Saving the French Silk Industry

Entomology

By MARJORIE MACDILL

Once again the silk growers of France have had to call in the aid of science to rescue an industry that, in these days of slender silhouettes and diaphanous garments, gives that country an important source of income.

Though attempts to produce silk commercially in the United States have resulted in a complete flop, the recent setback in French sericulture and the ensuing research has a closer bearing on home affairs than the price of silk stockings. The secret lies in an interesting point in insect epidemiology: the disease of the silkworms, responsible for all the havoc among the nurseries of the Midi, is very closely related to a malady that attacks in epidemic form three well-known members of the U. S. Bureau of Entomology's Rogues' gallery; namely, the army worm, the tent caterpillar and the gypsy moth.

Obviously here is a fine example of what is one man's meat is another man's poison, or, in this case, vice versa. What French scientists find out about this dreaded disease of the industrious little caterpillars of the mulberry tree is likely to come in handy during the next outbreak of the army worm or in standing off the inroads of the gypsy moth in New England woodlands. Using some other parasitic insect to attack a pest is old tactics, but the epidemiology of insect diseases as a factor of control in agricultural warfare against six-footed invaders is a possibility that is just beginning to be talked about. Consequently every piece of new information on the subject that is uncovered is eagerly awaited by entomological investigators.

The first time that silk culture in France stood in grave danger of extinction from one of these epidemics in miniature was in 1865. The consulting expert then most eligible to draft by the minister of agriculture to salvage the source of crepe de chine and Lyons velvet was no less person than Louis Pasteur, the father of modern bacteriology. At that time Pasteur, who had started out in life as a chemist, had never seen a silkworm. T. J. H. Fabre, one of the great figures of entomology, whose wasps and beetles will live as long as French is read or translated, was given the task of instructing so famous a pupil.

Long years after Fabre related the story of the experience in a tone not entirely devoid of sarcasm. "He knew nothing," declared the eminent savant, "of the metamorphosis of insects; for the first time he had just seen a cocoon and learned that in this cocoon is a something, a sort of rough outline of what will one day become a butterfly; he was ignorant of what is well known to the most insignficant pupil in our southern schools and this novice, whose naive questions astonished me so much, was destined to revolutionize the hygiene of the silkworm nurseries even as he brought about a complete revolution in the practice of medicine and general hygiene."

LOUIS PASTEUR saved France's silk crop in '65. Now his modern successors have been called on to repeat the performance

In less than five years Pasteur succeeded in elucidating the problem of pébrine, the disease that had cut down production in some sections to one-half, and in putting into practice an effective and practical method of control. Silk culture was saved in a grave crisis that could have wiped out the industry in France. The selection of healthy stock following the principles laid down by him are still in use today and give excellent results.

Unfortunately, centuries of domestication and the necessity of raising caterpillars in nurseries in large numbers where epidemics spread rapidly from one individual to another, make the silkworm a ready prey to disease. Though, thanks to Pasteur, pébrine has almost disappeared, there are plenty of other maladies to take its place. The most troublesome of these are the diseases known as grasserie and flecherie. The ravages of these plagues in the regions of extensive culture, notably in the departments of Arceche and le Gard in the lower Rhone valley, finally came to such a pass about five years ago that a request was made to the minister of agriculture to appoint a scientist to study them and, if possible, find their causes and some means of prevention.

Dr. Andre Paillot, formerly of the University of Lyons, who had been engaged in research on insect diseases for many years, was chosen to be chief physician to innumerable myriads of small wriggling "patients". He started out in 1924 to work on the task which kept him actively on the job for about three years. In order to come in close contact with the growers and study, first hand, actual conditions in the nurseries, Dr. Paillot had made an automobile specially equipped for laboratory work in the field. Drawers for bacteriological paraphernalia were fitted into the back seat, shelves for holding other supplies were screwed to the sides of the sedan body while a high powered microscope was fastened to a stationary base so that immediate examinations could be made. Glass boxes held caterpillars artificially inoculated for experimental purposes while a microlamp and centrifuge, operating on the battery current of the car, completed the outfit. In this way he could work on fresh specimens before any secondary infections had a chance to set in and obscure the original cause of disease. In the winter the laboratory had a fixed base at Saint-Genis-Laval.

