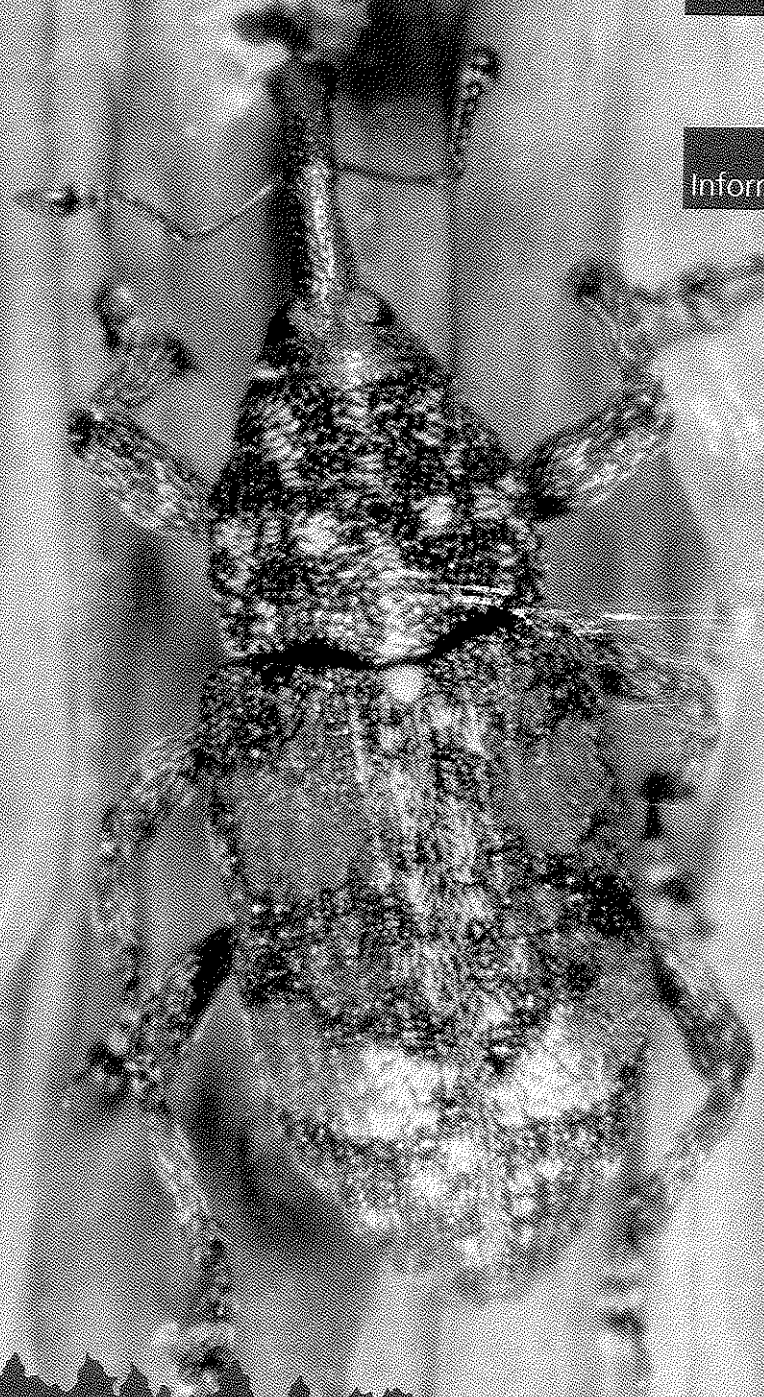




Annotated bibliography of North and Central American species of bark weevils, *Pissodes* (Coleoptera: Curculionidae)

D.W. Langor

Northern Forestry Centre
Information Report NOR-X-355



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Cover photo:

Pissodes strobi adult feeding on white spruce (*Picea glauca* [Moench] Voss).

**ANNOTATED BIBLIOGRAPHY OF
NORTH AND CENTRAL AMERICAN SPECIES
OF BARK WEEVILS, *PISSODES*
(COLEOPTERA: CURCULIONIDAE)**

D.W. Langor

INFORMATION REPORT NOR-X-355

**CANADIAN FOREST SERVICE
NORTHERN FORESTRY CENTRE
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ABSTRACT

On an enclosed computer diskette, annotations are provided for nearly 700 references dealing with taxonomy, biology, ecology, and management of North American species of weevils in the genus *Pissodes*. The bibliography includes references spanning the years 1817 to 1996, inclusive. References are arranged alphabetically and consecutively numbered. Indexes for authors, subjects, hosts, and geographical distribution are included. The purpose of this bibliography is to provide easy access to published information on this group of forest insects, much of which is not readily accessible through on-line data bases.

RÉSUMÉ

Dans la disquette ci-jointe, on trouvera des annotations concernant près de 700 documents de référence sur la taxonomie, la biologie, l'écologie et la gestion des diverses espèces de charançons d'Amérique du Nord du groupe *Pissodes*. Les documents référencés dans la bibliographie vont de 1817 à 1996 inclusivement. L'information est classée par ordre alphabétique et par ordre de numéros consécutifs, selon le cas. On trouvera également des index des auteurs, des sujets traités, des organismes hôtes et des régions concernées. L'objet de cette bibliographie est de faciliter l'accès aux publications concernant ce groupe d'insectes forestiers, dont une grande partie n'est pas accessible aux bases de données en ligne.

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I thank D. Robinson, E. Hopp, D. Oranchuk, and D. Leroy of the Canadian Forest Service (CFS) Northern Forestry Centre library, for assistance in locating many references; R. Martin and K. Jacubec for data entry; J. Foltz (University of Florida, Gainesville, Florida) and R. Lavallée (CFS, Laurentian Forestry Centre, Ste.-Foy, Quebec) for generously sharing their personal data bases of *Pissodes* references; R. Alfaro (CFS, Pacific Forestry Centre, Victoria, British Columbia), R. Lavallée, and J. Volney (CFS, Northern Forestry Centre, Edmonton, Alberta) for reviewing earlier versions of this manuscript; and B. Laishley (Northern Forestry Centre) for editorial advice.

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NOTE

*The exclusion of certain manufactured products does not necessarily imply
disapproval nor does the mention of other products necessarily imply
endorsement by Natural Resources Canada.*

INTRODUCTION

The genus *Pissodes* is Holarctic in distribution, and includes 29 described species in North and Central America. All species are associated with conifers and feed on the phloem and outer wood of stems and branches, but some also feed on the pith of leaders and shoots. Most species usually attack and feed on weakened and recently dead host material, and thus have no adverse impact on forest resources. Species such as the white pine weevil, *P. strobi* (Peck), and the lodgepole terminal weevil, *P. terminalis* Hopping, which infest the terminal leaders, attack only living trees and cause considerable damage. Some species, such as *P. nemorensis* Germar and *P. schwarzi* Hopkins, which normally attack the boles of weakened and dead trees have been known to attack and kill seedlings. *Pissodes fasciatus* LeConte and *P. strobi* have been implicated in dissemination of fungal diseases of conifers. The most destructive species in this genus is *P. strobi*, which attacks the terminal leaders of young *Pinus* and *Picea*, and kills 2–5 years growth with each attack. This results in deformation of stems, wood defects, and loss of merchantable volume of wood. *Pissodes strobi* is thus one of the most destructive pests of conifer plantations in Canada and the northern United States, and has been the focus of more research than any other species in the genus.

Due to the large impact of *Pissodes* on timber production, stand dynamics, stand development, and forest management, there is continuing demand for information regarding biology, habits, population dynamics, interactions with hosts, management, and taxonomy. The literature on this group of organisms is vast but much of it is difficult to obtain because of publication in obscure journals or series and because the titles

of many publications do not indicate inclusion of information on *Pissodes*. There are two previously published bibliographies that focused on literature dealing with only *P. strobi* (Mott 1930; Sutherland and DeBoo 1973), but these are now outdated and incomplete. This annotated bibliography was thus compiled to aid other researchers and forest managers who may be interested in this genus. The bibliography is based mainly on references in the files of the author and the library at the Northern Forestry Centre and in files of colleagues at other institutions. Searches were also made of Biological Abstracts, Entomology Abstracts, Forestry Abstracts, The Review of Applied Entomology, and Zoological Record, as well as of several data bases, AGRICOLA (Agricultural On-Line Access), CAB (Commonwealth Abstract Bureau), and Tree CD. All literature published up to December 31, 1996 is included. The references are arranged alphabetically by author and numbered consecutively. Indexes are included for author, subject, geographical distribution, pesticides, and hosts.

This bibliography concentrates largely on literature containing original scientific and technical data and also includes comprehensive reviews and syntheses. This bibliography is restricted to published reports and theses. Annual station or departmental reports, survey reports, progress reports, textbook chapters, pest or management leaflets, superficial reviews of morphology or biology, and other similar reports are not included unless they contain important historical information, unique biological facts, or research data not found elsewhere in more mainstream publications.

BIBLIOGRAPHY

1. Aarhus, D.G. 1971. Curculionidae of North Dakota. Ph.D. thesis, N.D. State Univ., Bismark, North Dakota.

Pissodes strobi was recorded in North Dakota.
2. Ahrens, J.F.; Dunbar, D.M. 1975. Are herbicides effective in control of pales and northern pine weevils in Christmas tree plantations? *Am. Christmas Tree J.* 10:17-20.

Herbicides applied to kill pine stumps effectively controlled breeding of *P. approximatus* (= *P. nemorensis*) in stumps.
3. Alfaro, R.I. 1980. Host selection by *Pissodes strobi* (Peck): chemical interaction with the host plant. Ph.D. thesis, Simon Fraser Univ., Burnaby, British Columbia.

The contents of this thesis was published in the primary literature. For content, see annotations for references 15, 25, 26, and 27.
4. Alfaro, R.I. 1982. Fifty year-old Sitka spruce plantations with a history of intense weevil attack. *J. Entomol. Soc. B.C.* 79:62-65.

Damage caused by *P. strobi* to pure and mixed stands of Sitka spruce at the Green Timbers plantations is summarized.
5. Alfaro, R.I. 1988. Laboratory feeding and colonization of non-host lodgepole pine by two populations of *Pissodes strobi* (Peck) (Coleoptera: Curculionidae). *Can. Entomol.* 120:167-173.

Weevils reared in Sitka spruce and Engelmann spruce were successfully induced to oviposit on lodgepole pine. Survival from egg to adult was similar in all three tree species. In choice feeding experiments, weevils reared in lodgepole pine rejected this species and chose Sitka spruce, suggesting that feeding preference is genetically fixed.
6. Alfaro, R.I. 1989a. Probability of damage to Sitka spruce by the Sitka spruce weevil, *Pissodes strobi*. *J. Entomol. Soc. B.C.* 86:48-54.

A nine-year record of attacks to Sitka spruce by the Sitka spruce weevil showed that tall trees with long leaders had higher rates of attack than short trees with short leaders.
7. Alfaro, R.I. 1989b. Stem defects in Sitka spruce induced by Sitka spruce weevil, *Pissodes strobi* (Peck). Pages 177-185 in R.I. Alfaro and S.G. Glover, eds. *Insects affecting reforestation: biology and damage*. Proc. XVIII Int. Congr. Entomol., IUFRO Work. Group Insects Affecting Reforestation (S2.07-03), July 3-9, 1988, Vancouver, British Columbia. For. Can., Pac. Yukon Reg., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia.

