Diagnoses of Insect Diseases

microbial infections in insects diagnosed as part of the research in developing new ways of controlling crop pests

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The first successful experiments in microbial control of a California crop pest had their beginning in the diagnostic part of the laboratory of insect pathology in the Division of Biological Control in Berkeley.

This diagnostic laboratory is the only laboratory of its kind in the United States that is equipped and has the specially trained personnel to diagnose diseases caused by all five groups of organisms responsible for most insect diseases—viruses, bacteria, fungi, protozoa, and nematodes.

The general aims and purposes of the laboratory are: *1*, to acquire basic information and knowledge about the diseases occurring naturally in insects, and the effect of these diseases on insect populations; *2*, to investigate possibilities of using these diseases in the control of insect pests; *3*, to treat and prevent diseases of beneficial insects, and to assist insectaries in keeping their stocks of insects healthy; *4*, to study the nature and properties of the five groups of organisms responsible for most microbial infections of insects.

What started out to be a research service to university entomologists has developed into a project of world-wide proportions and significance—and one that directly benefits California agriculture.

Facilities for this diagnostic work have only recently been formally initiated, but during the past three years approximately 400 unsolicited shipments of sick and dead insects sent to the laboratory have been diagnosed as to the cause of the disease concerned. The rate of shipments received is increasing.

Control Method Suggested

The first reported instance of successful microbial control as a consequence of the work done in the diagnostic part of the laboratory was initiated when an entomologist brought in a sick alfalfa caterpillar for diagnosis. His interest was primarily one of ecology—the mutual relations between organisms and their environment—but the rapid disintegration of the infected caterpillar suggested a possible means of control.

The disease was diagnosed as a polyhedrosis—a wilt disease of the alfalfa caterpillar—which kills the insects and occurs naturally in epidemic proportions.

Unfortunately natural outbreaks of the polyhedrosis usually appear so late in the larval life of the insect that most of the damage to the alfalfa is done before the caterpillars are destroyed by the virus.

Experiments were undertaken and in 1948 field tests demonstrated the possibility of advancing the time of the outbreak of the disease by infecting populations of the alfalfa caterpillar with the polyhedrosis virus.

Further experiments in 1949 involved the use of airplanes to spread the polyhedrosis virus over fields infested with alfalfa caterpillar. In one of the tests—on a ranch near Dos Palos—100% of the caterpillars in each treated plot were infected while only a small percentage of caterpillars developed the disease naturally in the untreated plots.

These tests indicated that epidemics of polyhedrosis can be started artificially and are capable of reducing potentially destructive populations of the pest to subeconomic levels.

Aid in Microbial Control

The co-operation between inquiring scientists and the laboratory has already led to the discovery of about 30 new insect diseases, to a better understanding of the dynamics of natural outbreaks, and

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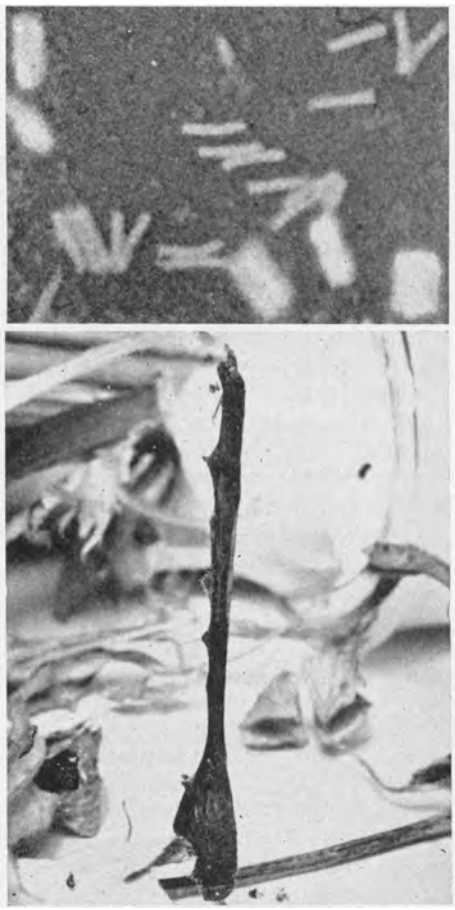
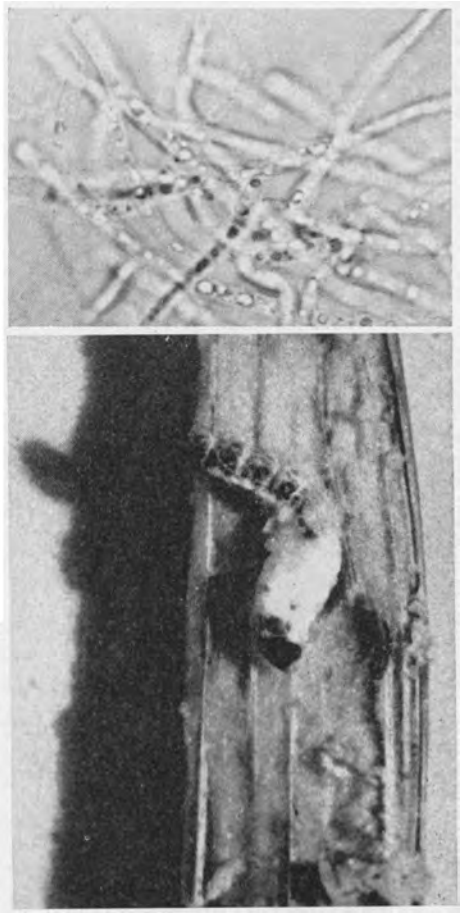


