Stem defects in Sitka spruce induced by Sitka spruce weevil, *Pissodes strobi* (Peck.)

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Abstract

The effects of attack by the Sitka spruce weevil (=white pine weevil), *Pissodes strobi* (Peck.), on Sitka spruce trees, *Picea sitchensis* (Bong.) Carr. are described. The study was based on records of attack collected for 10 years (between 1959 and 1968), in a stand located near Nitinat Lake, British Columbia. The stand was revisited in 1984 and tree quality was rated based on stem form. Also, the consequences of each attack in the period 1959-1968 for the quality of the stem in 1984 was determined. Twenty-six percent of the trees in this severely attacked area were rated as having good form; 51% had a medium form and 23% were so deformed that their condition was rated as poor (no good for lumber). The trees sustained an average of 2.4 attacks per tree in the 1959-1968 period. These attacks resulted in an average 1.6 defects per tree. In 36% of the attacks studied the tree was able to develop one single stem and appeared normal, without external symptoms of attack. The remainder of the attacks developed into various defects as follows: scar 9%, minor crook 45%, major crook 7.3% and fork 2.7%. It was concluded that the Sitka spruce weevil caused a severe productivity depletion of the stand surveyed.

Résumé

L'auteur examine les dommages causés par le charançon du pin blanc (*Pissodes strobi* [Peck.]) sur des épinettes de Sitka (*Picea sitchensis* [Bong.] Carr.) Il utilise les données recueillies pendant 10 ans (entre 1959 et 1968) dans un peuplement fortement attaqué, situé près du lac Nitinat, en Colombie-Britannique, ainsi que les données d'évaluation de la qualité des arbres d'après la forme de la tige qui ont été obtenues en 1984 lors d'une réinspection du même peuplement. Il analyse les conséquences de chaque attaque ayant eu lieu entre 1959 et 1968 pour la qualité de la tige en 1984. La forme de la tige a été jugée bonne pour 26 % des arbres, moyenne pour 51 % et médiocre (c'est-à-dire inacceptable pour la production de sciages) pour 23 %. Les arbres one subi en moyenne 2,4 attaques au cours

de la période de 1959 à 1968, et ces attaques ont causé en moyenne 1,6 défaut par arbre. À la suite de 36 % des attaques étudiées, les arbres ont réussi à conserver une tige unique et un aspect normal, sans symptômes externes d'une attaque. Les attaques étudiées ont résulté en divers défauts: cicatrices, 9 %; courbures mineures, 45 %; courbures importantes, 7,3 %; et développements en fourche, 2,7 %. L'auteur conclut que le charançon du pin blanc a causé une grave perte de productivité dans le peuplement étudié.

Introduction

The Sitka spruce weevil (=white pine weevil), *Pissodes strobi* (Peck.), is the most damaging pest of Sitka spruce, *Picea sitchensis* (Bong.) Carr., in coastal British Columbia, Washington, and Oregon. In early spring, the adult weevils crawl or fly to the tree leader (apical shoot) grown in the previous season where females lay eggs in niches excavated under the bark. The larvae kill the leader by mining and consuming its phloem. Following an attack, the lateral branches from the stem whorl immediately below the damaged leader assume a vertical position and compete for dominance. This process usually results in the formation of stem defects, such as crooks and forks, at the point of injury. Repeatedly attacked trees are stunted and overtopped by competing vegetation (often volunteer deciduous species), to the point were a severely attacked plantation may be worthless (Alfaro 1982).

The intensity of weevil attack on young plantations (percentage of trees attacked per year) is routinely reported in weevil surveys (Harris et al. 1968; McMullen 1976; Alfaro 1982; Heppner and Wood 1984; Cozens 1987; Humphreys and Ferris 1987). However, the exact nature of the damage has not been described, neither have there been any reports on the consequences of the attack for the ensuing development of the tree. Of particular importance in determining the economic damage caused by this weevil is the proportion of the attacks that result in the formation of a stem defect. This paper describes the condition of the tree stem in Sitka spruce trees several years after attack by the Sitka spruce weevil. This study was based on detailed records of attack obtained between 1959 and 1968 on southern Vancouver Island, by the Canadian Forestry Service, as part of investigations of the biology of this weevil and the possibilities of chemical control (Silver 1968). In 1984 the plots were revisited and the type and severity of the stem defects encountered was noted.