Grasserie, the disease which Dr. Paillot found was making the most serious inroads in the infected regions, has been known since a very early date. The first known record occurs in some Latin verses entitled, "The silkworm of the mulberry tree", by a poet Vida who wrote them in 1527. He described the symptoms recognizably enough and attributed the malady to the evil influence of the winds from the Mediterranean, an idea that still prevails among the peasants of the Midi. In the eighteenth century the disease was well known but its ravages do not appear to have been so severe as those of recent time. Later on in the nineteenth century (*Turn to next page*)

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Italian scientists devoted considerable attention to it. In the last twenty-five years entomologists in the principal silk growing countries have made detailed researches with grasserie while in Germany and the United States careful studies have been made on the closely allied diseases that attack pests, such as the nun moth of Europe and the gypsy moth and tent caterpillar of this country.

All these affections belong to a group known as the polyhedral diseases. They attack only members of the moth and butterfly family of insects, and these in the larval and pupal stages only. They are believed to be caused by a filterable virus, the type of causative agent that is so minute that it will slip through a fine porcelain filter. The name arises from myriads of tiny geometrically shaped bodies that can be seen in the blood of diseased insects under the microscope. It was once thought by some that these polyhedra were the cause of the disease, but recent work has shown fairly conclusively that they are only the decomposition products of the action of the virus on the insect's body.

In Germany where there have been one or two very striking epidemics among nun moth caterpillars, the disease is known as "Wipfelkrankheit" from the fact that all the sick caterpillars crawl up to the tops (German, Wipfel) of the trees, hang there by their last pair of legs and die in large numbers. In this country it is simply known as wilt. The affected caterpillars lose their appetite, take no food and subsequently die. Grasserie takes its name from the "gras vers" (fat worms) that are slightly swollen and covered with yellowish splotches. They likewise refuse food and die in large numbers.

Though these diseases are very like it has been proved that they are separate and distinct, since it has not been found possible to infect caterpillars with the virus from diseased caterpillars of another species.

Caterpillars can be inoculated with the diseases by feeding them with the infected virus or leaves which have been stained with the blood of infected insects. Dr. Paillot discovered that he could inoculate worms with the blood of insects infected two days previously and in which no polyhedra could be detected at the time. As the result of many experiments and observations he came to regard the disease to be due to ultramicroscopic intracellular (*Turn to next page*)

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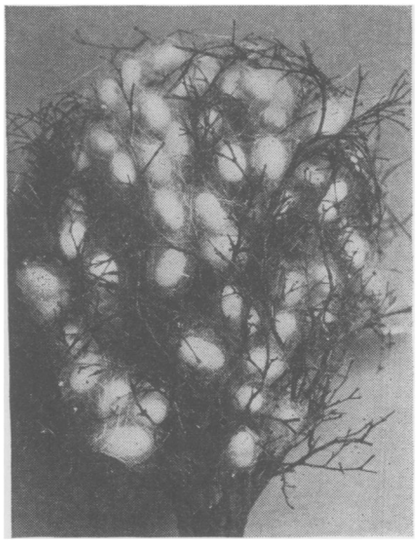

FROM SILK COCOONS like these come silk stockings and shirts

organisms which destroy the nuclei of certain cells. The parasites were invisible by ordinary light but under the ultra-microscope they could be seen as minute animated granules of less than one two-hundred-fiftieth of an inch in diameter. They could be strained out of the infective virus by very fine-pored porcelain filters and this filtrate was found not to be infectious. This, he concluded, was good evidence that the minute granules were the cause of the infection. He gave these infinitesimal particles, so much smaller than ordinary germs, the new name Borrellina in honor of his friend, Professor Borrel of the Pasteur Institute.