Attacks by *P. strobi* on Sitka spruce caused a high incidence of stem defects resulting in severe depletion in stand productivity.
8. Alfaro, R.I. 1994. The white pine weevil in British Columbia: biology and damage. Pages 7-22 in R.I. Alfaro, G. Kiss, and R.G. Fraser, eds. *The white pine weevil: biology, damage, and management*. Proc. Meet., January 19-21, 1994, Richmond, British Columbia. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 226.

The biology, epidemiology, and damage caused by *P. strobi* is summarized with respect to spruce in British Columbia. The process of host selection is reviewed with the purpose of identifying potential sources of genetic resistance.
9. Alfaro, R.I. 1995a. A sequential sampling system for the white pine weevil, *Pissodes strobi* (Coleoptera: Curculionidae). *J. Entomol. Soc. B.C.* 92:39-43.

A sequential sampling system is described for determining degree of infestation by *P. strobi* in spruce stands. The method requires sampling of a maximum of 60 randomly selected trees. Sampling is stopped as soon as sufficient data are collected to support a decision.

10. Alfaro, R.I. 1995b. An induced defence reaction in white spruce to attack by the white pine weevil, *Pissodes strobi*. Can. J. For. Res. 25:1725-1730.

Shortly after feeding and oviposition by *P. strobi* in the shoot, the cambium produced traumatic resin canals which emptied their contents into feeding and oviposition cavities and larval galleries, resulting in mortality of eggs and larvae.

11. Alfaro, R.I. 1995c. Contrôle intégré des charançons en Colombie-Britannique: progrès réalisés. [Integrated control of weevils in British Columbia: progress.] Pages 88-99 in R. Lavallée and G. Bonneau, eds. Compte-rendu du colloque sur le charançon du pin blanc. Proc. Symp., September 27-28, 1994, Ste.-Foy, Québec. Ressour. nat. Can., Serv. can. for., Rég. Qué., Cent. for. Laurentides, Ste-Foy (Québec), et Ressour. nat. Qué., Dir. conserv. for., Québec (Québec).

Current research programs on *P. strobi* biology and control in British Columbia are reviewed, including epidemiology, systemic pesticide application, silvicultural control by manipulation of overstory shading and stand density, genetic resistance of trees, risk assessment, decision support systems, and integrated pest management.

12. Alfaro, R.I. 1996a. Feeding and oviposition preferences of white pine weevil (Coleoptera: Curculionidae) on resistant and susceptible Sitka spruce clones in laboratory bioassays. Environ. Entomol. 25(5):1012-1019.

Feeding and oviposition of *P. strobi* was negatively correlated with the density of resin canals in the bark of Sitka spruce. Weevils caged on resistant trees preferred to feed and oviposit on the internode below the leader, where resin canal density was lower. Experiments indicate that resistance is based on blockage by the tree of the normal preference of weevils for feeding and ovipositing on leaders. The blockage is probably caused by repellency caused by high resin concentration in the leader.

13. Alfaro, R.I. 1996b. Role of genetic resistance in managing ecosystems susceptible to white pine weevil. For. Chron. 72:374-380.

Describes conditions that make stands of spruce susceptible to attack by *P. strobi* in British Columbia, and discusses how host genetic resistance could be utilized to complement silvicultural tactics in the management of this pest.

14. Alfaro, R.I.; Borden, J.H. 1980. Predation by *Lonchaea corticis* (Diptera: Lonchaeidae) on the white pine weevil, *Pissodes strobi* (Coleoptera: Curculionidae). Can. Entomol. 112:1259-1270.

The predatory behavior and development of *L. corticis* is described.

15. Alfaro, R.I.; Borden, J.H. 1982. Host selection by the white pine weevil, *Pissodes strobi* Peck: feeding bioassays using host and non-host plants. Can. J. For. Res. 12:64-70.

Many species of trees and shrubs were tested in single- and double-stimulus bioassays to determine the presence or absence of chemical feeding stimulants for *P. strobi* reared from Sitka spruce. Stimulants were present in nearly all conifers tested and absent in all non-conifers.

16. Alfaro, R.I.; Borden, J.H. 1985. Factors determining the feeding of the white pine weevil (Coleoptera: Curculionidae) on its coastal British Columbia host, Sitka spruce. Proc. Entomol. Soc. Ont. Suppl. 116:63-66.

A complex mixture of chemicals that triggered feeding in *P. strobi* was present in the bark, cuticle, and xylem of Sitka spruce leaders. Testing of other species indicated that feeding stimulants were restricted to conifers and varied in quality and/or quantity among species. Chemicals with feeding deterrent or repellent qualities were found.

17. Alfaro, R.I.; Borden, J.H.; Fraser, R.G.; Yanchuk, A. 1994. An integrated pest management system for the white pine weevil. Pages 226-238 in R.I. Alfaro, G. Kiss, and R.G. Fraser, eds. The white pine weevil: biology, damage, and management. Proc. Meet., January 19-21, 1994, Richmond, British Columbia. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 226.

A general integrated pest management system is presented, and research needs that would increase effectiveness of the integrated pest management system are reviewed.

18. Alfaro, R.I.; Borden, J.H.; Fraser, R.G.; Yanchuk, A. 1995. The white pine weevil in British Columbia: basis for an integrated pest management system. *For. Chron.* 71:66–73.

A detailed integrated pest management system is presented, and research needs that would increase effectiveness of the integrated pest management system are reviewed.

19. Alfaro, R.I.; Borden, J.H.; Harris, L.J.; Nijholt, W.W.; McMullen, L.H. 1984. Pine oil, a feeding deterrent for the white pine weevil, *Pissodes strobi* (Coleoptera: Curculionidae). *Can. Entomol.* 116:41–44.

Pine oil effectively reduced feeding by the white pine weevil in a laboratory feeding bioassay. Possible utilization of pine oil under field conditions is discussed.

20. Alfaro, R.I.; He, F.; Kiss, G.; King, J.; Yanchuk, A. 1996. Resistance of white spruce to white pine weevil: development of a resistance index. *For. Ecol. Manage.* 81:51–62.

An index of resistance to attack by *P. strobi* was developed based on tree variables that measured attack intensity, severity, and tolerance of the tree to attack. The index was used to screen 139 families of spruce for weevil resistance. Geographic sources of genotypes resistant to weevil attacks were mainly in the moist-warm habitats of the SubBoreal Spruce biogeoclimatic zone.

21. Alfaro, R.I.; Hulme, M.A.; Harris, J.W.E. 1985. Insects associated with the Sitka spruce weevil, *Pissodes strobi* (Col.: Curculionidae) on Sitka spruce, *Picea sitchensis*, in British Columbia, Canada. *Entomophaga* 30:415–418.

Insects associated with *P. strobi* are listed along with biological notes.

22. Alfaro, R.I.; Hulme, M.; Ying, C. 1993. Variation in attack by Sitka spruce weevil, *Pissodes strobi* (Peck), within a resistant provenance of Sitka spruce. *J. Entomol. Soc. B.C.* 90:24–30.

There was a positive correlation between percentage of trees attacked in a family and the mean height of the trees in the family. A genetic basis for tree resistance is discussed.

23. Alfaro, R.I.; Kiss, G.K.; Yanchuk, A. 1996. Variation in the induced resin response of white spruce, *Picea glauca*, to attack by *Pissodes strobi*. *Can. J. For. Res.* 26:967–972.

The intensity of the traumatic resin response was highest in trees where weevil attacks failed and lowest in healthy, unattacked trees. The number of eggs laid on a leader was inversely related to the intensity of the traumatic resin response and to the timing of the attack (highest early in the season).

24. Alfaro, R.I.; Omule, S.A.Y. 1990. The effect of spacing on Sitka spruce weevil damage to Sitka spruce. *Can. J. For. Res.* 20:179–184.

Trees in all three spacing treatments sustained heavy attacks by *P. strobi*; however, trees in closer spacings received a lower incidence of attack than those in more open plantations.

25. Alfaro, R.I.; Pierce, H.D., Jr.; Borden, J.H.; Oehlschlager, A.C. 1979. A quantitative feeding bioassay for *Pissodes strobi* Peck (Coleoptera: Curculionidae). *J. Chem. Ecol.* 5(5):663–671.

A feeding bioassay for *P. strobi* is described, which consists of plastic petri dishes containing paired agar disks immersed in paraffin wax. Candidate feeding stimulants or deterrents were applied to lens paper covering the disks. Response of weevils is assessed by counting the number of feeding punctures in each disk.

26. Alfaro, R.I.; Pierce, H.D., Jr.; Borden, J.H.; Oehlschlager, A.C. 1980. Role of volatile and nonvolatile components of Sitka spruce bark as feeding stimulants for *Pissodes strobi* Peck (Coleoptera: Curculionidae). *Can. J. Zool.* 58:626–632.

A bioassay was employed to determine which chemicals stimulate feeding by adult weevils. A complex mixture of nonvolatile chemicals stimulated feeding, and these were synergized by several monoterpenes.

27. Alfaro, R.I.; Pierce, H.D., Jr.; Borden, J.H.; Oehlschlager, A.C. 1981. Insect feeding and oviposition deterrents from western red cedar foliage. *J. Chem. Ecol.* 7(1):39–48.

The most active fraction was the volatile mixture comprising the leaf oil, particularly thujone.

28. Alfaro, R.I.; Wegwitz, E. 1994. The spruce weevil in the Green Timbers Plantations. Pages 222–225 in R.I. Alfaro, G. Kiss, and R.G. Fraser, eds. The white pine weevil: biology, damage, and management. Proc. Meet., January 19–21, 1994, Richmond, British Columbia. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 226.

Plantations surveyed by Alfaro (1982), see reference 4, were surveyed again in 1993. Sitka spruce in pure plantations was virtually eliminated by weevils and windthrow. Mixed stands had developed into pure stands of Douglas-fir.
29. Alfaro, R.I.; Ying, C.C. 1990. Levels of Sitka spruce weevil, *Pissodes strobi* (Peck), damage among Sitka spruce provenances and families near Sayward, British Columbia. Can. Entomol. 122:607–615.

Weevil attacks were spatially aggregated within plantations. Damage varied considerably among provenances and families within provenances.
30. Allen, E. 1994. Damage appraisal in pests of young stands. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Work. Pap. WP-1.5-002. [See pages 43–47.]

Gives brief overview of biology, distribution, and type of injury caused by *P. strobi* and *P. terminalis* in British Columbia. Potential study plots and contact people in British Columbia are listed.
31. Allen, R.M.; Coyne, J.F. 1956. Insect problems in forest-tree genetics. J. For. 54:193.

Pissodes nemorensis killed about 250 Sonderegger pine seedlings in Mississippi.
32. American Naturalist. 1868. Entomological calendar. Am. Nat. 2:163–165.

One of the earliest accounts of the phenology and behavior of *P. strobi*.
33. American Naturalist. 1958. Christmas tree insect control. Mich. State Univ., Coop. Ext. Serv., East Lansing, Michigan. Ext. Bull. 353. [See pages 24–26.]

Recommends DDT for control of *P. strobi*.
34. Amirault, P.A.; Pope, B. 1989. Pest distribution and impact in young lodgepole pine stands in west-central Alberta. For. Can., Northwest Reg., North. For. Cent., Edmonton, Alberta, and Alta. Dep. For. Lands Wildl., Edmonton, Alberta. Can.-Alta. For. Resour. Dev. Agreement.

