Letters

AIDS Transmission and Insects

According to William Booth's article (News & Comment, 24 July, p. 355), scientists have ruled out the normal insect vector route, gut to salivary gland to victim, for AIDS. They also note that 100 femtoliters of infected blood clinging to a mosquito's proboscis, if her meal is interrupted, will pose no threat of infection to anyone later bitten. But this overlooks the most obvious means by which a mosquito (or other bloodsucking insect) can transmit AIDS. The blood in her gut, if she is swatted while completing her meal, will surely contain more than enough viral particles to infect. If the itchy spot is immediately scratched, a normal reaction, the standard method of transmission is present: virus-containing body fluid on damaged epithelium. Indeed, scratching the site may prove unnecessary. The minute puncture of the bite may be sufficient to provide entry to the virus.

There are morals in this. First, look beyond the usual categories of biological and mechanical vectors. Second, when visiting an area where there is a high rate of AIDS infection, always apply insect repellent and never swat a feeding mosquito.

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Detection of Molecule Spectra

A review article on interstellar molecular clouds by John Bally published in *Science* last year (11 Apr. 1986, p. 185) said, "Little was known about the composition and physical conditions of these opaque objects [the interstellar clouds] until the late 1960s, when the development of sensitive radio receivers and the application of new technology in radioastronomy led to the accidental discovery of radio frequency spectral emission lines of several molecules, such as OH, H_2O, NH_3, and H_2CO, in interstellar space." This proposed history is strikingly astray.

Actually, there has been a long interest in the possibility of detecting molecular spectra in interstellar space, although this was limited to a few individuals (*1*). In 1955, in a discussion at the Fourth International Astronomical Union Symposium, the possibility was pointed out of detection of a number of molecules in astronomical sources, including the free radicals OH, CH, SiH, as well as NH_3, H_2O, and CO (*2*). The first substantial search for a microwave line of OH was made by Barrett and Lilley in 1957 (*3*), but failed primarily because the frequency of OH was not well enough known. A general discussion by Barrett of microwave lines of astronomical interest followed in 1958 (*4*). The OH ground-state frequency was then carefully measured by Ehrenstein *et al.* in 1959 (*5*) with the comment, "One of the molecules whose presence in interstellar space may be detectable by means of its radio-frequency spectrum is the OH radical. Attempts at observing it with radio telescopes have been unsuccessful thus far. To make future searches more fruitful, frequencies of the appropriate absorption line were measured in the laboratory. . . ." In 1963, Barrett, joined by Weinreb and others, took up the search again for OH at its measured frequency and detected it (*6*). Such a history can hardly be represented as "accidental" discovery. Furthermore, while Weinreb *et al.* used a new correlation technique in the second search for OH, this did not produce any marked gain in sensitivity over what had been current microwave practice for some time at wavelengths near 18 centimeters, where this OH frequency lies.

In late 1967, in a collaboration between the physics department and the radio astronomy laboratory the University of California, Berkeley, a receiver was built for the region near 1.25-cm wavelength appropriate to attempt the detection of ammonia, which had previously been suggested. At the time not all astronomers expected such molecules to be found; there was as yet no clear evidence that clouds would be dense enough or that many molecules could form (*7*). An application by Snyder and Buhl for antenna time at the National Radio Astronomy Observatory (NRAO) to search for H_2O was, for example, turned down on advice from expert reviewers at about this time. However, the search at Berkeley proceeded. It resulted in the discovery of ammonia (*8*) and immediately thereafter of water (*9*). The antennas and receiving equipment used were types that were more or less available and could have been used before that. Thus, the failure to detect these molecules earlier and the gap of 5 years between discovery of OH and more complex molecules occurred primarily because no one had looked carefully, and neither accident nor brand-new technology played significant roles. Discovery of NH_3 and H_2O immediately encouraged Zuckerman and Palmer to combine with Snyder and Buhl to search for H_2CO, which was detected with an NRAO antenna and receiver (*10*), again of types that had been available for some time. These discoveries allowed immediate estimates of molecular temperatures and demonstrated cloud densities substantially higher than had generally been expected. They also prompted the subsequent search for and detection of what is now a list of about 75 molecular species.

Detection of molecular lines in the millimeter range, of which CO has probably been the most important, has much more directly depended on development of new receivers and antennas and hence on new technology than those at longer wavelengths, and perhaps this is what the author of the *Science* article had in mind. The general point needs to be made and emphasized, however, that support by national agencies of large equipment developments and generally accepted lines of research must always be balanced by thoughtful support of individuals, sometimes working in not-so-popular directions. As in this case, it is not just support of popular and expensive equipment developments that open up new fields; the less expensive but persistent interests of individual scientists are sometimes more effective.

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Response: The letter from Barrett *et al.* represents a valuable contribution that clarifies the origins and early history of the study of interstellar molecules. My article was meant to be a review of the current state of the subject and not a discussion of the history of this field. I regret the use of the word "accidental" in my introduction to describe the detection of the first interstellar molecules since it does a great disservice to those who spent years of effort searching for the first interstellar molecules.

