TIMBER TYPES IN RELATION TO INSECT OUTBREAKS IN THE CANADIAN ROCKY MOUNTAINS[1]

GEO. R. HOPPING[2]
Dominion Entomological Laboratory
Calgary, Alberta

INTRODUCTION

The importance of the forests of the Canadian Rocky Mountains cannot be gauged by commercial timber values alone. Portions of this region aggregating 8,000 square miles in area have been organized into national parks. The remaining forested area, comprising 149,000 square miles, is owned mainly by the Province of Alberta. Although the recreational and the commercial timber values are of prime importance, the maintenance of proper watershed conditions on the eastern slope is even more vital.

[1]Contribution No. 2757, Division of Entomology, Science Service, Department of Agriculture, Ottawa, Canada.

[2]Officer-in-Charge.

Some of the forests of this region are highly susceptible to outbreaks of destructive forest insects of several species. There is an apparent correlation between the number and severity of such outbreaks and the type of timber stand. In order to get some insight into the causes of these outbreaks, immediate control measures possible, and more nearly permanent remedies, it is necessary to know something about the history and characteristics of the timber types.

CHARACTER OF THE TIMBER STANDS

There are six distinct timber types in the Canadian Rocky Mountains. They may be defined as follows:—

1. *Alpine fir type.*—Restricted stands of alpine fir, *Abies lasciocarpa* (Hook.) Nutt. on the upper slopes and in high alpine valleys, 6,000 to 7,000 feet in elvevation, sometimes associated with whitebark pine, *Pinus albicaulis* Engelm., and alpine larch, *Larix lyallii* Parl. This is a climax type that has occupied these areas for a long period.

2. *Western White and Engelmann spruce type.*—Stands composed mainly of spruce, either *Picea engelmanni* Parry or *Picea glauca* (Moench) Voss var. *albertiana* (S. Brown) Sarg., with small percentages of alpine fir and lodgepole pine, *Pinus contorta* Dougl. var. *latifolia* Engelm. These are climax stands 300 to 500 years old, mainly in sub-alpine valleys.

3. *Lodgepole pine type.*—Extensive pure stands of young lodgepole pine or fully stocked stands of mature pine with an understory of spruce, associated in places with trembling aspen and Douglas fir. This is a fire succession type that has originated during the last 200 years. It is transitional and will eventually revert to the spruce type in most cases.

4. *Trembling aspen type.*—Pure stands of trembling aspen, *Populus tremuloides* Michx., not so extensive as type 3, often with an understory of young spruce. This also is a fire succession type and is often supplanted by spruce, for which it acts as a nurse crop.

5. *Douglas fir type.*—Relatively pure stands of Douglas fir, *Pseudotsuga taxifolia* (Poir.) Britton, associated with small amounts of lodgepole pine, spruce, and trembling aspen. This type is not widespread but is very distinct and attains its best development in the Porcupine Hills of south-central Alberta. This appears to be a climax type, for some of the trees are 500 years old, and the reproduction is composed mainly of Douglas fir.

6. *Black spruce type.*—Relatively pure stands of black spruce, *Picea mariana* (Mill.) B.S.P., associated on wetter sites with tamarack, *Larix laricina* (Du Roi) K. Koch., and on drier sites with white spruce, lodgepole pine, or jack pine, *Pinus banksiana* Lamb. This is a climax type of northern Alberta and the Northwest Territories.

SUSCEPTIBILITY OF STANDS TO INSECT OUTBREAKS

All of the major outbreaks of forest insects in this region during the past 40 years have occurred in the transitional or fire-succession timber types. This may or may not be significant, for 40 years is a very short period in the life of a forest. Of greater significance is the fact that no destructive outbreaks have occurred in the climax types for 300 to 500 years; this suggests a balance of faunal populations in relation to environment. If fire can be kept out of the transitional stands, they will revert to climax types, in which a similar balance will probably be established. This will take a long time, and major outbreaks undoubtedly will occur meanwhile. Timber utilization can hasten the replacement of transitional species with climax species and will be an important factor in maintaining or destroying the resistance of present climax stands.

The estimate of the susceptibility of each timber type is based on the character and history of the stand and the incidence and destructiveness of past outbreaks.

The alpine-fir stands are subject to sporadic restricted attack by the western balsam bark beetle, *Dryocoetes confusus* Swaine. The trees killed are usually overmature, the effect being similar to that of a selection cut making room for more vigorous young trees. Utilization is not feasible because of inaccessibility, and the net result of the bark-beetle activity is actualiy beneficial under these conditions. Susceptibility to insect outbreaks may be classed as medium in this timber type.

The climax spruce stands have low susceptibility to insect outbreaks. No destructive infestations have occurred in these stands for hundreds of years. Injury from the two-year-cycle spruce budworm has occured sporadically during the past 30 years at least, but there has been no serious tree mortality.

