Microbial Pesticides: Coming, But Slowly

The concept of using insect pathogens to control pests has some problems to overcome before it gives chemical pesticides tough competition

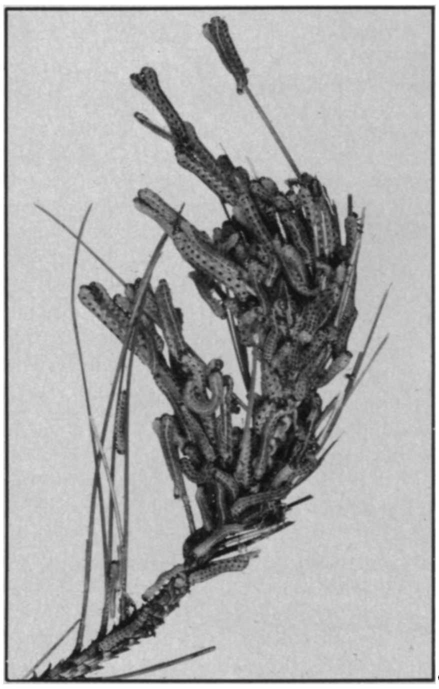
BY JOAN AREHART-TREICHEL

During the first half of the 20th century, DDT and other chlorinated hydrocarbon pesticides enjoyed astonishing success. Slowly but insidiously, however, pests started developing resistance to these pesticides, and because the chemicals persisted in the environment and accumulated in the food chain, they began poisoning plankton, fish, birds and even mammals. After that, less persistent but more toxic organophosphate pesticides came into vogue. But they weren't the answer either, for while they tended to spare animals, they threatened humans. Thus, some farsighted biologists asked why we can't control pests with their own natural pathogens. Such microbial agents would be both effective and safe because they would be part of the natural scheme of things.

Now, 10 or 15 years later, some microbial agents are commercially available in the United States and others are in use by the government on public land. Yet they are hardly giving chemical insecticides much competition, comprising only $15 million of a $500 million market. The reason? Some serious problems must be overcome. This fact was brought home at the 1977 annual meeting of the American Institute of Biological Sciences in East Lansing, Mich., at a symposium entitled "The Economics and Efficacy of Microbiological Agents in Biological Control."

Researchers both in the United States and other countries are coping with the difficulties and are forging ahead with microbial agents. True, those in the field are not sure whether microbials will ever completely replace chemicals, but they are confident that microbials still have a major role to play in the overall pesticide market.

What are some of the microbial agents already commercially available in the United States? The most widely used is a bacterial agent, *Bacillus thuringiensis;* it is used to control a wide range of leaf-eating caterpillars. Abbott Laboratories markets this bacterium under the trade name of Dipel; Sandoz, Inc., under the name of Thuricide; and Nutrilite Products, Inc., under the name of Biotrol. Another bacte-



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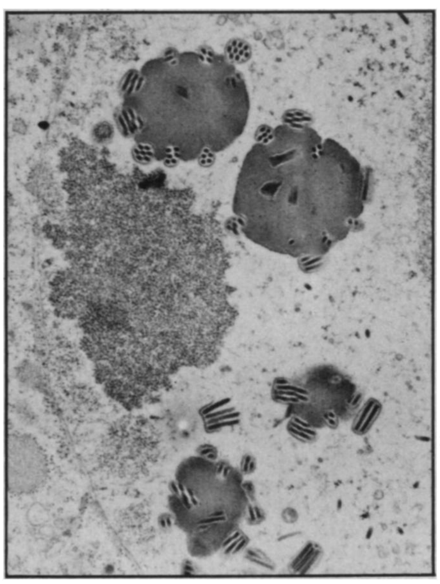
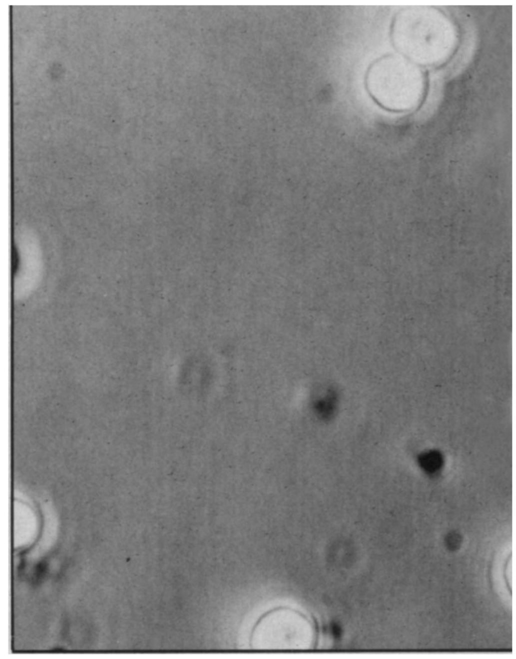
Canada fights the European pine sawfly that can defoliate a small pine in a week.



