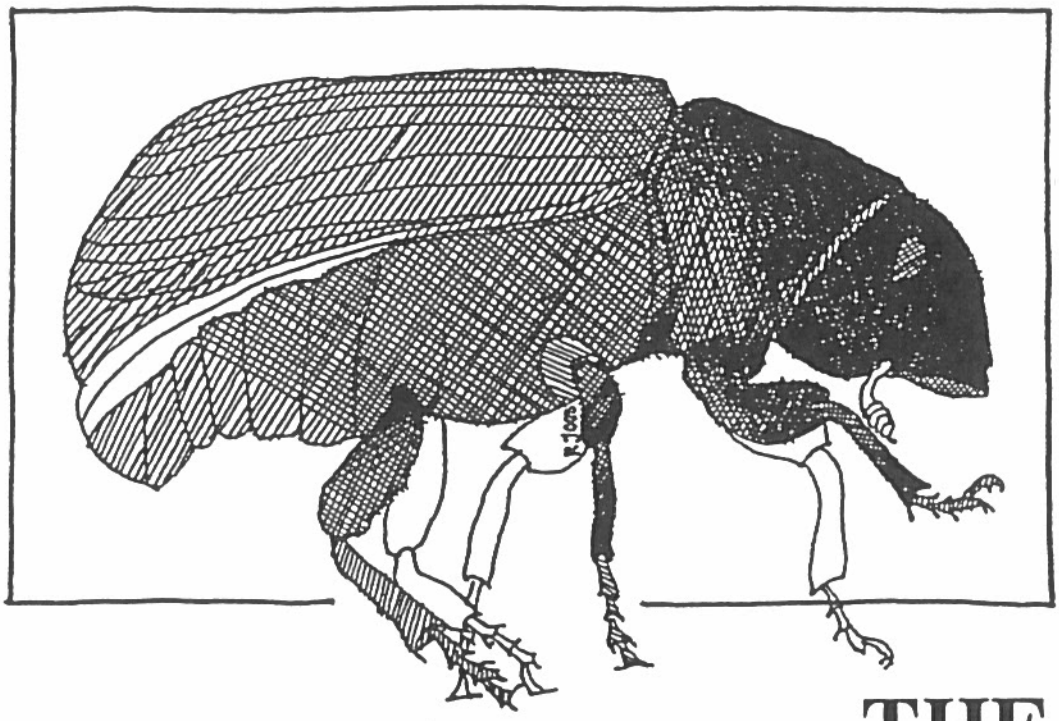
SYMPOSIUM PROCEEDINGS

FACULTY OF FORESTRY. UNIVERSITY OF TORONTO. TORONTO. ONTARIO



THE PINE SHOOT BEETLE IN ONTARIO

EDITORS
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SANDY M. SMITH

1998

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HISTORY AND SURVEYS FOR THE PINE SHOOT BEETLE IN ONTARIO

Rob Favrin / Gord Howse / Canadian Food Inspection Agency / Canadian Forest Service

1993 to 1997

1993

Maritimes. The Canadian Forest Service visually surveyed 158 pine stands throughout the three provinces of New Brunswick, Nova Scotia and Prince Edward Island. All sites were negative for *T. piniperda*.

Québec. Visual surveys were conducted in pine plantations in south central Québec (St. Hyacinthe district). Lindgren funnel traps were placed in the vicinity of the ports, saw mills and pine plantations in all three districts Montréal, St. Hyacinthe and Québec). Pine shoot beetle was not detected in the province in 1992.

Ontario. In response to the finds of this pest in a number of the U.S. Lake States in 1992, Agriculture Canada initiated surveys in 1993. In Ontario, Lindgren funnel traps were set along the north shore of Lake Erie from Niagara Falls to Sarnia. Beetles were captured at four sites in the Niagara peninsula. Three of the four sites were within a few miles of the N.Y. border (Niagara River).

Subsequent visual surveys were conducted at 84 sites in 20 counties of southern Ontario. Pine shoot beetle was found at 14 of these sites in 7 counties: Halton, Haldimand-Norfolk, Hamilton-Wentworth, Niagara, Peel, Waterloo and Wellington. The seven counties were subsequently regulated with respect to the movement of *Pinus*.

1994

Maritimes. Visual inspection surveys were conducted by the Canadian Forest Service in 123 pine stands in Nova Scotia, New Brunswick and Prince Edward Island. No evidence of *T. piniperda* was found in any of the stands.

Québec. Targeted sites included sawmills which process pines, areas around the port of Montréal, Christmas tree farms and other pine plantations. Forty Lindgren traps were placed throughout the region and approximately 300 hectares were visually inspected. No *T. piniperda* were found.

British Columbia. Trapping was conducted in fourteen locations in B.C. Targeted areas were similar to those mentioned for Québec. No *T. piniperda* were captured.

Ontario. Surveys focused on areas surrounding the seven counties found to be infested in 1993, as well as along the St. Lawrence Seaway. Fifty-five traps were placed in early March. Five traps

were placed in the Sault Ste. Marie area by the Canadian Forest Service. Only one trap outside of the known infested counties caught beetles in 1994 (Dufferin county). Four adult beetles were caught around May 1st in a private woodlot northeast of Orangeville. The county was subsequently added to the list of regulated counties. At the end of July and in early August, visual inspection surveys were also conducted in Brant, Oxford, Perth and Bruce counties. PSB was found at three sites in Brant county and one site in Oxford county. All finds were in wild *Pinus sylvestris* stands.

At two of the sites in Brant County, teneral adults were found under the bark of recently dead trees, i.e. trees with red needles but still resinous. The bark of these trees had numerous exit holes from which many young adults had already emerged. Adjacent trees were symptomless. At the third site, beetles were collected from apparently healthy shoots adjacent to a dead tree. The beetle had tunneled about 5 mm from the entrance hole. At the Oxford County site, beetles were found in windfallen shoots in a 300 acre wild stand of Scots pine.

Flagging shoots were not observed at any of the four sites described above. Inspection field staff found that discoloured or flagging shoots were not always a reliable indicator of PSB presence when conducting visual inspection surveys, particularly in unmanaged stands. They found that it was also important to focus on areas around recently dead or damaged trees and to look for green windfallen shoots around the base of trees in the latter part of the summer and fall.

1995

Maritimes. Visual inspection surveys were conducted in late summer-early fall by several cooperating agencies including AAFC, the Canadian Forest Service and Provincial departments of Natural Resources in Nova Scotia, New Brunswick and Prince Edward Island. No evidence of *T. piniperda* was found in the 63 pine plantations, Christmas tree farms or nurseries. Additional details on site type and host species is summarized by the Canadian Forest Service.

Québec. About 191 sites were surveyed for evidence of the pine shoot beetle in Québec. Targeted sites included sawmills which process pine, areas around the port of Montréal, Christmas tree farms and other pine plantations. Over 50 Lindgren traps were placed throughout the region and approximately 270 ha. were visually inspected. No *T. piniperda* activity was found.

British Columbia. AAFC surveys for pine shoot beetle were combined with the Dunnage Site Survey for exotic bark beetles. Traps were placed at 19 sites around Greater Vancouver, Squamish, Chilliwack and on Vancouver Island between Victoria and Nanaimo. The Canadian Forest Service also conducted surveys for this pest for the fourth consecutive year. Over 1800 Scots pine at five locations in the Fraser Valley were examined. Pine shoot beetle was not found in either of these surveys.

Ontario. Surveys were focused on the areas surrounding the infested counties, as well as along the St. Lawrence Seaway. Traps were placed in early March. Also, five traps were placed in the Sault Ste. Marie area by the Canadian Forest Service.

Two traps outside of the known infested counties caught beetles in 1995. Single adults were captured at Orono Provincial Forestry Nursery, Durham County and at a private residence near Tottenham in Simcoe County. These counties were subsequently added to the new list of regulated counties. Metropolitan Toronto was also included as a regulated area because of the high volume of pine material moving into the city, the low number of host stands at risk, the lack of exports of Christmas trees and nursery stock and its geographical position amidst infested counties.

Visual inspection surveys were also conducted in late July and August. As a result of these surveys, *T. piniperda* was found in an unmanaged *Pinus sylvestris* stand in southern Grey County.

1996

Maritimes & British Columbia. Surveys for pine shoot beetle using the trapping methods described above were conducted as a component of broader Exotic Bark Beetle Survey in which Lindgren traps were baited with one of the three different lure types (Ips lure, ethanol and α-pinene). No *T. piniperda* were found.

Québec. In addition to trapping conducted in conjunction with the Exotic Bark Beetle Survey, the Québec Region carried out trapping and visual surveys specifically directed at Pine Shoot Beetle detection. About 40 sites were trapped and visually inspected. Targeted sites included sawmills which process pine, Christmas tree farms and other pine plantations. No evidence of *T. piniperda* was detected.

Ontario. Surveys were focussed on areas surrounding the infested counties, as well as along the St. Lawrence Seaway and around Sault Ste. Marie. In 1996, *T. piniperda* adults were found in three new counties: York, Lambton and Middlesex. These counties were subsequently added to the list of regulated areas under Directive D-94-22.

1997

Surveys for pine shoot beetle in **Ontario** led to the discovery of this pest in one new county (Northhumberland) on the eastern edge of the infested area. The find was from a Lindgren funnel trap placed in an unmanaged Scots pine stand (approx. height = 40'). There are now 18 regulated counties in Ontario (Fig. 1). In Atlantic, B.C. and Québec regions, trapping for *Tomicus* was conducted using α-pinene-baited traps incorporated into the Exotic Bark Beetle Survey as discussed above.

An overview of the regulated counties in North America for the period 1992-1997 is shown in Figure 2.

