LETTERS

Fusion Program

I was very interested in Mark Crawford's article "Hard times in magnetic fusion" (News and Comment, 31 May, p. 1069), and I thought it deserved a perspective from the cognizant authorizing committee in the House of Representatives. I chair the Subcommittee on Energy Research and Production of the House Science and Technology Committee, which authorizes the Department of Energy (DOE) Magnetic Fusion Energy (MFE) program, and I believe several points should be made so that your readers will better understand what has happened with the MFE program. The MFE funding cuts are typical of budget reductions in energy technology development programs, for example, nuclear fission and electric energy R&D, but they have lagged behind the program cuts in these other areas by about 2 years. Many members on the Science and Technology Committee recognized the realities of dimmer fusion budget prospects shortly after the passage of the MFE Engineering Act of 1980 and thought it was imprudent to think in terms of such a goal-oriented program toward a demonstration reactor in the 1980's. However, the major reason that the MFE program has suffered significant budget cuts is the fact that there are no champions on the appropriations committees in either the House or the Senate. In fairness, I should point out that certain House members have been preoccupied with appropriation priorities for the Tennessee Valley Authority's nonpower activities and entities such as the Appalachian Regional Commission, two programs where very drastic cuts have been recommended recently by the Reagan Administration. Nevertheless, I believe the positive aspect of the budget crunch has been that DOE is looking at smaller, less costly concepts and, in particular, at a lower cost, that is, under $500 million, fusion ignition device. It is unfortunate that DOE has not been able to convince the appropriations committees that, even at a reduced funding level (in the neighborhood of $400 million), it is still important to maintain a focus in the U.S. MFE program and that a lower cost ignition device will do precisely that. It is regrettable that machines such as the MFTF-B cannot be operated as designed, but the community consensus is that it is much more important to retain a program thrust that provides meaningful near-term goals for the mainline program than to heavily support a backup concept given the limited resources.

It is also important to recognize the climate for international cooperation in magnetic fusion. The Technical Working Party of the Versailles Summit has recently issued a statement of strong support for the U.S. lower cost ignition experiment. It should be emphasized, however, that the United States cannot expect major cost-sharing in such a device from either the Joint European Torus group or Japan. I believe that the revised strategy for the U.S. MFE program should be to embrace a lower cost ignition device in the near term with plans for the United States to "leap frog" the Japanese Fusion Energy Reactor and the European Community's Next European Torus device in the early part of the next century. Certainly we must keep in mind that the MFE program, although now on a stretched-out timetable relative to the very ambitious Engineering Act, must not lose its focus. I think this is particularly important in the sense that Congress should not support a diffuse, unfocused program at a constant level of effort, such as in the case with the so-called "national trust" programs in high energy and nuclear physics. The pressures to hold down federal spending will continue, but I believe that if DOE makes its case, a strong, focused effort can go forward at a budget level of roughly $400 million, allowing for inflation.

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Medicinal Plants

While I was pleased with the useful compilation of "Natural plant chemicals" by Manuel F. Balandrin *et al.* (Articles, 7 June, p. 1154), I fear one statement might further discourage investigations of medicinal plants here in the United States.

Balandrin writes that "The development of new medicinals from higher plants is costly and time-consuming because those readily available plants having pronounced pharmacological effects . . . have been known for centuries and have been thoroughly investigated." Casual readers might take this to imply that further developments of new medicines from higher plants are unlikely.

Science has just published reports of two exciting new botanical drugs from long-established medicinal plants with pronounced pharmacological effects, qinghaosu from *Artemisia*—an old Chinese folk remedy for malaria (Articles, 31 May, p. 1049); and etoposide, a semisynthetic antitumor compound from *Podophyllum peltatum*—an old Indian folk remedy for cancerous conditions (Articles, 7 June, p. 1154).

Papaya's digestive properties have been known for centuries, but only in this decade was chymopapain approved by the Food and Drug Administration for lower back problems. And it was in this decade that the FDA approved the use of *Lobelia* in pills to help curb the smoking habit. *Lobelia* was used by the Amerindians for just that purpose. These recent breakthroughs should alert the American pharmaceutical industry to the fact that there are many more useful compounds awaiting discovery among the tens of thousands of existing folk medicines, many in the disappearing forests of Latin America.

Whole plant utilization—extracting medicines, leaf proteins, vitamins, polyphenols, essential oils, and chemurgics and using the residues for alcohol production for energy—could move us from the petrochemical to the phytochemical era, with the possible fringe benefits of slowing the "greenhouse effect" and making us more self-sufficient.

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Duke touches on an important point. We did not mean to imply that further drug development from higher plants is unlikely. As we repeatedly pointed out, higher plants and their secondary metabolites continue to be important as sources and models of drugs, food additives, and a plethora of other specialty products. In addition to the examples mentioned in our article and in Duke's letter, we can cite the recent discovery, isolation, and structure elucidation of the natural plant-derived sweetener, hernandulcin (*1*), and the medicinally active sulfur compounds of garlic and onions (*2*). Furthermore, nabilone (Cesamet), a synthetic cannabinoid related in chemical structure to delta-9-tetrahydrocannabinol (the main active principle of marijuana), has recently been approved for commercial marketing by the Food and Drug Administration (FDA). This compound is useful in the treatment of the nausea and vomiting associated with cancer chemotherapy. It also has useful antiglaucoma and minor central nervous system tranquilizing properties (*3*).