Materials and methods

The 1960's study

In 1960, Dr. G.T. Silver (formerly with the Canadian Forestry Service, Pacific Forestry Centre, Victoria, B.C.) established four research plots near Nitinat Lake on Vancouver Island, British Columbia in an area of natural Sitka spruce regeneration

which originated after logging. The plots were rectangular in shape, had a combined surface area of 1 ha, and initially included 692 trees which were marked with metal tags (Silver 1968). At the time of establishment, average tree age and height were 7 years and 1.3 m, respectively. In the early spring of every year, from 1959 until 1968, every plot tree was examined and tree height, length of all leaders (including multiple leaders) and attack condition (attacked or not attacked) were recorded. Since the examinations were conducted in early spring, before growth started, they represented tree condition at the end of the previous growing season.

The 1984 study

The studies reported in this paper were conducted in Silver's check plot which was never treated, and it therefore represents uncontrolled damage levels. This plot occupied 0.32 ha and initially contained 231 trees; by 1984 only 160 trees survived. Average height and diameter at breast height by 1984 were 24 cm and 14.2 m, respectively. In the fall of 1984 every surviving tree with an intact tag was located and examined as follows. First, the entire length of the stem was observed, and the number and type of stem defects and stem quality (as explained below) was recorded. Then, using the available height records, the section of the stem grown between 1959 and 1968 (the period covered by the records) was located with the help of a height measuring pole. If past attacks had been recorded for this period, the precise location at which the attacks had been reported was examined and any stem defects noted. The frequency of stem defects in the 1959-1968 period was tabulated by the number of attack-years (years in the 1959-1968 period that a tree was attacked in one or more of its leaders).

Based on a preliminary inspection of the stand, stem defects caused by Sitka spruce weevil were classified (Figure 1) according to the following scheme:

(1) Scar: This is a minor defect characterized by a minor loss of cylindricality of the stem at the point where the original leader (now dead and usually broken off) departed from the stem. This defect is usually accompanied by abnormal bark growth at the point of injury. Scars are classified as minor defects.

(2) Crook: This consists of a deflection of the stem longitudinal axis at the point of injury, such that the vertical axis of the stem sections above and below the defect are not in line with each other. For the examination of the section grown between 1959 and 1968, crooks were further classified as minor or major. In minor crooks the deflection was minor in nature and lumber recovery was expected from the section containing the crook. This was the case when the deflection was less than 50% of the tree diameter at the point of injury (Figure 1). Major crooks consisted of a major deflection of the stem which was expected to prevent any lumber recovery from a section containing the crook. This usually occurred when the stem deflection was greater than 50% of the stem diameter.

(3) Fork: This consists of a bifurcation of the main stem into two or more stems above the point of injury.

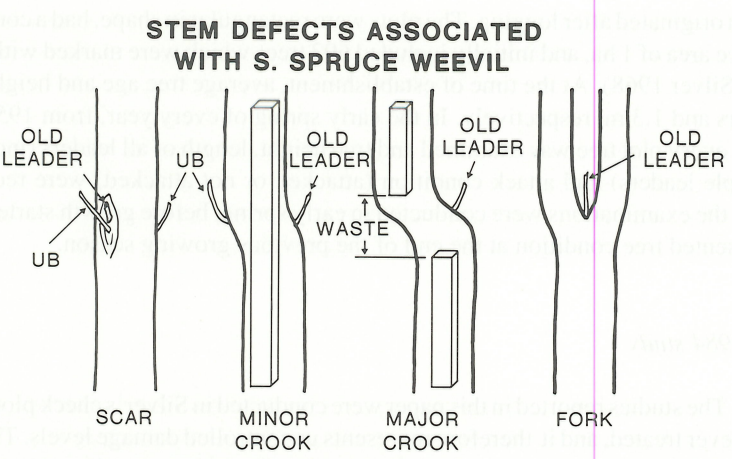

Figure 1. Stem defects in Sitka spruce associated with Sitka spruce weevil attack. Once a leader is killed, the lateral branches from the highest whorl curve up and compete for dominance. In the most common case only one branch dominates and a crook is formed. The unsuccessful branches (UB) can often be identified by their acute angles.