written by Rob Favrin

Figure 1. Counties regulated for Pine Shoot Beetle in Ontario

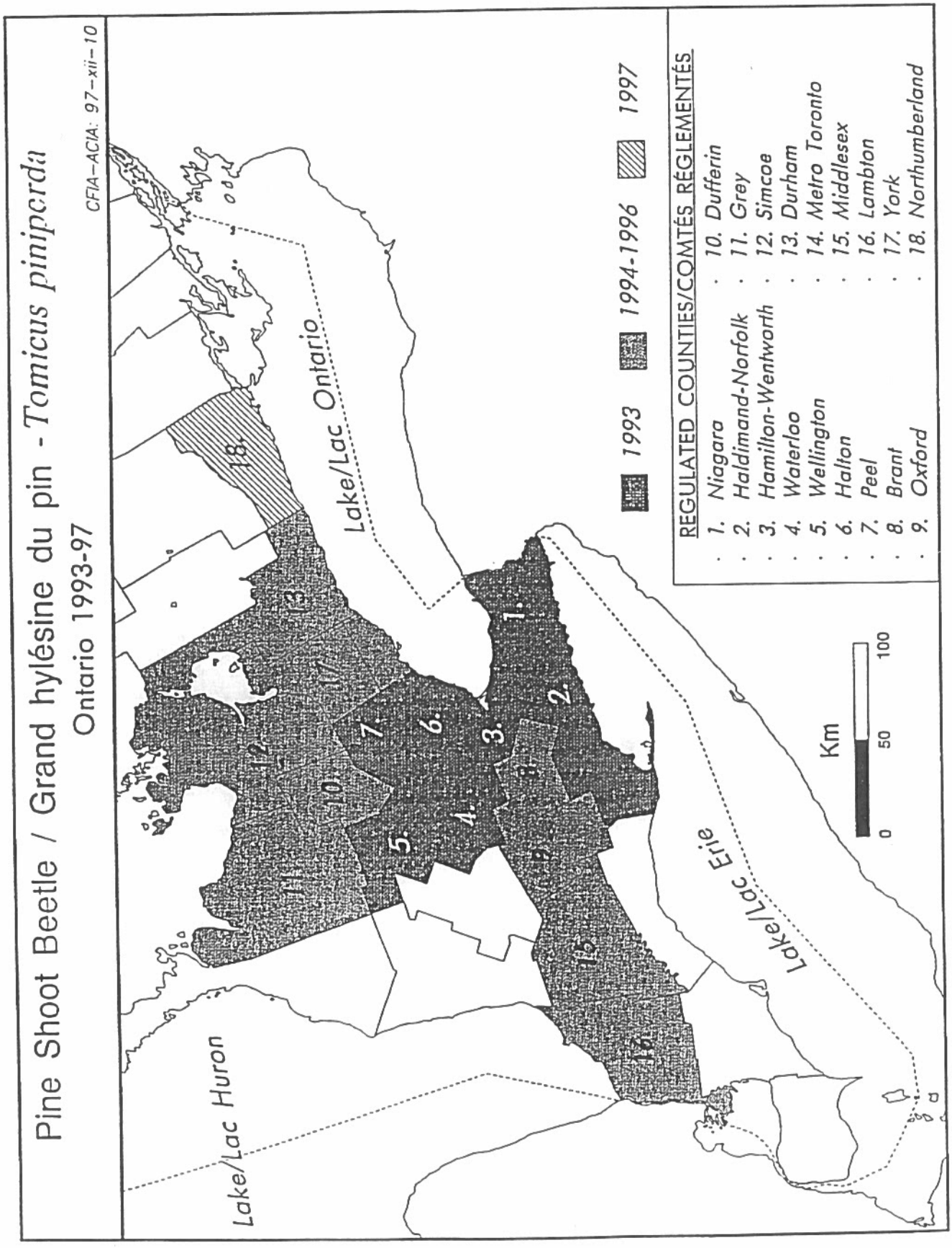
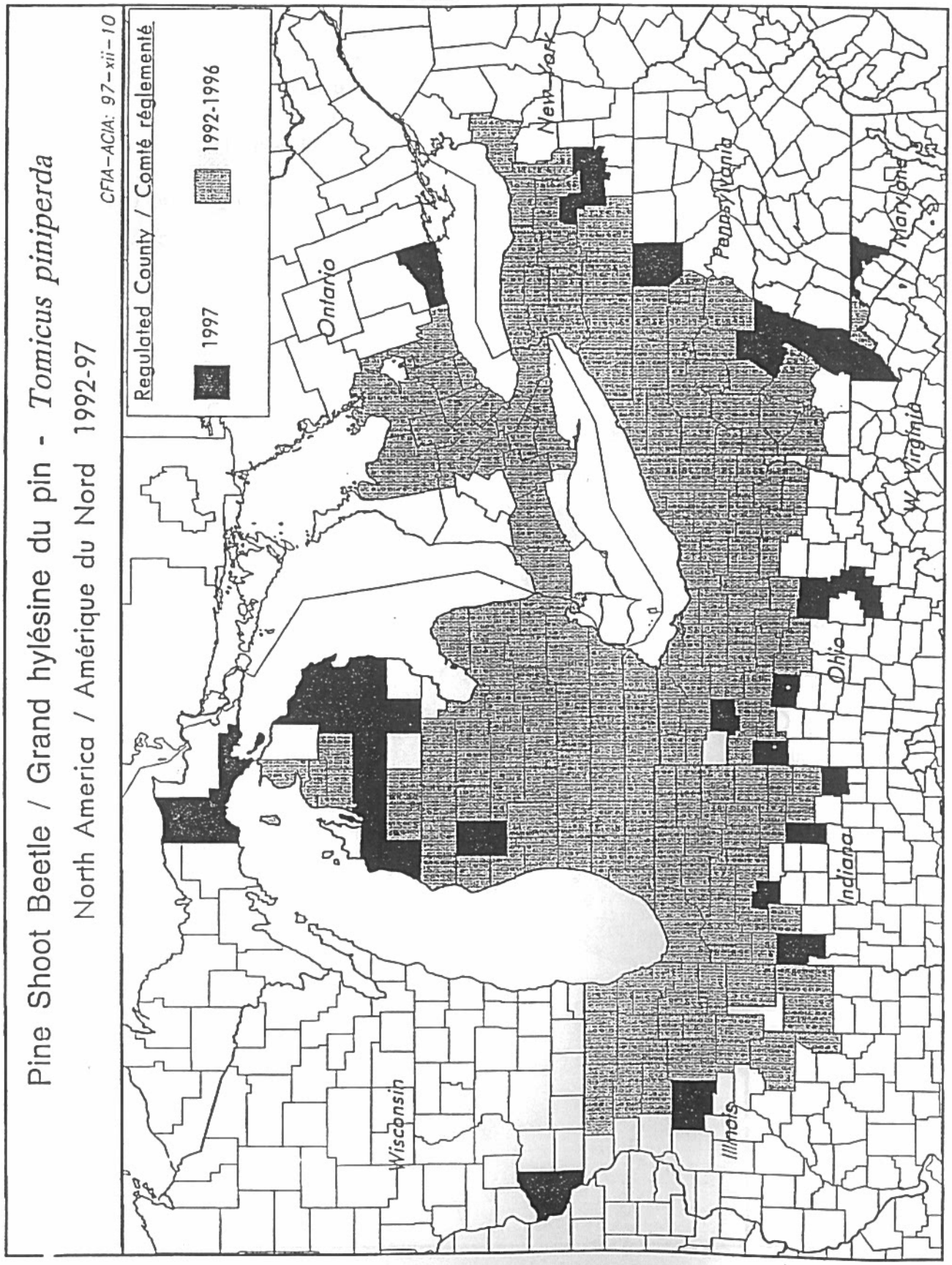


Figure 2. Counties regulated for Pine Shoot Beetle in North America



Biology of the Pine Shoot Beetle in Southern Ontario

Krista Ryall / University of Toronto

The pine shoot beetle, *Tomicus piniperda*, was first found in Ontario approximately five to six years ago. While there are numerous European reports on this species' life cycle and biology, little is known about this beetle in Canada. After several years of study, its life cycle here has been found to follow a similar pattern as is typically found in its native European range. Figure 1 illustrates a generalized life cycle of this beetle. Emergence of the parental generation occurs relatively early in the spring when the maximum daily air temperature reaches 11-12°C. In southern Ontario, emergence has been found to occur in mid to late April over the past two years. Appropriate brood material that is present in the stand at this time is extremely susceptible to colonization by the emerging adults. *Tomicus piniperda* requires weakened or stressed trees in which to reproduce and also readily colonizes logs that have been cut mid-winter or early-spring. In addition, *T. piniperda* requires sections of thick, rough corky bark on the tree bole to reproduce.

The primary host of *T. piniperda* is Scots pine, *Pinus sylvestris*, but this bark beetle species is able to reproduce and feed upon a number of other pine species found in Ontario. A preliminary study has found that the beetle will readily feed upon shoots of red (*P. resinosa*) and jack pine (*P. banksiana*), although it was not successful at feeding on white pine (*P. strobus*) when given a choice. Under natural field conditions, the parental generation will colonize logs of all four species of pine (Scots, red, jack, and white pine), but at differing densities (Fig. 2). Significantly fewer galleries were initiated on white pine as compared to the three other pine species. A comparison of brood production (number of new beetles produced per unit area) for the four different species also indicated significant differences (Fig. 3). The most beetles (per unit area) were produced on red pine, at approximately 750 beetles per square metre. Jack pine produced an intermediate value of around 400 beetles per square metre. Production on Scots pine was lower in 1997 than typically observed in Europe or observed in the previous two years (see below), with only approximately 200 beetles per square metre. Finally, white pine produced approximately 100 beetles per square metre, indicating that it is not a preferred species for colonization and is less suitable for successful reproduction than other pine species (although a small

number of beetles were successfully produced on trap logs of white pine in the field). Natural infestations of both jack and red pine have been found at several other locations in southern Ontario.

Gallery lengths in both years averaged around 7-8 cm, similar to previous European reports. Mean egg production per gallery, however, in both years measured was lower than European reports by about 50%, with only 20-25 eggs laid per gallery on average. Brood production by *T. piniperda* on Scots pine was found to be similar in the first two years studied (1995-96), at around 900-1000 new beetles produced per square metre of bark surface area. This consistent brood production occurred even under highly variable gallery densities, ranging from around 80 to over 220 galleries per square metre. This finding indicates that the *Tomicus piniperda* may have been operating very near to its carrying capacity in these years, efficiently and fully utilizing the resources available to it. Hence, appropriate brood material left in a stand may be highly colonized by this species and will be the source of a large number of emergent beetles later in the season.

In 1996 and 1997, emergence of the new generation of adult beetles occurred in mid to late July in southern Ontario. Typically, in the field, the galleries require about three months for the juveniles to develop through to pupation and emerge as adults. Warmer temperatures will speed up the development of the juvenile stages and the exact degree days of development for this species under Ontario conditions is still being determined. The timing of the emergence of this new generation is critical because, shortly after emergence, the beetles will begin a requisite period of maturation shoot feeding in the crowns of the trees.

This maturation feeding period is unique to the pine shoot beetle and is the primary cause of damage by this species. Each individual beetle feeds on several shoots over a period from late-July through to mid to late-September. After this time, the beetles move to overwintering sites, likely under the bark at the tree base. In the latter portion of the shoot feeding period, the majority of the feeding occurs in current year shoots. However, at the beginning of the feeding period, a variable proportion of the attacks are located in one-year-old growth. This can be especially damaging because all of the current year shoots that would have been produced are destroyed, causing a larger growth loss for the tree.

The level of parasitism of the pine shoot beetle by native parasitoid species was also studied on the four pine species. Jack pine was found to have a very high level of parasitism, approximately 31%, much higher than Scots (11%), white (7%) or red (1%) pine. Four different parasitoid species were found in total in our study. These species and their level of parasitism on the different pine species will be studied in closer detail in future studies.

In conclusion, the timing of critical life cycle events in southern Ontario is similar to previous European reports. Accurate knowledge of this timing will be beneficial in the design and implementation of control practices.