Pissodes terminalis was found in low incidence in most stands surveyed.
35. Anderson, J.M.; Fisher, K.C. 1956. Repellency and host specificity in the white pine weevil. Physiol. Zool. 24:314–324.

The response of *P. strobi* to odors emanating from the ground up bark of seven conifer species was tested in an olfactometer. Weevils responded to odors from red, black, and white spruce and eastern white pine. The incidence of weevil damage to each of these seven species in plantations was assessed.
36. Anderson, J.M.; Fisher, K.C. 1960. The response of the white-pine weevil to naturally occurring repellents. Can. J. Zool. 38:547–564.

The degree of repellency of *P. strobi* to ground up bark of seven conifer species was assessed in an olfactometer. Red spruce and black spruce were most repellent; Norway spruce, Siberian spruce and *Picea asperata* were the least repellent.
37. Anderson, W.H. 1947. A terminology for the anatomical characters useful in the taxonomy of weevil larvae. Proc. Entomol. Soc. Wash. 49(5):123–132.

Gives definitions of morphological terms and illustrates structures in 13 figures showing various parts of the anatomy of larvae of *P. strobi* and *P. fasciatus*.
38. Appleby, J.E.; Miller, F.; Randell, R. 1988. Insecticide sprays for control of the northern pine weevil in southern Illinois. J. Arboric. 14(1):26–28.

Carbofuran was effective at controlling *P. approximatus* (= *P. nemorensis*) breeding in stumps of Scots pine in Christmas tree plantations.

39. Applejohn, A.P. 1993. Spring activity of the white pine weevil *Pissodes strobi* (Peck) (Coleoptera: Curculionidae) in northern Ontario jack pine plantations. M.Sc. thesis, Univ. Toronto, Toronto, Ontario.

Provides information on emergence of adults from overwintering sites, mating, aggregation, feeding, and sexual maturation. Commencement and duration of activities were related to weather (temperature) and site phenology. The initiation and duration of oviposition were examined to determine when sufficient eggs were in place to cause leader mortality. Results suggest that heat accumulation models may be useful in monitoring *P. strobi* in young jack pine plantations.

40. Archambault, L.; Lavallée, R.; Morissette, J. 1995. Influence des facteurs de site sur les taux d'attaque et le développement du charançon du pin blanc en plantations d'épinettes de Norvège. [Influence of site factors on attack rate and development of the white pine weevil in Norway spruce plantations.] Pages 21–34 in R. Lavallée and G. Bonneau, eds. *Compte-rendu du colloque sur le charançon du pin blanc*. Proc. Symp., September 27–28, 1994, Ste.-Foy, Québec. Ressour. nat. Can., Serv. can. for., Rég. Qué., Cent. for. Laurentides, Ste-Foy (Québec), et Ressour. nat. Qué., Dir. conserv. for., Québec (Québec).

In the Norway spruce plantations studied, attack rates increased from 1987 to 1991 and stabilized in 1992. Attack rates were influenced by soil texture and drainage. Plantations on the best sites were least affected by weevils. Weevils developed best on well-drained soils.

41. Archambault, L.; Morissette, J.; Lavallée, R.; Comtois, B. 1993. Susceptibility of Norway spruce plantations to white pine weevil attacks in southern Quebec. *Can. J. For. Res.* 23:2362–2369.

Most surveyed plantations were infested by weevils. Drainage and stand variables influenced levels of attack. Plantations on the most productive sites were attacked less than those on the least productive sites. There was no significant correlation between plantation density and level of attack.

42. Ashman, R.I. 1962. Forest plantations in Maine. Maine Agric. Exp. Stn., Orono, Maine. Bull. 601. [See pages 46–47.]

A summary of white pine weevil damage to pine and spruce plantations is provided.

43. Ashmead, W.H. 1888. Descriptions of new *Braconidae* in the collection of the U.S. National Museum. *Proc. U.S. Natl. Mus.* 11:611–671. [See pages 617–618.]

Gives a description of the hymenopterous parasitoid, *Bracon pissodis*, reared from *P. strobi*.

44. Atkinson, T.H. 1979. Bionomics of *Pissodes nemorensis* (Coleoptera: Curculionidae) in north Florida. Ph.D. thesis, Univ. Fla., Gainesville, Florida.

The contents of this thesis was published in the primary literature. For content, see annotations for references 45 and 46.

45. Atkinson, T.H.; Foltz, J.L.; Connor, M.D. 1988a. Bionomics of *Pissodes nemorensis* Germar (Coleoptera: Curculionidae) in northern Florida. *Ann. Entomol. Soc. Am.* 81:255–261.

Gives a summary of the phenology, adult flight activity, and mortality of *P. nemorensis* in slash pine in northern Florida.

46. Atkinson, T.H.; Foltz, J.L.; Connor, M.D. 1988b. Flight patterns of phloem- and wood-boring Coleoptera (Scolytidae, Platypodidae, Curculionidae, Buprestidae, Cerambycidae) in a north Florida slash pine plantation. *Environ. Entomol.* 17(2):259–265.

Pissodes nemorensis was commonly collected on traps deployed near severed and damaged pines.

47. Baldwin, H.I. 1942. Protection of white pine from weevil injury by spraying. N.H. For. Recreation Comm., Caroline A. Fox Res. Demonstr. For., Hillsboro, New Hampshire. *Fox For. Notes* 32.

Lead arsenate was effective at protecting trees from weevils.

48. Baldwin, H.I. 1949. Growth and weevil damage of Norway spruce growing under aspen. N.H. For. Recreation Comm., Caroline A. Fox Res. Demonstr. For., Hillsboro, New Hampshire. *Fox For. Notes* 45.

Spruce growing under an overstory of aspen sustained nearly five times more damage by *P. strobi*, and grew faster than those in the open.

There was a high amount of variability between seed sources with respect to incidence of white pine weevil damage.

49. Baldwin, H.I.; Eliason, E.J.; Carlson, D.E. 1973. IUFRO Norway spruce provenance tests in New Hampshire and New York. *Silvae Genet.* 22(4):93-114.

All provenances were severely attacked by *P. strobi*. Families from more northerly sources sustained less damage than others.

50. Balsbaugh, E.U., Jr.; Aarhus, D.G. 1990. Checklist and new state records of Curculionidae (broad sense) (Coleoptera) for North Dakota. *J. Kans. Entomol. Soc.* 63:227-236.

Pissodes strobi is recorded from the state of North Dakota but no localities are given.

51. Barnes, T.C. 1928. A biological study of the white-pine weevil with special reference to anatomy, flight, phenology, parasitism, behaviour, and injuries to young trees. D.Sc. thesis, Harvard Univ., Cambridge, Massachusetts.

The digestive, reproductive, and flight muscle systems are described and drawn. Information is provided on phenology, flight, behavior, predators, parasitoids, and damage to trees.

52. Basham, J.T. 1971. Absence of decay development in two cases of top mortality in conifers. *Can. Dep. Fish. For., Can. For. Serv., Ottawa, Ontario. Bi-mon. Res. Notes* 27(3):24.

No stem decay fungi were associated with leaders killed by *P. strobi*.

53. Bassett, H.F. 1865. The white pine weevil. *Practical Entomol.* 25(1):20.

An early general account of the biology, damage, and control of *P. strobi*. Cutting and burning of leaders is recommended as a control.

54. Batzer, H.O. 1961. Jack pine from Lake States seed sources differ in susceptibility to attack by the white-pine weevil. U.S. Dep. Agric., For. Serv., Lake States For. Exp. Stn., St. Paul, Minnesota. *Tech. Notes* 595.

55. Batzer, H.O. 1962. White-pine weevil damage differs significantly by seed source on two northern Minnesota jack pine plantations. U.S. Dep. Agric., For. Serv., Lake States For. Exp. Stn., St. Paul, Minnesota. *Tech. Notes* 618.

No seed source had significantly less weevil damage than local stock.

56. Beal, J.A. 1952. Forest insects of the southeast: with special reference to species occurring in the Piedmont Plateau of North Carolina. Duke Univ., Sch. For., Durham, North Carolina. *Bull.* 14. [See pages 41-42.]

Pissodes nemorensis frequently killed small pines up to 2 in. in diameter on the Piedmont plateau. A braconid parasitoid, *Coeloides pissodis* (Ashm.), commonly attacked larvae.

57. Becker, W.B. 1955. Tests with BHC emulsion sprays to keep boring insects out of pine logs in Massachusetts. *J. Econ. Entomol.* 48(2):163-167.

Benzene hexachloride and lindane emulsifiable concentrates diluted in water and sprayed on red pine and eastern white pine logs were effective at preventing attack by *P. approximatus* (= *P. nemorensis*) and other bark- and wood-boring insects.

58. Becker, W.B. 1959. Further tests with BHC emulsion sprays to keep boring insects out of pine logs in Massachusetts. *J. Econ. Entomol.* 52(1):173-174.

Benzene hexachloride emulsion sprays applied to pine logs were not very effective at preventing attack by *P. approximatus* (= *P. nemorensis*).

59. Becker, W.B. 1962. Autumn versus spring spraying of unseasoned pine logs with BHC. *J. Econ. Entomol.* 55(6):1020-1021.

Attacks by *P. approximatus* (= *P. nemorensis*) were too few to allow a valid comparison.

60. Becker, W.B. 1964. Tests with endosulfan to prevent borer damage to unseasoned pine logs. *J. Econ. Entomol.* 57(1):166-167.

Endosulfan gave good protection against *P. approximatus* (= *P. nemorensis*) attacks, and protection increased with an increase in the active ingredient.

61. Bella, I.E. 1985a. Pest damage incidence in natural and thinned lodgepole pine in Alberta. *For. Chron.* 61:233–238.

Incidence of terminal damage by *P. terminalis* and *Petrova* spp. (Tortricidae) combined increased in thinned stands relative to unthinned stands.

62. Bella, I.E. 1985b. Western gall rust and insect leader damage in relation to tree size in young lodgepole pine in Alberta. *Can. J. For. Res.* 15:1008–1010.

Incidence of terminal damage by *P. terminalis* and *Petrova* spp. (Tortricidae) combined increased with tree diameter class, from 1 to 15 cm dbh.

63. Bellocq, M.I.; Smith, S.M. 1994. Predation and overwintering mortality of the white pine weevil, *Pissodes strobi*, in planted and seeded jack pine. *Can. J. For. Res.* 24:1426–1433.

There was no difference in weevil damage to the stand, and in mortality of weevils due to natural enemies, between planted and seeded stands. Overwintering mortality of adult weevils was 92% in planted and 76% in seeded stands.

64. Bellocq, M.I.; Smith, S.M. 1995a. Influence of reforestation technique, slash, competing vegetation, and duff depth on the overwintering mortality of *Pissodes strobi* (Coleoptera: Curculionidae), the white pine weevil. *For. Ecol. Manage.* 78:1–10.

Over 3 years, winter mortality of adult weevils ranged from 83% to 88% in young jack pine stands. Mammalian predation significantly increased adult mortality by 5–13%. Mortality was higher in planted stands than in seeded stands. Distance from slash and presence of competing vegetation had no effect on mortality of weevils. Mortality was inversely related to depth of duff, but the relationship was not significant. Implications for forest management are discussed.

65. Bellocq, M.I.; Smith, S.M. 1995b. Manejo de *Pissodes strobi* (Coleoptera, Curculionidae) en bosques de *Pinus banksiana* en Ontario, Canadá: factores de mortalidad de la plaga y selección de microhabitat por mamíferos predadores. [Management of *Pissodes strobi*

(Coleoptera: Curculionidae) in *Pinus banksiana* forest in Ontario, Canada: overwintering mortality and microhabitat selection by mammalian predators.] *Ecol. Austral* 5:11–20.