Jean R. Adams/USDA

Cabbage looper virus: One of a growing number of promising microbial pesticides.

rial agent, Japidemic, is marketed by Fairfax Biological Laboratories for management of Japanese beetles and is sold on the Eastern seaboard to protect home lawns, golf courses and grass on airfields. A viral product called Elcar is sold by Sandoz for use against cotton bollworms and tobacco bollworms. Viruses for fighting

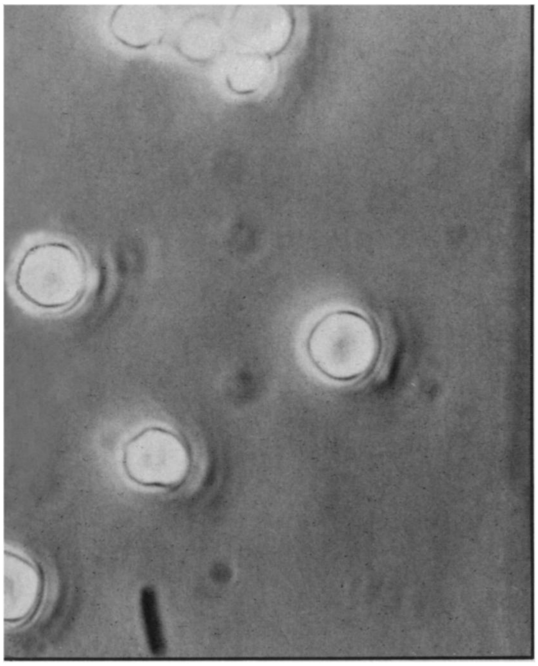


the gypsy moth and Douglas fir tussock moth have also been developed by the U.S. Forest Service and registered by the Environmental Protection Agency, but they are not as yet commercially available. A nematode parasite for controlling mosquitoes is also being produced by Fairfax.

Yet these microbial controls are hardly more than a twig in field or forest compared with the hundreds of chemical pesticides already available. One of the major reasons microbial pesticides lag behind is that it is time-consuming and tricky to develop them. For instance, chemical pesticides can be synthesized in large batches for mass use, but this is not the case for most viruses, bacteria, protozoa, fungi and parasitic worms that attack pests and that could be used for biological controls, explains V. Frank Boyd of Sandoz, Inc. in Homestead, Fla. The only organism lending itself readily to mass production has been *B. thuringiensis.*

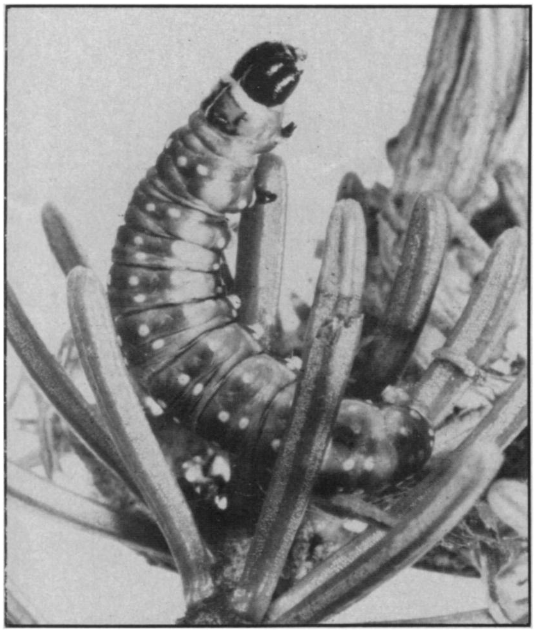
Another problem in getting microbial insecticides to the market is keeping them stabilized so they will have a durable shelf life before use. For example, crude viral material is more effective in fighting pests than is purified viral material, because it contains proteins that provide a stabilizing effect, explains J.C. Cunningham of Canada's only large-scale viral pesticide program — the Forest Pest Management Institute in Sault Ste. Marie, Ontario. But this viral material also contains bacteria. So if it sits around for a few days after being formulated in water, the bacteria multiply, and it gets rather rank. More research is required to develop a product that can be supplied to the public, he admits.

A third obstacle to getting microbial agents marketed is the difficulty of making them work over thousands of acres as well as under lab conditions. Microbials do not always perform consistently in the field because of variations in temperature and moisture, explains Robert J. Cibulsky of Abbott Laboratories. It may also take a microbial pesticide several days to kill insects that a chemical will kill in a shorter



Yendol/Penn. State Univ.

Gypsy moth virus as biological pesticide: Yet to become commercially available.



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Eastern spruce budworm destroys trees by the millions. Viral agents may stop it.

time or may even kill instantly.

The marketing of microbial pesticides is also being retarded by the currently unresolved question of who should make them. It can easily cost a company several million dollars to research and develop a microbial agent, Cibulsky points out, so companies do ample thinking before they sink money into them, particularly when they have the option of producing equally profitable chemical pesticides or drugs instead. Then there is the difficulty of conducting efficacy and safety tests on new microbials, especially in order to meet hazy EPA guidelines for registration. EPA guidelines for safety testing have cleared up a bit during the past five years or so, Franklin B. Lewis of the U.S. Forest Service in Hamden, Conn., concedes, but not guidelines for efficacy testing or production. "This is an unfortunate situation from a practical view," he asserts.