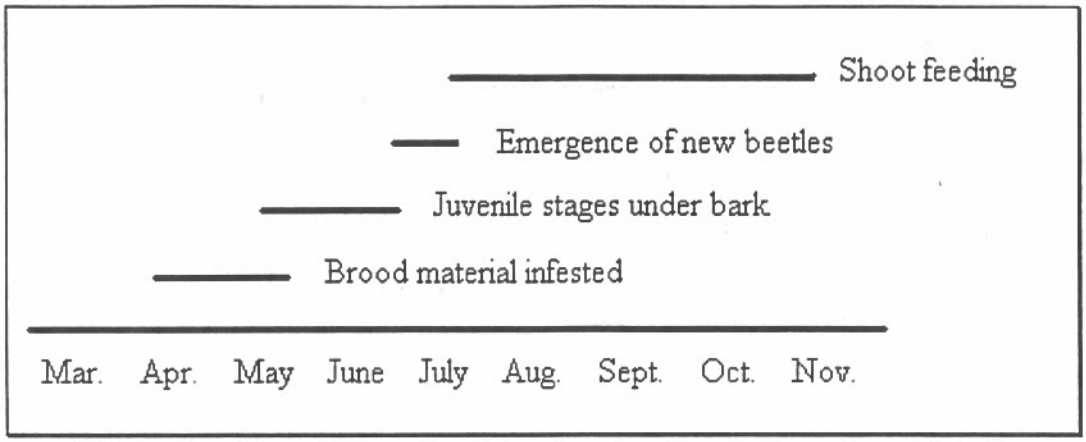


Fig. 1. Generalized life cycle of the pine shoot beetle in southern Ontario

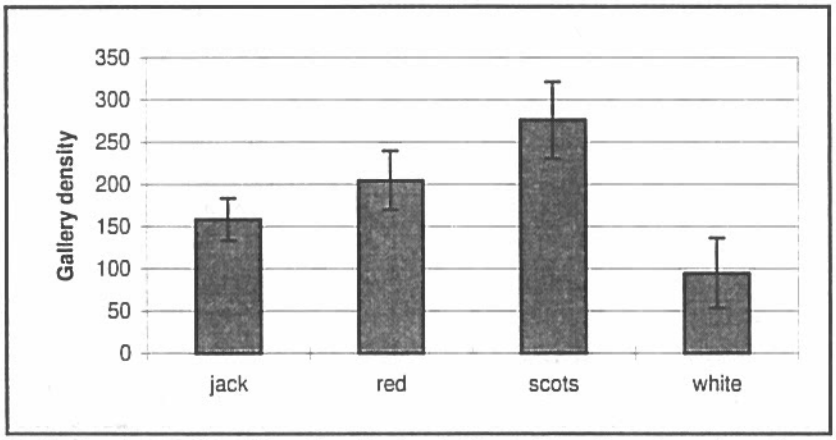


Fig. 2. Average density of galleries initiated by the pine shoot beetle

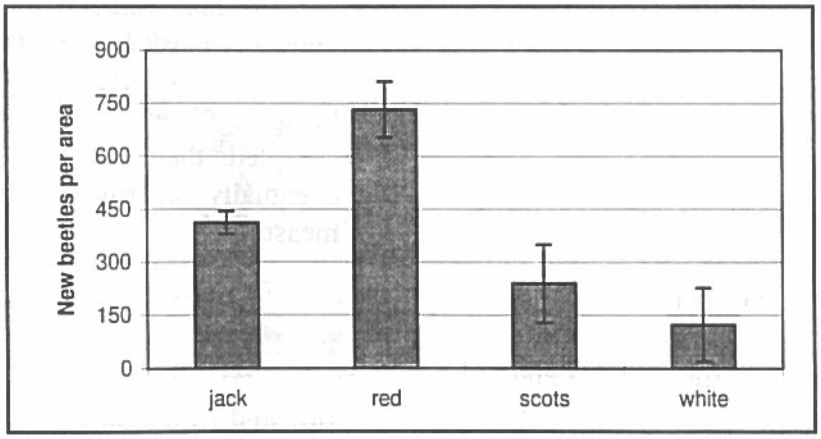


Fig. 3. Average production of new adult pine shoot beetles per unit area (m^2)

written by Krista Ryall

REGULATION OF THE PINE SHOOT BEETLE IN ONTARIO

Ken Marchant / Canadian Food Inspection Agency

The non-native status of this species, combined with its potential to cause damage, resulted in the imposition of a federal quarantine restricting movement of potentially infested material by the Plant Protection Division of Agriculture and Agri-Food Canada. This division is responsible for working to keep new pests from entering and spreading in Canada. When the pine shoot beetle was found here in Ontario, it was quickly determined that it was of quarantine significance, especially considering that bark beetles have had a bad track record when infesting new regions. While this new beetle hasn't done any significant damage over the last several years, regulatory measures, such as quarantines of imports, domestic movement restrictions and export certification are still in place. Details of this regulation is as follows.

REGULATED COMMODITIES

- Pine Christmas tree, boughs and wreaths
- Pine nursery stock for ornamental use
- Pine forest products with bark (round wood, pulp wood, fire wood)
- Unprocessed pine bark

UNREGULATED COMMODITIES

- Kiln-dried pine wood products
- Pine seeds and cones
- Pine forest product with bark removed (less than 2% surface bark remaining [Applicable to U.S. and Canada only!])
- Cut your own Christmas trees harvested after November 15 [Intra-provincial movement only]
- Commercially packaged and labeled pine nuggets [heat or chemical treatment]
- Shredded or pulverized bark mulch

PINE SHOOT BEETLE IMPORT POLICY (D-94-22) OCTOBER 1997

This policy is constantly being updated, working in conjunction with industries to ensure that they are not being regulated out of business, as it is accepted that the beetle will spread eventually regardless of our regulatory measures.

PINE LOGS WITH BARK

Infested U.S. counties to infested areas of Canada

Importing establishment required to hold permit to import (mill to be pre-approved by CFIA-Plant Protection)

Infested U.S. counties to NON-infested areas of Canada (Previously prohibited unless debarked, much higher risk)
Importing establishment required to hold permit to import (mill to be pre-approved by CFIA-Plant Protection). New rules proposed if destined to establishment within 100 km of infested area.

NON-infested areas of U.S. to Canada
No phyto/permit required (if Gypsy moth requirements are also met)

NON-infested counties within partially infested states to Canada
In lieu of phyto, logs may be accompanied by affidavit or certificate of origin attesting to origin, exporter declaration and destined to a sawmill or establishment pre-approved (under permit) by CFIA-Plant Protection

Current Canadian Plant Protection policy requires that all shipments of pine logs with bark from partially infested states such as Michigan be certified to have originated in non-infested counties. Logs from PSB infested counties are not permitted unless they have been debarked prior to entry. Based on this year's survey results, many counties of Michigan would no longer be eligible to ship to Canada. Shutting down exports of pine roundwood with bark from Michigan would impose considerable hardship on Michigan producers and the many Ontario sawmills which rely on this material and we may have to rethink this policy.

At present, mills located in non-PSB infested areas of Canada importing logs from partially infested states are required to hold an import permit issued by the Plant Protection Division of the Canadian Food Inspection Agency (CFIA). This sets out specific requirements that must be met by the mill to mitigate the risk posed through importations of logs with bark. Participating mills are required to develop a "quality plan" along ISO principals against which they are audited by CFIA - Plant Protection. Emphasis is placed on the disposal of bark and other high risk waste products during periods of high risk. Participating mills are audited twice a year and compliance to this point has been excellent.

Proposed changes to Policy - 1997 developed by Ken Marchant and Marcel Dawson

Many counties of Michigan were determined to be infested with PSB during the 1997 survey. Failure to amend Canadian Import Policy would place undue hardship on Canadian importers dependent on U.S. pine roundwood. The following amendments to D-94-22 would allow for the import of pine logs with bark from infested counties for processing purposes. Section 43 of the Plant Protection Regulations allows for exemption from Phyto requirements if permit conditions are met. The following proposed restrictions are applicable to pine logs with bark from pine shoot beetle regulated areas (identified in D-94-22) moving to non-infested areas in Canada which are within 100 kilometres from the PSB generally infested areas. Consultation will take place with Ontario stakeholders during the fall of 1997.

Proposed changes to Policy - 1997

Period 1 - July 1 to January 31 (Beetle free logs or overwintering beetles)

Imported pine logs from regulated areas must be completely processed (defined as debarked and where all bark, culls and other debris have been mulched or chipped to contain no piece larger than 5 centimetres in length or width, or incinerated) within 30 days of importation. All pine logs imported between January 16 to January 31 must be completely processed within two weeks of importation.

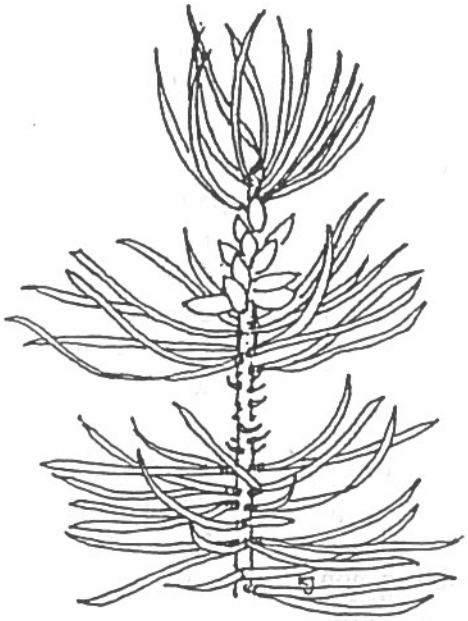
Period 2 - February 1 to April 30 (Breeding period)

Imported pine logs from regulated areas must be completely processed within 30 days of importation. All pine logs imported between April 16 and April 30 must be completely processed within two weeks of importation.

Period 3 - May 1 to June 30 (2nd breeding cycle emergence of new adults)

Imported pine logs from regulated areas must be completely processed within 30 days from the date of felling of the timber. All shipments will have to be accompanied by documents attesting to the date of felling.

written by Ken Marchant



EFFECTIVE MANAGEMENT STRATEGIES FOR THE PINE SHOOT BEETLE

Taylor Scarr / Harri Liljalehto / Ministry of Natural Resources

Trying to manage an introduced pest, such as the pine shoot beetle, presents many challenges to us. This is because we don't know its true distribution or its behaviour in its newest range, forcing managers to make decisions without knowing what the species is going to do here. After an introduced species first becomes a threat, a pest risk assessment is conducted by Agriculture and AgriFood Canada using European data. Assessment results are also discussed with the U.S., if applicable. The assessment of risk is still a guess, however. The pine shoot beetle is often reported to be the most damaging bark beetle pest in Europe, however it is still difficult to determine what will occur here in Canada, due to the many unknowns. For instance, the natural control of introduced pests are often missing. Hence, native parasitoids and their ability to adapt to using this new host must be examined. Climate limitations may also impact the rate of spread and establishment of this species. In addition, the resistance of the various tree hosts must be determined as some species may be more susceptible than others. For example, our native red pine may be more susceptible to attack by the pine shoot beetle than its primary host, Scots pine. All of these, and many other, unknowns must be researched to enable managers to gain a better understanding of this species in its newest range.

Government roles are also unknown as it must be determined who is responsible for various activities. Introduced species are the jurisdiction of the federal government through the Agriculture and Agri-Food and Plant Protection Agencies. Provinces typically play only a consultation role, although the federal government began consultation immediately about the pine shoot beetle upon its discovery here in Ontario. The second major issue is who is going to pay for the control endeavours. Third, we don't have the proper management tools to deal with this new species. For example, we have no pesticides registered for species that we don't historically have here in Canada, forcing us to stretch the label interpretation of our registered pesticides. Finally, we don't have the silvicultural techniques in place to deal with these new species. Therefore, our focus is on regulation of these new introduced species. Quarantines are management tools that are used but they may be more of a problem than the pest is itself on the forest industry. However, it is still unknown whether this species

IMPACT ON THE LANDSCAPE INDUSTRY: A GROWER'S PERSPECTIVE

Paul Fraser / Somerville Nursery

Paul Fraser from Somerville Nurseries provided information on the effect of the pine shoot beetle to the Landscape Industry in Ontario. After surveying a number of other nurseries in the region, he concluded that the beetle has had little impact to date. It seems that there are a number of reasons why this is the case, and several precautions that nurseries can take to limit the future impact of this beetle on their businesses.

Good sanitation practices can function to prevent the establishment of this beetle in individual nurseries, for instance, by avoiding planting next to older, untended Scots pine stands and removing all dead and dying material in a timely manner before it can serve as brood material for this beetle. Alternating tree species or letting a field lay fallow for a year can also prevent the build-up of the beetle. Preventative spraying has not occurred to any large extent, except as part of the regular pesticide application regime. Finally, shipping the trees before they become too large or crowded can help avoid damage by this species.

The current regulations restricting movement of material from infested to uninfested regions are considered to be of major concern to the nursery owners. Currently, growers must submit to either regular field inspections during the growing season or to a preshipment inspection to be certified as free of the beetle or to fumigate the trees before shipment. All trees over one metre tall or three centimetres diameter must be examined. All dead or dying material is to be removed before the onsite inspections. Growers are also required to put out Lindgren traps with α-pinene lures between 15 March to 30 May and to send all collected beetles to the Canadian Food Inspection Agency (CFIA). If any beetles are found, they must be eradicated from the site. Infected material is supposed to be segregated to prevent spread of the beetles. Finally, growers must maintain accurate records of all spraying and shipping practices.

Ten of the largest nurseries in southern Ontario were contacted to survey their impressions of the impact of the pine shoot beetle. All ten grew pine on their plantations. Of those, only three had ever experienced a problem with the pine shoot beetle. In all three of these infestations, there were a limited number of trees infected and all were successfully sanitized. The pines attacked were Scots and Austrian pine. Infested material was destroyed and not

may become a significant pest on jack pine in northern Ontario or in eastern Ontario in conjunction with the severe ice damage.

