tion between offspring viability and number of matings with the same male led the authors to conclude that genetic enhancement of offspring is probably the cause of increased viability of offspring of 'promiscuous' females. This conclusion, however, is open to discussion.

In the study of Olsson *et al.*, the number of females having mated repeatedly with the same male (n=15) was much lower than the number of females that mated with multiple males (n=31), resulting in a greater probability of detecting a significant correlation for the second group of females. Indeed, for two of the three variables measured (proportion of hatched young that exhibit malformation and survivorship of juveniles) the coefficient of correlation (r_s) was slightly greater in the first group (0.42 versus 0.33 and 0.41 versus 0.37, respectively). Further, examination of this dataset using a power analysis[2] demonstrates that the probability of detecting a significant correlation with only 15 individuals is low (0.3 assuming r_s= 0.40; see figure).

In conclusion, the available data are not sufficient to demonstrate that differences in the proportion of hatched young with deformities and survivorship of juveniles are caused by genetic enhancement of their offspring rather than increased nutrient acquisition by females mating multiply or some other factor influencing both the tendency of females to mate multiply and the viability of their offspring[3].

Laurent Keller*
Institute of Zoology and Animal Ecology,
Bâtiment de Biologie,
University of Lausanne,
1015 Lausanne, Switzerland

*Also at Zoologisches Institut, University of Bern, Wohlenstrasse 50a, CH-3032 Hinterkappelen, Switzerland.

OLSSON *ET AL.* REPLY — Is increased viability of offspring from our multiply mated female lizards due to a greater number of sexual partners (via sperm competition), as we suggested[1], or to a greater number of matings *per se* (via ejaculate nutrients or some other factor), as Keller suggests? Further analysis of the data supports our original interpretation.

Because the nutrient content of the ejaculate is likely to vary only negligibly among males, we can use our full dataset (n = 31) to compare offspring traits with number of ejaculates (matings) or number of partners. This procedure yields equal power in all tests. Number of matings was not significantly correlated with offspring mass (r_s = −0.02, P = 0.90), hatching success (r_s = 0.09, P = 0.65), or proportion of malformed offspring (r_s = 0.02, P = 0.91). Recapture rate correlates significantly with number of matings (r_s = 0.40, P = 0.03), but this correlation is not significant if the number of partners is factored out in a Spearman's partial correlation analysis (r_s = 0.33, P = 0.08)

We can also control for differences in maternal investment between offspring, which could otherwise mask subtle effects of ejaculate nutrients. Because clutch size is correlated with hatching mass (r_s = −0.48, P = 0.005), we factored out this parameter in partial correlations. The number of matings still does not affect mean offspring mass (r_s = 0.17, P = 0.36), hatching success (r_s = 0.04, P = 0.80), or proportion of malformed young (r_s = 0.04, P = 0.80). In contrast, number of partners is significantly correlated with hatching success (r_s = 0.58, P = 0.0009), proportion of malformed offspring (r_s = −0.38, P = 0.008), mean offspring mass (r_s = 0.46, P = 0.01), and recapture rate (r_s = 0.41, P = 0.03). Thus, ejaculate nutrients or variation in maternal investment cannot explain our results.

Mats Olsson
Thomas Madsen
Richard Shine
School of Biological Sciences,
Zoology Building A08,
University of Sydney,
Sydney,
New South Wales 2006,
Australia
Annica Gullberg
Håkan Tegelström
Department of Genetics,
Uppsala University,
S-75007 Uppsala,
Sweden

1. Olsson, M. *et al. Nature* **369**, 528 (1994).
2. Cohen, J. *Statistical Power Analysis for the Behaviour Sciences* (Erlbaum, London; 1977).
3. Parker, G. A. *Nature* **355**, 395–396 (1992).

Chain mail

SIR — Goodenough and Dawkins[1] identify a quasi-religious mind virus (the St Jude chain letter) and postulate a class of postal parasites. By coating this mind virus with a purportedly therapeutic information package, they cleverly succeed in duplicating and circulating many copies. Such deceptive packaging typifies the dominant variety of postal parasites collectively termed 'junk mail' which shares with certain computer viruses and with popular song viruses the potential for completely clogging the systems in which they circulate.

A more complex mind virus is the idea of nuclear fission. It first infected O. Hahn and F. Strassmann in protoviral form in December 1938. Hahn and Strassmann passed the protovirus by letter to L. Meitner and O. Frisch, hosts in whom it assumed more typical morphology. Frisch passed it verbally to N. Bohr. Bohr crossed the Atlantic to the United States with L. Rosenfeld, infecting him along the way. The two vectors then divided. Rosenfeld travelled to Princeton, where he infected among others E. Wigner, W. Lamb Jr and I. I. Rabi. Wigner infected L. Szilard. Rabi and Lamb hurried to Columbia and spread the infection to E. Fermi and generally among susceptible hosts (physicists). Bohr in the meantime went to Washington, Fermi followed, and together the two sufferers infected an entire conference of physicists, including E. Teller and G. Gamow. The infection then spread rapidly across the United States[2].

To acquire full virulence, scientific viruses must undergo independent replication. This doubting-Thomas test serves as an inoculant (note the withering effect of independent-replication failure on the cold-fusion virus). With experimental demonstrations in different institutions, publication of the Hahn–Strassmann report[3] and confirming reports in this journal[4,5], the nuclear-fission infection spread rapidly throughout the scientific world.

Goodenough and Dawkins observe that 'chain letter' is a misnomer because such a letter forms, not a "linear array of links", but "an exponentially branching tree". But clearly "chain" refers to an exponential chain reaction. The nuclear-fission mind virus not only spread by this mechanism; its toxicity turned out also to depend on such a mechanism, a nice economy of form.

Unlike the relatively benign St Jude mind virus, the nuclear-fission information parasite did not merely induce mental and paper copies of itself but also took control of vast national machineries of production, first in the United States, then in the former Soviet Union (with K. Fuchs an important vector), then elsewhere. Nuclear weapons, a pathological end product of this parasitism, might be characterized as a form of gall, encapsulating the virus's toxic products. Perhaps paradoxically, after two appalling early episodes of gall lysis, these objects acquired such a fearsome (and deserved) reputation for toxicity that no one has dared lyse any since except under conditions of relative biological containment. Although governments have recently begun reducing their gall inventories, the nuclear-fission mind virus and its symbiont the nuclear-fusion mind virus continue to proliferate.

Richard Rhodes
609 Summer Hill Road,
Madison,
Connecticut 06443,
USA

1. Goodenough, O. R. & Dawkins, R. *Nature* **371**, 23–24 (1994).
2. Rhodes, R. *The Making of the Atomic Bomb* (Simon and Schuster, New York, 1986).
3. Hahn, O. & Strassmann, F. *Naturwissenschaften* **27**, 11 (1939).
4. Meitner, L. & Frisch, O. *Nature* **143**, 239 (1939).
5. Frisch, O. *Nature* **143**, 276 (1939).

© 1994 Nature Publishing Group