Kuwaiti Fires and Nuclear Winter

I was surprised to see in Michelle Hoffman's article "Taking stock of Saddam's fiery legacy in Kuwait" (Research News, 30 Aug., p. 971) an attribution to me of what are described as "doomsday scenarios . . . that the fires could touch off a global weather catastrophe," which is also described as "nuclear winter." While there is a great range of nuclear winter scenarios (*1*), they generally involve global temperature declines in the 10° to 25°C range. The concern that Richard Turco and I expressed, before the massive oil well fires in Kuwait were set, was about much more minor effects, both in geographic extent and severity; in particular, we described (*2*) the possibility that, if a significant amount of smoke rose to high altitude, temperatures might fall by 1° to 2°C (not 10° to 25°C) over much of South Asia (not the entire planet). The comparison explicitly made was with the temperature decline after the Mount Tambora explosion of 1815, estimated to be about 1°C (*3*). We also clearly stated that "we cannot be certain that this extent of cooling and darkening of the ground would be the result of massive burning of the Kuwaiti oil fields," and predicted that the contribution to global greenhouse warming would be negligible. Indeed, the smoke does not appear to have risen as high as we feared, in part because of synoptic weather conditions limiting "self-lofting"; and significant climatic effects seem to have been restricted to the war zone itself.

The Kuwaiti fires can be considered a very small-scale intimation of nuclear winter, with regional temperatures falling by about 7°F (4°C) below regional averages (*4*). Because a slight *warming* is expected from smoke in the lower few kilometers of the atmosphere (*1*), where much of the Kuwaiti smoke has been confined, such regional temperature declines result from the small amounts of sooty smoke at higher altitude and represent a remarkable validation of nuclear winter effects.

It would be a mistake to conclude, because the Kuwaiti oil well fires have not produced a "global weather catastrophe," that we have nothing to fear from nuclear winter. Test fires and hydrodynamic simulations repeatedly show (*1, 5*) that the fine sooty smoke from the burning of cities in a nuclear war would be more abundant, would be carried higher into the atmosphere, and would be blacker than the Kuwaiti oil fire smoke; and the temperature declines for a wide range of nuclear war scenarios would be much larger than occurred in Kuwait. Massive reductions in world nuclear arsenals appear to be the most reliable way to guarantee that nuclear winter will not transpire.

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Fertility, Health, and Consanguineous Marriages

One conclusion of A. H. Bittles *et al.* (Articles, 10 May, p. 789) is that in the populations they examine "the high gross and net fertility of consanguineous couples . . . would make rapid elimination of deleterious recessives improbable. . . ." Although this argument appears intuitively to be correct (probably because the frequency of recessive *genotypes* is higher in the progeny of consanguineous couples than of unrelated couples), in fact, higher fertility of consanguineous couples results in a faster elimination of deleterious alleles than in the case of equal fertility. Haldane (*1*) showed that the equilibrium frequency of a detrimental recessive allele is lowered by increased inbreeding. This occurs because inbreeding exposes more detrimental alleles to selection by increasing the frequency of recessive homozygotes.

That higher fertility of consanguineous couples lowers the frequency of detrimental alleles can be simply demonstrated if one assumes consanguinity occurs with a frequency I and that these couples have a relative fertility of $1 + X$ (assuming that random mating occurs with a frequency of $1 - I$ and that these unrelated couples have a relative fertility of 1). Therefore, the contribution to the progeny generation from the consanguineous couples is

$$I' = I(1 + X)/(1 + IX)$$

If $X > 0$, then $I' > I$, or the effect of higher fertility of consanguineous couples is really to increase the proportion of progeny from these matings. This actually enhances the ability of inbreeding to decrease the frequency of detrimental alleles just as if the inbreeding coefficient were increased. As an example, if $I = 0.335$, as in the Hindu group of Bittles *et al.*, and $X = 0.2$, then $I' = 0.376$.

Some South Indian communities may have had high rates of consanguineous matings for more than two millenia (*2*). If inbreeding continues over several generations then it is preferable to use the value of the inbreeding coefficient at equilibrium (f_e). For the Hindu group of Bittles *et al.*, $(f_e) = 0.0476$. Therefore, with a fertility effect of $X = 0.2$,

$$f_e I'/I = (0.0476)\ (0.376)/(0.335) = 0.0534$$

which is a 12.2% increase in inbreeding. This in turn leads to a similar percentage reduction, not an increase, in the equilibrium allele frequency.

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Response: P. Hedrick is correct that, from a theoretical viewpoint, the greater fertility of consanguineous couples should result in increased numbers of recessive homozygotes, with enhanced opportunity for selection against detrimental alleles. However, one of the lessons of the South Indian study (*1*) has been that correlating theoretical concepts with empirical data drawn from human populations is difficult, and this applies when one considers the elimination of lethal alleles from a gene pool.

The Hindu population of Karnataka is heterogeneous, comprising multiple ethnic, language, and caste groups which, even in the present generation, are strictly endogamous. Since the subpopulations exhibit widely variant effective population sizes and levels of preferential consanguinity, both random and nonrandom inbreeding effects can be expected to operate to concomitantly differing degrees. When one makes assumptions about patterns of reproductive preference and behavior in previous generations, one treads on thin ice, especially when dealing with time scales greater than two millennia (*2*). Although there are a few anecdotal reports indicating that marriages between cousins have some regional precedent