classes (Figure 2):

Good: Stem fairly straight, up to three minor defects (scars or minor crooks). No major defects (major crooks or forks). Full or nearly full lumber recovery expected.

Medium: Stem fairly straight, several minor defects, up to one major defect. Some lumber recovery is expected.

Poor: Stem not straight, many minor defects, two or more major defects. This type of tree will yield no lumber.

Results

Tree form

Examination of the entire tree stem indicated that, of the 160 trees surveyed, 42 (26%) were rated as having a good stem form, 82 (51%) had a medium form, and 36 (23%) were classified as poor (not good for lumber). The trees had an average of 2.8 defects/tree (range 0-11), and 10% of the trees had no visible stem defects. Of all defects observed (n=429), 14% were scars, 77% were crooks, and 9% were forks.

Quality the stem section grown between 1959 and 1968

Mean tree heights at the end of the 1959 and 1968 growing seasons were 1.3 and 4.6 m, respectively; the trees grew an average 3.3 m in this period. An examination of the attack records for the trees in this study (those that survived to

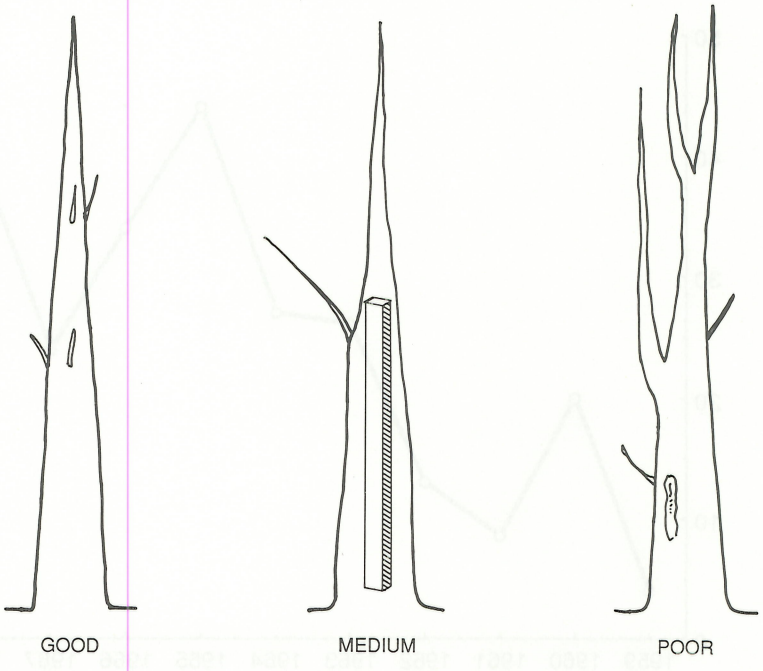

Figure 2. Schematic representation of the tree types used to classify the form of Sitka spruce trees attacked by Sitka spruce weevil.

The quality of the tree stem was classified into the following subjective form 1984), indicated that the percentage of trees attacked increased from 4% in 1959 to a maximum of 44% in 1965; after 1965, the attack rate oscillated around 30% per year (Figure 3). These attack rates were similar to the rates for the entire stand. The number of attack-years in the period from 1959-1968 varied from 0 (never attacked) to 7. The distribution of the number of trees versus the number of attack-years was highly skewed: 21% of the trees were never attacked, and 1.2% were attacked in 7 of the 10 years of observation. The mean number of attack-years per tree was 2.4 (Figure 4). These attacks resulted in an average of 1.6 defects per tree in the stem section grown between 1959 and 1968. There was a distinct trend toward a higher number of defects in this stem section with increasing number of attacks in the period (Figure 5).

