THE "GOUT DISEASE" OF BALSAM FIR

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INTRODUCTION

FOR a number of years, foresters in Nova Scotia have noticed that many of the balsam stands throughout the province were developing a diseased appearance. The twigs and branches of the affected trees appeared as though they were swollen. These swellings were particularly noticeable at the nodes and occurred most commonly near the tops of the crown. Often the buds were suppressed and the twigs and branches died back. The branches took on a bent and twisted appearance in many cases and frequently the crowns were flat-topped. Another characteristic was an unusually rapid taper of the stem.

The condition, which came to be known as "gout" or "dropsy," was investigated by pathologists, but no causal organism was discovered. It was thought that possibly a virus might be implicated. In the fall of 1930, the writer made some observations which suggested that a small insect might be the cause (Balch, 1931) and this has been followed up during the past season by further investigation and experiment. While this work has only been preliminary in nature, enough evidence has been secured to show that an insect, which has been called the balsam bark louse or woolly aphid (*Dreyfusia piceae* Ratz.), is invariably associated with the early stages of "gout" and is doubtless the first cause of the disease.

THE BALSAM BARK LOUSE

This insect, one of the Adelgids, or Chermes, related to the spruce gall aphid, apparently has been imported from Europe. It has not been given much attention in America, although it was reported as present in New England over thirty years ago (Kotinsky, 1916) and has probably been in Nova Scotia twenty years or more. In Europe, it has not been considered a very serious pest, but a closely related species, *Dreyfusia nusslini* C.B., has been very destructive, particularly to young trees. *Dreyfusia nusslini* has not yet been found in Canada.

The young larvae are about .4 mm. long, oval, flattened, black, with a fringe of white wax around the edge and down the middle of the back. They can be found on the bark of the stem or twigs, on the new shoots or at the bases of the buds, at any time of the year. They are barely visible to the naked eye, but as they develop into adults, white wax threads are secreted over the body and they become more conspicuous as little, white woolly masses.

There are no males and the wingless females lay about a hundred eggs in

the spring. A few of the first of these have been found sometimes to produce winged forms but these do not seem to lay eggs and may be a rudimentary generation, of no importance as a factor in spreading the infestation. The great majority of the spring larvae are similar to their parents. Some settle down and remain dormant until the next spring, and others give rise to one or two more generations the same year. They overwinter as first stage larvae.

FEEDING HABITS

The mouthparts or "stylets" consist of four fine, grooved, hair-like structures which are fitted together to form a long slender "bristle" containing two channels. One of these carries saliva to the point of feeding, the other serves to suck up the cell sap used as food. This bristle is four to five times as long as the larva itself and is at first coiled back within the body. When the larva has selected a place to feed, it is able, by the aid of its beak, to insert this slender pointed tube into the plant tissue to its full length. The insect re-

mains in the same place throughout its life and feeds by probing the tissue in the neighbourhood of the end of the stylets.

EFFECT ON TWIGS

There are two types of attack. On many trees the insect will be found only on the twigs and smaller branches. The young larvae tend to move toward the new growth and settle at the bases of the buds or at the base of the new shoot. In succeeding years, some of the offspring remain near the parent, some move to the new growth. As a result the insects will be found, after several years' attack, chiefly at the nodes and on the buds. When the numbers are large, they may occur anywhere on the twig except on the needles.

At the point where the stylets are inserted, an abnormal growth takes place. There is a stimulation of the cambium which produces an unusual amount of "rotholtz" or "pressure wood." The size and number of the cortical cells are also increased and as a result a swelling occurs. Sometimes on the young shoots, where the stylets easily reach to the cambial area, the formation of xylem is interfered with and the cortical tissue extends into the pith. This leaves pits in the wood of the twig.

This swelling will result from the insertion of the stylets of a larva, even if the larva does not develop. One or two larvae can cause a considerable enlargement, but a very large number will sometimes cause very little. This may be due to the attack so weakening the tissues that they are unable to respond to the stimulation. The amount of enlargement seems to be governed chiefly by the vigour of the part attacked. It also varies somewhat between individual trees, and *Abies pectinata* seems to react less than other species of the genus.

About a year following attack, small purplish pockets appear in the cortex. These consist of broken down cells largely filled with resin and surrounded by a periderm of rather tough cells containing a purple substance. This has not yet been studied carefully, but it seems to be the result of an attempt on the part of the tree to segregate the affected tissue.

As the attack progresses the shoots become shorter and tend to droop and twist; the buds become suppressed, the branches, or leaders, cease to grow in length. They continue for a time, however, to grow in diameter, and this increases the swollen, gnarled appearance. Gradually, the affected parts die back.

The flat-topped appearance may be due to dying back of the tip of the crown, to suppression of the leader and failure of any one lateral shoot to take its place or to the leaning over of a leader which is not killed.

EFFECT ON STEM

The other type of attack is confined to the stem. It may be found any-

where from the base of the roots upwards, and often trees are white with the wool of the insect. Others may show very little wool, as the larvae tend to crawl into cracks and beneath mosses and lichens.