Overwintering mortality of weevil adults was higher in planted than in seeded jack pine plantations. Mortality caused by mammals, birds, insect predators, parasitoids, and crowding of larvae is summarized. Habitat preferences of shrews are summarized. Management strategies to increase mortality of *P. strobi* are discussed.

66. Bellocq, M.I.; Smith, S.M. 1996. Mortality of the white pine weevil associated with silvicultural practices in jack pine plantations. *For. Chron.* 72:388–392.

Type of reforestation (planted vs. aerial seeding) did not influence mortality of immature *P. strobi* due to bird predation, insect predators and parasitoids, or crowding of pupae, but 16% more weevils died during the winter in planted than in seeded stands, which suggests an effect of site condition (most likely depth of duff) or small mammal predation on overwintering adults in the duff.

67. Belyea, H.C. 1923. The control of the white pine weevil (*Pissodes strobi*) by mixed planting. *J. For.* 21:384–390.

The incidence of weevil attacks in a mixture of eastern white pine and Scots pine was similar to that in pure stands of eastern white pine; however, eastern white pine sustained 40% fewer attacks in mixed stands than in pure stands. See also annotations for Belyea and MacAloney (1926).

68. Belyea, H.C.; MacAloney, H.J. 1926. Weather injury to terminal buds of Scotch pine and other conifers. *J. For.* 24:685–690.

Data presented by Belyea (1923) were re-examined in light of the possibility that some of the damage attributed to *P. strobi* attack may have been caused by frost. Nonetheless, the conclusions of the former paper were upheld.

69. Belyea, R.M.; Sullivan, C.R. 1956. The white pine weevil: a review of current knowledge. *For. Chron.* 32:58–67.

Summarizes information on weevil biology, damage, and control.

70. Benoit, P. 1971. Méthode de classification des pins gris et détermination de leur susceptibilité aux insectes secondaires. [Method of classifying jack pine and determining their susceptibility to secondary insects.] For. Chron. 47:201-204.

Presents a method for classifying jack pine foliage and assessing susceptibility of trees to attack by secondary insects such as *P. approximatus* (= *P. nemorensis*).
71. Berry, A.B.; Stiell, W.M. 1976. Control of white pine weevil damage through manipulation of stand climate: preliminary results. Environ. Can., Can. For. Serv., Petawawa For. Exp. Stn., Chalk River, Ontario. Inf. Rep. PS-X-61.

Overstory shading in eastern white pine stands reduces attacks by *P. strobi*, but also reduces growth rate of pines.
72. Bess, H.A. 1944. Insect attack and damage to white-pine timber after the 1938 hurricane in New England. J. For. 42:14-16.

Pissodes approximatus (= *P. nemorensis*) was abundant in windthrow and stumps.
73. Blackman, M.W. 1919. The white pine weevil, with methods of control and recommendations for a modified system of planting white pine and Norway spruce. Maine For. Dep., Augusta, Maine.

Gives general information on the description of *P. strobi*, life history, damage symptoms, and choice of food plants. Control methods are reviewed with emphasis on silvicultural control.
74. Blackman, M.W.; Ellis, W.O. 1916. Some insect enemies of shade trees and ornamental shrubs. N.Y. State Coll. For., Syracuse Univ., Syracuse, New York. Bull. 16(26). [See pages 72-78.]

Gives general information on the description of *P. strobi*, life history, damage symptoms, and choice of food plants. Pruning and destruction of infested terminals and manual collection of adults on terminals are recommended as controls. Weevil damage to eastern white pine is less when interplanted with Scotch pine.
75. Blackwelder, R.E., compiler. 1947. Checklist of the coleopterous insects of Mexico, Central America, the West Indies, and South America. Part 5. Smithsonian Inst., Washington, D.C. U.S. Natl. Mus. Bull. 185. [See page 824.]

Records *P. strobi* from Mexico and USA. [Author's note: the record for Mexico, based on that recorded by Champion (1902) is incorrect.]
76. Blatchley, W.S.; Leng, C.W. 1916. Rhynchophora or weevils of north eastern America. The Nature Publ. Co., Indianapolis, Indiana. [See pages 178-183.]

Provides a key to 12 species of *Pissodes* (*sensu* Hopkins [1909], see reference 296) from eastern North America. Brief morphological descriptions of adults and information on hosts, distribution, and habits are provided.
77. Bliss, M., Jr.; Kearby, W.H. 1970a. Evaluation of dieldrin, dimethoate, and endosulfan as stump sprays for control of the pales weevil and northern pine weevil in central Pennsylvania. J. Econ. Entomol. 63:341-342.

Dieldrin and endosulfan in oil gave complete control of *P. approximatus* (= *P. nemorensis*) in infested Scots pine. Dimethoate in oil also gave good control.
78. Bliss, M., Jr.; Kearby, W.H. 1970b. Notes on the life history of the pales weevil and northern pine weevil in central Pennsylvania. Ann. Entomol. Soc. Am. 63(3):731-733.

The phenology of *P. approximatus* (= *P. nemorensis*) is described.
79. Bond, A.R. 1955. White pine weevil and white pine blister rust. Old Line Acorn 12(3):3-4, 6.

Briefly describes the biology of *P. strobi* and its damage. Control by pruning and pesticides is discussed.
80. Bonneau, G.; Guérin, D. 1990. Les aires reboisées et les insectes nuisibles: situation actuelle au Québec. [Reforestation and pest insects: current situation in Quebec.] Rev. Entomol. Que. 35:11-17.

Gives a brief summary of damage caused by *P. strobi* to Norway spruce plantations in Quebec.
81. Booth, D.C. 1978. The chemical ecology and reproductive isolation of the white pine weevil, *Pissodes strobi* (Peck) and the

- northern pine weevil, *P. approximatus* Hopkins (Coleoptera: Curculionidae). Ph.D. thesis, State Univ. N.Y., Syracuse, New York.
- The contents of this thesis was published in the primary literature. For content, see annotations for references 82 and 83.
82. Booth, D.C.; Lanier, G.N. 1974. Evidence of an aggregating pheromone in *Pissodes approximatus* and *P. strobi*. Ann. Entomol. Soc. Am. 67(6):992-994.

Preliminary field studies indicate that an aggregating pheromone is produced by males of both species.

 83. Booth, D.C.; Phillips, T.W.; Claesson, A.; Silverstein, R.M.; Lanier, G.N.; West, J.R. 1983. Aggregation pheromone components of two species of *Pissodes* weevils (Coleoptera: Curculionidae): isolation, identification and field activity. J. Chem. Ecol. 9(1):1-12.

Grandisol and grandisal were identified from males of *P. strobi* and *P. approximatus* (= *P. nemorensis*).

 84. Boulet, B. 1991. Le charançon du pin blanc en plantation. [The white pine weevil in plantations.] Pages A1-A4 in Insectes et Maladies des Arbres Québec 1990. For. Can., Qué. Reg., Laurentian For. Cent., Ste.-Foy, Québec.

Summarizes results of a survey of damage caused by *P. strobi*. Eastern white pine, Norway spruce, and white spruce were the most susceptible species. A general increase in damage was noted between 1986 and 1990. Weevils preferred trees from 5 to 20 years old.

 85. Boulet, B. 1995. Zones de susceptibilité aux attaques du charançon du pin blanc, *Pissodes strobi* (Peck), dans les plantations au Québec. [Hazard zones for the white pine weevil, *Pissodes strobi* (Peck), in plantations in Quebec.] Pages 100-110 in R. Lavallée and G. Bonneau, eds. Compte-rendu du colloque sur le charançon du pin blanc. Proc. Symp., September 27-28, 1994, Ste.-Foy, Québec. Ressour. nat. Can., Serv. can. for., Rég. Qué., Cent. for. Laurentides, Ste.-Foy (Québec), et Ressour. nat. Qué., Dir. conserv. for., Québec (Québec).

Historical data on *P. strobi* were analyzed to delimit weevil hazard zones. The distribution and abundance of weevils in plantations have increased over the previous decade. A map showing weevil hazard zones in Quebec is provided.

 86. Böving, A.G. 1929. Taxonomic characters for the identification of the mature larvae of *Pissodes strobi* Peck and *Pissodes approximatus* Hopkins (Fam. Curculionidae). Proc. Entomol. Soc. Wash. 31(9):182-187.

Describes several morphological characters for discriminating among larvae of *P. strobi* and *P. approximatus* (= *P. nemorensis*).

 87. Boyce, T.M. 1990. Molecular evolutionary genetics of the bark weevils: speciation and mitochondrial DNA evolution. Ph.D. thesis, Cornell Univ., Ithaca, New York.

The relevance of molecular genetics of *Pissodes* to pest management is discussed. See also annotations for references 88 and 89.

 88. Boyce, T.M.; Zwick, M.E.; Aquadro, C.F. 1989. Mitochondrial DNA in the bark weevils: size, structure and heteroplasmy. Genetics 123:825-836.

Pissodes contains a large mitochondrial genome of 30-36 kb, mainly due to a dramatically enlarged A + T-rich region. Every sampled specimen of *P. strobi*, *P. nemorensis*, and *P. terminalis* exhibited heteroplasmy.

 89. Boyce, T.M.; Zwick, M.E.; Aquadro, C.F. 1994. Mitochondrial DNA in the bark weevils: phylogeny and evolution in the *Pissodes strobi* species group (Coleoptera: Curculionidae). Mol. Biol. Evol. 11(2):183-194.

Variation in mtDNA of *P. strobi*, *P. terminalis*, *P. nemorensis*, *P. schwarzi*, and *P. affinis* was investigated using restriction enzymes. Genetic diversity and divergence were relatively high. Phylogenetic relationships among species were postulated.

 90. Brace, L.G. 1971. Effects of white pine weevil damage on tree height, volume, lumber recovery and lumber value in eastern white pine. Environ. Can., Can. For. Serv., Ottawa, Ontario. Publ. 1303.

Weevil attacks reduced tree heights by as much as 10 ft, and total cubic volumes by 3 to 20%. The average reduction in timber value due to weevil attacks was 25%.

91. Brace, L.G. 1972. Weevil control could raise value of white pine by 25%. *Can. For. Ind.* 92:42-45.

Weevil attacks reduced tree heights by as much as 10 ft, and total cubic volumes by 3 to 20%. The average reduction in timber value due to weevil attacks was 25%.

92. Bradbury, R. 1986. Efficacy of selected insecticides against the white pine weevil (Coleoptera: Curculionidae). *Maine For. Serv. Tech. Rep.* 25.

In spring field trials, the pyrethroids, permethrin, esfenvalerate, and fluvalinate, were effective in reducing damage to leaders when applied by compressed air sprayers or mistblowers. There was no significant difference in efficacy between single applications and double applications. Also, the systemic insecticide, Metasystox-R, applied in four single applications made at 10-day intervals, resulted in complete leader protection.

93. Brandt, N.R.; McDowall, L.L. 1970. Noteworthy insects of jack pine in Manitoba and Saskatchewan. *Can. Dep. Fish. For., Can. For. Serv., For. Res. Lab., Winnipeg, Manitoba. Inf. Rep.* MS-X-30.

Gives distribution of *P. strobi* in Manitoba and Saskatchewan.