A total of 411 attacks in the stem section grown between 1959 and 1968 were inspected. Of these, 265 (64%) resulted in some form of defect; in the remainder (36%) the tree had completely overgrown the injury and no visible sign of injury was present. Of the 411 attacks studied, 9% became scars, 45% minor crooks, 7.3% major crooks, and 2.7% were forks (Figure 6). These results show that the majority of the attacks resulted in defects, and that the most common defect was

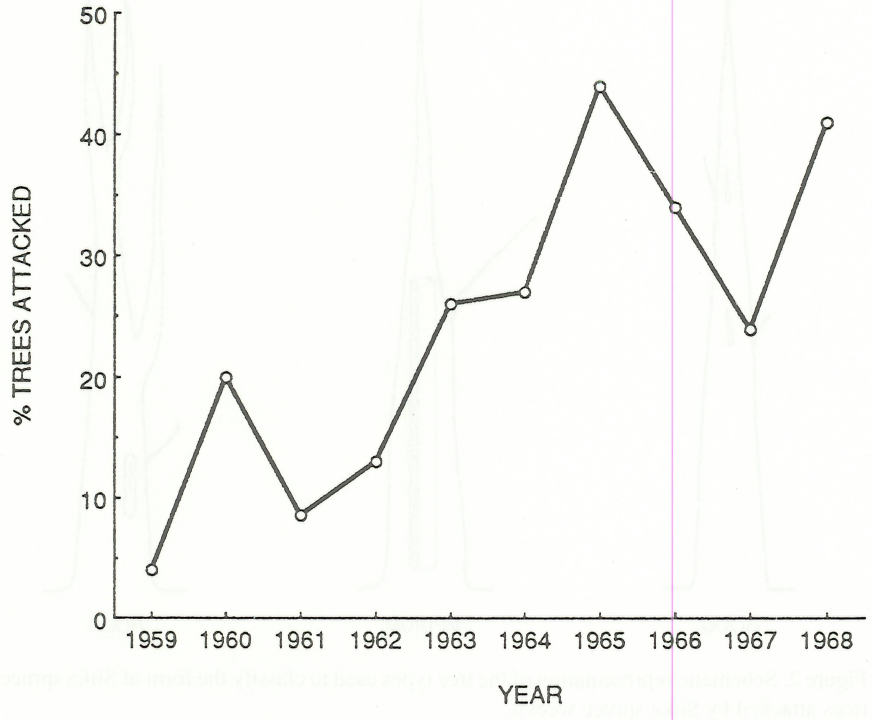

Figure 3. Percentage of Sitka spruce trees attacked by the Sitka spruce weevil in the 1959-1968 period, near Nitinat Lake, British Columbia.

a minor crook. Ten percent of the attacks resulted in major defects (major crooks and forks).

Discussion

In addition to quality losses, trees with major crooks or forks sustain volume losses because the section of the stem where the defect is located is usually wasted (Figure 1). Further waste occurs if the remaining stem sections, after the defects are removed, are of odd lengths that are not currently utilized by industry. Attacked trees also suffer height growth loss regardless of whether a defect is formed. This is because a destroyed leader is replaced by lateral branches which are shorter than the leader. Hence, the total loss caused by this weevil consists of volume loss due to reduced growth and waste, quality losses, and, indirectly, tree mortality as attacked trees are stunted and overtopped by other vegetation.

