(the most contaminated well) (1), Environmental Protection Agency carcinogenic potency values (2), and an assumed consumption of 2 liters per day. The "hazard index" (3) for well G water is 9.1 from the organohalogens present versus 11.6 for U.S. tap water due to chloroform alone. Thus, unless the contamination of the wells before 1979 was orders of magnitude higher than that reported in (1) there seems little likelihood that the contamination could have caused the elevated leukemia rate in Woburn.

As for the arguments quoted in the article relating toxic substances to immunosuppression and human cancer, they are clearly ludicrous with respect to such low concentrations. If we are to stop the nonsense that is now persisting in toxic substances litigation, it is time for respected toxicologists and public health professionals to work together with engineers and other interested parties to develop a rational plan to deal with and prevent the potential health risks caused by the contamination of ground water and drinking water with toxic substances.

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2. *Health Assessment Document for Trichloroethylene, Final Report* (EPA/600/8-82/006F, Environmental Protection Agency, Washington, DC, 1985), pp. 8–133.
3. The "hazard index" is a comparative risk number generated by multiplying the daily dose in micrograms from drinking 2 liters of water by the carcinogenic potency of the chemical in rodents. Average concentrations of trichloroethylene, perchloroethylene, and chloroform in well G were 262, 26.4, and 4.3 μg per liter, respectively (1). U.S. chlorinated drinking water supplies contain chloroform at a mean concentration of 83 μg per liter [S. J. Williamson, *Sci. Total Environ.* **18**, 187 (1981)].

Moonlight and Circadian Rhythms

Charles A. Czeisler *et al.* (Reports, 8 Aug., p. 667) may have used much more light than necessary to affect human circadian rhythms. There is evidence that significantly lower light levels, under the proper conditions, can have noticeable effects. Consider, for example, a folk belief still prevalent in the Shetland Islands around the turn of the century that illustrates this.

These islands lie between 60 and 61 degrees of north latitude (200 kilometers north of the Scottish mainland), or only 6 degrees south of the Arctic Circle. In the winter, daylight is only a few hours long and, until recently, artificial light was a luxury. The winter moon, as high in the night sky as the sun is in the summer, is particularly prominent there. A strongly held belief of the Shetlanders was that moonlight should never fall on the face of a sleeping person (1). Being unused to having unexpected periods of light during the long winter nights, they had presumably come to notice the unsettling effect such light could have when it happened to shine at a "sensitive" time in the circadian cycle. The full moon (about 0.3 lux) is 3×10^{-6} as bright as the midday sun (2). It would thus supply about 4×10^{-5} as much light as that employed by Czeisler *et al.* If it shone on a sleeper for (typically) an hour, the integrated intensity of nocturnal light that so worried the Shetlanders would be no more than 10^{-5} of that employed in these recent experiments.

This suggests that much lower light levels could be used to probe the effects on humans. These lower levels are, interestingly enough, those already found ample to affect circadian pacemakers in a variety of creatures (3) and to show an effect on the human menstrual cycle (4). It is possible that the accumulated experience that led to this "folk wisdom" could have contributed to the widespread importance accorded the moon in prehistoric Britain (5).

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1. This belief was voiced on numerous occasions by my mother, the late Elizabeth Stout of Shetland.
2. See, for example, G. Abell, *Exploration of the Universe* (Holt Reinhart, New York, ed. 2, 1969), chap. 20.
3. A. Winfree, *Phys. Today* **28**, 34 (March 1975) cites the critical time and intensity as "close to (subjective) midnight and . . . equivalent to a few minutes' full moon!"
4. E. M. Dewan, *Sci. Technol.* (No. 85) (January 1969), p. 20.
5. E. Hadingham, *Early Man and the Cosmos* (Walker, New York, 1984), chap. 5.

Response: Light of very low intensity can indeed affect circadian pacemakers, particularly in plants and insects (1). In fact, exposure to light with a mean flux of 5 photons per second per eye for 12 hours alternating with 12 hours of darkness is sufficient to entrain wheel-running activity rhythms to a 24-hour period in the nocturnal cockroach (*Periplaneta americana*) (2). As we stated in our report, it had originally been reported that a light-dark cycle of ordinary indoor illumination (200 to 500 lux) was insufficient to similarly entrain human circadian rhythms (3), but we had subsequently shown that when such human studies were conducted in a manner comparable to the animal studies, entrainment to a 24-hour day could be achieved with ordinary room illumination (4). However, studies in other species indicate that the amplitude of the response of the circadian system to light signals is related to the intensity, duration of exposure, and circadian phase of administration. On the basis of prior studies in humans, it was difficult to determine whether indoor light had a direct synchronizing effect or a behaviorally mediated one. We therefore attempted to determine whether relatively brief exposure to bright (about 10,000 lux) light comparable in intensity to natural sunlight (which reaches over 100,000 lux at midday) could reset the human circadian pacemaker, even when the timing of the sleep-wake cycle was held fixed. The data from the case study we reported, which we have subsequently confirmed and extended in eight trials in three other subjects, demonstrates that the effect we observed requires bright light, since it did not occur in control studies when these subjects were instead exposed to ordinary indoor light of 50 to 250 lux. Thus, we would not expect moonlight [about 0.3 lux (5)] to have effects similar to that of the bright light used in our study in individuals living in temperate or equatorial latitudes. It is conceivable that the circadian system of individuals living in constant darkness might become more sensitive to resetting by lower intensity light, as has been reported in *Drosophila* (6). However, the occurrence of midwinter sleep-onset insomnia during the "dark period" in Tromsø, Norway (about 69° latitude), when people depend completely on artificial indoor room lighting, and its reported improvement following exposure to morning bright light (2500 lux) (7) again suggests that in humans, ordinary indoor illumination is a weaker synchronizing cue than light of greater intensity.

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