Malathion Threat Debunked

Malathion appears relatively safe to use for Medfly control, and certainly safer than another chemical that might have to be used

With its $14-billion agricultural industry threatened by an infestation of the Mediterranean fruit fly, the state of California on 10 July began a program of aerial spraying with the insecticide malathion in an effort to control the infestation (*Science*, 24 July, p. 417). The decision to spray the chemical, which was essentially forced by the federal government, was taken amid a great deal of controversy about whether or not malathion poses a health hazard.

Perhaps the safest thing to say about all the furor is that many scientists think that the hazards were exaggerated. One of the organophosphates, malathion is related to nerve gas, a relationship that would appear to put it in bad company when it comes to spraying residential areas. But, according to Bruce Ames of the University of California at Berkeley, who is noted for his research on testing for environmental carcinogens and mutagens, "I don't think that it [the spraying] is hazardous at all for two reasons. The dose is incredibly low. And they have really tested malathion very thoroughly and it all indicates that it is pretty harmless."

In terms of acute toxicity, that is, what happens when an individual swallows or inhales a large quantity of a material all at once, Herbert Harrison of the Environmental Protection Agency (EPA) says, "Of all the organophosphates, malathion is the safest. It is not readily absorbed through the skin. . . . The only way you could kill yourself is to drink a substantial quantity."

According to the Registry of Toxic Substances, a publication put out by the U.S. Department of Health and Human Services, the oral LD_{50} (the dose required to kill one-half the population of test animals) for rats is 885 milligrams per kilogram of body weight. For comparison, the oral LD_{50} in rats for parathion, one of the most toxic organophosphate insecticides, is 20 milligrams per kilogram of body weight.

Ames points out that, because of the way malathion is being sprayed in California, largely in an area of about 140 square miles around San Francisco Bay, only about 1 milligram of the agent will be delivered per square foot. Moreover, the spray particles will be large, and because they contain a protein derivative that serves as bait for the Medflies, the particles congeal as they fall. All this tends to minimize the risk of their being inhaled. Finally, malathion has a short half-life, breaking down in a few days in the sun, although the spraying will be repeated every 7 to 10 days for 2 months.

A more troublesome issue than that of malathion's acute toxicity concerns its potential long-term effects, especially regarding whether or not it might cause cancer or birth defects. Here some questions remain, but in general malathion

Mediterranean fruit fly USDA

gets good marks on the appropriate tests. Says Kim Hooper of California's Hazard Evaluation System and Information Service, "Malathion was a gray compound in some tests. But if it were positive as a carcinogen, it would be weaker than saccharin." The sweetening agent, which has been implicated as a weak carcinogen in some tests, is, as we all know, still on the market. In fact, people in the United States consumed roughly 5 million pounds of saccharin in 1980.

In 1978, the National Cancer Institute (NCI), as part of what was then the Carcinogenesis Testing Program (and is now the National Toxicology Program) completed tests on the carcinogenicity of malathion in mice and in two strains of rats. The institute report concluded that the chemical did not significantly increase the cancer incidence in the animals. According to the EPA's William Burnam, however, reanalysis of the data by a statistical method different from that used by NCI suggested an increase in liver cancer in male mice that was of borderline significance. The EPA would still like to resolve this discrepancy.

Nevertheless, the doses given all the animals in the NCI study were high, up to a few grams per day. Ames points out that the TD_{50} (the amount that has to be consumed daily to produce cancer in half of the test animals) is about 1 microgram per kilogram of body weight per day for the extremely potent carcinogen aflatoxin, a product of a mold that grows on peanuts, among other places. The comparable figure for saccharin is 5 grams per kilogram per day. Continuing the comparison of malathion to saccharin, Ames concludes, "Spraying the malathion is the equivalent of putting a can of diet soda on your front lawn."

On balance, the available evidence suggests that malathion does not cause birth defects, although again there are some shady areas. The most extensive animal study thus far, which was performed by Kundan S. Khera of the Health Protection Branch of Canada's Department of Health and Welfare, turned up nothing significant. One of two smaller studies suggested that the agent might cause birth defects, but in Hooper's view, these were not as well designed as the Canadian study.

There have also been reports in the literature that malathion produces an increase in sister chromatid exchange, a chromosomal aberration indicative of harmful genetic defects, in cultured cells. But malathion is only a weak mutagen in this test, again in the same league as saccharin, according to Sheldon Wolff of the University of California at San Francisco. "It is just because sister chromatid exchange is so sensitive that we pick up anything at all," he explains.

To further explore the hypothesis that malathion might cause birth defects, investigators at the National Center for Disease Control will examine the data on birth defects that they have collected over the years to see whether any increase in the incidence can be spotted in areas where malathion has been used. Results of the survey are not yet in.

Because of mechanical problems with the helicopters doing the spraying, the

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California program got off to a slower start than was expected, prompting Governor Edmund G. Brown, Jr., to ask for federal assistance with the project. Meanwhile Medfly larvae have turned up outside the area where the infestation was originally thought to be confined. In one case they were found only 30 miles from the San Joaquin Valley, a major agricultural region. Ames, for one, thinks the start of the spraying program may have been delayed too long in the first place. He says of the Medfly, "It is like a case of gangrene; the longer the delay, the worse it is. It just spreads and spreads."

