Letters

Human Trials of Malaria Vaccine

John Walsh's recent article "Human trials begin for malaria vaccine" (News & Comment, 13 Mar., p. 1319) contains the speculative statement that "such a vaccine [referring to sporozoites] would protect tourists and military personnel against infection. . . ." This statement must be based on the unproved assumption that in a malaria-endemic area, protection conferred by a synthetic peptide or a recombinant sporozoite vaccine would be of short duration and could not be boosted by exposure to the parasite through infected mosquito bites. Recombinant and synthetic peptide sporozoite vaccines are now undergoing their first clinical trials, and the vaccinated volunteers have not yet been challenged, that is, exposed to infected mosquito bites. Therefore, any statement regarding the duration and effectiveness of the protection conferred by the vaccine is conjectural and premature.

The only other malaria vaccine trials were performed in 1975 with an unusual type of vaccination, namely, repeated exposure to the bite of relatively large numbers of infected irradiated mosquitoes (*1*). Unlike the volunteers in the current trials, those volunteers were exposed to intact inactivated nonreplicating sporozoites, without administration of an adjuvant. Under those conditions protection was complete in some individuals and lasted from 3 to 6 months. The bite of infected mosquitoes at the time of challenge had a clear booster effect enhancing antibody titers and prolonging protection. Also, the repeated exposure to infective mosquito bites of people living in malaria-endemic areas leads to antisporozoite antibodies that increase with age (*2*). Mice immunized by the repeated administration of irradiated sporozoites develop complete protection that lasts 3 to 4 months, but the protection can be prolonged for the lifetime of these animals if they are occasionally exposed to the bite of infected mosquitoes.

The experimental data on vaccination of laboratory animals with synthetic peptides or recombinant polypeptides (*3*) are still too limited to permit prediction of the outcome of the human trials under similar conditions.

In any case, if protection should be short-lived, it would still benefit migrant workers, road construction crews, gold miners, and others, namely, the people from countries that have regions of malaria endemicity. It might be well to remember that the people living in malaria-endemic areas are the main target for malaria vaccine development and application and that acceptance of a future malaria vaccine can only be harmed by statements assigning its usefulness only to tourists and military personnel.

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REFERENCES

1. D. F. Clyde, V. C. McCarthy, R. M. Miller, W. E. Woodward, *Am. J. Trop. Med. Hyg.* **24**, 397 (1975).
2. E. H. Nardin, R. S. Nussenzweig, I. A. McGregor, J. Bryan, *Science* **206**, 597 (1979).
3. F. Zavala *et al.*, *ibid.* **228**, 1436 (1985).

Impending Energy Crisis?

Robert L. Hirsch (Articles, 20 Mar., p. 1467) summarizes very well in engrossing detail the declining status of the U.S. oil industry. However, his table 3 shows 100 to 200 billion barrels of oil (BBO) still remaining as U.S. oil resources. This table gives an unduly optimistic and misleading picture of the probable U.S. energy future.

The public constantly confuses two technical petroleum terms: reserves (discovered recoverable oil) and resources (theoretical oil yet to be found). The particular term being used depends greatly on whose funds are involved (*1*). Economists and the general public commonly view crude oil as a huge theoretical resource, akin to gold dissolved in sea water. But operating petroleum geologists and engineers must convert any resources into reserves that can be sold in the open market (*2*). This is much more restrictive. Private oil companies are in business to make money, not to find oil. If it costs more in energy to produce new energy, then production will not be continued for long by any corporation working with its own funds. Government agencies (spending taxpayers' money) cannot find oil any more easily than private companies can where no fields exist.

The recent U.S. oil-finding record is dismal. In 1977 through 1985, only 2 BBO were found in new U.S. and Alaskan fields, in spite of the greatest U.S. well-drilling effort ever (while contemporaneous U.S. production totaled 27 BBO, and consumption was 55 BBO) (*3*). Looking for new big U.S. oil fields is now about as effective as buffalo hunting (*4*). This is alarming when the total volume of oil used for U.S. transportation alone (for which there is no economic substitute) is 107% of our domestic crude oil production (*5*).