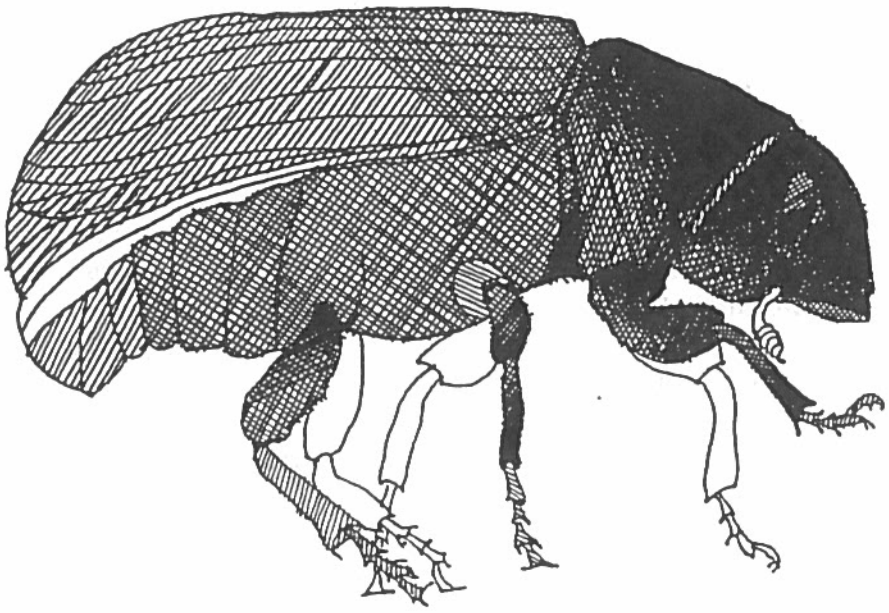
The many government cutbacks has left only a handful of people available to conduct the surveys for this new species. Because of these limitations, we have missed the opportunity to seek out and destroy this insect immediately after it was discovered. If we had been able to delineate where the beetle was in terms of its specific locations, we could have gone in and removed all of the infested material. Unfortunately, neither the resources nor the federal commitment were available for such an undertaking. It is likely that this beetle has been here for around ten years and appears to be spreading largely due to the increased survey area and less due to the actual spread of this species. Hence, it is no longer possible to go in and eliminate this beetle from specific stands as it is too widespread. Instead, infested counties are quarantined, regulated, and then left alone without further intervention. The government cutbacks has also resulted in a limited information program about this species, despite the overwhelming importance of getting information out to the landowners, growers and timber mills on how to minimize the spread and damage by the pine shoot beetle.

If the pine shoot beetle is found in a new area, agents from the Canadian Food Inspection Agency should be contacted immediately. Although the finding of even one beetle used to result in a complete restriction on moving material, there are now policies in place that have the potential to allow the movement of material while minimizing the risk of spread of this beetle. Second, an attempt can be made to seek out and destroy the infestation through sanitation, thus reducing the prevalence of this pest in the specific plantation. After control has been achieved, growers can then try to get the CFIA to relax restrictions because of their individual management protocols. It may become feasible to make all of southern Ontario regulated because it would now be better for counties to be regulated so that they can import wood from regulated counties which is currently restricted. It seems that this species may not become any more damaging than just another relatively benign eastern pine beetle but we still must focus on regulation restrictions as it is still to early to predict its future impact.

Harri Liljalehto had a number of practical suggestions to offer with respect to coping with this new insect. The mills in southern Ontario can receive wood from Michigan, however, they still must take the consultation opportunities with the CFIA very seriously. Although the CFIA is limited in man-power, they are very anxious to work out arrangements where they understand the mills' needs while explaining the their own needs about moving wood both internationally and within the province. To better facilitate this, it is important to explain every detail of the mill operation to the CFIA's agents, including how and when material is processed, handling of potentially infested bark, and convenient times to ship and process material. Through communicating each others problems about the international trade of wood, good relationships can be built.

The quarantines are somewhat flexible. Proof of this can be seen in the fact that the CFIA has been able to keep several mills operating over the last few years that could have been completely shut down otherwise. Mill owners and growers need to think about how they can vary the operations of their organization to reduce risk of spread and damage by this species now that we know more about its biology, history and impact.

summarized by Krista Ryall



IMPACT ON THE CHRISTMAS TREE INDUSTRY: A GROWER'S PERSPECTIVE

Doug Drysdale Jr. / Drysdale Farms

Doug Drysdale Jr. from Drysdale Farms represented the Christmas Tree Growers in Ontario and provided some information on the viewpoint of this industry towards the pine shoot beetle. Scots pine is the primary species affected by this species and in recent years, this pine species has been rapidly falling out of favour with the consumers, hence it is being planted and grown less, lessening the industry's concern about this beetle. In the 1950's and 1960's, Scots pine was readily available from the OMNR and was the tree of choice, representing about 90% of all trees grown. However its place later fell to approximately only 40-50% in the 1980's, and now makes up only about 20% of the area planted with various Christmas tree species. Scots pine is being replaced by firs, such as balsam, fraser, and douglas, and these species are not thought to be susceptible to attack by the pine shoot beetle.

Of some concern is the abandoned Scots pine stands that were planted in the 1950's and 1960's that now serve as good host areas for the pine shoot beetle and may help to increase its population size and rate of establishment and spread. However, when plantations are actively and properly managed, it is uncommon to see any significant damage by the pine shoot beetle. In fact, the yearly shearing required to grow this tree species in Christmas tree plantations may eliminate feeding material available to the beetle. Trees that have been affected by the beetle are destroyed instead of sold and so do not increase the risk of its spreading.

In conclusion, to date, this species has not had an appreciable impact on the Christmas tree industry and one is not expected to occur in the future. Restricting shipment of material from county to county have had and can continue to have serious negative impacts on growers, especially smaller operations. In fact, such restrictions may have a more serious impact than the beetle itself. Finally, the numerous small cut-your-own operations are not easily regulated, there is little likelihood of the beetle spreading in such stands because the trees are cut and removed during the fall/winter when the beetle cannot be transported.

summarized by Krista Ryall

IMPACT ON THE LANDSCAPE INDUSTRY: A GROWER'S PERSPECTIVE

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Paul Fraser from Somerville Nurseries provided information on the effect of the pine shoot beetle to the Landscape Industry in Ontario. After surveying a number of other nurseries in the region, he concluded that the beetle has had little impact to date. It seems that there are a number of reasons why this is the case, and several precautions that nurseries can take to limit the future impact of this beetle on their businesses.

Good sanitation practices can function to prevent the establishment of this beetle in individual nurseries, for instance, by avoiding planting next to older, untended Scots pine stands and removing all dead and dying material in a timely manner before it can serve as brood material for this beetle. Alternating tree species or letting a field lay fallow for a year can also prevent the build-up of the beetle. Preventative spraying has not occurred to any large extent, except as part of the regular pesticide application regime. Finally, shipping the trees before they become too large or crowded can help avoid damage by this species.

The current regulations restricting movement of material from infested to uninfested regions are considered to be of major concern to the nursery owners. Currently, growers must submit to either regular field inspections during the growing season or to a preshipment inspection to be certified as free of the beetle or to fumigate the trees before shipment. All trees over one metre tall or three centimetres diameter must be examined. All dead or dying material is to be removed before the onsite inspections. Growers are also required to put out Lindgren traps with α-pinene lures between 15 March to 30 May and to send all collected beetles to the Canadian Food Inspection Agency (CFIA). If any beetles are found, they must be eradicated from the site. Infected material is supposed to be segregated to prevent spread of the beetles. Finally, growers must maintain accurate records of all spraying and shipping practices.

Ten of the largest nurseries in southern Ontario were contacted to survey their impressions of the impact of the pine shoot beetle. All ten grew pine on their plantations. Of those, only three had ever experienced a problem with the pine shoot beetle. In all three of these infestations, there were a limited number of trees infected and all were successfully sanitized. The pines attacked were Scots and Austrian pine. Infested material was destroyed and not

salvaged by fumigation. These three growers indicated that this pest was of potential major concern, while growers who did not have first-hand experience did not consider it to be of concern. Standards to receive phytosanitary certificates from the CFIA are not considered to be prohibitive and no major changes to the regulations were thought to be of great importance at the present time.

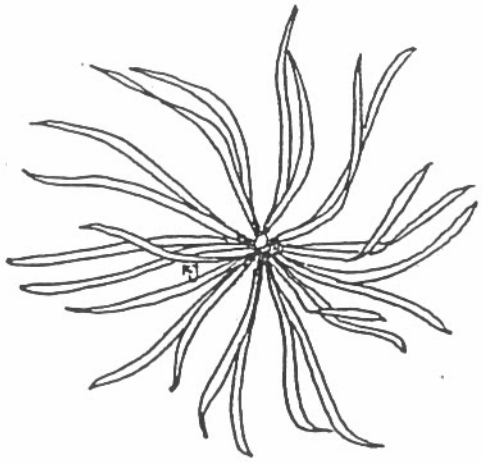
In summary, the current inspection system of the Landscape Industry is perceived to be working adequately, possibly largely because so few beetles are being found. There is apprehension over the potential damage caused by this species but this is largely related to the economic losses due to shipping restrictions. Growers can minimize the risk of infestation through good cultural growing practices. The CFIA is considered to be doing a good job with the limited staff available to them, although there exists a desire among the growers to streamline the inspection procedures to minimize costs to the growers. Literature on the beetle's life cycle and control methods would be helpful.

With particular reference to Somerville, this beetle has not yet posed a problem but they are situated in what can be considered a high risk area. Many older, untended Scots pine stands are located around the nursery, providing the potential for a serious infestation of the nursery itself. In addition, if the county were quarantined, it could prove to be financially devastating to the nursery due to the extreme importance of the American market.

Several recommendations were posed that could help reduce the costs incurred by the growers and also reduce the risk of infestation. If growers have a consistent history of being free of pine shoot beetle (i.e. at least two years), then the requirements for field inspection could possibly be relaxed to only one per season. A field accreditation system could be implemented if the growers have a history of clean fields. Finally, the timing of spring cleanup currently seems premature. If the litter was left in the field throughout April and May, it could act as a trap and could then be destroyed later in May after colonization but before emergence of the new generation.

Historically, this species has not been a problem but it still poses threat due to quarantine restrictions.

summarized by Krista Ryall



IMPACT ON THE TIMBER INDUSTRY: AN INDUSTRY PERSPECTIVE

Chris McDonnell / Tembec

There is a specific sawmill perspective vis a vis the pine shoot beetle's impact on the timber industry. Tembec has 30 sawmills, pulpmills and value-added facilities in Ontario and Quebec and is expanding into eastern Canada. This is a publicly traded company and will be willing to work with the Plant Protection Agency (CFIA). However, many other small private mills will be hard to track for similar compliance. Indeed, there is a broad spectrum of sawmilling facilities in this province, from large established companies to small portable companies.

In conjunction with the large number of participants in the roundwood industry, there is quite extensive movement of wood throughout the province. This large-scale movement occurs for a number of reasons. First, as Ontario moves towards value-added products (for example, taking small pieces of soft wood and preparing them for jointing) southern Ontario becomes more interesting, because these smaller pieces can now be used profitably. Second, transportation is becoming much easier, allowing trucks to haul steel in one direction and wood in the other direction. Finally, the great demand for pole quality material results in it being transported over great distances.