The study reported here provided a "snap shot" of the stem quality at this particular time, 25 years after the first records were obtained. In the future, as trees continue to grow, it is likely that some of these defects may be partially overgrown,

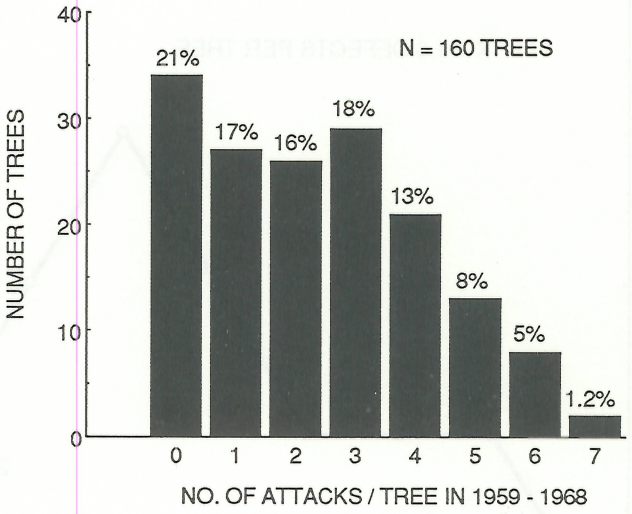

Figure 4. Number (and percent) of Sitka spruce trees tabulated by the number of times a tree was attacked by the Sitka spruce weevil in the 1959-1968 period.

with some changing in severity and others disappearing. The quantification of the economic loss due to reduced quality will be possible only at harvest when the final tally of utilization and wastage will be obtained. However, judging by the large number of defects per tree and the relatively high proportion of severe defects, it is anticipated that the economic losses of severe weevil attack in this stand will be very important.

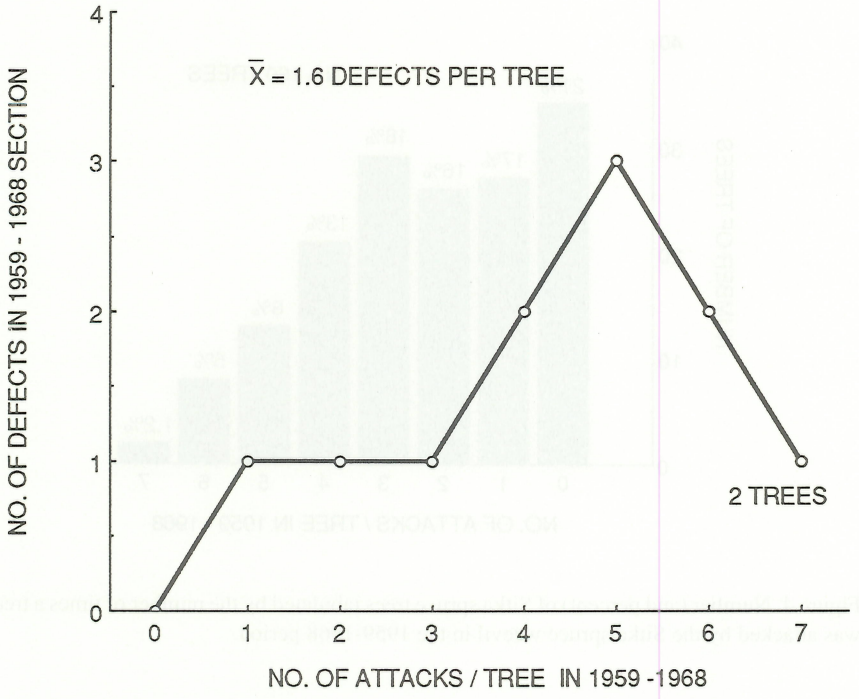

Figure 5. Number of defects in Sitka spruce stem sections grown in the 1959-1968 period, tabulated by the number of attacks per tree in the same period.

