Here, again, as in 1918, the hibernacula were not always penetrated. Some crotches containing hibernacula, encrusted with a heavy deposit of lime sulphur in the April spraying, yielded healthy larvae a week after application, but, on the whole, results were satisfactory. In this year, lead arsenate applications applied as soon after blossoming as possible gave better results than the lime sulphur sprays applied just before blossoming.

In consideration of the whole matter of spraying, growers have the choice of lime sulphur or lead arsenate, used separately or in association in two sprays, one just before and the other just after blossoming. In a heavy degree of attack, both applications may be made. The lime sulphur application has a slight preference over the later lead arsenate sprays owing to its possible effect against the fungous disease, "leaf curl." The spray for "leaf curl" is an early lime sulphur spray applied even before the buds break. A grower with a light attack of fungous and peach worm has the opportunity of economizing by combining this peach leaf curl spray with the spray for the peach worm.

FOREST ENTOMOLOGY

BY RALPH HOPPING.

If I were to ask you what was the most important crop of British Columbia, many of you would probably answer "apples" or "strawberries," for instance. The forests, however, produce the most valuable crop and turn in the most revenue to the Provincial Government. I understand the revenue is greater than all the other industries combined.

Although the Government is doing a great deal at the present time to preserve the forests, we are not properly or adequately taking care of this, the most valuable crop in the province; principally because the public does not realize that it is so valuable or so necessary, and we must have the support of the public when public money is expended.

The forests of B. C. have been subject to great losses from year to year, through two chief agencies: FIRE and DESTRUCTIVE INSECTS. Fire is the more spectacular, but the depredations of insects are at present of much greater importance in the open stands of yellow pine in the dry southern interior of the province. During the past eight years the loss from insects in and around Princeton and Merritt has amounted to over 200 million feet of lumber, worth at least 6 million dollars to the province.

The fires are being taken care of more and more effectively as the years go on by the protective force of the Forest Branch. Through close co-operation with this same Forest Branch, we are gradually beginning to take care of the insect depredations. This work, however, is a specialized department, as the insects attacking trees are of many species, each species of tree often having its own special group of insects.

The technique of the control measures employed to combat these depredations or epidemic infestations, as they are called, is supervised by a forest entomologist employed by the Entomological Branch of the Department of Agriculture.

The duties of a forest entomologist are many and varied. He must not only be able to tell in the field just what is killing a forest tree, and maintain as complete a collection as possible of all forest insects for identification purposes, but he must be able to recommend methods of control and to apply them in the field. In order to identify many of the tree killers in the bush, he must also be familiar with the different designs of the egg galleries.

Most of the insects killing forest trees are beetles. As many of the insects of all groups are injurious to the interests of mankind, we have little hesitation in killing them, nevertheless the methods employed are as painless as possible, in spite of the fact that many scientists insist that they have no sense of pain. I remember my daughter bringing a small boy just five years old into my study one time, where she showed him some of the brilliantly colored specimens and the boxes of beetles, both large and small. He was a very grave little fellow and looked at them without comment for some time. Finally he said, "Did you kill all of them?" "No," I replied, "but I killed a great many of them." I was astonished to hear him ask, "Oh, I suppose their souls are all in Heaven?" I do not remember what my reply was, but it probably was not satisfactory to myself or the child.

There is considerable loss due to the attacks of various bark-beetles in nearly all our British Columbia conifierous trees. For instance, bark-beetles kill each year many western white pines, **(Pinus monticola)**, and in some districts in the province have become epidemic and have killed the greater part of the white pine timber. Douglas fir **(Pseudotsuga taxifolia)** is subject to attack by the Douglas fir bark-beetle, and at least two such epidemic areas are now known to exist. Stands of true fir or balsam **(Abies)** are dying here and there from bark-beetle attacks. By far the greatest losses, however, occur in lodgepole **(Pinus contorta)** and yellow pine **(Pinus ponderosa)** and are mostly confined to the southern part of the interior.

The largest outbreak in lodgepole pine is in the Yahk district in the south-eastern part of the province, but various epidemic areas of greater or less magnitude occur between Penticton and Nelson and between Penticton and Princeton, and east of Okanagan Lake.

The losses in yellow pine have been much the most serious, owing not only to the greater commercial importance of this pine, but also to the virulence and long sustained attack of the bark-beetles causing the injury. The greatest outbreaks, in which the loss has been excessive, have occurred around Princeton, where it is estimated that 150 million board feet have been killed during the past six years, and in the Cold-

water Valley, near Merritt, where a very active infestation is now in progress. It is evident that the yellow pine in this whole forest between Princeton and Kamloops is threatened with ruin by these outbreaks, and that our control operations, now being conducted through the co-operation of the British Columbia Forest Branch, the Dominion Forestry Branch and the Dominion Entomological Branch, offer the only hope of saving it. Fortunately they promise to be successful.

There are three types of bark-beetle attack:

1. An endemic or so-called "normal" infestation exists in almost all forests, in which over-mature or weakened trees or their parts, are killed here and there from bark-beetle attacks.

2. Sporadic outbreaks frequently develop in the neighbourhood of slash, windfalls or light burns, particularly in bodies of weakened timber, but subside before many trees are killed.

3. Epidemic outbreaks resulting from a more serious disturbance of Nature's equilibrium, from either natural or artificial causes, spreading rapidly through the forest, killing great numbers of trees in a very short period.

An endemic infestation need cause little concern, although it effects considerable loss when this is computed over a period of years, and it is, of course, from this normal infestation that the serious outbreaks develop. The sporadic outbreaks, although small, may be important in stands of valuable timber, and may develop, if not controlled, into the more serious epidemic type. The epidemic outbreak is a serious matter, often killing 95% of the timber stand, in certain tree species, in the short period of five or six years. Control measures for epidemic outbreaks should be undertaken with the least possible delay, under the direction of a competent forest entomologist.