The main fire-succession type, lodgepole pine, is highly susceptible to destructive and extensive outbreaks of the mountain pine beetle, *Dendroctonus monticolae* Hopk., and the lodgepole needle miner, *Recurvaria milleri* Busck. An outbreak of *D. monticolae* in Kootenay National Park began in 1930 and in 12 years killed 85 to 90 per cent of the timber over an area of 250 square miles. The estimated loss was over 400,000,000 board feet (4). An outbreak of the same beetle that started near Banff in 1940 was controlled after treatment of 30,000 trees on 15,000 acres. An outbreak of the lodgepole needle miner that commenced in 1942 in Banff National Park is still in progress and now covers 450 square miles in four national parks.

Susceptibility of stands to outbreaks of the mountain pine beetle is influenced by available moisture; composition of the stand, whether pure or mixed; age; distribution of diameter classes and site quality.

Most of the outbreaks in Western Canada have started during prolonged drought periods when the vigour of all trees was reduced (4). Beal (1) also found a relationship between drought and outbreaks of the Black Hills beetle, *Dendroctonus ponderosae* Hopk. Craighead (2) stated, "Extensive outbreaks of the southern pine beetle and hickory bark beetle have always occurred in drought years."

It is noteworthy that all of the large outbreaks of the mountain pine beetle have started in fully stocked stands of mature lodgepole pine. It seems reasonable to suggest that the pine in mixed stands is less susceptible to attack.

Very few, if any, outbreaks of *D. monticolae* have started in stands under 80 years of age. The limitation of trunk area on small trees prevents a rapid build-up of the beetle population. Moreover, Hopping and Beal (4) found a direct relationship of diameter to incidence of attack under outbreak conditions. Practically no attack occurred on trees below five or six inches in diameter, and for every inch increase above this there was an increase of approximately five per cent in the proportion of trees attacked.

Site quality seems to be another factor influencing stand susceptibility. In ponderosa-pine stands, the poorer sites are associated with greater bark-beetle hazard (5), but apparently this is not the case with lodgepole pine. All of the outbreaks of the mountain pine beetle in the Rocky Mountains have started on the better sites.

Severity of attack by the lodgepole needle miner does not seem to be associated with size or age of the trees, or with site quality, but the younger, more vigorous trees are able to withstand the attack over longer periods than the older, slower-growing stock.

The aspen fire-succession type is also subject to extensive outbreaks, chiefly of defoliators. Several species of tent caterpillars, *Malacosoma* spp., periodically cause extensive defoliation. More restricted areas of aspen are defoliated by the American poplar beetle, *Phytodecta americana* Schaeff., and the large aspen tortrix, *Archips conflictana* Wlkr. The poplar borer *Saperda calcarata* Say, causes severe damage in some areas.

The black-spruce stands of northern Alberta are of a climax nature, and no serious insect outbreaks have occurred in these stands for a long period. This timber type may be placed in the low susceptibility class.

CONTROL POSSIBILITIES

The data presented indicate that the main insect problems arise in extensive stands of lodgepole pine. A bark-beetle outbreak can be controlled by applied methods if discovered in the early stages. A 100 per cent cruise is necessary to locate all infested trees, and each one must be treated by cutting and burning, by burning the trunk as it stands, or by killing the bark-beetle broods with certain penetrating chemicals.

No effective applied control has been developed for the lodgepole needle miner. Since the larva spends nearly all its time within the mine, it is difficult to develop a spray with sufficient penetration to kill the miner and not injure the trees. Even if this could be done, aeroplane spraying of 450 square miles of timber would require an expenditure of at least one and a half million dollars on the basis of present material and labour costs. Most of the parasites would be killed and the needle miner population would probably increase again very rapidly. The spray operation would have to be repeated every few years until the factors favouring increase became inoperative.

Applied control for the mountain pine beetle and the lodgepole needle miner is only a palliative. As long as these pure stands of mature and overmature pine remain, outbreaks will recur whenever other factors are favourable. It appears that longer-lasting results will be obtained by a thorough investigation of forest management with a view to replacing the lodgepole-pine stands with a mixed type more nearly climax in nature and of greater tree vigour. More nearly permanent beneficial results in the control of this needle miner may also be obtained by intensive investigations of biological factors.

Detailed forest management plans for areas in the Rocky Mountains and particularly in national parks cannot be made until much more timber inventory work is completed. The most desirable type of mixed stand can be determined only by silvicultural research to establish soil characteristics on the various sites in the region, and the soil and climatic factors best suited to the various species. A fairly reliable guide should be the composition of the climax types that originally occupied the pine areas; some clues have been left to indicate the nature of these stands.

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