Although the stylets can penetrate only 2 mm. into the bark, they have a marked effect on the growth of the wood, which becomes dark and brittle. The tracheids are thick walled, with much reduced lumina. An analysis by the Chemical Department of the Mersey Paper Company, obtained through the courtesy of Mr. E. S. Richards, has shown that there is an abnormally high content of lignin. Apparently this is the same type of wood which is normally formed under the stimulus of pressure and by which the tree builds itself to resist the strains of wind and gravity. In a severely infested tree, however, this wood may occupy the whole of the ring to the complete exclusion of the spring wood. Also, the rings as a rule are abnormally large, until the tree begins to die, when one or two very small rings may occur.

In the bark there is sometimes a slight swelling of the lenticular areas, where the insects prefer to feed, and a "pimpled" effect results. Also, superficial dead areas appear which are separated from the living bark by a purple periderm similar to that mentioned above. Considerable amounts of resin may exude from these areas.

The stem attack and twig attack are often combined on the same tree. They do not seem to be caused by different races, as larvae from the stem when placed on the smaller branches generally settle by preference on the new shoots.

An exact explanation of the processes by which "gout" develops cannot yet be given, but it is initiated by the stylets of the insect. There is still a possibility that a fungous, bacterial or virus disease is introduced, but the evidence so far does not suggest this. It seems more probable that the saliva of the insect contains a stimulating substance, possibly an enzyme, which is stimulating in small and toxic in large quantities.

DAMAGE

Either type of attack will kill trees. The twig attack kills tops and reduces growth but death does not necessarily result. If it does, it is a comparatively slow process. Such trees, however, are extremely susceptible to attacks by defoliators and have been easily killed by the black-headed budworm (*Peronea variana* Fern.) in Cape Breton.

The stem attack kills more rapidly. When the insects become numerous enough to be noticeable, the tree is likely to die. Such attacks develop generally in patches, spreading slowly from a definite centre, but they are capable of killing a small stand outright. We do not know yet to what extent they may spread through the forest. All ages and types of trees appear to be

susceptible but so far the more serious attacks have commenced in thinned out or cut-over stands.

Where this insect is present, no management plans should be made for balsam without careful consideration of its probable effect. A number of permanent sample plots have been established and will provide some information concerning the susceptibility of stands and the degree and rapidity of deterioration.

The infested area in the Maritimes, and probably in Canada, includes the whole of Nova Scotia and the southern part of New Brunswick. *Dreyfusia* has not yet been found north of a line drawn from Buctouche to Fredericton and down to Lawrence. It occurs, however, in practically every stand of balsam fir in Nova Scotia and has already caused serious deterioration and considerable mortality.

It may be that Maritime conditions favour the insect but it appears capable of spreading into the interior. A group of trees has already been killed near Fredericton. The territory occupied by the balsam louse is practically the same as that occupied by the beech coccus (*Cryptococcus fagi*) which is a similar wingless, wool covered insect, depending on wind, birds and other animals for its spread. The coccus has already killed a great part of the beech in Nova Scotia and seems likely to destroy most of the trees wherever it becomes established. It is also an "imported" insect and the history of its entry into Canada, and subsequent dissemination, may be the same as that of the balsam bark louse.

CONTROL

Spraying a lysol solution with a knapsack sprayer has been used a great deal against *Dreyfusia nusslini* on plantations in Europe (Chrystal, 1926). Miscible oils may be used in nurseries and on ornamentals if applied thoroughly at the time of hatching in the spring. Control by spraying in Canadian forests is, however, out of the question at present.

Where isolated infestations appear in new areas it may be possible to check them considerably and perhaps even eradicate them by burning the infested trees. The possibility of destroying the insects by simply felling the trees is being investigated. Such work would have to be done in the winter, when motile larvae and eggs are not present, or the insects would be spread in the process.

Owing, however, to the impossibility of finding the insect when in small numbers, control even in new areas will be difficult. On the other hand, where the presence of the insect is recognized in merchantable stands it will be possible to cut the infested areas during the winter before the trees die and thus combine salvage with partial control.

Up to the present no parasites or predators which offer any promise of natural control have been found.

It seems that certain stands are less susceptible than others and that site or density of stand may be important. Silvicultural methods may be worked out when we have more knowledge. Chrystal reports that thinning has been very effective against *nusslini* in Denmark. Schneider-Orelli (1929), on the other hand, working on the same species in Switzerland, recommends that young stands of fir be grown under shade. In the Maritimes there seems little doubt that open stands are more readily attacked and thinning would probably encourage the infestation.

Further work is planned which may make more exact description of the characteristics of this insect attack possible. New possibilities for control may appear. Meanwhile, this account is intended to draw attention to a condition which is already serious in Nova Scotia and may possibly be found developing in other parts of Canada. It is thought, however, to be confined at present to Nova Scotia and southern New Brunswick and to certain regions along the coast of New England*. This permits the hope that it may flourish only within a certain distance of the coast but the writer is inclined to expect that it will move slowly westward.

*Dr. H. B. Pierson reports that "gout" has been noticed in parts of eastern Maine for some years. Kotinsky reported *D. piceae* killing trees at New Haven, Conn., in 1916.

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