It appears probable that serious bark-beetle outbreaks usually develop through some notable disturbance of the natural conditions in the forest, such as windfalls over large areas where many trees are blown down, fires caused by lightning, or through human agency, such as carelessness with fire, lumbering operations, or slashings of any description.

In windfalls and fires, we have conditions produced in which the bark-beetles are not hampered by the resistance of the healthy trees. The bark-beetles breed freely under these conditions and often start outbreaks as a result, immediately following the fire or heavy windstorm.

In logging operations we have a much more prevalent cause of epidemics. The immense amount of fresh slash, in the form of tops and cull logs, affords an ideal breeding ground for the destructive bark-beetles. The method of logging in the winter and not in the summer has been especially favourable to attack upon the standing timber. The beetles, completing their life-cycle in the freshly cut material, emerge,

and, having no new supply of cut material to enter, for they will not breed in dry logs, enter the living standing trees and kill them within one year. They then spread from year to year throughout the timber stand, leaving devastation in their wake. They also produce conditions favourable to the increase of other insects, usually considered as secondary, which, if they do not kill trees outright, nevertheless injure or kill parts of trees and assist the more important species in the general destruction.

The most important pine killing bark-beetles of British Columbia belong to two species of the genus **Dentroctonus,** of which one confines its attack to yellow pine, while the other attacks not only yellow pine but white pine and lodgepole pine as well.

In general, the method of attack is the same for both species. Emerging from a recently killed host tree in June or July, they attack other trees during July and August. Entrance tunnels are cut through the bark to the wood surface, and from the ends of these they excavate tunnels in the inner bark or between the bark and the wood surface, in which they lay their eggs in small niches cut along the sides. The larvae which hatch from the eggs also cut galleries more or less at right angles to the egg-tunnels and thus generally complete the killing of the tree by girdling it from top to base. Transformation to the pupal stage takes place either in the autumn or during April and May of the following spring, and the new brood of adult beetles emerges through exit-holes in the bark to attack fresh trees and thus extend the outbreak.

The number of insects a single tree can harbour is enormous. It has been estimated that in California a sugar pine 9 feet in diameter and 200 feet in height has produced one million beetles to spread to surrounding trees in the forest. Here in B. C. we have caged a yellow pine 24 inches in diameter and captured over 6000 of the killing species of beetle, over 16,000 insects of all kinds from the tree, over 10,000 of which were more or less injurious.

When these beetles emerge from a tree in July and August they immediately attack other trees. The emergence is not all in one day but spread over at least six weeks. By some instinct which they possess they are enabled to concentrate the attack on one particular tree. The first few hundred die by drowning in the pitch, but, as the attack goes on continuously from day to day, the resistance of the tree is weakened and it at last succumbs. If we have a late fall, many of the trees yellow before winter sets in, but, be the fall early or late, nearly all the trees so attacked yellow and die by the last of June of the following year. That is, trees attacked by September are dead the following June. It is therefore necessary in order to control an outbreak that the infested trees be cut and burned before the emergence in July and August. Our working period is from about April 1st to June 15th, as it is almost impossible to burn while the snow is on the ground.

An epidemic of one year, if not controlled, may increase 150 to 200% the next. Control work will decrease it at least 80%. If our forests were not disturbed, only large windfalls would increase these infestations to epidemic proportions, but promiscuous cuttings, unless regulated by the government, upset the natural balance and cause such outbreaks as we are having at the present time, which would answer the question, "Why is the Forest Entomologist"?

In conclusion, I wish to state that if a thorough campaign of slash disposal and control of incipient outbreaks is carried on in the future, the tremendous loss caused in the past to the forests of the province will not only be stopped, but much of the fire risk now caused by slash and dead standing timber will cease to exist.

MOSQUITO CONTROL AT BANFF

BY ERIC HEARLE, DOMINION ENTOMOLOGICAL BRANCH

In the Agricultural Gazette for May-June, 1922, the writer contributed a brief statement on an aerial survey of mosquito breeding places, conducted in the Lower Fraser Valley of British Columbia, which survey was made in 1921. In the same year, in company with Mr. Arthur Gibson, Dominion Entomologist, a brief survey was made of mosquito infested areas in the Rocky Mountains' National Park, adjacent to the town of Banff and the station of Lake Louise, Alberta.

It has been recognized for some time that relief from the mosquito trouble might be possible, and in the summer of 1916 the late Dr. Hewitt undertook a preliminary survey and drew up valuable recommendations. During the last three or four years a certain amount of control work has been conducted under Messrs. Sanson and Childe, of the Parks Branch, and considerable success was met within the reduction of the mosquitoes. In the Spring of 1922, Mr. Arthur Gibson, the Dominion Entomologist, arranged for a detailed investigation into the pest, and the writer was given charge of all the investigational and control work. Oiling operations were extended much further than previously, and as a result the mosquito pest in the vicinity of Banff was reduced to a negligible quantity during the past season.

The 1922 investigations showed that out of a mosquito fauna of some 18 species only three of the species were important pests.

Constituents of the Pest:

There were found to be two main problems—the snow-pool problem in the early summer and the flood water problem dependent upon the river freshets. In the former, one species only is important—**Aedes cataphylla Dyar**; but in the latter, while **Aedes cataphylla Dyar** is the species of main importance, **Aedes intrudens Dyar** and **Aedes vexans Meigen** have also to be reckoned with. In May the melting snows fill