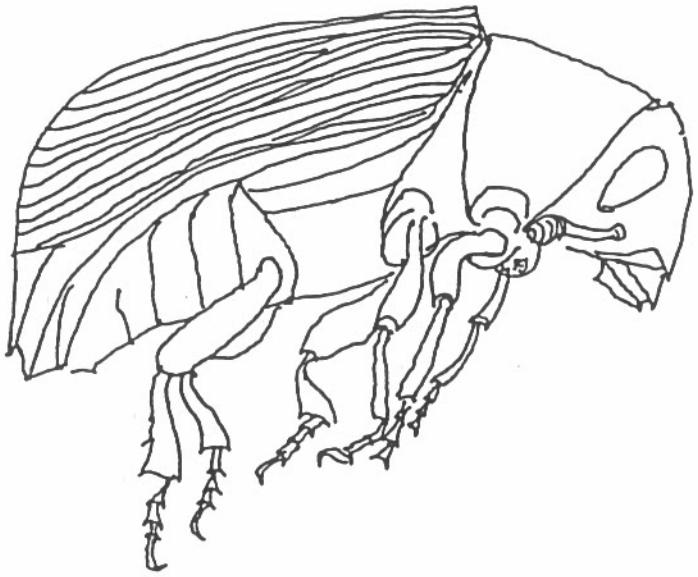
Tembec is very familiar with regulations concerning the pine shoot beetle. The key people are in the mills themselves, for example, the person in the scale shack in the middle of the log yard because they measure where the wood comes from. It is critical to know where the wood is coming from and this is measured as it arrives so it is not too hard to track down its origin. The issue of bark and wood processing is challenging, however, it is improving. Large-scale plants are able to use bark to fuel wood kilns and are able to adjust the scheduling of pulp mills to address timing issues related to the pine shoot beetle. This is much harder for small mills to do, because they need a critical mass of bark to sell and aren't able to be as flexible with their scheduling.

There are a number of on-site inspections of plants during which it is critical to hear what the inspector has to say, as the company is not interested in spreading a pest that may end up in white pine. Much more education is needed, as the pine shoot beetle is just one of a myriad of problems. The mills are trying to produce end-products in demand and it may be hard to fit this new problem into their current system.

Concise accurate information is needed to inform workers on what the pest is and what it does. The information needs to be readily available so workers don't have to track it down and summarize it each time. Everyone wants to understand why they have to do the various restrictions and so the availability of accurate information greatly helps with compliance.

There are a number of critical times during the year for moving bark and storing wood. It needs to be better understood whether mills can cause this new species to increase in numbers and whether the surrounding forests are susceptible due to occasional build-up of potential brood material. Accumulation of wood occurs in early spring in anticipation of optimal operating conditions and also because less wood comes in in early summer so mills must store wood so that they can continue to cut throughout the summer.

The pine shoot beetle doesn't yet represent a challenge to the timber industry, because it is just one of many provincial regulations. It may become important, however, and the challenge is to communicate the risk to those major participants that are critical in overall management of this beetle.



THE PINE SHOOT BEETLE IN THE UNITED STATES

Bob Haack / Deb McCullough / USDA Forestry / Michigan State University

Summary of Pine Shoot Beetle Research at Michigan State University
written by Deborah G. McCullough

At Michigan State University, we have been actively studying the ecology and management of pine shoot beetle (PSB) (*Tomicus piniperda* L.) since shortly after it was discovered in North America in 1992. Although we have seen little evidence that PSB causes significant damage to trees, the PSB quarantine and associated regulations have had major impacts on pine-based industries in Michigan. Michigan is one of the top three producers of Christmas trees in the US and an estimated 1.5 million Scotch pine trees are exported and sold out-of-state each year. Pine Christmas tree fields in quarantined counties must be inspected by state officials just before harvest. If the inspector finds evidence of PSB infestation, then the field is restricted and trees cannot be shipped out of the regulated area. Forest products companies have also recently been affected by PBS regulations that address shipment of pine logs from quarantined counties to mills in non-quarantined counties.

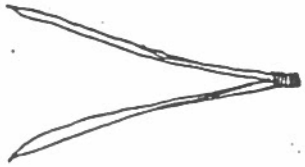
We began studies in Scotch pine Christmas tree fields in 1993 to identify effective and practical ways of managing PSB. Reducing or eliminating potential brood material for PSB is important to prevent the build-up of beetle populations. Stumps are particularly a problem in these fields; fresh stumps are present annually and are readily colonized by parent PSB adults in spring. We evaluated insecticides, repellents and a cultural method of cutting stumps off low to the ground to determine their effectiveness in controlling PSB. Results indicated that several insecticides, including pyrethroids and chlorpyrifos products, were effective when applied to the bark of stumps. Cutting stumps off very short reduced the phloem available to developing PSB larvae and was also effective. Verbenone, a compound that is repellent to other pine bark beetles showed some potential, although it was not as effective as cutting stumps short or applying an insecticide. Another repellent, 4-allylanisol, did not appear to be effective in our test. We also found that insecticides were effective if applied in early spring, before stumps were colonized by parent beetles, and when applied in May, before progeny adults emerged from stumps. The latter timing

is probably more practical for most growers. In other studies, we found that several pyrethroids and chlorpyrifos were effective when used as cover sprays to control progeny beetles beginning their maturation feeding in shoots of live pines. Progeny beetles usually began emerging from brood material in early to mid-June, at about 450-550 degree days base 50°F.

Results from our studies and those of other researchers were used to develop a PSB Compliance Program for Christmas tree fields. Under the Compliance Program, growers must complete a year-round integrated management program for PSB. The program includes: (1) destruction of potential brood material (e.g. cutting stumps low, burning or chipping recently culled trees); (2) trap logs that attract parent beetles and are then destroyed before progeny beetles complete development; and (3) application of a cover spray when newly-emerged progeny adults begin shoot-feeding. This program was tested in a 2-year pilot project in over 20 fields in Michigan and Indiana, in cooperation with Dr. Cliff Sadof at Purdue University. We found the Compliance Program resulted in very low to undetectable levels of PSB in fields. The Compliance Program was implemented operationally in 1997, providing growers in quarantined states with the option of enrolling fields in the Compliance Program. If growers complete all activities by specified deadlines, the likelihood that fields will be restricted during pre-harvest inspections is considerably reduced.

In the last two years, we have examined interactions among PSB, native bark beetles and other phloem-feeding insects, and the predators and parasitoids of native bark beetles. Results to-date indicate that there is a diverse complex of phloem-feeding insects utilizing pine slash, logs and stumps. Although PSB adults colonize brood material earlier in the spring than most native bark beetles, there is at least one native species and a weevil that are also active early. Native predators and parasitoids are attacking PSB adults and larvae in pine forest stands. A native clerid beetle appears to be the most common predator and at least some proportion of these predators are also active in early spring.

We are also determining if PSB exhibits a preference for Scotch pine over native red and jack pine. Results from other scientists indicate that PSB can develop and shoot-feed in most North American pine species. However, anecdotal evidence suggests that while PSB has been established for several years in much of Michigan, it is not common in most stands of red and jack pine. Preliminary laboratory and field studies suggest that PSB adults may prefer to colonize Scotch pine logs, but more work is needed to confirm this. Surveys in stands throughout Lower Michigan indicate that shoot damage caused by PSB is more common in Scotch pine stands than in red and jack pine stands, but that most shoot damage is attributable to storms, squirrels and other factors.



Haack, R. A.[1] and R. K. Lawrence[2]. 1997. Highlights of Forest Service research on *Tomicus piniperda*: 1992-1996. Pages 115-122 *in* 1997 Japanese beetle and pine shoot beetle regulatory review: Proceedings, Louisville, Kentucky, 24-26 February 1997. USDA APHIS, Riverdale, Maryland.

Highlights of Forest Service Research on *Tomicus piniperda*: 1992-1996

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As part of the USDA Forest Service research effort on the pine shoot beetle (PSB), *Tomicus piniperda* (L.) (Coleoptera: Scolytidae), we conducted several studies during the years 1992-1996. A few of these studies have been published (Carter et al. 1996, Haack and Lawrence 1995a, 1995b, 1997, Haack *et al.* 1997a, 1997b, Lawrence and Haack 1995), but many more still await publication. Below, we give a brief summary for several of our published and unpublished studies. For the yet unpublished studies, readers should note that the early results given here are tentative and may change as the papers move through the review process. Nonetheless, we hope that these early results will be of interest to many readers.

Where does PBS overwinter? Three studies were conducted during 1993 and 1995. Two studies involved Scotch pine Christmas trees in Indiana (Haack and Lawrence 1997, Haack *et al.* 1997a) and one involved mature Scotch pine and red pine trees in Michigan (unpublished data). Overall, most PSB adults overwinter inside the outer bark along the lower trunk, near groundline. Adults often overwinter on the same tree on which they were last shoot feeding. Considering the 249 overwintering PSB adults found on 12 Scotch pine Christmas trees, 98% were found along the first 20 cm of trunk. Similarly, considering the 681 overwintering PSB adults that were on the lower trunks of four heavily infested mature Scotch pine trees, 64% were within 20 cm of groundline and 85% were within 40 cm of groundline. Likewise, for the 103 overwintering PSB adults found along the lower trunks of 4 mature red pine trees, 71% were within 20 cm of groundline and 97% were within 40 cm of groundline.

When does PSB initiate spring flight? PSB spring flight was monitored each year from 1993 to 1996. Early results were published in Haack and Lawrence (1995a). The European literature states that PSB spring flight begins when temperatures first reach 10-12°C (50-54°F; Bakke 1968). However, it has been our experience that PSB required temperatures of at least 12°C (54°F) for at least 2 consecutive days, and that beetle flight was most common on sunny, calm days. In the Great Lakes region, the first few warm days in the late winter on early spring (February to March) are often associated with sudden shifts in the jet stream, and thus these first warmish days are often associated with rain and high winds. On such days, although the temperature threshold for PSB flight is met, it has been our experience that PSB does not generally fly.

In 1993, when we and several cooperators monitored spring flight at 22 locations in the six PSB-infested states of Illinois, Indiana, Michigan, New York, Ohio, and Pennsylvania, initiation of the PSB flight was very similar regionwide (unpublished data). In that year, PSB initiated flight during the last week of March or in very early April in all six states. At one particular site near Battle Creek, in southern Michigan, initial PSB peak spring flight has occurred on 29 March 1993, 23 March 1994, 12 March 1995, and 3 April 1996. In all 4 years, PSB peak flight occurred 3 to 6 weeks earlier than initial peak flight of the native pine-infesting bark beetles and their associated predators (unpublished data).

Given that the timing of initial PSB spring flight is so dependent on temperature, it is logical that PSB flight will tend to occur earlier to the south and later to the north. We looked at historical temperature records for selected cities in Indiana and Michigan and estimated when PSB peak spring flight would likely have occurred each year if PSB had been present (unpublished data). For example, in Indianapolis, Indiana (39.45°N; weather records years including 1914 to 1996), peak PSB flight was estimated to have occurred from early January to late March, with most occurrences falling in the month of February. Similarly, in East Lansing, Michigan (42.45°N; 1864 to 1996), peak PSB flight was estimated to range from late January to late April, with most occurrences happening during the first half of March. Further north, in Grayling, Michigan (44.4°N; 1892 to 1996), peak PSB flight was estimated to have occurred from early March through late April, but with most occurrences falling between late March and early April.

Funnel traps versus Theysohn traps. In 1995, we compared the efficiency at which two bark beetle traps captured PSB adults when baited with standard alpha-pinene lures (unpublished data). We compared the 12-unit funnel trap from PheroTech (Delta, BC) with a single unit Theysohn trap from El-Tech Technology (Larchmont, NY) at five sites in Michigan. On average, more than twice as many PSB adults were collected in funnel traps than in Theysohn traps. When the data were expressed as the number of PSB captured per unit area of trap surface

area, the funnel traps still collected significantly more PSB than did the Theysohn trap.

8-unit, 12-unit, or 16-unit traps? Funnel traps from PheroTech are sold as 8-unit, 12-unit, or 16-unit traps. Each unit is a funnel. Trap cost, of course, increases with the number of funnels. In 1995, we compared the number of PSB adults captured in three different sizes of traps at a single site in Michigan (unpublished data). Overall, significantly more PSB adults were collected in 12- and 16-unit traps compared with the 8-unit traps.

