

tically infinite source of energy will be at the free disposal of man, the consequences of which can hardly be foreseen.

SEARCHING FOR PARASITES TO FIGHT FRUIT PESTS.

BY H. A. CRAFTS.

A most unique calling is that of George Compere, chief field entomologist for the Department of Horticulture, State of California, and also for the Department of Agriculture of Western Australia. His work consists in searching the world for beneficial insects, or parasites, for the preservation of the fruit industry of the two states mentioned, from the ravages of insect fruit pests. The reason that he is able to serve both governments at once to their mutual satisfaction is that the fruit pests of California and Western Australia are identical with but few exceptions. Two of these exceptions are comprised in the codling moth and the fruit fly; the first is prevalent in California, but not in Western Australia, and the reverse is true of the second.

The prime object of three out of the seven world tours made by Compere was the finding of the parasite, or natural insect enemy, of the fruit fly; yet Compere did not forget the interests of his own State while making these tours; among the beneficial insects calculated to combat the fruit pests of California obtained by him during these travels was the parasite for the codling moth, which he found on the western coast of Spain, and one for the purple scale, discovered in the interior of China.

Compere's methods are peculiar to himself. When starting upon one of these insect expeditions, he severs all social ties, and remains in communication only with the horticultural officials of the two countries employing him. He goes alone and unattended, and engages no helpers until he arrives in a field of immediate search; then he may hire a guide, and perhaps an interpreter.

During his long sea voyages he is immersed in his collection of books on entomology, and studies them carefully in their bearing upon his peculiar line of investigation. But no sooner is a landing made, although it may be only for a few hours' stop at some lonely island in the middle of the Pacific Ocean, than Compere seizes his paraphernalia and hastens ashore to hunt insects until the steamer shall proceed.

His outfit on one of these expeditions is simplicity itself. It consists of a large sheet of white cotton cloth, a stick, an insect-case, and a microscope. As soon as he espies a tree or shrub that he thinks may be inhabited by some important member of the insect family, he proceeds to spread his sheet underneath its boughs, and when that is done he begins to beat the branches with his stick. When he has dislodged a great number of insects, he falls upon his knees, with the microscope to his eye, and makes a careful scrutiny of the sheet. Should he discover any interesting individual he proceeds to capture it, and consign it to his insect case.

And thus Compere goes about the world, hunting every nook and corner; plunging into jungle, morass, or tropical forest in his tireless search for more insects, regardless of personal danger. Once while traveling in India he found himself in a plague-infected district, and lost five guides in succession from the disease before he had completed his search. Then he was detained in quarantine on the frontier, and when he was about to leave, the local officials took it upon themselves to fumigate his baggage. Among his baggage was his case of insects, and every one of the creatures was killed by the noxious fumes. Then all the labor Compere had been to, all the dangers he had braved upon this expedition, came to naught. But the next season saw him on the ground again, and this time he was more successful.

One may ask why it becomes necessary to search in foreign lands for these beneficial insects, and why they may not be found within the borders of the State of California in conjunction with the injurious insects. This is quite readily explained: California is a new State, and her fruit industry is of comparatively recent origin and of very rapid development. Neither the injurious nor the beneficial insect was in the State originally. The first came in through negligence and lack of foresight; the second can be brought in only by great labor and research. The early fruit growers were more influenced by enthusiasm for the introduction of new and rare fruits than by wise caution in not importing at the same time about all the fruit trees in the known world. The pests came in through infested trees, shrubs, green and dried fruits, etc., because in the early days no one thought of horticultural inspection and quarantine such as California has since established; but the parasites did not come with them; so the pests gained a foothold, multiplied by the million, and have been productive of infinite evil.

Again, it may be asked why it is so difficult to obtain these parasites even in foreign lands, which are apparently their natural home. This question is also easily answered: In lands where pest and parasite

exist in conjunction, there is eternal war between the two species; one is on the offensive, the other on the defensive, with the parasite always in the ascendancy.

The pest gradually disappears under the constant attacks of the parasites, and as it disappears the parasite is deprived of its natural food; for under no conditions will it subsist upon a vegetable diet; and then the parasite disappears by reason of a food famine. So Compere does not look for a parasite in any locality where the pest is prevalent, for the very presence of the pest is proof positive that the parasite is not existent in that neighborhood, but must be looked for in some place where the pest is very scarce; and the pest or natural food of the parasite being scarce, of course that insect is found in diminished numbers; consequently the search for it is made much harder.

After the search has been made and the insect found, comes the delicate and difficult task of transporting a colony to one or both of the two countries in whose interest the search has been made. This requires patience, perseverance, and a considerable amount of ingenuity and inventive genius. You cannot pick up any kind of an insect and put it in your pocket and carry it home some 25,000 miles, nor can you send it by mail or express and stand any chance of its arriving at its point of destination alive and in good condition. There is a difference in insects and the ways of handling them.

Take Compere's experience with the parasite for the fruit fly! The discovery and final landing of this insect in West Australia required three consecutive tours of the world, as I have already stated.

There was one long and unsuccessful hunt in the Orient; then Compere heard of the insect having been in Washington, D. C. To that city he went, and learned that the creature had been sent to the Smithsonian Institution in that city for identification by Dr. H. Von Ihering, director of the museum at Sao Paulo, Brazil, but had been returned after identification. That was a good enough clew for Compere, so he hurried down to Bahia, and in that neighborhood found the object of his search, in the shape of a large beetle.

There are two general classes of parasites that are sought after to prey upon the fruit pests—the internal and the predaceous. The first is one that lays its eggs in the grub of the injurious insect, and as the young hatch and develop they feed upon the surrounding tissue, and the pest is killed in embryo. The predaceous parasite is one that in its mature form pounces upon the pest insect in whatever form the latter may be found and devours it.

