 years, that is, 300 are produced in 30 million years, a flux 100 times larger.

How large must a comet swarm be to cause a mass extinction? Certainly the number of large impacts would need to be comparable to the random background or the signal cannot be resolved from the noise. The earth-crossing asteroids appear capable of accounting for all known terrestrial craters (*7*). Weissman (*5*) estimated that modern long-period comets account for about 5% of the crater record. We suggest that, given the noisy and incomplete nature of the cratering and mass extinction records, the number of impacts due to swarm passages would need to be about half of all impacts, and thus the impact rate would be enhanced by a factor of $\gtrsim$10 (over the mean impact rate of *all* objects) during swarm passages. The conclusions of our article stand: the Ir data are inconsistent with periodic increases of comet accretion large enough to produce most observed mass-extinction events.

Hatfield objects to our statement that our results cast "serious doubt on the existence of periodicities in castastrophe-induced extinctions." Let us first agree that our data offer no evidence regarding the periodicity of mass extinctions. The question we attempted to address was whether periodic accretion of extraterrestrial objects could have imposed a periodicity on these extinctions. Although we did not raise the issue of a terrestrial mechanism to produce periodic (in the strict sense) extinctions, we do indeed doubt that there is evidence to support such a model.

We justify this assertion on the basis of three arguments: (i) Our data place severe limits on comet swarms as currently hypothesized. Large periodic swarms of comets (the only extraterrestrial agent that could plausibly impose a periodicity and also explain the K-T event) are virtually ruled out. (ii) By demonstrating that the K-T iridium profile is very different from that in the succeeding 30 million years, our data strengthen the case for a major impact event at the end of the Cretaceous. Although a direct causal relationship between the impact event and the mass extinction remains circumstantial, the close temporal relationship between the Ir anomaly, the extinction of marine plankton, and the evolution of nonmarine flora strongly support such a hypothesis. (iii) Given that an extraterrestrial agent of periodicity is lacking, but the temporally best-resolved mass extinction has a probable extraterrestrial cause, we question whether a terrestrial periodicity can be justified. How strong is the evidence for periodic extinctions if the K-T event was caused by a random extraterrestrial event and must be removed from the data set? These arguments do cast "serious doubts" on the generation of mass extinctions by periodic earth-indigenous catastrophes.

FRANK T. KYTE
JOHN T. WASSON
Institute of Geophysics and Planetary Physics, University of California, Los Angeles, CA 90024

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4. M. Davis, P. Hut, R. A. Muller, *Nature (London)* **308**, 715 (1984).
5. P. R. Weissman, *Geol. Soc. Am. Spec. Pap. 190*, 15 (1982). By choosing 0.5 km as a minimum radius we were able to use Weissman's estimate of 16 long period comets per astronomical unit per year as the modern background flux.
6. Actually Weissman (5) estimates that on the average, long-period comets make five passes through the inner solar system. This is why he estimates that although the modern flux of long-period comets is 16 per astronomical unit per year, only three are dynamically new.
7. G. W. Wetherill and E. M. Shoemaker, *Geol. Soc. Am. Spec. Pap. 190*, 1 (1982).
8. Supported by National Science Foundation grant OCE-84-10177.

Fact Versus Supposition

Arthur H. Neufeld's recent letter "Reproducing results" (3 Oct., p. 11) raises the question, "Does anybody care?" (if much of what is published goes unchallenged and may be untrue). In comparing modern science with that of "[s]everal decades ago," Neufeld also asks, "who has the time, interest, money, or need to reproduce another scientist's results?" One should also consider whether it is a prudent use of time and money to conduct research on the basis of supposition rather than fact.

Supposition should become fact by withstanding challenge, not by reiteration. It should not be sufficient to merely "reproduce another scientist's results by exactly duplicating the experiments." There is a need to design experiments that enable hypotheses to be challenged while viable theories (that is, verifiable explanations for particular phenomena) are being established. It appears to be customary under the modern peer review system to categorically reject papers for publication that do not support the accepted dogma, irrespective of whether the dogma is fact or supposition. Bucking this trend is time-consuming and reduces productivity, putting a damper on scientific progress without altering the proportions of information and misinformation in the literature.

Those of us who care and thought we were alone may gain encouragement from the fact that psychologists have had these problems under study since the early 1970's. Surprisingly their findings have only recently been brought to the attention of the general scientific community (*1*). The prospects for reeducating those already indulging in "self-deception" are probably remote, but we can have hopes for the education of future scientists.

DELTA E. UPHOFF
Division of Cancer Biology and Diagnosis, National Cancer Institute, Bethesda, MD 20892

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1. M. J. Mahoney, "Self-deception in science," paper presented at the AAAS Annual Meeting, Philadelphia, PA, 28 May 1986; D. Dickson, *Science* **232**, 1333 (1986).

Erratum: In the article about AIDS in Belle Glade, Florida, by Colin Norman (News & Comment, 24 Oct., p. 415), a footnote to a table showing the distribution of AIDS cases among risk groups stated that the total number of homosexual and bisexual men included 4322 who were also intravenous drug users. The correct figure should have been 1997.

Erratum: In the cover caption for the issue of 5 September (p. 1013), the giant larva appears at the left (not the right, as indicated) and the smaller larva appears at the right.