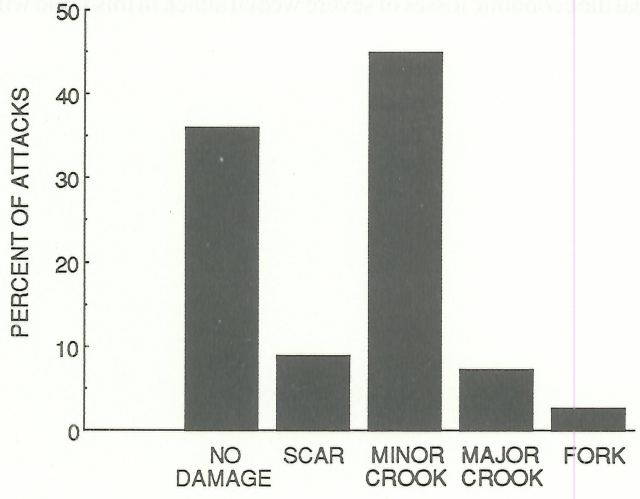

Figure 6. Percentage of attacks in the 1959-1968 period that resulted in various stem defects.

Literature cited

Alfaro, R.I. 1982. Fifty-year-old Sitka spruce plantations with a history of intense weevil attack. J. Entomol. Soc. B.C. 79:62-65.

Cozens, R.D. 1987. Second broods of *Pissodes strobi* (Coleoptera: Curculionidae) in previously attacked leaders of interior spruce. J. Entomol. B.C.

Harris, J.W.E.; Holms, J.C.V.; Molnar A.C. 1968. Status of the Sitka spruce weevil on Vancouver Island, 1967. Can. Dept. For. and Rural Development, For. Res. Lab., Victoria, B.C., Inf. Rep. BC-X-15, 19 p.

Heppner, D.G.; Wood, P.M. Vancouver Region Sitka spruce weevil survey results (1982-1983), with recomendations for planting Sitka spruce. B. C. Minist. For. Internal Rep. PM-V-5.

Humphreys, N.; Ferris, R.L. 1987. Forest insect and disease conditions. Vancouver Forest Region. Government of Canada, Canadian Forestry Service. Pacific Forestry Centre File Report. 49 p.

McMullen, L.H. 1976. Spruce weevil damage. Ecological basis and hazard rating for Vancouver Island. Can. For. Serv. Pac. For. Cent. Inf. Rep. BC-X-141. Victoria, B.C. 7 p.

Silver, G.T. 1968. Studies on the Sitka spruce weevil, *Pissodes sitchensis*, in British Columbia. Can. Entomol. 100:93-110.

Pissodes nitidus Roelofs, the yellow-spotted pine weevil (Coleoptera: Curculionidae): a serious pest of Korean pine plantations in northeast China

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Abstract

The yellow-spotted pine weevil, *Pissodes nitidus* Roelofs, is a serious pest of terminals of young Korean pine, *Pinus koraiensis* Sieb. and Zucc., in Northeast China. Up to 20% of stand volumes can be lost after two to four repeated attacks with 0.25 to 0.33 m of height loss resulting for each attack. Heat sum requirements for each life stage have been computed. More than 50 species of parasitoids have been reared from infested leaders of Korean pine. Most are members of the Chalcidoidea and the Ichneumonoidea. The major parasites have three generations per year and hibernate as mature larvae. Strategies for management of *P. nitidus* infestations including leader clipping and parasite enhancement are discussed.

Résumé

Le charançon *Pissodes nitidus* Roelofs est un ravageur important des pousses terminales des jeunes pins de Corée (*Pinus koraiensis* Sieb. and Zucc.) dans le nord-est de la Chine. À la suite de deux à quatre attaques répétées, la perte en volume peut atteindre 20% au niveau des peuplements, chaque attaque causant une perte en hauteur de 0.25 à 0.33 m. Les sommes calorimétriques requises pour chaque stade biologique ont été calculées. Plus de 50 espèces de parasitoïdes ont été obtenues à partir d'échantillons de pousses apicales infestées de ces pins. La plupart appartiennent aux *Chalcidoidea* et aux *Ichneumonoidea*. Les principaux parasites produisent trois générations par année et hibernent sous forme de larves matures. Diverses stratégies sont examinées pour la lutte contre les infestations de *P. nitidus*, y compris la coupe de la pousse apicale et la facilitation de parasites.