How many alpha-pinene lures to use? We tested PSB's dose response to alpha-pinene be comparing the number of PSB adults collected in standard 12-unit funnel traps when baited with 1, 2, 3 or 4 alpha pinene lures per trap (unpublished data). Lure release rates were ca. 150 mg/day at 24°C. Early results suggest that 2-lures per trap attract significantly more beetles than traps baited with only 1 lure. Although using 3 or 4 lures per trap attracted steadily more beetles in absolute terms, the increases were not significantly greater. Based on these results, we recommend the use of 2 lures per trap. Actually, the standard PSB "lure" that PheroTEch now markets consists of two individual bottles of alpha-pinene.

Liquid versus gelled alpha-pinene lures? The first alpha-pinene lures that PheroTech offered in 1993 had clear liquid consistency. In 1995, PheroTech offered a new alpha-pinene formulation that was gelled and red in color. In 1995, we tested these two lures by comparing the number of PSB adults collected in standard 12-unit funnel traps that were baited with either 2 clear-liquid lures each or 2 gelled lures each (unpublished data). When the total catches were compared for the entire PSB flight period, beetle catches were not significantly different between the two formulations. However, it did appear that in early in the PSB flight season, especially on days when the maximum temperatures only reached the upper 50s or lower 60s°F, that the liquid lures attracted more PSB adults than did the gelled lures. Nevertheless, both types of lures were highly attractive to PSB.

Does log length, diameter, or pile size affect PSB density? In 1995, we conducted a replicated study to test how pine species (Scotch vs. red), log length (30 cm vs. 60 cm), log diameter (5 cm, 10 cm, and 15 cm), and log pile size (1, 2, or 3 logs per pile) affected PSB attack density on trap logs (unpublished data). In general, PSB attack density was greater (a) on Scotch pine logs, (b) on 60-cm logs, (c) on the 10-15 cm logs, and (d) on logs in 2-3 log piles, especially when the logs were of smaller size. PSB attack densities appeared to be linked to bark roughness, with higher densities on logs with rougher bark. These results suggest that the most effective trap logs will be from Scotch pine trees and be a minimum of 60-cm long and 10-cm in diameter. Logs can be placed out singly in the field, especially if using Scotch pine. If Scotch pine is not available, red pine is adequate, but logs with rougher bark should be used.

How does log placement from the edge of a plantation affect PSB attack density in trap logs? We conducted a replicated test to examine how PSB density would vary when trap logs were placed at various distances from the edge of infested Christmas tree plantations (unpublished data). We placed Scotch pine logs (ca. 15 cm in diameter and 50-cm long) at distances of 25, 50, and 100 meters from the borders of isolated PSB –infested Christmas tree stands. Overall, all sample logs were attacked by PSB no matter their distance nor direction from the plantation. However, PSB attack density tended to decrease with increasing distance from the stand edge. These results demonstrate that PSB adults are very active during the spring flight season, moving out from isolated plantations in all directions. The fact that PSB adults located trap logs at 100 m from a stand edge indicates that trap logs do not have to be placed within the center of a plantation to be attacked. However, since attack densities were highest at locations nearest the stand edge, we recommend that trap logs be placed within a stand or close to the stand edge.

Does tree species, felling date and log exposure affect subsequent attack density? We conducted two studies to address this issue (unpublished data). First, in 1993, Scotch pine trees were felled at various times from February to July. Logs from these trees were exposed to bark beetle attack and later debarked. PSB attacked logs from trees cut from February through May. Highest attack densities occurred in the February-cut logs, which were felled prior to peak adult flight that occurred later in March. In the second study, at monthly intervals from October 1993 to January 1994, jack pine, red pine, white pine and Scotch pine trees were felled at a single site in Michigan. Logs from these trees were placed either in direct sunlight or in shade, and later debarked and inspected. Overall, PSB adults attacked logs from each of the four felling dates. In general, attack densities and brood densities were higher on shaded logs compared with those in full sunlight. Of the four pine species tested, Scotch pine was the most heavily attacked, followed by red, jack, and white pine. Attack densities were very low on white pine logs. In fact, no PSB attacked the October-felled white pine logs. These studies indicate that PSB adults can be expected to colonize slash and stumps created during the previous fall and winter as well as slash and stumps created during the spring months. As a result of shading, logging slash created during the thinning operations and left in the stands will probably produce more PSB adults than will slash left in clearcuts. If attack density is a good indicator of pest potential, then PSB will likely be a greater pest in Scotch and red pine stands than in jack and white pine forests in the Great Lakes area.

What portion of a recently cut pine tree does PSB infest? The goal of this project was to determine the within-tree attack pattern of PSB in mature red pine and Scotch pine trees with respect to felling date (unpublished data). In a single mixed-pine site in Michigan, we felled pole-sized red pine and Scotch pine trees during the months of February,

April, May, June, and July, and allowed the entire trees to undergo natural attack for 6-10 weeks prior to inspection. Overall, for the February-cut red and Scotch pine trees, PSB adults colonized the entire trunk up through the mid-crown region. In addition, the basal portions of some main branches were also attacked. PSB attacks were only found on trees felled between February through June. Moreover, only Scotch pine trees were attacked by PSB in May and June. For both red pine and Scotch pine, PSB attack densities were highest on the February-cut trees. Attack densities on the April- and May-cut trees were less than 10% of the levels for the February-cut trees. These results indicate that PSB will reproduce in practically the entire trunk of mature red and Scotch pine trees, and that trees cut prior to the initial peak flight of PSB in spring will be attacked most heavily. The PSB adults that were attacking the pine trees felled in April through June were undoubtedly constructing their second or third egg galleries (i.e. "sister brood") for that season. Laying multiple batches of eggs is common in bark beetles, however, parent adult survival decreases sharply between successive broods.

Can PSB reproduce and shoot-feed in North American pines? Over the past few years, we have conducted various tests to determine whether PSB could successfully attack, breed, and shoot-feed in North American pine (Lawrence and Haack 1995 and unpublished data). We conducted our tests in Michigan, using mostly pines grown at Michigan States University Kellogg Forest. The Kellogg Forest has plantation of more than 70 species of trees from all over the world. We tested three eastern North American pines (eastern white, red, jack) and three western pines (limber, ponderosa, western white). Scotch pine, a native host of PSB was used as the "control". Although variation occurred among the different pine species, PSB was able to reproduce and shoot-feed in all species tested. In general, performance was better in the 2-3 needle hard pine compared with the 5-needle soften pines. Of the six North American pine species that we tested, PSB was able to reproduce and shoot-feed best in Ponderosa pine and red pine. In other studies conducted by Drs. Thomas Eager and Wayne Berisford at the university of Georgia (unpublished data), PSB was found to successfully breed in five of the major southern pines (loblolly, slash, long leaf, shortleaf, and Virginia). In addition, several other species of North American pines have served as suitable hosts for PSB when grown in Europe (Langström and Hellqvist 1985, Langström *et al.* 1995). These results suggest the PSB will be able to utilize most if not all North American pines as hosts for breeding and shoot-feeding.

Can PSB reproduce and shoot-feed in North American *non*-pine conifers? In addition to the pine species mentioned above, we also tested a few non-pine conifers (unpublished data). As above, these trees were growing at experimental forests in southern Michigan. We tested white spruce, Douglas-fir, balsam fir, and tamarack. PSB did attack and oviposit in Douglas fir and white spruce, but brood survival only occurred in white spruce.

Although, PSB was able to breed in white spruce, attack rates and brood survival were low compared with Scotch pine. In our shoot-feeding tests, we caged PSB adults on branches in the field and then returned 3-4 weeks to determine their fate. In these tests, only 2 of the 400 PSB adults placed on non-pine conifers survived, and those 2 were on white spruce. These results are not too surprising given that reports in the Eurasian literature state that Norway spruce is occasionally used by PSB for reproduction and shoot feeding. This study indicates that on occasion PSB may use North American non-pine conifers as hosts. However, given PSB's strong preference for pines, we do not advocate the expansion of the PSB federal quarantine to include any genera of non-pine conifers.

During which months of the year is PSB found in shoots? We addressed this question in 1994 by monitoring 15 Scotch pine Christmas trees for new shoot-feeding attacks (unpublished data). At 2-week intervals from April through November, we removed all PSB-attacked shoots that we saw on the 15 test trees. In 1994, initial peak PSB spring flight occurred on 23 March. We found live adults in shoots from the first sampling date of 8 April 1994 through 1 November 1994. No live adults were found on any of the 15 trees on the last sampling date of 16 November 1994. All PSB adults found in April and May represent parent adults that were shoot-feeding prior to reproduction or who were shoot-feeding after having constructed one or more egg galleries. Most of the adults encountered in the shoots from mid-June and onward were F_1 progeny adults, given that the new generation of adults started emerging in early June. The fact that adults were found in shoots on all sampling dates during April and May indicates that there is no "PSB-free' period for shipping of pine nursery stock and ornamental pines. That is, at all times of the year live beetles can be found either feeding in the shoots or overwintering at the base of live trees. The nursery industry had hoped that a PSB-free period would be found so that pine stock could be shipped out of infested areas without any treatments or inspections. The fact that new attacks were found on all sampling periods indicates that PSB adults are very active during spring and summer and that they freely move from tree to tree, and possibly between stands as well.

When do PSB adults exit pine shoots in search of overwintering sites? We monitored the timing of PSB shoot departure during the autumn months of 1992, 1993, and 1994 (Haack *et al.* 1997a). One northern Indiana site was monitored all 3 years, while another southern Michigan site was added in 1994. Overall, PSB adults started departing from shoots in mid- to late October in each year, apparently in response to the first few hard freezes. Practically all adults had vacated the shoots within 4-6 weeks after initial shoot departure began. Considering all years and both study sites, the percentage of recently attacked shoots (i.e., shoots with mostly green foliage) that still contained live PSB adults decreased from 89-96% in mid-October, to 15-66% in early November, to 2-10% in mid-November, and to 0-2% by late

November. As PSB continues to extend its range, PSB departure from shoots will tend to occur earlier at more northern sites, and later at more southern sites. Considering the federal quarantine, these results suggest that the current 31 October date to end the "open season" for shipping logs without restrictions is relatively safe, but that an ending date of 30 September would be safer, especially if one single date is used for the entire PSB-infested region.

What do overwintering PSB adults do when infested Christmas trees are taken indoors in December? To answer this question, we selected 12 PSB-infested Scotch pine Christmas trees in early December 1993 (Haack and Lawrence 1997). Four trees were dissected immediately to determine the location of the overwintering adults, while the other eight trees were taken indoors and placed in Christmas tree stands and watered regularly for one month. After one month, four of the trees were debarked and the other four trees were placed outdoors in Michigan and then dissected about seven weeks later. Overall, egg galleries were found on 4 of the 8 trees that were held indoors for 4 weeks. Some of the egg galleries were initiated directly from the overwintering tunnels at the base of the trees. All adults, eggs, and larvae had died in the four trees that had been place outdoors for 7 weeks after having been indoors for 4 weeks. PSB adults removed from the four trees dissected in early December produced viable progeny when place on scotch pine logs that were held in the laboratory. This study indicates that PSB adults do not require a lengthy cold period before becoming reproductively active and it shows that adults can reproduce in Christmas trees while they are held indoors at the end of the Christmas season will depend largely on the prevailing temperatures.

If the exotic clerid *Thanasimus formicarius* were released in North America, what non-target impacts would occur? Classical biological control is being considered as part of the overall regional suppression program for PSB in the United States (USDA APHIS 1996). The main objective is to establish biocontrol agents that will reduce PSB populations in forested areas where active pest suppression using cultural of chemical controls is not practical or economical. In most years in the Great Lakes region, PSB initiates host colonization at least 3-4 weeks before any competition from native pine-infesting bark beetles and their associated natural enemies (Haack and Lawrence 1995a, 1995b, Haack *et al.* 1997b). As a result, USDA entomologists looked to Europe and Asia for natural enemies that were better synchronized with the early spring flight of PSB. After consulting the literature and several European and Asian forest entomologists, there was a general consensus that the clerid *Thanasimus formicarius* (L.) would be the best candidate because its spring flight closely matches that of PSB, and it is known to cause high levels of PSB mortality.