Top: **An electron micrograph of the virus, occurring as single particles and in bundles, responsible for the polyhedrosis of the alfalfa caterpillar. Magnified 30,000 times.** ***Bottom:*** **An alfalfa caterpillar dead of polyhedrosis. The fluid contents of the body have gravitated to the anterior end of the insect.**



Top: **Light microscope preparation showing hyphal threads of the fungus *Beauveria bassiana*. Magnified 870 times.** ***Bottom:*** **Larvae of European corn borer killed by *Beauveria bassiana*. The whitish coat of the fungus covering the anterior part of the larvae is visible to the unaided eye.**

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to the development of promising new methods of pest control.

The majority of diseased insects sent to the laboratory for diagnosis come from California research institutes, insectaries, farm advisors, and farmers but some 60 shipments have been received from 16 other states, as well as from Hawaii, Puerto Rico, and Washington, D.C. Over 25 shipments have come from foreign countries including Canada, China, India, Burma, Australia, South Africa, New Zealand, Israel, Great Britain, France and others.

In many cases experimental projects in the Berkeley laboratory were started with disease material received from other states, and even from abroad.

A bacteriologist in Maryland sent in a culture of a spore-forming bacillus which another scientist had brought from Germany before the last war. This bacterium—*Bacillus thuringiensis*—was tested on a number of California crop pests, and has shown some promise in the control of such insects as the alfalfa caterpillar.

Comparative Studies

Shipments of diseased insects from out-of-state and from foreign countries also permit comparative studies with the diseases of pests from California fields and orchards.

Diseased larvae of the codling moth taken from apples and walnuts in southern France are just as welcome as those sent in from an orchard in Yolo County. Any shipment that arrives at the insect pathology laboratory may bring material that might supply the missing knowledge of a still uncontrolled crop pest.

The potential benefits to be derived from a wider knowledge of pest diseases are not limited to insects now rampant in California.

For some months shipments of dead European corn borers have been arriving from Iowa. The control of this insect is one of the most important entomological problems in the United States. In recent years it has spread from the Middle West as far west as Colorado. Efforts to control the pest include attempts to discover an infectious organism that could be utilized in field applications to control the borer.

Aid in Allied Research

Another type of service performed by the laboratory consists in diagnosing and stopping outbreaks of disease in insects being reared in insectaries, including those being reared for testing the effects of insecticides as well as those reared as insect parasites.

One California company manufacturing insecticides found its tests of a new insecticide hampered by outbreaks of a disease that killed the test insect—variegated cutworm—and interfered with the evaluation of the tested chemical. The disease was diagnosed as a granulosis, a type of virus infection not then reported in the United States. This discovery presented new control possibilities. At the same time the insectary was advised how to rear healthy specimens of the cutworm for the company's experiments.

Other manufacturers of insecticides, as well as laboratory research people, have sent in insects whose untimely death ruined their experiments. In these cases the diseases are diagnosed and cures or preventative measures suggested. Often the outbreaks can be stopped by simply changing the humidity and temperature in the insectary. In other cases measures such as the institution of better sanitation or even the replacing of the stock may seem advisable.

Shipping Procedures

Insects sent in for diagnosis, cure, or out of curiosity, may help complete the still sketchy picture science has of insect diseases.

When possible, shipments should consist of: *1*, healthy insects; *2*, insects in the early stages of the infection; and *3*, insects moribund or dead of the disease.

The electron microscope, a tool in the diagnosis of insect virus diseases.

Each of these groups should be kept well separated from the others, but may be included in the same large package.

Shipments should be sent to the laboratory by the fastest possible means—by air mail where the distance is considerable. They can be packed in any tight container, such as clean glass vials, pill boxes, and the like, but should not be placed in alcohol or other preservatives.

Certain information should always accompany each shipment: *1*, the scientific and common names of the insect when known; *2*, the exact locality at which it was collected; *3*, the extent of the disease outbreak and the conditions under which it occurred; *4*, the name of the host plant or animal; *5*, the name of the collector.

Identification

If the disease can not be recognized at the laboratory by general observation, various techniques, procedures, and equipment such as several types of microscopes, including the electron microscope, are used.

In some cases the microorganism is cultivated on artificial media and identified through subsequent study. Other times special histological sections are prepared which enable the scientists to arrive at a diagnosis. By employing these and certain other specialized techniques it usually takes only a short time to determine the cause of the insect's illness or death.

Sometimes the cause of the disease may be so complex that several weeks are required before the full story can be known. Finally, however, a full diagnostic report is made out and sent to the person who submitted the diseased specimens.

Basic Research

The successful use of microorganisms in the control of insect pests depends to a large degree on the thoroughness with which the basic research required for such work is accomplished. The diagnostic service provided by the laboratory of insect pathology constitutes such fundamental research.

The laboratory performs a direct service not only to other scientists and specialists but to farmers and growers in furnishing information relating to insect mortality.

Such activity enables the California specialists to be in a position to discover new diseases and afflictions which may eventually be put to practical use in efforts to aid in the control of certain insect pests through the agency of microorganisms.

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The above progress report is based on Research Project No. 1310, being conducted by the Division of Biological Control.