94. Bridgen, M.R.; Hanover, J.W.; Wilkinson, R.C. 1979. Oleoresin characteristics of eastern white pine seed sources and relationship to weevil resistance. *For. Sci.* 25(1):175-183.

Variation in monoterpenes and resin acids was examined to ascertain relationships between seed source and resistance to *P. strobi*. Monoterpenes varied with seed source but resin acids did not. There was no relationship between weevil resistance and oleoresin composition and viscosity.

95. Brisbin, R.L.; Sonderman, D.L. 1971. Tree grades for eastern white pine. *U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania. Res. Pap.* NE-214.

Grading system includes defects due to *P. strobi*.

96. Britton, W.E. 1918. An injurious weevil attacking red pine. Pages 365-366 in *Seventeenth report of the state entomologist of Connecticut for the year 1917.* Conn. Agric. Exp. Stn., New Haven, Connecticut. Bull. 203.

Pissodes approximatus (= *P. nemorensis*) was collected from red pine.

97. Britton, W.E. 1920. The white pine weevil, *Pissodes strobi* Peck. Pages 144-155 in *Nineteenth report of the state entomologist of Connecticut for the year 1919.* Conn. Agric. Exp. Stn., New Haven, Connecticut. Bull. 218.

Includes general information on biology, natural enemies, damage, and control.

98. Britton, W.E.; Walden, B.H. 1912. Record of preliminary tests to prevent damage by the white pine weevil. Pages 307-309 in *Thirty-fifth annual report of the Connecticut Agricultural Experiment Station, 1911.* State Conn., Hartford, Connecticut. Public Doc. 24.

Several pesticides and tree tanglefoot showed promise for preventing damage by weevils.

99. Brooks, J.E. 1985. Resistance by Sitka spruce to the white pine weevil: chemotyping resistant trees. M.Sc. thesis, Simon Fraser Univ., Burnaby, British Columbia.

The contents of this thesis was published in the primary literature. For content, see annotations for references 101-102.

100. Brooks, J.E.; Borden, J.H. 1992. Development of a resistance index for Sitka spruce against the white pine weevil, *Pissodes strobi* Peck. *For. Can., Pac. Yukon Reg., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep.* 180.

Resistant trees were able to deter feeding by weevils. Analysis of foliar monoterpene composition revealed that resistant trees had significantly lower concentrations of isomyl isovalerate and isopentenyl isovalerate.

101. Brooks, J.E.; Borden, J.H.; Pierce, H.D., Jr. 1987. Foliar and cortical monoterpenes in Sitka spruce: potential indicators of resistance to the white pine weevil, *Pissodes strobi* Peck (Coleoptera: Curculionidae). Can. J. For. Res. 17:740-745.

Monoterpenes were not consistent indicators of resistance to *P. strobi*. Isovalerates could be used as indicators of resistance.
102. Brooks, J.E.; Borden, J.H.; Pierce, H.D., Jr.; Lister, G.R. 1987. Seasonal variation in foliar and bud monoterpenes in Sitka spruce. Can. J. Bot. 65:1249-1252.

The concentration of several monoterpenes varied from May to September. There was no significant difference in percent monoterpene composition of buds between weevil resistant and susceptible trees.
103. Buckhout, W.A. 1899. Miscellaneous notes in botany and forestry. Penn. State Rep. [See pages 252-253.]

General information on *P. strobi* life cycle, damage to eastern white pine, and natural enemies is included. Pines in a denser stand have a better chance of recovery than those isolated.
104. Cameron, E.A. 1974. Bionomics and impact of the lodgepole terminal weevil, *Pissodes terminalis* Hopping (Coleoptera: Curculionidae), in the Sierra Nevada of California. Ph.D. thesis, Univ. Calif., Berkeley, California.

Incidence of weevil attacks was highest on trees 3.0-7.5 m tall. Each attack reduced height growth by about 25-33% in the year of attack. See also annotation for reference 105.
105. Cameron, E.A.; Stark, R.W. 1989. Variations in the life cycle of the lodgepole terminal weevil, *Pissodes terminalis* Hopping (Coleoptera: Curculionidae), in California. Can. Entomol. 121:793-801.

The life cycle of *P. terminalis* requires 1-2 years, depending on altitude. Notes are provided on adult feeding, oviposition, and mortality.
106. Carlson, J.; Hong, Y.-P.; Kiss, G. 1994. DNA markers associated with weevil resistance in interior spruce. Pages 158-168 in R.I. Alfaro, G. Kiss, and R.G. Fraser, eds. The white pine weevil: biology, damage, and management. Proc. Meet., January 19-21, 1994, Richmond, British Columbia. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 226.

Some Random Amplified Polymorphic DNA (RAPD) markers appeared to be associated with weevil resistant phenotypes of white spruce.
107. Carlson, J.A.; Churcher, J.J. 1984. An analysis of methods for sampling Sitka spruce weevil damage. B.C. Minist. For., Burnaby, British Columbia.

Several sampling schemes are described and compared.
108. Carlson, J.A.; Jeklin, E.M.J.; Wood, P.M. 1984. Interim guidelines for the management of Sitka spruce weevil in the Vancouver Forest Region. B.C. Minist. For., Burnaby, British Columbia. For. Serv. Intern. Rep. PM-V-4.

Guidelines are presented in the form of a flow chart, which outlines the procedures and steps required to ensure natural productivity on sites threatened by weevil attack. Each step is discussed in detail.
109. Carlson, R.L. 1966. The effect of the Sitka-spruce weevil on Sitka spruce. M.Sc. thesis, Univ. Washington, Seattle, Washington.

Data on the impact of *P. sitchensis* (= *P. strobi*) on Sitka spruce height growth, volume, and wood defects are presented.
110. Carlson, R.L. 1971. Behavior of Sitka-spruce weevil, *Pissodes sitchensis* Hopkins (Coleoptera: Curculionidae), in southwestern Washington. Ph.D. thesis, Univ. Wash., Seattle, Washington.

Feeding, mating, and oviposition of *P. sitchensis* (= *P. strobi*) varied with air temperature. Information is provided on phenology, behavior, and mortality. Weevils selected trees with the largest leaders. The terpene, limonene, was attractive to weevils.
111. Champion, G.C. 1902. Biologia Centrali-Americana. Insecta. Coleoptera. Vol. 4, part 4. F. DuCrane Goodman and O. Salvin,

series eds. R.H. Porter, London, England.
[See pages 119–120.]

Pissodes strobi adult morphology is described and the distribution of the species is given. (Author's note: the record for Mexico is undoubtedly incorrect.)

112. Chénier, J.V.R.; Philogène, B.J.R. 1989a. Evaluation of three trap designs for the capture of conifer-feeding beetles and other forest Coleoptera. *Can. Entomol.* 121:159–167.

Sticky stovepipe traps, Lindgren funnel traps, and plastic window traps baited with ethanol and monoterpenes all collected *P. strobi*, but 90% of all specimens were collected by stovepipe traps.

113. Chénier, J.V.R.; Philogène, B.J.R. 1989b. Field responses of certain forest Coleoptera to conifer monoterpenes and ethanol. *J. Chem. Ecol.* 15:1729–1745.

Pissodes strobi adults were attracted to monoterpene- and ethanol-baited stovepipe traps and Lindgren funnel traps.

114. Chilcote, C.A. 1985. Genetic variation within and between sympatric populations of *Pissodes strobi* on two host species: eastern white pine and jack pine. M.Sc. thesis, Mich. State Univ., East Lansing, Michigan.

Analysis of allozyme variation in *P. strobi* revealed little genetic distance between sub-populations in different hosts. Results suggest a polyphagous panmictic population.

115. Cibrián Tovar, D.; Méndez Montiel, J.T.; Campos Bolaños, R.; Yates, H.O., III; Flores Lara, J. 1995. Forest insects of México. Univ. Autón. Chapingo, Chapingo, México. Publ. 6. [See pages 346–352.]

Gives brief morphological descriptions of the life stages, as well as general information on life cycle, habits, damage, and management for *P. zitacuarence*, *P. guatemaltecus*, and *P. cibriani*. Color photos of life stages and damage are included.

116. Clark, E.C.; Schenk, J.A. 1962. Damage caused by the Engelmann spruce weevil in northern Idaho. *J. For.* 60(11):821–823.

The extent and incidence of damage to Engelmann spruce plantations is described.

There were differences among stands with respect to susceptibility to weevil attack.

117. Clark, R.C.; Pardy, K.E. 1972. Insects of balsam fir in Newfoundland. *Environ. Can., Can. For. Serv., Nfld. For. Res. Cent., St. John's, Newfoundland. Inf. Rep. N-X-79.* [See page 7.]

Pissodes dubius (= *P. striatulus*) and *P. strobi* are reported from Newfoundland. [Author's note: the record for *P. strobi* is undoubtedly incorrect.]

118. Cline, A.C.; MacAloney, H.J. 1931. A method of reclaiming severely weeviled white pine plantations. *Mass. For. Assoc., Boston, Massachusetts. Bull.* 152.

It was observed that the tallest and fastest growing trees within a stand sustained the most severe injuries due to weeviling. It is recommended that severely weeviled trees be removed from the stand to release the least injured trees, and that remaining trees be pruned. An economic assessment of this strategy is provided.

119. Cline, A.C.; MacAloney, H.J. 1933. Additional notes on the improvement of weeviled white pine plantations. *Conn. For. Park Assoc., New Haven, Connecticut. Publ.* 24.

In eastern white pine, the stem was more likely to develop a crook than a fork if *P. strobi* killed only one internode in a given year; however, a fork was most likely to develop if two internodes were killed. It is recommended that the pruning of weevil-infested leaders occur before weevil damage extends beyond one internode.

120. Cline, A.C.; MacAloney, H.J. 1935. Progress report of the reclamation of severely weeviled white pine plantations. *J. For.* 33:932–935.

This paper provides a progress report on an experiment set up by Cline and MacAloney (1931) to investigate reclamation of severely weeviled white pine plantations. Results for a 4-year period show that pruned trees are improving in form. Most of the girdled trees have died, and the stand has been opened gradually. The method provided satisfactory damage reduction according to the expectations of the authors.

121. Coleman, M.N.; Nieman, T.C.; Boyle, T.J.B. 1987. Growth, survival, and stem form of a 22-year-old Norway spruce progeny test. Can. For. Serv., Petawawa Natl. For. Inst., Chalk River, Ontario. Inf. Rep. PI-X-73.

Data provide evidence that some spruce families are tolerant to weevil attack, or recover well from such attacks.
122. Commonwealth Institute of Entomology. 1975. *Pissodes strobi* (Peck). Map 345 in Distribution maps of pests. Commonw. Inst. Entomol., London, England.

Shows map of distribution of *P. strobi*.
123. Condrashoff, S.F. 1966. A description of the immature stages of *Steremnius carinatus* (Boheman) (Coleoptera: Curculionidae). Can. Entomol. 98:663-667.

A key is included to differentiate between *Pissodes* and *Steremnius* larvae and pupae.
124. Connola, D.P. 1954. Recent research on two important forest insect problems in New York. N.Y. State Ranger Sch. Alum. News 1954:25-28, 32.

DDT was effective for controlling *P. strobi*.
125. Connola, D.P. 1961. Portable mistblower spray tests against white pine weevil in New York. J. For. 59:764-765.