Global oil-finding rates are also bad news. The "giant" oil fields (each containing over 0.5 BBO recoverable oil), which are the largest targets and easiest to locate, now number only 320 worldwide (1% of known fields) but contain 75% of the world's crude oil. Discovery of new oil in such giants peaked at 125 BBO during the period from 1961 through 1965, when the total global production was 50 BBO. Since then, the amount of new oil discovered in giant fields has dropped steadily to only 10 BBO during 1981 through 1985. In this 5-year period, global production exceeded 100 BBO.

The first and second oil price shocks occurred in 1973 and 1979. The third and permanent global oil shock will be caused, as Hirsch predicts, by Organization of Petroleum Exporting Countries (OPEC) price increases within the next decade—just as soon as the non-OPEC giant fields start their inevitable decline (*6*). Meantime, the world's population continues to soar.

We should be reminded that foreign peoples develop their oil for themselves—not for us—and we have no inherent right to burn up their wealth for our convenience. Sixty-two percent of the world's oil reserves are in the Moslem nations surrounding the Persian Gulf, and there is no love lost between Arab oil exporters and other countries. The globe has only three oil-producing "superpowers," the United States, the U.S.S.R., and Saudi Arabia. U.S. oil production peaked in 1970 [as predicted by M. King Hubbert in 1956 (*7*)] and that of the U.S.S.R. in 1983. What will happen when U.S. and Soviet generals suddenly realize that their geologists cannot deliver the vast oil supplies forecast as resources? We can only hope that the United States and the U.S.S.R. will then cooperate in a plan whereby future oil from the Persian Gulf area will be shared peacefully by all nations. The alternative will be World War III.

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REFERENCES

1. L. F. Ivanhoe, *Stud. Geol.* (No. 21) (1986).
2. C. D. Masters, "Global oil assessments and the search for non-OPEC oil" (U.S. Geological Survey, Open File Report 86-373, Reston, VA, 1986).
3. *U.S. Crude Oil, Natural Gas, and Natural Gas Liquid Reserves, 1985 Annual Report* [DOE/EIA-0216 (85), Department of Energy, Washington, DC, 1986], p. 6, table 1; *Annual Energy Review 1985* [DOE/EIA-0384 (85), Department of Energy, Washington, DC, 1986], p. 101, table 45.
4. L. F. Ivanhoe, *Am. Assoc. Pet. Geol. Explor.* **6**, 38 (November 1985).
5. *Energy Security* (DOE/S-0057, Department of Energy, Washington, DC, 1987), pp. 48, 101, and 209.
6. L. F. Ivanhoe, *Am. Assoc. Pet. Geol. Bull.*, in press, (preprint of paper to be given at AAPG National Convention, Los Angeles, 9 June 1987).
7. M. K. Hubbert, *Drilling and Production Practice* (American Petroleum Institute, New York, 1956), pp. 7–25.

Hirsch's jeremiad that the United States is heading into another energy crisis combines faulty analysis with self-interest to produce bad policy advice for the nation. Basically, he argues that it should be national policy to inflate oil prices in the United States so that domestic producers, including his employer, will have greater incentives to explore. But it was not the domestic producers who took us from the days of gas lines and exponentially rising crude oil prices to the current situation of glut in all energy markets as far as the eye can see. It was domestic consumers, who learned they could get by quite nicely on less energy, and production from places such as Mexico and Canada, who were not in OPEC, that broke the back of OPEC. What we learned from the days of the so-called "energy crisis" was that there is no need to panic as long as we are willing to let markets work.

Right now the world is awash in oil (and the United States is similarly swimming in natural gas, coal, uranium, and electricity). This vast change is truly remarkable to anyone who remembers the dire warnings of the Senate Energy Committee in 1979 that Saudi Arabia, then producing around 12 million barrels of crude per day, was soon going to top out at 16 million barrels per day and then we would all freeze in the dark. Hirsch's figure 2 shows Saudi production at well under 3 million barrels per day for 18 months. Iran and Iraq are each capable of increasing their current production by a factor of 5 or 6, at least. I see no reason to believe that oil will again be in short supply in the future, where a cartel can exercise market power.

I would not be troubled if the United States finds itself buying 70% of its oil abroad, as long as the stuff was plentiful and cheap. I see no compelling evidence to support Hirsch's assertion that "as worldwide oil production comes into closer balance with demand, OPEC will regain market control and be able to force up prices." Indeed, his policy prescription seems to be to drive up prices now, artificially, rather than let them slide up gradually as the market comes into better balance.