The Brazilian beetle discovered by Compere belongs to this last described class and the naturalist decided to herd a lot of them together, confine them and then personally conduct them all the way to Perth, West Australia, *via* London and Marseilles. He had constructed a tin case containing compartments and he divided his colony of beetles into sections, and put a section into each compartment. Then he secured passage on the first steamer out that was going his way; secured on board a corner in which to keep his insects, and then provided for feeding them on grubs on the voyage. He secured an ice box, charged with ice, and filled it with fresh meat; then he caught a lot of blow flies and shut them up in a tin case by themselves. Next he provided an open case in which to place a piece of meat for exposure to the blow flies, and still another case in which to place his maggots as fast as they developed upon the meat.

The maggots were used as food for the beetles. But the latter proved to be hungry fellows, and they devoured between one hundred and two hundred maggots per day, and Compere was compelled to exert himself to secure a sufficient amount of food, and he was constantly filled with anxiety as he observed that the bugs were regular cannibals, and just so soon as grubs became short, turned upon one another.

He kept them alive, owever, until he reached London, and in that city, hiring a cab, he scoured the precincts in search of suitable food for his hungry beetles. Happily he ran across a firm in Gray's Inn which made a business of supplying fishermen with bait, and of them he bought two gallons of maggots.

These lasted until he reached Port Said, and in that vicinity he discovered that the very fruit fly which was the natural food of the beetles was prevalent in that region. Here he secured sufficient food for his beetles for the balance of the journey to West Australia, where the insects were landed alive and in good condition, the journey from Bahia to Fremantle having occupied a period of forty-six days.

But in West Australia a new and unlooked-for difficulty was encountered. It was in the dormant period of the fruit fly that the beetles arrived, and therefore there was no food for them. They were placed in cold storage, in the hope of keeping them alive until the fruit fly season opened, but in this the entomologists were disappointed, and the next year Compere found it necessary to make another trip to Brazil

after more beetles. This expedition was properly timed, another colony of beetles was secured and successfully transported to West Australia, where the insect has since been bred by the million and turned loose upon the fruit fly.

The securing of the purple scale parasite in China and its transfer to California were accompanied with almost equal difficulties. This parasite, unlike the fruit fly parasite, is a minute wasp, so small as to be almost invisible to the naked eye, and is one of the internal species.

It was transferred in this fashion: The California horticultural officers at San Francisco secured from Southern California a number of small lemon trees heavily infested with purple scale, and these were potted, boxed up, and dispatched to Compere in China, as soon as he had found his parasite.

As the little trees reached him he unboxed them and exposed them to the parasite until they became thoroughly infested with that insect. Then he reboxed the trees and dispatched them back to California.

The product of his first expedition died in cold storage on the way over from Hongkong, and this necessitated making a second trip. This latter was successful and the little wasps are being reared in their new home in immense quantities and sent into the scale-infested orchards of the southern part of the State.

SCIENCE NOTES.

Work on the Panama canal is progressing faster than has been calculated, and as a result it is estimated that the expenses for the current year will exceed appropriations by about \$8,000,000. The office of the canal commission has issued the following statement: "With the present organization and the progress which now is made, the canal can be completed more rapidly than by restraining expenditure within the appropriations which were made at the last session of Congress to continue the work until 1908. Work on the locks and dams at each terminus has been opened and will be pushed vigorously during the year, while very little was done at those places during the fiscal year which terminated June 30, 1907. The time of completion of the canal appears to depend now upon work at Gatun, rather than on the work of excavation, which has hitherto been generally taken as the determining feature. The progress in this direction has been faster than anticipated, and the appropriation made at the last session of Congress would not be sufficient to supply the necessary plant to begin laying the concrete in the locks and dams during the next fiscal year, although progress already made indicates that such a beginning is advisable. In order to avoid reducing the force, to keep within the expenditures already authorized for this fiscal year, the chairman of the commission has recommended to the Secretary of War that the work be allowed to proceed, and that Congress be appealed to at its next session to make good any deficiency in the funds now available. If the funds requested are not provided it will, of course, be necessary to reduce the rate of expenditure to keep within the appropriations on hand. About \$8,000,000 in excess of the appropriations already made could be used to advantage in pushing forward the work during the present year."

Extended experiments recently conducted in this country have shown clearly that fruit trees suffer very materially, and are often killed outright, when grass is allowed to grow under the tree and close up to the trunk. Various probable reasons for this effect, such as the removal of plant food and of water by the grass, also the supposed liberation of carbonic acid, which might prove injurious to the roots of the trees, were respectively demonstrated to be outside the primary cause of injury, and, finally, after seven years' work, it was concluded that the injurious effect could only be due to some poisonous substance formed in the soil by the roots of the grass. On the other hand, it is a well-known fact that in many instances considerable difficulty is experienced in obtaining a growth of grass under trees. Mr. C. A. Jensen has given an account of certain experiments bearing on this point in Science. There is distinct evidence that plants produce toxic conditions in the substance in which they grow, and as a rule the excretions given off by the roots of a certain plant are more toxic to the same or a nearly related plant than to plants not so closely related. The effect of tree seedlings on the growth of wheat was tested, and after eliminating as a cause of injury such factors as removal of plant food or water by the tree-roots, it seemed that the roots of the latter had some direct effect on the growth of the wheat, which suffered in all the experiments. The seedlings were placed in plant pots, hence the roots of the tree and those of the wheat plants were in close contact. Trees of various kinds were used in the experiments, and the retarding influence, although noted in every instance, differed in degree; cherry was least active in checking growth, pine most so. The conclusion arrived at was that the effect of trees on wheat appears to be due to the excretion by the trees of substances toxic to wheat.