Terrestrial catastrophism: Nemesis or galaxy?

CLUBE and Napier[1] have claimed recently that the hypothesis of an unseen solar companion triggering periodic mass extinctions[2,3] can be eliminated. We disagree with their analysis. More importantly we point out that our theory has been completely misquoted. Their statement that "the binary system would not in general maintain the high eccentricity necessary for Oort cloud perturbations" attacks only one variant of the solar-companion theory, that given by Whitmire and Jackson[2], who conjectured that a high eccentricity was necessary to perturb the inner Oort cloud sufficiently to explain periodicity in mass extinctions. Our variant of the solar-companion theory[3] does not in fact require an unusual eccentricity, e, any greater than the typical phase-space average value $e = 0.7$.

Two further points of Clube and Napier are clearly misleading. First, in stating that "among binaries with solar-type primaries, only ~1% have periods in excess of 0.3 Myr", they do not mention that this is caused by a purely observational bias, as wider pairs cannot be recognized by eye against the background stars on the sky. Instead, systematic searches for very wide binaries can be carried out only statistically, by performing a correlation test over an entire field to obtain binary candidates[4], followed by a confirmation through, for example, radial velocity measurements[5]. Indeed, these studies[4,5] have indicated a high incidence (~15% according to ref. 4) of very wide binaries with separations of ~0.1 pc (the expected original separation between the sun and the hypothetical companion star[6], at the time of the formation of the solar system). Clube and Napier seem to have ignored this result of ref. 4, which is quoted in our paper[3]. Secondly, their statement that "only ~3% of binaries have eccentricities ≥ 0.75" is again misleading as it does not apply at all to very wide binaries, for which the observations tell us nothing about the eccentricity[4,5].

There are other points on which we disagree. For example, we find a galactic modulation of comet perturbations to be significantly out-of-phase with periodicities in extinctions as well as cratering[7]; we estimate the expected lifetime of comets and wide binaries under the influence of passages with giant molecular clouds to be two or three orders of magnitude larger than Clube and Napier claim (P.H. and S. Tremaine, in preparation); we agree with P. Thaddeus and G. A. Chanan (unpublished) that galactic modulation of passages through interstellar clouds is orders of magnitude too weak to generate detectable periodicities in comet perturbations. These differences between our respective theories will be resolved by more detailed research and we shall not address them here. What we do object to is the direct misquotation of our work, and the misleading statements which indirectly misrepresent our work. Indeed, the hypothesis of a solar companion star, generally referred to as Nemesis, remains as viable as when it was first proposed.

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1. Clube, S. V. M. & Napier, W. M. *Nature* **311,** 635–636 (1984).
2. Whitmire, D. P. & Jackson, A. A. *Nature* **308,** 713–715 (1984).
3. Davis, M., Hut, P. & Muller, R. A. *Nature* **308,** 715–717 (1984).
4. Bahcall, J. N. & Soneira, R. M. *Astrophys. J.* **246,** 122–135 (1981).
5. Latham, D. W., Tonry, J., Bahcall, J. N., Soneira, R. M. & Schechter, P. *Astrophys. J. Lett.* **281,** L41–L45.
6. Hut, P. *Nature* **311,** 638 (1984).
7. Muller, R. A. *IAU Symp.* **112,** (Reidel, Dordrecht, 1984).

CLUBE AND NAPIER REPLY—Davis, Hut and Muller are correct in stating that their version of the Nemesis hypothesis requires an orbital eccentricity $e \geq 0.7$ as opposed to $e \geq 0.85$ in the Whitmire–Jackson version, but the distinction is scarcely relevant. Stability, not eccentricity, is the real issue and our point[1] is that their contrived orbit (the major axis is assumed arbitrarily to be close to the plane) is unstable in a galactic environment dominated by molecular clouds. Furthermore, it has been emphasized[2] that, in arriving at the most probable theory for extraterrestrially-induced extinctions, it is necessary to consider all the relevant evidence; thus, it is not simply a question of abandoning the earlier "giant meteorite" scenario[3] and arbitrarily embracing star-induced comet showers[4] at ~26-Myr intervals[5] brought on by a hypothetical unseen companion[6]. One must consider also the evidence for (1) a recently disturbed (~5 Myr) Oort cloud (inconsistent with the phase of Nemesis); (2) the well-known longer-term cycles[7] in the terrestrial record (~30 and ~250 Myr being expectations of the galactic theory); and (3) the approximately constant time-averaged cratering rate over the last ~3,000 Myr (inconsistent with the declining flux implicit in the proposed evolution from an orbit with semi-major axis ~0.1 AU). Davis *et al.*[6] (see also Muller *et al.*[8]) not only neglect the existence of the molecular cloud system, but also clearly fail to address these points.

They also assert that the absence of very wide binaries is "caused by a purely observational bias". According to Retterer and King[9], the absence of binaries with periods $\gtrsim 0.3$ Myr "represents a real absence of binaries rather than merely an inability to detect them. If wide binaries were present, Bahcall and Soneira [ref. 4 of Davis *et al.*[6]] would have been able to detect them in large numbers at separations up to 0.25 pc; instead they found no binaries wider than 0.1 pc". This is consistent with many earlier binary-star surveys, with ref. 5 in Davis *et al.*[6]) and with our statement[1] that "the proposed binary characteristics are very rare or absent amongst observed systems".

Finally, Davis *et al.* refer to unpublished work in support of the proposition that the galactic theory is untenable. It is of course not possible to respond to unspecified criticisms. What does seem clear is that, on present evidence, the Nemesis hypothesis is both contrived and unworkable.

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1. Clube, S. V. M. & Napier, W. M. *Nature* **311,** 635–636 (1984).
2. Bailey, M. E. *Nature* **311,** 602 (1984).
3. Alvarez, L. W. Alvarez, W., Asaro, F. & Michel, H. W. *Science* **208,** 1095–1105 (1980).
4. Hills, J. G. *Astr. J.* **86,** 1730–1740 (1981).
5. Raup, D. M. & Sepkoski, J. J. *Proc. natn. Acad. Sci. U.S.A.* **81,** 801–806 (1984).
6. Davis, M., Hut, P. & Muller, R. A. *Nature* **308,** 715–717 (1984).
7. Holmes, A. *The Age of the Earth—Introduction to Geological Ideas* (Benn, London, 1927).
8. Muller, R. A., Hut, P., Davis, M. & Alvarez, W. *Nature* **312,** 230–381 (1984).
9. Retterer, G. M. & King, I. R. *Astrophys. J.* **254,** 214–220 (1982).

Activation of chromaffin cell Ca^{2+} channels by novel dihydropyridine

GARCÍA *et al.*, in their paper on the action of the calcium channel activator BAY-K-8644 on adrenal medulla cells[1], attempted to show that the radiolabelled calcium antagonist ^{3}H-nitrendipine bound to membrane-fragment calcium channels. The data presented are, however, extremely contradictory. Thus, in the text it is reported that the dissociation constant (K_D) of ^{3}H-nitrendipine is 1.18 ± 0.32 nM for 325.4 ± 136 fmol per mg of protein, implying that one homogeneous class of