But perhaps the biggest hurdle of all to the widespread marketing of microbials is making them economically competitive with chemical pesticides. There are many chemical pesticides on the market for cotton, which is the largest pesticide market in the world, and farmers are more likely to buy from this large, well-established line than to purchase some newly arrived, unfamiliar microbial agent, Cibulsky says. There is also tremendous consumer pressure on farmers to grow perfect-looking produce, he adds, and chemicals are more likely to completely protect crops than microbials are.

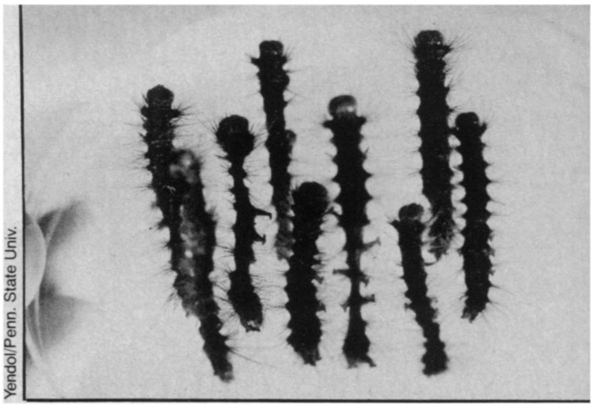
Nonetheless, progress is being made toward coping with this problem. Legislation is being proposed in an effort to change public attitudes toward cosmetic pesticide use, reports Robert L. Ridgway of the U.S. Department of Agriculture's Agricultural Research Service in Beltsville, Md. Also, some of the other obstacles to the widespread marketing of biological pesticides are being overcome.

As of this autumn, the USDA will be placing more emphasis on the development of microbial agents than before, and it will be exploring ways of providing industry with more incentives to market them, Ridgway says. Firmer EPA guidelines on efficacy and safety tests for microbials should also emerge in the near future, William G. Yendol of Pennsylvania State University predicts, since the EPA asked an AIBS task force to collect information on the efficacy of microbials, and since the task force is just now reporting its findings to the EPA.

A National Science Foundation workshop on microbial pesticides, to be held this month in Gainesville, Fla., should also further the marketing of microbials, George E. Allen of the University of Florida at Gainesville believes, because it will deal with the better use of agents already available. Large farm use of microbials is also getting underway. The state of Mississippi and cotton growers in that state are using microbials to control the bollworm, Boyd points out, and whereas Sandoz now has to produce viral agents within insects, it may be able to grow them in tissue culture in the future.

As for the problem of who should develop microbials, Cibulsky proposes that the government initiate the basic research and toxicology, then let companies manufacture the agents. Boyd agrees, particularly since microbials are natural products and not patentable. He suggests that government agencies conduct research on agents, then turn them over to companies for exclusive marketing for a number of years.

Meanwhile, the search for more microbial agents continues. The USDA-ARS has 40 scientists working in programs that are designed to develop bacteria, viruses, protozoa, fungi and nematodes that might make good pesticides. The research is tak-



Yendol/Penn. State Univ.

Gypsy moth larvae infected with a virus. Note characteristic "hanging downward."

ing place at four major centers—in Beltsville, Md., Columbia, Mo., Peoria, Ill., and Brownsville, Texas. Three particularly promising agents emerging from these programs, Ridgway reports, are a bacterial agent to control caterpillars, a virus to control the bollworm and tobacco budworm, and a protozoa to manage grasshoppers.

Canada's Forest Pest Management Institute is progressing in the development of viral agents to fight the European pine sawfly, which can completely defoliate small pines in a week; the Douglas fir tussock moth, and the Eastern spruce budworm, which has killed millions of acres of balsam fir in eastern Canada and the United States. So far, institute researchers have tested these agents on thousands of acres of forest in Ontario and British Columbia and have found them effective in preventing insect outbreaks for several years running.

The German drug company, A.G. Hoechst, which started researching viral agents in 1973, is targeting its research at an international pesticide market. According to Hoechst's Ernst-Friedrich Schulze, "We think we can produce a largely standardized laboratory preparation by the end of 1978 and should be ready for commercial production in another four or five years."

Still other areas of current microbial research, Cibulsky points out, include a bacteria pathogen of certain mosquito species, a fungal agent for beetle grubs, a fungal agent for mosquitoes and aphids and insect viruses needed for integrated control of pests on cotton, corn, apples and other crops.

Thus, those scientists working in the area of microbial pesticides remain optimistic that, even if microbials never completely replace chemicals, they will certainly give them more and more competition. Asserts Cibulsky, "I don't think in the next five years we are going to see many microbial agents replace chemicals, but we will probably see more supplementation."

Declares Boyd, "It's no secret that the squirt, spray, dust knock-down-and-kill chemical insecticides are a thing of the past. There is a gradual phasing out by industry of chemicals and the arrival of biologicals due to environmental problems." □