As Barrett *et al.* point out, the impression that early developments in molecular line astronomy were in part due to "accidents" and in part due to improvements in instrumentation is derived from developments at millimeter wavelengths, which now produce most of our information about the cold phase of the interstellar medium. In this field, the last 15 years has been marked by dramatic improvements in receiver performance, antenna surface accuracy, and systems integration. Many of the observed spectral lines and new phenomena were unexpected. The discovery of X-ogen (later identified to be HCO^+), giant molecular clouds in CO, and bipolar outflows are but a few examples of surprising new finds.

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Subseabed Waste Disposal

Eliot Marshall, in his article "Thirty ways to temporize on waste" (News & Comment, 7 Aug., p. 591), refers to the support of Senator Chic Hecht (D–NE) for continued research on "putting nuclear waste in the deep seabed" as "proposing something new." This is not the case. Subseabed disposal of radioactive waste is not a "new" idea (*1*). The United States and nine other nations have been investigating subseabed disposal for more than 10 years, and research results to date indicate that subseabed disposal can be conducted without proposing unacceptable risks to human health or the marine environment. In 1986, however, the Department of Energy (DOE) terminated U.S. participation in the international subseabed disposal research effort "purely on the basis of near term budget priorities," according to a DOE statement of 5 January 1986.

Senator Hecht's bill, the "Subseabed Nuclear Waste Disposal Research Act of 1987" (S. 1428), would authorize continuation of U.S. research on subseabed disposal. Rather than proposing something new, the bill reasserts the wisdom of section 222 of the Nuclear Waste Policy Act of 1982 (NWPA), which mandates continued research on alternative disposal methods. A bill proposed by Senator Daniel Evans (R–WA), the "High-Level Radioactive Waste Storage Act of 1987" (S. 1266), contains similar provisions for reauthorizing research on subseabed disposal. In light of the problems facing land-based disposal, it seems prudent to keep our options open rather than abandon the only credible backup to deep geologic repositories.

We should heed the lesson of the *Challenger* accident, which left NASA without alternative launch capability because it had abandoned its expendable rocket program. It is unwise to put all one's eggs in a single basket, especially when the possibilities and consequences of failure are significant and the cost of maintaining a backup is relatively low. For less than 5% of the land repository program budget, the United States could keep the subseabed option open. Senators Hecht and Evans have good reasons for supporting continued development of subseabed disposal. If one of their states is selected for a repository site, and if the site turns out to be flawed technically, having an alternative available would provide a significant safeguard.

Subseabed disposal is also a significant potential international disposal option. The United States is not the only nation encountering severe problems in siting a land-based repository. In fact, only the Soviet Union claims to have developed a permanent repository for high-level waste. For small nuclear nations, the land-based option may be foreclosed altogether. For developing country nuclear nations the cost of building a deep geologic repository on land would severely strain resources even if the country possessed the capability to design and construct reliable facilities. These problems would be significantly reduced if an internationally chosen, constructed, regulated, and monitored site were to be developed.

Such a site would, in addition, provide a significant boost to U.S. nonproliferation policy objectives, since it could also safely accommodate spent fuel. This would verifiably close the back end of the nuclear fuel cycle without raising the issue of the United States having to accept foreign wastes. Continued research and development of the subseabed disposal option would, therefore, serve both domestic and foreign policy objectives of the United States. Moreover, if the U.S. program were to be continued, it would ensure the continuation of the cooperative international program within the Nuclear Energy Agency of the Organization of Economic Cooperation and Development. This would permit the United States to realize the full benefits of this program for only a fraction of its total cost.

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TMI and Chernobyl

The article "Nuclear power after Chernobyl" by John F. Ahearne (8 May p. 673) contains some disturbing inconsistencies.

Ahearne states that among the similarities between the accidents at Three Mile Island (TMI) and Chernobyl is the fact that "both reactors are very sensitive," yet he notes that at Chernobyl the operators had only seconds to react, while at TMI there were hours. The Chernobyl accident involved a reactivity excursion, something that did not happen at TMI, nor could it have, given the entirely different neutronic characteristics of that reactor.

Ahearne states that in both instances the operators "took a series of steps that were deliberate and that defeated the safety systems." At Chernobyl the operators did deliberately violate their procedures by turning safety systems off; but at TMI the operators, faced with a situation in which different procedures posed irreconcilable requirements depending on which instrument readings they believed, and because of their ignorance at the time that the PORV (a pressure relief valve at the top of the pressurizer) was stuck open, chose what was in retrospect the wrong response and shut off the safety injection of water into the reactor vessel to prevent what they believed to be the imminent danger that the system would go "solid," that is, lose the necessary steam "bubble" in the top of the pressurizer. Thus they acted after the accident had begun and did what they believed their procedures called for, while at Chernobyl the procedure violations occurred before the onset of the event (in fact caused it) and were indeed deliberate.

It is indeed true that containment overpressure capabilities in U.S. light-water reactors range from about 2 to 5 kilograms per square centimeter, but this says nothing about their protective capabilities without