In 1995, a cooperative effort was initiated among three USDA agencies – APHIS, Forest Service, and Agricultural Research Service – to evaluate *T. formicarius* for possible release in the US. The forest Service effort addressed

potential non-target impacts of releasing *T. formicarius*. In particular, we evaluated the non-target impacts of *T. formicarius* on the native North American clerid *Thansimus dubius* (F.) under laboratory conditions (unpublished data). Overall, our preliminary laboratory results provide no evidence that *T. formicarius* will competitively displace *T. dubius*.

Have any species of nematodes been found inside PSB adults? In 1993, numerous nematodes were observed inside the bodies of PSB adults that had been collected from various sites throughout the Great Lakes region. Several adults were sent to the laboratory of Dr. Harry Kaya at the University of California-Davis where the associated nematodes were identified by a visiting scientist from Korea, Dr. Ho Yul Choo, who is an expert in scolytid-associated nematodes. He identified all the nematodes as belonging to the genus *Parasitaphelenchus* (unpublished data). In a 4 February 1994 letter, Drs. Choo and Kaya stated that these nematodes are at best "weak parasites" in bark beetles, and "do not cause much pathology to the beetles."

What species of bluestain fungi have been found in association with PSB in North America? In 1993, PSB adults from throughout the six infested states were examined for associated bluestain fungi by Dr. Eugene Smalley, University of Wisconsin-Madison. From newly emerged F_1 PSB adults that we collected from pine logs in spring, Dr. Smalley isolated *Ophiostoma ips, Ophiostoma nigrocarpa, Ophiostoma piceae, Leptographium terebrantis*, and *Leptographium procerum* (unpublished data). All of these fungi are native to North America and are common associates of *Ips pini, Dendroctonus valens*, and pine root weevils in the genus *Hylobius*. In fall 1993, we collected PSB adults from pine shoots and sent them to Dr. Smalley for fungal isolation. The main fungus that was isolated from fall-collected PSB adults was *Aureobasidium pullulans*. No species of *Ophiostoma* nor *Leptographium* were isolated from the fall-collected PSB adults. These results suggest that PSB adults acquire bluestain fungi when moving to overwintering sites near groundline, or when co-infesting logs with other reproducing bark beetles. Although no species of European fungi were isolated from the PSB adults that we collected, it is still possible that some European bluestain fungi entered North America when PSB first became established. Although North American populations of PSB do not appear to carry any strongly pathogenic fungi at this time, it is still possible for PSB to vector certain pathogenic fungi in other parts of North America. Because of PSB's overwintering and shoot-feeding habits, PSB could serve as a vector for pathogenic fungi like the pitch canker fungus.

How many introductions of PSB occurred and where did PSB first become established in North America? In 1993 and 1994, PSB adults were collected from several locations within the infested portions of the Great Lakes region. DNA analyses were performed on these beetles by Dr. M. Carol Carter (Carter *et al.* 1996). Overall, the DNA

results suggest that there were at least two separate PSB introductions, one that started in northern Ohio along the shores of Lake Erie, and a more recent introduction in northern Illinois along the shores of Lake Michigan. It is hoped that PSB adults will be collected from several countries in Europe and Asia and comparisons will be made between the DNA profiles of the North American populations and the Eurasian PSB populations. If a close match were found, then we could infer that the current North American beetles came from that specific part of the world. Knowledge of the origin(s) of our PSB populations would be valuable in predicting its colonization potential and behavior in North America, as well as for selecting the proper country or countries for possible importation of biological control agents.

References Cited

Bakke, A. 1968. Ecological studies on bark beetles (Coleoptera: Scolytidae) associated with Scots pine (*Pinus sylvestris* L.) in Norway with particular reference to the influence of temperature. Medd. Norske Skogforsksvesen. 21(6), No. 83:443-602.

Carter, M.C.A., J.L. Robertson, R.A. Haack, R.K. Lawrence, and J.L. Hayes. 1996. Genetic relatedness of North American populations of *Tomicus piniperda* (Coleoptera: Scolytidae). Journal of Economic Entomology 89: 1345-1353.

Haack, R.A. and R.K. Lawrence. 1995a. Attack densities of *Tomicus piniperda* and *Ips pini* (Coleoptera: Scolytidae) on Scotch pine logs in Michigan in relation to felling date. Journal of Entomological Science 30: 18-28.

Haack, R.A. and R.K. Lawrence. 1995b. Spring flight of *Tomicus piniperda* in relation to native Michigan pine bark beetles and their associated predators. Pages 524-535 *in* F.P. Hain, S.M. Salom, W.F. Ravlin, T.L. Payne, and K.F. Raffa (eds), Behavior, population dynamics and control of forest insects, Proceedings of the joint IUFRO conference for Working Parties S2.07-05 and S2.07-06, Maui, Hawaii, 6-11 February 1994. Ohio State University, Wooster, Ohio.

Haack, R.A. and R.K. Lawrence. 1997. *Tomicus piniperda* (Coleoptera: Scolytidae) reproduction and behavior on pine Christmas trees taken indoors. Great Lakes Entomologist 30: 19-31.

Haack, R.A., R.K. Lawrence, and G.C. Heaton. 1997a. Overwintering behavior of *Tomicus piniperda* (Coleoptera: Scolytidae) on Scotch pine Christmas trees in Indiana and Michigan. Journal of Economic Entomology (in prep.).

Haack, R.A., R.K. Lawrence, D.G. McCullough, and C.S. Sadof. 1997b. *Tomicus piniperda* in North America: an integrated response to a new exotic scolytid. Pages 62-72 *in* J.C. Gregoire, A.M. Liebhold, F.M. Stephen, K.R. Day, and S.M. Salom (eds), Proceedings: Integrating cultural tactics into the management of bark beetle and reforestation pests. USDA Forest Service, General Technical Report NE-GTR-236.

Langström, B. and C. Hellqvist. 1985. *Pinus contorta* and a potential host for *Tomicus piniperda* L. and *T. minor* (Hart.) (Col., Scolytidae) in Sweden. Journal of Applied Entomology 99: 174-181.

Langström, B., B.F. Lieutier, C. Hellqvist, and C.Vouland. 1995. North American pines as hosts for *Tomicus piniperda* (L.) (Col., Scolytidae) in France and Sweden. Pages 547-557 *in* F.P. Hain, S.M. Salom, W.F. Ravlin, T.L. Payne, and K.F. Raffa (eds), Behavior, population dynamics and control of forest insects, Proceedings of the joint IUFRO conference for Working Parties S2.07-05 and S2.07-06, Maui, Hawaii, 6-11 February 1994. Ohio State University, Wooster, Ohio.

Lawrence, R.K. and R.A. Haack. 1995. Susceptibility of selected species of North American pines to shoot-feeding by an Old World scolytid: *Tomicus piniperda*. Pages 536-546 *in* F.P. Hain, S.M. Salom, W.F. Ravlin, T.L. Payne, and K.F. Raffa (eds), Behavior, population dynamics and control of forest insects, Proceedings of the joint IUFRO conference for Working Parties S2.07-05 and S2.07-06, Maui, Hawaii, 6-11 February 1994. Ohio State University, Wooster, Ohio.

USDA APHIS. 1996. Pine shoot beetles compliance management program. USDA APHIS, Plant Protection and Quarantine, Domestic and Emergency Programs, Riverdale, Maryland. 24 pp.

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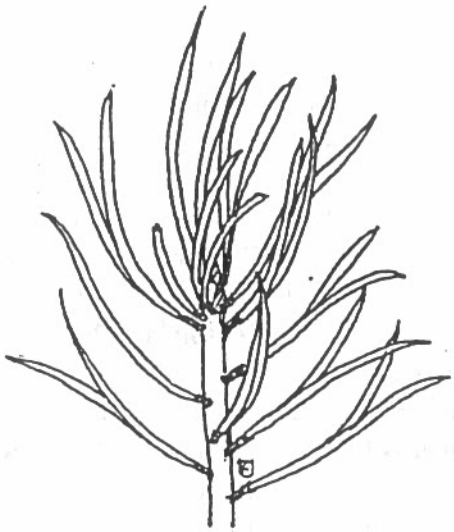

Discussion

Taylor Scarr - Moderator

IS THIS SPECIES A PROBLEM?

The overall consensus would seem to be that this species does not currently present a big pest problem in terms of its direct impact on the various industries. This contrasts European reports where this species is a serious pest, causing incremental losses but still rarely killing trees. In Scandinavia, this species is similar to *Ips pini*, in that they are secondary beetles that attack trees after they are already experiencing a stress, such as fire or defoliation. Incremental losses are due to the shoot feeding but are only significant if the population is very large, typically as the result of large amounts of brood material left around year after year, for example around a sawmill. Otherwise, damage levels are typically low and not too severe.

Often in the first year after a fire, the pine shoot beetle will infest the brood material but in the second year the level of available brood material is again limited causing the population to drop down. It is unlikely that this species could be as damaging as the serious pests, the mountain pine beetle and the southern pine beetle, are here in North America, unless there are mitigating factors which lead to tree stress (e.g. drought) or unusually high beetle populations (from poor sanitation).

Other European reports find that if management practices are not followed, approximately 10% growth losses are experienced as a result of shoot feeding by this species. However, by reducing slash, chipping tree tops, and removing the bark from stumps, the population can be kept at reasonable low levels year after year. In Scandinavia, strict federal laws require newly harvested logs to be removed from the forest in the spring before the emergence of the parental generation, however, such a law may not easily be established in the United States.

In China, this species actually kills many Yunnan pines. In the 1970's, many pine trees were planted offsite, and this region has regular serious droughts. As a result, the pine shoot beetle is responsible for killing thousands of acres of living but severely stressed trees. In addition, in Europe, this species seems to have its most serious impact in the Mediterranean where the trees are already stressed as a result of drought.

Here in North America, it is likely that this species is quite manageable under normal conditions, however this is not known for certain. It has most likely been in North America for about 10 years and, although there is much pine in Michigan and Ontario, to

date, there is no evidence of any stands being significantly affected. One stand in New York shows evidence of serious damage and mortality as a result of this beetle.

There is the possibility that this species will pose a problem when attacking a stand in conjunction with another damaging agent, such as the pine false webworm. Indeed, a number of Russian studies have found that pine shoot beetle attack occurs in the spring following late season defoliation by sawflies.

This species does not have a serious impact on tree form as it is rarely found to attack the leaders of the trees it feeds on. Healthy trees in the uncut buffer zone around a clear-cut are unlikely to be susceptible to attack as repeated defoliation or severe drought conditions seem necessary before trees are stressed enough to be attacked by the pine shoot beetle, and unless fresh brood material is available yearly, the populations will be limited.

COULD THE PINE SHOOT BEETLE BECOME AS DAMAGING AS *IPS*?

There exists the possibility that this recently introduced species could eventually pose as serious a problem as the other bark beetle, *Ips*, already does, however there are a number of factors that make this less likely to occur. Because *Tomicus* has just one generation per year, it is unable to take advantage of brood material that becomes available later in the season. Indeed, most drought stress occurs here in mid to late summer, causing many trees to become susceptible to attack, but *Tomicus* would be unable to breed in them until the following spring by which time the material may have dried out too much. Alternatively, it will have been colonized already in the summer by *Ips* because of *Ips*'s numerous generations each year. However, if drought conditions are extended throughout a single season or over several years, then the potential for damage may be more serious.

This beetle has been monitored for the last four to five years and has yet to pose a problem to the nursery and Christmas tree industries, however it still may be too early to conclude that it is unimportant. Indeed, in the timber industry, the impact by this species is as yet unknown. It is known that this beetle does pose a problem in its originating countries, causing losses and occasional mortality. In addition, because the beetle was transported to the United States and Canada from Europe, this indicates that it is very hardy and able to survive difficult conditions. Hence, there still exists the potential for this species to increase in importance in the years to come.

IS MANAGEMENT REALLY NECESSARY?