If the spraying program does not control the infestation, California agricultural officials may have to turn to other methods of combating the Medfly to protect their agricultural industry. The next most likely step is fumigation of California crops with ethylene dibromide, which Ames has found to be a carcinogen in test animals at a dose of 2 milligrams per kilogram of body weight per day. Hooper says, "This is a potent carcinogen in both species, mice and rats. It is spermatoxic and a mutagen in many tests." In other words, he thinks it makes a lot more sense to spray with malathion than to take the chance that ethylene dibromide will have to be used. Nevertheless, the whole situation has Hooper rather bemused. "I often have to tell people that a chemical is more hazardous than we thought," he says. "It is weird for me to be in this position [of defending malathion]."—JEAN L. MARX

Earthquake Prediction Retracted

Brian Brady of the U.S. Bureau of Mines in Golden, Colorado, has formally withdrawn his prediction of two mammoth earthquakes off the coast of Peru. Because the prerequisite seismic activity has not occurred, "The probability of the last two [large] events occurring is extremely small," he says. Brady informed his Peruvian colleagues of his decision in a letter prepared on 20 July. His withdrawal came 5 weeks after William Spence of the U.S. Geological Survey (USGS) in Golden, the scientist most closely associated with Brady's prediction, rejected it as being no longer supportable. More than 5 months earlier, the U.S. National Earthquake Prediction Evaluation Council flatly condemned the prediction as unsubstantiated and scientifically unconvincing (*Science*, 20 February, p. 808).

In the opinion of most seismologists, nothing predicted for Peru by Brady has occurred. Brady disagrees, but he concedes that not enough has happened to justify any longer his prediction of a magnitude 8.8 earthquake on 10 August and one of magnitude 9.8 on 15 September. Brady expected a dozen forerunners of the big quakes to strike a small region southwest of Lima last fall. Those moderate events did not show up in the USGS's worldwide records as they should have, but Brady says that a local seismic network detected two earthquakes of magnitude 3.2 and 4.5 that could have been all that was detected of those foreshocks. The next test came in mid-May when at least five earthquakes of magnitude 4.5 were due. Waverly Person of the USGS in Golden reports that, in the region that Brady considered crucial, nothing of that magnitude has happened. Along the Peruvian coast as a whole, he says, seismic activity has been "just about what you would expect." Brady says that local seismic networks did find two events of magnitude 3.8 and 4.2, which meant to him that the prediction could not be dropped.

The magnitudes of warning shocks, it seems, are not crucial in Brady's prediction scheme. The size of a foreshock of a large event cannot be reliably predicted, he says, unless its own foreshocks have been reliably detected. Thus, more common, smaller earthquakes can just as readily fit the requirements of his foreshock predictions. Spence, who had for several years provided evidence supporting the possibility of huge Peruvian earthquakes, bowed out at this point. The seismic record, he said, had clearly failed to support Brady's prediction.

Finally, after the largest predicted foreshock (magnitude 7.5 to 8.0) failed to appear on 28 June, everyone agreed that a necessary precursor had indeed failed to appear. Brady had seen this event as the final signal that the rock along 1900 kilometers of the sea floor off Peru had begun to fail on a microscopic scale. On the basis of his rock failure experiments in the laboratory, relativity theory, and his study of the San Fernando earthquake of 1971, Brady felt that the huge earthquakes predicted for August and September required such a foreshock. Without it, the big ones are extremely unlikely, he says. Perhaps his theory is wrong, but he may have simply misinterpreted the complex pattern of seismic activity in the area, he says.

Although the U.S. National Earthquake Prediction Evaluation Council had been convinced much earlier that Brady could not reliably predict great earthquakes with his theory, many Peruvians took seriously the prediction of a credentialed U.S. government scientist. "The impact on the city of Lima was greater than I had expected," says John Filson, the head of earthquake studies at the USGS in Reston. He visited there on the day of the predicted earthquake to lend credence to the council's boast that none of its members would mind being there then. In spite of his reassurances to the Peruvian press, the prediction was "taken very seriously," he says. Alberto Giesecke, former head of the Peruvian Geophysical Institute, agrees. The city seemed exceptionally quiet that day, he says, and many of those with the money to do so arranged to be elsewhere. Although taken seriously before 28 June, the prediction does not haunt Peruvians any longer. As one headline after 28 June put it, "Peru–Sí, Brady–No."

A lesson learned from the experience, some scientists say, is that the federal government's handling of earthquake predictions can still be improved. In particular, scientists have censured the Agency for International Development's Office of Foreign Disaster Assistance (OFDA). Filson notes that for 2 years the USGS had emphasized to OFDA that Brady's predictions totally lacked support in the scientific community, outside of Spence's feasibility arguments. These "early informal reviews by the Survey were not taken as seriously as we would have liked," he says. Clarence Allen of Caltech, chairman of the council, says, "Many of us are upset with OFDA's handling of this." In spite of the lack of scientific support, OFDA continued to place credence in Brady's prediction and even promoted the idea, he says.—RICHARD A. KERR

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