The statement Duke cites referred to the *commercial* development of medicinals from higher plants, which results from a complex interaction between scientific and technical feasibility and economic factors such as long-term funding commitments for research (both for random biological screening and for literature searches of folklore reports), patentability of newly discovered natural plant products, development and marketing costs, market sizes to be addressed, and so forth. Plants such as the opium poppy, foxglove (*Digitalis* spp.), belladonna, marijuana, and even onions and garlic, were literally handed down to us by our ancestors. The biological activities of these plants had been known for centuries to peoples of many cultures, and there was never any question of their efficacy or their pharmacological effects. In a real sense, extensive empirical bioscreening and pharmacological research ("clinical trials") had already been done on these dramatically active plants by the time chemists arrived on the scene and set about the tasks of isolating and elucidating the chemical structures of their active principles. Alas, most of these ethnomedical "gifts" have been thoroughly investigated—early studies on these plants, in fact, were largely responsible for ushering in the era of modern organic medicinal chemistry. Today, although higher plant compounds with interesting and potentially useful biological properties are continually being discovered and developed from more obscure plants, this type of research can be more costly and time-consuming than in previous years. However, there is much evidence to show that natural product research is still potentially less expensive and more fruitful (in terms of new prototype compounds discovered) than are large chemical synthesis programs. Unfortunately, funding decisions are often made on the basis of perceptions rather than reality, and there are widely held misconceptions that higher plants are no longer viable as sources of useful new drugs. There can be no question that the jungles of Latin America (and elsewhere) *do* contain as yet undiscovered medicinals and other products. However, these jungles will not surrender their secrets readily. We are going to have to "fish a little harder" for such substances than we did in the past, which will require attitudinal changes on the part of institutions and long-term funding commitments for natural product research programs.

In contrast to the area of medicinal plant research, pesticide development from higher plants has traditionally received less attention. However, pesticide chemists have recently begun to reexamine the folklore histories of purportedly bioactive plants in search of new leads. In the case of insecticides, for example, compounds from the neem tree have been receiving a great deal of attention recently. Neem has a long and well-established folklore history of use in India as an insecticide, among other things. Extracts of this plant have now been approved by the Environmental Protection Agency for use as an insecticide on nonfood plants (for example, ornamental flowers). Thousands of other plant species also possess significant insecticidal activity. As in the case of medicinal plant research, however, the secrets of these less dramatically active plants may have to be extracted at a higher price.

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U.S. Oil Consumption

Energy efficiency has played a much greater role, and nuclear power a lesser one, in reducing U.S. oil and energy consumption in recent years, than Mark P. Mills suggests (Letters, 12 July, p. 118).

Mills apportions the 4.4 quads per year increase in domestic energy production between 1978 and 1984 among the various fuel sources, headed by coal with 54 percent and nuclear at 20 percent. Yet coal's 1978 to 1984 increase was 3.0 quads (*1*) and nuclear's only 0.54 quads, giving them 69 and 12 percent, respectively, of the increase in production—far different shares than Mills asserts.

Nor does Mills quantify efficiency contributions. Using his own definition of efficiency gains—decline in total energy per real gross national product—efficiency measures added 12.9 quads per year between 1978 and 1984. This is almost triple the net gain from new supplies. If the above supply gains and demand savings are combined, the latter account for 74 percent of the total. Only 18 percent of the increase is from coal, and nuclear is almost unnoticeable at 3 percent.

Mills' statement that "utilities are directly responsible for reducing total U.S. oil consumption by one-third since 1978" also gives undue credit to the electricity sector. U.S. oil consumption fell from 38 quads in 1978 to 31 quads in 1984, a remarkable drop in so short a time, but still under 20 percent. Electric utilities did reduce their own oil-burning by an impressive two-thirds, from 4 quads to 1.3, but this reduction accounted for under 40 percent of total national oil savings.

Nor did nuclear power have a big hand in utility oil savings. From 1978 to 1984, electricity generation from oil fell by 245 billion kilowatt-hours (kWh), yet nuclear generation rose only 51 billion kWh. Rather, it was coal-fired electricity, up by 366 billion kWh, that displaced utility oil while also accommodating modest overall electricity growth.

Important lessons may be drawn from these data. First, most oil consumption occurs outside the electricity sector, in furnaces, vehicle engines, and feedstock uses; so most oil savings have and will come in these areas. Second, within the electricity sector, coal generation overshadows nuclear power by more than four to one; hence, keeping utilities from reviving oil use will depend more upon improving coal's economic and societal acceptability, for example, through acid rain mitigation, than upon efforts to resuscitate nuclear power. Third, efficiency measures remain America's biggest energy resource by far. Efforts to exploit our Saudi-size reserves of inefficient energy use will provide the greatest payoff among our energy options, as they have since the 1970's.

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References and Notes

1. Data herein are from U.S. Energy Information Administration's *Monthly Energy Review*, March 1985. Coal production data for 1978 are taken as the average of 1977 and 1979 to avoid overstating growth from artificially low 1978 output due to coal strike.

Erratum: In the article "Science and technology in India" by J. S. Rao (12 July, p. 130), it is incorrectly stated at the top of the first column on page 133 that C. V. Raman founded the Indian Institute of Science in Bangalore. The Indian Institute of Science was founded by Jamshed Tata.