This species seems to have such little direct impact on the Christmas tree and Nursery Industries as to make regulation perhaps unnecessary. Christmas trees are shipped at a time of year when transport of the beetles is not very likely to occur. This beetle has probably been here for more than four years and yet posed no problem before it was regulated. Properly managed

Christmas trees stands rarely see any impact from this species, except as a result of regulatory restrictions. Even unmanaged stands are not seeing a very large direct impact from this beetle. It is possible that this is more of a forestry issue, especially in overgrown, untended Scots pine plantations, where it may be problematic.

Management may help to minimize the risk of shipping this beetle to somewhere new where it could become a problem. It is argued, however, that much shipping to the south has occurred for many years and a survey of the southern states has failed to find the beetle anywhere. Hence, there must be a very low probability of the beetle being shipped and becoming established, given that millions of trees have been shipped south over the last ten years.

When stands are properly managed, the risks are minimized and the populations can be kept to very low levels. Regulation is likely still to be of importance because the country of destination may have quarantines, hence their shipping restrictions must still be met.

WHAT WOULD BE THE IMPACT OF RELAXING THE QUARANTINE REGULATIONS?

There exists the likelihood that the beetle will continue to spread despite the efforts of the regulations, hence, they are perhaps not useful. However, it is possible that they will aid in keeping this pest from becoming established in the western part of the continent. The quarantines at least provide the benefit of slowing the spread of this beetle, even if eradication is not possible, which may give the native enemy complex a chance to catch up and respond to these new populations. Trade barriers may be established if the regulations are relaxed, however this is unlikely, and large amounts of material are not shipped out of the country anyway. It could however affect interprovincial or interstate trade as, in the absence of a federal quarantine, the individual provinces or states may impose their own. However, most of the nursery shipments outside Ontario are to infested parts of the United States.

Relaxation of the regulations would make it easier for the forest industry to buy roundwood, which may or may not represent a means of moving the pine shoot beetle. The possibility of the conditions around Ontario's mill yards being conducive to reproduction by this beetle needs to be addressed. However, if the beetle causes no damage to the forest industry's resources, then the quarantine is more of a problem than the beetle itself. In addition, if the beetle gets to a mill, the worst thing it can do is breed in already dead/moribund trees. E.B. Eddy feels that the pine shoot beetle doesn't appear to be a threat to their resource. Given the expense of the quarantine, they feel that the forest industry would rather put money into other more serious threats.

In conclusion, the quarantine is seen as having more significant negative impacts than is the beetle itself, and it poses administrative and financial problems. However, the quarantine may help prevent losses from future unknowns.

INFORMATION GAPS/RESEARCH DIRECTIONS

- Deregulation needs to wait for at least several more years as there is the potential for a negative impact outside of Ontario, perhaps on lodgepole pine in the west.
- The timing of sanitation needs to be examined to determine if it is better to remove brood material before or after parental colonization.
- Does watering of logs affect the survival of overwintering or reproducing pine shoot beetles?
- The actual economic impact of this beetle on the various industries needs to be determined and compared to the economic impact as a result of the quarantine restrictions.
- The impact of this species in complex with other effects needs to be examined. For example, atypical circumstances, such as the impact of the severe ice damage in eastern Ontario may increase the spread and establishment of this species, due to the abundance of heavily damaged red pine. Other examples include drought or the defoliation of pines after attack by budworm or sawflies which may make the trees more susceptible to colonization by this beetle.
- The efficacy of the quarantine, regulation, and management practices needs to be determined.
- Also of importance is to obtain a better resolution of the actual distribution of this species, given that we believe it has been here longer than originally thought. Hence, the apparent increased spread of this species over the last few years may simply be due to increased trapping and surveying efforts.
- Is a positive trap capture a good indication of the actual distribution?
- Pheromones specific to this species need to be identified.
- The possibility of this species having more than one generation per year needs to be addressed.
- A field accreditation program should be established to reduce inspection requirements and costs to growers.
- A fact sheet on the pine shoot beetle, containing information on its life cycle, cultural control and regulatory requirements is felt to be needed.
- The origin of the North American populations should be determined, along with the actual number of introductions.
- The conservation or enhancement of native natural enemies needs to be studied further. Potential candidate species from Europe for introduction also need to be determined.
- There is a need to review the requirement to regulate stump cut heights, seedlings, and all pine species.
- The timing of shoot emergence in relation to Christmas tree harvest needs to be studied.
- It needs to be determined how to regulate the areas north of the counties, e.g. by townships.
- Finally, the threat to non-pine conifers needs to be determined.

Possible Approaches for Managing the Introduced Pine Shoot Beetle

1. Survey susceptible pine stands (Scots pine or those with red, jack and white pine associated with Scots pine, or with any of the woody debris described below (#3) during the late summer/early fall to estimate beetle populations in the shoots (% shoots attacked).

2. If populations are high (>30% shoots destroyed), especially following stressful conditions (drought, disease or insect attack, human disturbance, etc.), then place trap logs (Scots pine logs >10cm DBH and > 60 cm long cut during the winter) on the ground in the stand during the fall/early spring and then remove and/or destroy these brood logs prior to 1 June of the same year.

3. Remove or treat (chip, remove bark, burn, etc.) all woody material (stumps, freshly-cut logs, downed woody debris greater than 10cm DBH, standing trees killed in the previous season, etc.) associated with susceptible stands (all pine species) between 1 April and 1 June to prevent it from becoming a source for producing more beetles.

4. Clip and destroy wilted or discoloured branch tips whenever possible to remove adults in midsummer to early fall (1 July to 1 October).

Selected References

Annila, E. and R. Heikkila. 1991. Breeding efficiency in *Tomicus piniperda* and shoot damage after late autumn thinning of young *Pinus sylvestris* stands. Scandinavian Journal of Forest Research. 6(2): 197-208.

Bright, D.E. 1996. Notes on the native parasitoids and predators of the larger pine shoot beetle, *Tomicus piniperda* (Linnaeus) in the Niagara region of Canada (Coleoptera: Scolytidae). Proceedings of the Entomological Society of Ontario. 127: 57-62.

Carter, M.C.A., Robertson, J.L., Haack, R.A., Lawrence, R.K., and J.L. Hayes. 1996. Genetic relatedness of North American populations of *Tomicus piniperda* (Coleoptera: Scolytidae). Journal of Economic Entomology. 89(6): 1345-1353.

Eidmann, H.H. 1992. Impact of bark beetles on forests and forestry in Sweden. Journal of Applied Entomology. 114(2):193-200.

Ericsson, A., Hellqvist, C., Langström, B., Larsson, S., and O. Tenow. 1985. Effects on growth of simulated and induced shoot pruning by *Tomicus piniperda* as related to carbohydrate and nitrogen dynamics in Scots pine (*Pinus sylvestris*). Journal of Applied Ecology. 22(1): 105-124.

Haack, R.A. 1996. *Tomicus piniperda* continues to spread. Newsletter of the Michigan Entomological Society. 41(1): b.

Haack, R.A. and D. Kucera. 1993. New Introduction - Common Pine Shoot Beetle. Pest Alert. U.S.D.A.: Forest Service. 2 pages.

Haack, R.A. and R.K. Lawrence. 1994. Geographic distribution of *Tomicus piniperda* in North America: 1992-1994. Newsletter of the Michigan Entomological Society. 39(4): 14-15.

Haack, R.A. and R.K. Lawrence. 1995. Attack densities of *Tomicus piniperda* and *Ips pini* (Coleoptera: Scolytidae) on Scotch pine logs in Michigan in relation to felling date. Journal of Entomological Science. 30(1): 18-28.

Hall, J.P. 1996. Forest Insect and Disease Conditions in Canada 1994. Forest Insect and Disease Survey. Natural Resources Canada: Canadian Forest Service. 112 pages.

Hollebone, J.E. 1996. Plant protection requirements on pine material to prevent the entry and spread of pine shoot beetle. Plant Protection Division. Directive D-95-14 Draft. 20 pages.

Hui, Y. and Z. Zhimo. 1995. Life table of *Tomicus piniperda* (L.)(Col., Scolytidae) and its analysis. Journal of Applied Entomology. 119: 145-148.

Kucera, D.R. 1992. Common Pine Shoot Beetle. Pest Alert: New Introduction. U.S.D.A., Forest Service. 1 page.

Langström, B. 1983. Life cycles and shoot-feeding of the pine shoot beetles. Studia Forestalia Suecia. 163: 1-29.

Langström, B. 1991. Shoot damage and growth losses following three years of *Tomicus* attacks in Scots pine stands close to a timber storage site. Silva Fennica. 25(3): 133-145.

Langström, B. and C. Hellqvist. 1990. Spatial distribution of crown damage and growth losses caused by recurrent attacks of pine shoot beetles in pine stands surrounding a pulp mill in southern Sweden. Journal of Applied Entomology. 110(3):261-269.

Lutyk, P. 1984. Feeding of *Tomicus piniperda* on shoots of Norway spruce and silver fir. Sylwan. 128(3): 65-68.

McCullough, D.G. and D.R. Smitley. 1995. Evaluation of insecticides to reduce maturation feeding by *Tomicus piniperda* (Coleoptera: Scolytidae) in Scotch pine. Journal of Economic Entomology. 88(3): 693-699.

Ryall, K.L. and S.M. Smith. 1997. Brood production and intraspecific larval competition in the recently introduced pine shoot beetle, *Tomicus piniperda* (L.) (Col., Scolytinae). Proceedings of the Entomological Society of Ontario. 128: 19-26.

Saarenmaa, H. 1985. The role of temperature in the population dynamics of *Tomicus piniperda* (L.)(Col., Scolytidae) in northern conditions. Zeitschrift Fuer Angewandte Entomologie. 99(3): 224-236.

Sadof, C.S., Waltz, R.D., and C.D. Kellam. 1994. Differential shoot feeding by adult *Tomicus piniperda* (Coleoptera: Scolytidae) in mixed stands of native and introduced pines in Indiana. Great Lakes Entomologist. 27 (4): 223-228.

Sajan, R.J., E.J. Czerwinski, and S. Melbourne. 1994. Results of Forest Insect and Disease Surveys in the Southern Region of Ontario, 1993. Natural Resources Canada: Canadian Forest Service - Ontario. Information Report O-X-437. 40 pages.

Salonen, K. 1973. On the life cycle, especially on the reproduction biology, of *Blastophagus piniperda (Col., Scolytidae).* Acta Forestalia Fennica. 127: 1-71.

Schroeder, L.M. 1987. Attraction of the bark beetle *Tomicus piniperda* to Scots pine trees in relation to tree vigor and attack density. Entomologica experimentalis et applicata. 44: 53-58.

Schroeder, L.M. and J. Weslien. 1994. Reduced offspring production in bark beetle *Tomicus piniperda* in pine bolts baited with ethanol and alpha-pinene, which attracts antagonistic insects. Journal of Chemical Ecology. 20(7): 1429-1444.

Ye, H. 1991. On the bionomy of *Tomicus piniperda* (L.)(Col., Scolytidae) in the Kunming region of China. Journal of Applied Entomology. 112(4): 366-369.

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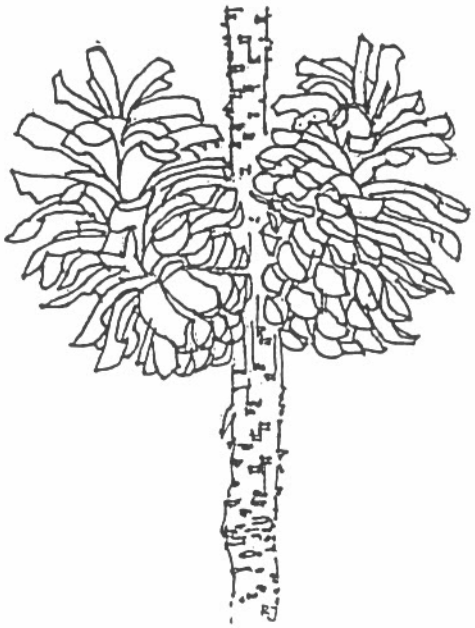

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