Application of DDT and lindane with a portable mistblower was effective at preventing attack by *P. strobi*.
126. Connola, D.P. 1966. Preliminary studies on resistance in eastern white pine to the white-pine weevil, *Pissodes strobi* (Coleoptera: Curculionidae), in New York. Ann. Entomol. Soc. Am. 59(5):1011-1012.

Indicates that there are possible inherent differences in susceptibility of trees to *P. strobi* attack associated with geographic origin of trees. Also it appeared that trees suffering from water deficiency were more susceptible to attack.
127. Connola, D.P. 1967a. Cage studies of white pine weevil resistance with potted eastern white pine. Pages 63-64 in Proc. 14th Northeast. For. Tree Improv. Conf., August 10-11, 1966, Toronto, Ontario. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania.

Some trees showed evidence of resistance to *P. strobi*. The most susceptible trees had a faster growth rate. See also abstract for reference 128.
128. Connola, D.P. 1967b. Three years of cage testing for resistance in eastern white pine (*Pinus strobus* L.) to the white pine weevil (*Pissodes strobi* (Peck)). Pages 891-901 in Proc. 14th Int. Congr. Union For. Res. Organ., Part III, Sect. 22, September 4-9, 1967, Munich, Germany. IUFRO Congr. Secr., Munich, West Germany.

Further results were presented on an experiment described in reference 126. The trees that were most susceptible to weevil attack in the earlier study were also the most susceptible in this study. The most susceptible trees had a faster growth rate.
129. Connola, D.P. 1973. A comparison of white pine weevil resistance in caged and outplanted seedlings from two sources. Pages 109-115 in Proc. 20th Northeast. For. Tree Improv. Conf., July 31-August 2, 1972, Durham, New Hampshire. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania.

Further results were presented on an experiment described in references 126-128. The trees that were most susceptible to weevil attack in the earlier studies were also the most susceptible in this study. Data are presented to suggest that environmental factors influence tree growth and susceptibility to weevil attacks.
130. Connola, D.P.; Beinkafner, K. 1976. Large outdoor cage tests with eastern white pine being tested in field plots for white pine resistance. Pages 56-64 in Proc. 23th Northeast. For. Tree Improv. Conf., August 4-7, 1975, New Brunswick, New Jersey. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania.

Trees from sources where there is a high incidence of weevil damage and those from areas of low weevil incidence tend to eventually sustain similar levels of damage when interplanted. Some trees appeared to be resistant to attack. Tree height and diameter as well as the length and bark thickness of leaders seem to influence susceptibility to weevil attack.

131. Connola, D.P.; McIntyre, T.; Yops, C.J. 1955. White pine weevil control by aircraft spraying. J. For. 53:889-891.

DDT applied by airplane effectively controlled *P. strobi*. Treatment is only necessary when annual weevil incidence regularly exceeds 5-10%.
132. Connola, D.P.; Smith, W.E. 1964. Fall spray tests with portable mistblower against white pine weevil. J. For. 62:732-734.

Applications of water emulsions of DDT in the fall successfully reduced *P. strobi* damage from a 20-33% pretreatment incidence to 4%. Although spring treatments were more effective, the fall provided more time and better weather conditions for treatment.
133. Connola, D.P.; Wixson, E.C. 1963a. Effects of soil and other environmental conditions on white pine weevil attack in New York. J. For. 61:447-448.

This note summarizes the major findings of a detailed study. Level of damage was highest in stands where soil mottling and hardpan occurred. Frequency of weevil attacks was influenced by tree height and reached a peak at the 10-20 ft height level. See also annotation for reference 134.
134. Connola, D.P.; Wixson, E.C. 1963b. White pine weevil attack in relation to soils and other environmental factors in New York. N.Y. State Mus. Sci. Serv., Albany, New York. Bull. 389.

Level of damage was highest in stands where soil mottling and hardpan occurred. Frequency of weevil attacks was influenced by tree height and reached a peak at the 10-20 ft height level. This publication includes detailed data summaries and soil maps.
135. Coulson, R.N.; Franklin, R.T. 1970. The occurrence of *Dioryctria amatella* and other insects in *Cronartium fusiforme* cankers. Can. Entomol. 102:353-357.

A species of *Pissodes* was found to be a winter inhabitant of cankers.
136. Cozens, R.D. 1983. The spruce weevil, *Pissodes strobi* Peck (Coleoptera: Curculionidae): a review of its biology, damage and control techniques with reference to the Prince George Timber Supply Area. B.C. Minist. For., Prince George, British Columbia. Intern. Rep. PM-PG-3.

Provides a comprehensive review of *P. strobi* biology, damage, detection and survey procedures, and control. Included are some recommendations about detection, appraisal, and management relevant to the Prince George region of British Columbia.
137. Cozens, R.D. 1984. Insect and disease risk factors in established interior spruce plantations. M.F. thesis, Univ. B.C., Vancouver, British Columbia.

Incidence of *P. strobi* damage to interior spruce was generally high in all plantations surveyed.
138. Cozens, R.D. 1987. Second broods of *Pissodes strobi* (Coleoptera: Curculionidae) in previously attacked leaders of interior spruce. J. Entomol. Soc. B.C. 84:46-49.

Oviposition and successful brood production by *P. strobi* were observed below the previous year's attacked dead leaders in as many as 19.5% of current attacked trees in a 15-year-old plantation of interior spruce. This occurrence may have significant impacts upon weevil survey and control programs.
139. Crosby, D. 1950. Concentrated lead arsenate spray for control of white pine weevil. J. For. 48:334-336.

Application of lead arsenate using backpack sprayers in the spring gave excellent protection against weevils for up to 4 years.
140. Crosby, D. 1954. How to control white pine weevil with a hand sprayer. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania. For. Res. Notes 30.

Gives directions on the use of a hand sprayer to control *P. strobi*, including information on equipment, pesticides, and timing.
141. Crosby, D. 1958. Control of the white-pine weevil with insecticidal emulsions. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania. For. Res. Notes 78.

Emulsions of DDT, heptachlor, lindane, and malathion were effective at controlling weevils.

142. Davidson, B.S. 1991. Impact of terminal stem loss on mature jack pine and its relationship to managing the white pine weevil in young jack pine plantations. M.Sc. thesis, Univ. Toronto, Toronto, Ontario.

When milled into lumber, standing jack pine trees with terminal loss due to *P. strobi* attack had significantly lower lumber grades, lower percentages of volume recovered from logs, and overall lower commercial value than those without damage. On average, the commercial value of mature jack pine stands in northeastern Ontario was estimated to be reduced by about 13% due to terminal loss. Weevil populations were higher in closed stands than in open stands. Clipping of infested terminals reduced damage for only 1 year afterward. Information is provided on adult overwintering survival and dispersal.
143. Day, M.W. 1939. Damage to Norway spruce plantations by the white pine weevil. Mich. Q. Bull. 22:117-118.

Serious damage was reported for plantations and effects on tree height were described. The smallest trees in the plantations were seldom infested.
144. DeBarr, G.L.; Barber, L.R.; Maxwell, A.H. 1982. Use of carbofuran for control of eastern white pine cone and seed insects. For. Ecol. Manage. 4:1-18.

Applications of carbofuran had an apparent negative impact on *P. strobi*.
145. DeBoo, R.F. 1973. Canadian contributions to forest insect control technology. Manit. Entomol. 7:46-49.

Gives dosage of methoxychlor required for control of *P. strobi*.
146. DeBoo, R.F. 1978. Management of pine insect pests. Pages 165-176 in D.A. Cameron, comp. White and red pine symposium. Proc. Symp., September 20-22, 1977, Chalk River, Ontario. Environ. Can., Can. For. Serv., Great Lakes For. Res. Cent., Sault Ste. Marie, Ontario. Symp. Proc. O-P-6.

Application of methoxychlor can effectively control *P. strobi* in plantations. Pruning of infested leaders is also effective.
147. DeBoo, R.F.; Campbell, L.M. 1971. Plantation research. IV. Field evaluation of insecticides for control of white-pine weevil (*Pissodes strobi*) in Ontario, 1971. Environ. Can., Can. For. Serv., Chem. Control Res. Inst., Ottawa, Ontario. Inf. Rep. CC-X-11.

Ground applications of methoxychlor provided good control of *P. strobi* when applied prior to adult feeding. Two applications, spaced 10-14 days apart, is recommended. Gardona® and Dursban also gave good protection for leaders, especially when combined with a sticker-spreader.
148. DeBoo, R.F.; Campbell, L.M. 1972a. Plantation research. VI. Hydraulic sprayer applications of insecticides for control of white-pine weevil (*Pissodes strobi*) in Ontario, 1972. Environ. Can., Can. For. Serv., Chem. Control Res. Inst., Ottawa, Ontario. Inf. Rep. CC-X-24.

Application of Gardona® and methoxychlor with sticker-spreader provided very good protection of leaders from attack by *P. strobi*. Applications of Dursban were not particularly effective.
149. DeBoo, R.F.; Campbell, L.M. 1972b. Plantation research. VII. Experimental aerial application of methoxychlor for control of white-pine weevil (*Pissodes strobi*) in Ontario, 1972. Environ. Can., Can. For. Serv., Chem. Control Res. Inst., Ottawa, Ontario. Inf. Rep. CC-X-25.

Aerial application of methoxychlor was much less effective at controlling *P. strobi* than ground applications.
150. DeBoo, R.F.; Campbell, L.M. 1974a. Plantation research. X. Experimental aerial applications of methoxychlor and Gardona® for control of white pine weevil (*Pissodes strobi*) in Ontario, 1973. Environ. Can., Can. For. Serv., Chem. Control Res. Inst., Ottawa, Ontario. Rep. CC-X-68.

Ground application of methoxychlor and Gardona® reduced weevil populations to acceptable levels, but aerial applications were less effective. The residual effectiveness of sprays was up to 3 weeks for ground applications and 1 week for aerial applications. Pesticides did not affect resident mammal populations in stands.

151. DeBoo, R.F.; Campbell, L.M. 1974b. Plantation research. XI. Experimental aerial applications of methoxychlor and carbaryl for control of white pine weevil (*Pissodes strobi*) in Ontario, 1974. Environ. Can., Can. For. Serv., Chem. Control Res. Inst., Ottawa, Ontario. Rep. CC-X-87.

Aerial applications of methoxychlor and carbaryl did not provide satisfactory levels of leader protection in high value eastern white pine plantations.
152. de Groot, P. 1985. Chemical control of insect pests of white pine. Proc. Entomol. Soc. Ont. Suppl. 116:67-71.

Reviews literature on chemical control of *P. strobi*.
153. de Groot, P.; Helson, B.V. 1993. Efficacy and timing of insecticide sprays for control of white pine weevil (Coleoptera: Curculionidae) in high-value pine plantations. J. Econ. Entomol. 86(3):1171-1177.

Permethrin was 121-183 times more toxic to *P. strobi* than methoxychlor in laboratory tests. Both pesticides achieved good control of weevils when applied to leaders in the spring, just after adult emergence. Control was effective for 2-3 weeks after application.
154. de Groot, P.; Helson, B.V. 1994. A review of chemical insecticides for control of *Pissodes strobi*. Pages 285-293 in R.I. Alfaro, G. Kiss, and R.G. Fraser, eds. The white pine weevil: biology, damage, and management. Proc. Meet., January 19-21, 1994, Richmond, British Columbia. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 226.

Gives a brief history of chemical control of *P. strobi*, discusses constraints and solutions and future prospects of chemical control.
155. de Groot, P.; Helson, B.V.; Zylstra, B.F.; McFarlane, J.W.; Comba, D.R. 1995. Control of white pine weevil in young jack pine plantations with permethrin and methoxychlor. North. J. Appl. For. 12(1):19-22.