The predictions of energy crisis ahead that seem to be emerging from the petroleum industry and its supporters remind me of something a former boss told me when I was working at the National Institutes of Health. "Remember," he said, "more people are getting rich from cancer than are dying of it."

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Hirsch's article invites four questions:

- If oil will soon be scarce and expensive, why aren't oil companies, as rational profit-seekers, betting on their own forecasts by spending far more on exploration?
- If depletion of U.S. hydrocarbon resources is worrisome, why is it in the public interest to subsidize depleting them even faster?
- If depletion is already so advanced, and the sustainable alternatives that Hirsch agrees we will "eventually" need will take a long time to adopt, shouldn't we be starting now, not further stalling, an orderly transition to them?
- If, as his opening quotation from the Department of Energy's Energy Research Advisory Board (ERAB) states, "energy use and reserve predictions have been consistently inaccurate," why trust those he cites?

Hirsch is right to be concerned about oil depletion. Yet he devotes only three dismissive sentences to the primary solution, which ERAB states thus: "Conservation and more efficient end-use technologies can be enormously important." For example, full use of advanced windows could save more oil, or gas fungible for oil, than Alaska supplies (1/5 of U.S. demand); 1 year's rapid deployment force budget, spent to cut buildings' heat losses, could about eliminate Mideast oil imports; and rolling back car efficiency standards from 27.5 to 26 miles per gallon will probably waste oil faster than the Arctic National Wildlife Refuge, or now-forbidden areas offshore California, could provide it. Improving buildings *or* cars could eliminate U.S. oil imports before new Arctic or offshore oil, synfuels, or power plants could come on line, and at a five to ten times lower cost.

Future needs for oil, and the rising import dependence which Hirsch decries, are not fate but choice. Saving oil takes time and costs money—but less than the 5 to 10 years times $50 billion to $100 billion per year and the $30+ per barrel cited by Hirsch for new oil. The U.S. oil industry, after a century's development, delivered in 1986 a dwindling 22×10^{18} joules at rising real cost. In contrast, the U.S. energy-saving "industry" developed over the past 13 years delivered in 1986 some 30×10^{18} joules, increasing by several percent per year, at falling real cost. Investing more money and attention in the former and less in the latter risks repeating the unhappy history of the 1973–1974 and 1979–1980 oil shocks: a failed government supply-side response overwhelmed by a successful market demand-side response.

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Hirsch speaks of "the long period required to crank up industry activity after the 1973 crisis . . . [a] doubling of the 1973 drilling level required more than 6 years, in spite of large financial incentives and large pressures from the government and public." That is the industry line; but what was the industry *really* doing in that time? By and large it was leaving exploratory drilling to the wildcatters while it bought up coal mines and competing energy threats such as Raytheon. It did go in for fantastically expensive offshore projects that virtually assured a killing at the bonanza price of oil and, do not forget, we all lived in the happy expectation that the price would reach $80 a barrel and stay there. Offshore development has much of the attraction that the cattleman finds in public grazing lands, and the industry does not have to put out that galling 3/16 to 1/4 royalty.

My guess for the future is no better than anyone else's, but I do know what we are waiting for: the golden times when cars are lined up for miles behind the pumps and widows are freezing and the price of oil is $80 a barrel. That time will probably come, but the question is, Will the industry buckle down to the businesslike fact that in the developed and "exploited" fields most of the oil is still in the ground and can be got out a lot more cheaply than the romantic offshore stuff—especially if it is in the Atlantic and not really there?

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Response: Ivanhoe believes the numbers I quoted for remaining U.S. oil resources are "unduly optimistic and misleading." I disagree but support his contention that there is considerable uncertainty in such projections. My disagreement is based upon the credibility of the references that I cited. Those sources are well respected and reflect a considerable body of knowledge developed over a long period. Nevertheless, it must be recognized that resource estimation is a very inexact science because our current understanding of geology does not allow accurate large-scale extrapolation due to the enormous complexity of the phenomena involved.

I am personally optimistic regarding remaining U.S. oil reserves and the potential for a dramatic recovery in U.S. oil production. My basis is the very significant advances of the past few years in geological and geophysical science. These provide the explorationist remarkably better pictures of the subsurface, which allow identification of oil reservoirs heretofore hidden except to accidental discovery.