Though it is stated of the polyhedral diseases that they confine themselves to the caterpillar and pupae of moths and butterflies, Dr. Paillot believes that he has seen the causative organisms under the ultramicroscope in adult silkworm moths. If it is true that the moths carry the disease and transmit it to the eggs, it would be comparatively easy to stamp out the disease just as Pasteur eradicated pébrine. A moth was allowed to lay her eggs on a square of cloth and then was killed and her body examined microscopically. If the germs of pébrine were present, both moth and the square of cloth containing the eggs were burned. Unfortunately the causative organism of grasserie is so minute that its demonstration under even ultramicroscopes is exceedingly difficult and is not at all practicable in the present state of scientific knowledge of the problem.

Though this phase of his work has not been entirely substantiated by other workers, Dr. Paillot believes that the disease is transmitted by moths to their eggs and that the different caterpillars hatched therefrom have various degrees of resistance to the malady which may be broken down by exterior predisposing conditions. Therefore his plan of eradication is a rigid inspection of breeding stock. In France this is no longer in the hands of independent growers but is controlled by specialists in the employ of the French government. In this way it is possible to give out eggs to the growers that come only from known parentage. If any of the stock at any stage of development shows signs of grasserie, they are immediately destroyed and the racks in the nurseries that they have occupied disinfected.

Heat and humidity and insufficient food were found to be important predisposing causes for the development of the disease. For this reason Dr. Paillot recommends that the temperature of the nurseries be kept constantly in the neighborhood of 65 degrees Fahrenheit.

At all times the nurseries should be kept scrupulously clean and periodic disinfections made. Infected worms should be burned, but the best course, he points out emphatically, is prevention by cleanliness, disinfection, and carefully controlled stock.

The problem of flecherie, on which Pasteur worked for a time, was also taken up by Dr. Paillot. This work was left in a rather incomplete state by the great bacteriologist and Paillot took up the trail where his famous predecessor left off. As the result of his investigations, he declares that flecherie is not the single morbid entity that it was formerly believed to be but is a whole group of maladies that affect the intestinal tract. All are characterized by symptoms of dysentery. Of the most practical importance among the microbic dysenteries is the one which has for its cause a germ that Pasteur observed under the microscope and called descriptively "a ferment of a string of beads", now identified as the germ *Streptococcus bombycis.* When this streptococcus infection is complicated with a secondary infection, as it frequently is, the resultant symptoms are those of true flecherie, or the flecherie of Pasteur.

Complicated as the problem is of stamping out diseases among the busy little spinners of the world's most highly prized fabric, putting the process in reverse on this side of the Atlantic to wipe out similarly affected pests is still harder.

No one who has seen extensive epidemics of wilt or Wipfelkrankheit can fail to be impressed, said one American entomologist recently, with the tremendous value of these diseases. They can accomplish a greater reduction of pests than do the combined efforts of all artificially introduced parasites, human spraying and other control measures. Yet man has been able to do very little as yet in the way of their artificial propagation in the places where they are most needed. Trees have been sprayed with emulsified caterpillar corpses but later in the season wilt took just as great a toll in another untreated lot of the same size which was miles away from the first. Quantitative experiments among high trees and underbrush subject to heat, cold and rain are more difficult to perform than experiments under laboratory control. Some sort of human endeavor, however, combined with the natural efficiency of the polyhedral diseases does hold out the hope, some entomologists believe, that they may possibly be utilized here advantageously in the future.

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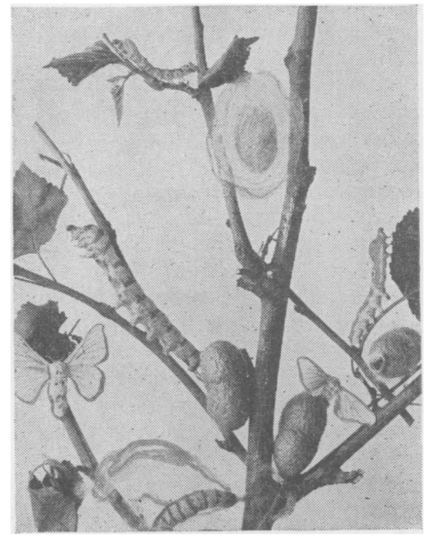

SILKWORMS, pupae, cocoons, adult moths and eggs—the whole silkworm family