Mistblower applications of permethrin and methoxychlor can be an effective method to control weevils in high value jack pine plantations.
156. de Groot, P.; Zylstra, B.F. 1996. Control of the white pine weevil in young plantations using a spring application of insecticides. Nat. Resour. Can., Can. For. Serv., Great Lakes For. Cent., Sault Ste. Marie, Ontario. Tech. Note 86.

Gives details of method of applying pesticides to leaders of trees with a backpack mistblower to control *P. strobi*.
157. de Groot, R.C. 1963. Association of *Fomes pini* with weevil-killed leaders of eastern white pine. Ph.D. thesis, N.Y. State Univ., Syracuse, New York.

Pissodes strobi-killed leaders of eastern white pine provided infection courts for the fungus, *Fomes pini* (= *Phellinus pini*). There was a higher rate of fungus infection through weeviled leaders than through lateral branches.
158. de Groot, R.C. 1965. Germination of basidiospores of *Fomes pini* on pine wood extract media. For. Sci. 11:176-180.

There was a much higher incidence of *F. pini* infection through weeviled leaders rather than through lateral branches in eastern white pine.
159. Deyrup, M.A. 1978. Notes on the biology of *Pissodes fasciatus* LeConte and its insect associates (Coleoptera: Curculionidae). Pan-Pac. Entomol. 54(2):103-106.

Information is provided on the habits, life cycle, oviposition, and feeding of *P. fasciatus*. Notes on the biology of parasitoids, predators, and other associated insects are provided.
160. Dietrich, H. 1931. Synonymy and notes on the *Pissodes* weevil attacking *Cedrus deodara*. J. Econ. Entomol. 24:872-874.

Pissodes deodarae was synonymized with *P. nemorensis* and phenological notes are given.
161. Dimond, J.B.; Bradbury, R.L. 1992. New approaches to chemical control of white pine weevil damage. Univ. Maine, Maine Agric. Exp. Stn., Orono, Maine. Bull. 837.

Dimilin was effective for controlling *P. strobi* when applied as a ground spray, but not as an aerial spray. Recommendations for effective use of Dimilin are given.

162. Dirks, C.O. 1964. The white pine weevil in Maine: its biology and dispersal and the effect of prompt clipping of infested leaders on trunk form. Univ. Maine, Agric. Exp. Stn., Orono, Maine. Bull. 625.

Information on phenology, habits, fecundity, mortality, overwintering and dispersal is given. Adults dispersed very slowly, mainly by walking. Pruning of infested leaders reduced incidence of weevil damage over a 4-year period. Prompt clipping of infested leaders also helped improve tree form.

163. Dixon, W.N.; Houseweart, M.W. 1978. Location and importance of feeding by the white pine weevil, *Pissodes strobi* (Peck). Univ. Maine, Sch. For. Resour., Life Sci. Agric. Exp. Stn., Coop. For. Res. Unit, Orono, Maine. CFRU Res. Note 1.

Weevils fed predominantly at the top of the trees and on the south and east exposed lateral branches. Fall feeding was essential for winter survival.

164. Dixon, W.N.; Houseweart, M.W. 1982. Life tables of the white pine weevil *Pissodes strobi*, in central Maine. Environ. Entomol. 11(3):555-564.

Life tables are presented for three generations of *P. strobi*. Most mortality occurred in the late larval instars. Intraspecific competition and natural enemies caused the most mortality.

165. Dixon, W.N.; Houseweart, M.W. 1983. Spring temporal and spatial activity patterns of adult white pine weevils (Coleoptera: Curculionidae) in Maine. Environ. Entomol. 12(1):43-49.

Diel and seasonal patterns of emergence, feeding, mating, and oviposition are described. These activities are influenced by photoperiod and temperature.

166. Dixon, W.N.; Houseweart, M.W.; Dimond, J.B.; Osgood, E.A. 1979. Helicopter application of insecticides for suppression of white pine weevil populations—a pilot study. Univ. Maine, Sch. For. Resour., Life

Sci. Agric. Exp. Stn., Coop. For. Res. Unit, Orono, Maine. CFRU Res. Note 4.

Pesticides were applied by helicopter in the fall to target feeding adults. Permethrin reduced incidence of weevil damage by 44%, methoxychlor by 8-15%, and carbaryl by 11%.

167. Dixon, W.N.; Houseweart, M.W.; Sheffer, S.M. 1979. Fall temporal activity and overwintering sites of the white pine weevil, *Pissodes strobi*, in central Maine. Ann. Entomol. Soc. Am. 72(6):840-844.

In the fall, weevils occur primarily on current-year apical buds and stems in north and east crown quadrants of upper crown branches. Fall adults are found on upper crown lateral branches while spring adults are predominantly located on the terminals of host trees. Weevils overwinter at the interface between an upper dry needle zone and a lower moist organic zone, about 20 cm from tree boles.

168. Dodge, C.R. 1874. [untitled]. Rural Carolinian 5:476-477.

Pissodes strobi caused damage to young cedars in a nursery in Georgia. Brief notes on life history and control by pruning are included.

169. Doidge, D.F. 1967. Note on a spruce bark weevil, *Pissodes alascensis* Hopkins (Coleoptera: Curculionidae), in British Columbia. J. Entomol. Soc. B.C. 64:63-66.

The distribution, hosts, and phenology of *P. alascensis* (= *P. rotundatus*). One or 2 years are required to complete development.

170. Doolittle, W.T. 1954. Weevils attracted to bud-pruned white pine. U.S. Dep. Agric., For. Serv., Southeast. For. Exp. Stn., Asheville, North Carolina. Res. Note 63.

Over eight times as many pruned trees were attacked by *P. strobi* as unpruned trees.

171. Droska, J.S. 1982. Responses of the white pine weevil *Pissodes strobi* (Peck) (Coleoptera: Curculionidae) to selected environmental factors in the fall. M.Sc. thesis, Univ. Maine, Orono, Maine.

The effects of bark temperature, leader diameter, and shade on the behavior of *P. strobi* in the fall were assessed. Weevils left densely shaded habitats containing host trees with small leader diameters, but were more tolerant of

shade if trees had thicker terminals. Adults responded positively to ultraviolet light.

172. Droska, J.S.; Knight, F.B.; Houseweart, M.W. 1983. Phototactic responses of the white pine weevil to ultraviolet light. Univ. Maine, Coll. For. Resour., Maine Agric. Exp. Stn., Coop. For. Res. Unit., Orono, Maine. CFRU Res. Note 13.

Pissodes strobi adults responded positively to ultraviolet light.

173. Drouin, J.A.; Sullivan, C.R.; Smith, S.G. 1963. Occurrence of *Pissodes terminalis* Hopp. (Coleoptera: Curculionidae) in Canada: life history, behaviour, and cytogenetic identification. Can. Entomol. 95:70-76.

The life history and behavior of *P. terminalis* on jack pine in Saskatchewan is described. The life cycle requires 1 year for completion. Damage and behavior is similar to that for populations on lodgepole pine. Cytogenetic analysis suggests that this is a hybrid species. Sexual dimorphism is evident in the chromosome complement.

174. Dunbar, D.M. 1976. More on the control of pales and northern pine weevils in white pine stumps. Am. Christmas Tree J. 20(2):7-8.

The herbicide Weedone was not effective at controlling *P. approximatus* (= *P. nemorensis*), but the insecticides chlorpyrifos, endosulfan, and lindane were very effective.

175. Ebata, T. 1991. Summary report of two spruce weevil surveys in twelve plantations in the Kitimat Valley. B.C. Minist. For., Victoria, British Columbia. Intern. Rep. PM-PB-69.

Survey methodology is provided and results summarized. Weevil populations grew exponentially from 1982 to 1988.

176. Eckert, R.T. 1974. White pine weevil response to host morphological and chemical factors and to micrometeorological conditions in a Norway spruce stand. M.Sc. thesis, State Univ. N.Y., Syracuse, New York.

Frequency of past weeviling was the most important variable in prediction of current damage in Norway spruce. Resistance to

weeviling in eastern white pine and Norway spruce appeared to be related to monoterpene composition. Information is provided on the timing of flight, mating, and oviposition, and the influence of weather on these activities. See also Eckert et al. (1975).

177. Eckert, R.T.; Westfall, R.D. 1975. The factor analysis of multivariate data systems. Pages 41-60 in Proc. 22nd Northeast. For. Tree Improv. Conf., August 7-9, 1974, Syracuse, New York. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania.

Factor analysis was used to examine relationships among tree morphology, weevil activity, and host damage. Weevil damage was not related to leader diameter, and influenced little by tree vigor.

178. Errico, D. 1990. Estimating the effects of reforestation pests on long-term wood supply. Pages 216-225 in Proc. XIX IUFRO World Congr., Div. 2, August 5-11, 1990, Montreal, Canada. Can. IUFRO Organ. Comm., For. Can., Hull, Quebec.

Estimates of percent yield reduction of spruce under different weevil attack intensities are provided. Harvest projections based on estimated yield reductions are also presented.

179. Evans, D. 1983. Annotated checklist of insects associated with native pines in British Columbia. Environ. Can., Can. For. Serv., Pac. For. Res. Cent., Victoria, British Columbia. Inf. Rep. BC-X-244. [See page 21.]

Gives list of *Pissodes* species associated with pines and their general distribution.

180. Evans, D.; Lowe, D.P.; Hunt, R.S. 1978. Annotated check list of forest insects and diseases of the Yukon Territory. Environ. Can., Can. For. Serv., Pac. For. Res. Cent., Victoria, British Columbia. Inf. Rep. BC-X-169.

Pissodes nemorensis, *P. canadensis*, *P. terminalis*, *P. schwarzi*, and *P. rotundatus* are recorded from the Yukon.

181. Felt, E.P. 1903. Insects affecting forest trees. Pages 449-531 in Seventh report of the Forest, Fish and Game Commission of the

- State of New York, 1901. Albany, New York. [See pages 497–500, 533–534.]
- Brief descriptions of the life stages, biology, parasitoids, and phenology of *P. strobi* are given.
182. Felt, E.P. 1906. Insects affecting park and woodland trees. N.Y. State. Mus. Mem. 8. [See pages 397–401.]
- Brief descriptions of the life stages, biology, parasitoids, and phenology of *P. strobi* are given. Descriptions of the adults and brief notes on distribution for *P. dubius* (= *P. striatulus*) and *P. affinis* are also provided.
183. Felt, E.P. 1910. Recent observations upon European insects in America. J. Econ. Entomol. 3:340–343.
- Reports a collection of *P. notatus* (= *P. castaneus*) from pine seedlings that arrived in the United States from Holland.
184. Felt, E.P. 1914. Notes on forest insects. J. Econ. Entomol. 7:373–375.
- Sweep nets were used to collect adult *P. strobi* from leaders of eastern white pine in plantations. This method showed promise as a control strategy.
185. Felt, E.P. 1915. Twenty-ninth report of the state entomologist on injurious and other insects of the State of New York, 1913. N.Y. State Mus. Bull. 175. [See pages 30–33.]
- The life stages and phenology of *P. strobi* are described. It is recommended that infested leaders are cut and placed in screened cages to allow escape of natural enemies but not weevils. Use of sweep nets to collect adults on leaders is also discussed.
186. Felt, E.P. 1928. Observations and notes on injurious and other insects of New York State. N.Y. State Mus. Bull. 274:145–176.
- Gives notes on damage caused by *P. strobi* to eastern white pine. Pruning and destruction of infested leaders and collection of adults from terminals using sweep nets are recommended controls.
187. Felt, E.P. 1935. The important shade tree insects in 1934. J. Econ. Entomol. 28:390–393.
- Pissodes approximatus* (= *P. nemorensis*) girdled and killed several small transplanted pines.
188. Finnegan, R.J. 1956. Weevils attacking pines in southern Ontario. Can. Dep. Agric., Sci. Serv., For. Biol. Div., Ottawa, Ontario. Bimonth. Prog. Rep. 12(2):3.
- The damage caused by *P. approximatus* (= *P. nemorensis*) adults and larvae to pine nursery stock and saplings is described.
189. Finnegan, R.J. 1958a. Ecological studies of *Hylobius radicis* Buch., *H. pales* (Hbst.) and *Pissodes approximatus* Hopk. (Coleoptera: Curculionidae) in southern Ontario. Ph.D. thesis, Univ. B.C., Vancouver, British Columbia.
- Descriptions of the life stages, phenology, habits, and natural mortality of *P. approximatus* (= *P. nemorensis*) are given.
190. Finnegan, R.J. 1958b. The pine weevil, *Pissodes approximatus* Hopk., in southern Ontario. Can. Entomol. 90:348–354.
- Descriptions of the life stages, phenology, habits, and natural mortality of *P. approximatus* (= *P. nemorensis*) are given.
191. Fisher, R.T.; Terry, E.I. 1920. The management of second growth white pine in central New England. J. For. 4:358–366.
- Gives a brief report of damage caused by *P. strobi* in young pine plantations.
192. Fitch, A. 1858. Fourth report on the noxious and other insects of the State of New York. Trans. N.Y. State Agric. Soc. 17:687–753. [See pages 732–736.]
- Reports on the damage caused by *P. strobi* in the state and gives some notes on biology.
193. Fletcher, V.E. 1986. Development of sampling guidelines for estimating the proportion of weeviled trees on a plantation. B.C. Minist. For., Victoria, British Columbia. Intern. Rep. PM-PB-18.
- Based on computer simulations and operational field surveys, a systematic sampling method was developed for estimating incidence of *P. strobi*-damaged trees in plantations.

194. Fogal, W.H.; Morgenstern, P.; Viidik, P.; Yeatman, C.W. 1982. Variation in susceptibility of native and introduced coniferous trees to some insects of eastern Canada. Pages 472–477 in H.M. Heybroek, B.R. Stephan, and K. von Weissenberg, eds. Resistance to diseases and pests in forest trees. Proc. Third Int. Workshop Genet. Host-Parasite Interactions For., September 14–21, 1990, Wageningen, The Netherlands. Cent. Agric. Publ. Doc., Wageningen, The Netherlands.

Reviews resistance of eastern white pine, jack pine, and Norway spruce to *P. strobi*.
195. Fontaine, M.S. 1981. Reproductive ecology of the deodar weevil, *Pissodes nemorensis* (Coleoptera: Curculionidae), in north Florida. Ph.D. thesis, Univ. Fla., Gainesville, Florida.

The contents of this thesis was published in the primary literature. For content, see annotations for references 196–198.
196. Fontaine, M.S.; Foltz, J.L. 1982. Field studies of a male-released aggregation pheromone in *Pissodes nemorensis*. Environ. Entomol. 11:881–883.

Response of *P. nemorensis* to traps containing various combinations of pine bolts and adult males and females indicated that males produced an aggregation pheromone. Peak response to male-baited traps was observed in November, and a small peak was observed in February.
197. Fontaine, M.S.; Foltz, J.L. 1985. Adult survivorship, fecundity, and factors affecting laboratory oviposition of *Pissodes nemorensis* (Coleoptera: Curculionidae). Can. Entomol. 117:1575–1578.

Adult females live an average of 130 days and lay 180 eggs. Oviposition was greatest on shoots of greatest diameter and with few needles.
198. Fontaine, M.S.; Foltz, J.L.; Nation, J.L. 1983. Reproductive anatomy and seasonal development of the deodar weevil, *Pissodes nemorensis* (Coleoptera: Curculionidae), in north Florida. Environ. Entomol. 12(3):687–691.

Adults emerging from breeding material in the spring were sexually immature. Adults fed throughout the summer, became reproductively mature in September, and mated and oviposited throughout the fall and winter. Reproductive development at different temperatures was studied, and the reproductive systems of both sexes are described.
199. Forbush, E.N. 1913. Useful birds and their protection. 4th ed. Mass. State Board Agric., Boston, Massachusetts. [See pages 168, 254–256.]

Reports that the downy woodpecker is an important predator of *P. strobi*.
200. Ford, R.P.; Talerico, R.L.; Mott, D.G. 1965. A field test of procedures for evaluating and scheduling white-pine weevil control. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania. Res. Note NE-37.

The method developed by Marty and Mott (1964) for use in evaluating and scheduling control of *P. strobi* was tested on 32 stands. The course of weevil infestations was correctly predicted in most stands. Control was required and predicted to be profitable in 11 stands.
201. Fowler, D.P.; Heimbürger, C.C. 1969a. Genetic improvement of red pine and eastern white pine. For. Chron. 45:414–420.

Prospects for genetic improvement of eastern white pine with respect to resistance to *P. strobi* are good, but much less so for red pine because of the much lower amount of genetic variability in that species.
202. Fowler, D.P.; Heimbürger, C. 1969b. Geographic variation in eastern white pine, 7-year results in Ontario. Silvae Genet. 18:123–129.

Geographic variation accounted for 0–38% of variation in incidence of *P. strobi* damage.
203. Fowler, R.F.; Wilson, L.F.; Paananen, D.M. 1986. Insect suppression in Eastern Region national forests: 1930–1980. U.S. Dep. Agric., For. Serv., North Cent. For. Exp. Stn., St. Paul, Minnesota. Gen. Tech. Rep. NC-103. [See page 52.]

- Gives a summary of pesticide applications against *P. strobi* including year of treatment, application rate and method, area treated, and results.
204. Fraser, R.G.; Heppner, D.G. 1993. Control of white pine weevil, *Pissodes strobi*, on Sitka spruce using implants containing systemic insecticide. *For. Chron.* 69(5):600–603.

Stem implants containing the systemic insecticides acephate and oxydemeton-methyl were effective at protecting trees from weevil attack.
 205. Fraser, R.G.; Szeto, S. 1994. Insecticides applied with Ezject will protect young Sitka spruce from white pine weevil attack. Pages 239–247 in R.I. Alfaro, G. Kiss, and R.G. Fraser, eds. *The white pine weevil: biology, damage, and management*. Proc. Meet., January 19–21, 1994, Richmond, British Columbia. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 226.

Oxydemeton-methyl and dimethoate applied to Sitka spruce with the Ezject lance can provide control of *P. strobi* for 2–3 years.
 206. Fuller, A.S. 1869. White pine weevil. *Am. Entomol.* 2:26.

The adult, larva, and pupa of *P. strobi* are illustrated. The damage symptoms are described and it is recommended that infested leaders be cut and burned.
 207. Fuller, A.S. 1886. A good word for the white pine weevil. *Am. Entomol.* 3:5–6.

It is argued that weevil damage to trees and the resulting bushy appearance may be aesthetically pleasing in ornamental settings.
 208. Furniss, M.M.; Daterman, G.E.; Kline, L.N.; McGregor, M.D.; Trostle, G.C.; Pettinger, L.F.; Rudinsky, J.A. 1974. Effectiveness of the Douglas-fir beetle antiaggregative pheromone methylcyclohexenone at three concentrations and spacings around felled host trees. *Can. Entomol.* 106:381–392.

Methylcyclohexenone is reported to be attractive to *P. fasciatus* LeConte.
 209. Gabriel, W.J. 1958. The possibilities of developing strains of white pine resistant to the white-pine weevil. Pages 58–60 in *Proc. Soc. Am. For. Meet.*, November 10–13, 1957, Syracuse, New York. Soc. Am. For., Washington, D.C.

A large number of geographic ecotypes, local races, and individual trees of eastern white pine were examined for evidence of resistance to *P. strobi*. It was concluded that this tree species shows little evidence of weevil resistance.
 210. Gagnon, G. 1995. L'efficacité du contrôle mécanique. [Efficacy of mechanical control.] Pages 79–87 in R. Lavallée and G. Bonneau, eds. *Compte-rendu du colloque sur le charançon du pin blanc*. Proc. Symp., September 27–28, 1994, Ste-Foy, Québec. Ressour. nat. Can., Serv. can. for., Rég. Qué., Cent. for. Laurentides, Ste-Foy (Québec), et Ressour. nat. Qué., Dir. conserv. for., Québec (Québec).

Mechanical control of *P. strobi* by removal and destruction of infested leaders in plantations over a 5 year period can reduce or at least stabilize weevil attack rates and minimize anticipated volume losses.
 211. Gara, R.I.; Carlson, R.L.; Hrutfiord, B.F. 1971. Influence of some physical and host factors on the behavior of the Sitka spruce weevil, *Pissodes sitchensis*, in southwestern Washington. *Ann. Entomol. Soc. Am.* 64(2):467–471.

Faster growing trees were weeviled more severely than the slower growing ones. Mating and oviposition were affected by temperature, and peaked at 90°F. Spring adults preferred areas of higher temperatures than the fall adults. Overwintering adults were active in the winter and fed on stems and laterals.
 212. Gara, R.I.; Wood, J.O. 1989. Termination of reproductive diapause in the Sitka spruce weevil, *Pissodes strobi* (Peck) (Col., Curculionidae), in western Washington. *J. Appl. Entomol.* 108:156–163.

Females exposed to various temperatures for up to 60 days did not break diapause. Females that fed on terminals under a long day photoperiod matured their ovaries, but not those that fed on lateral branches. Males did not show evidence of reproductive diapause.

213. Garrett, P.W. 1970. Early evidence of weevil resistance in some clones and hybrids of white pine. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania. Res. Note NE-117.

Pinus monticola had a low incidence of weevil, and a hybrid between *P. strobus* and *P. wallichiana* was heavily weeviled.
214. Garrett, P.W. 1972. Resistance of eastern white pine (*Pinus strobus* L.) provenances to the white-pine weevil (*Pissodes strobi* (Peck.)). *Silvae Genet.* 21:119-121.

Incidence of *P. strobi* damage in 27 provenances of pine ranged from 71% to 100%. There was no correlation between latitude of seed source or average tree vigor and weevil damage. The chances of locating provenances with good weevil resistance are remote.
215. Garrett, P.W. 1973. Geographic variation in resistance to white pine weevil (*Pissodes strobi*) (Coleoptera: Curculionidae) by eastern white pine (*Pinus strobus*). *Can. Entomol.* 105:347-350.

Weevil damage on 12 sources of pine was measured. Differences between sources at age 13 were significant, but all sources were heavily weeviled. It is doubtful that sources resistant to white pine weevil will be found.
216. Garrett, P.W. 1986. Role of tree improvement in providing pest-resistant eastern white pine (*Pinus strobus* L.). Pages 75-84 in D. T. Funk, comp. Eastern white pine: today and tomorrow. Symp. Proc., June 12-14, 1985, Durham, New Hampshire. U.S. Dep. Agric., For. Serv., Washington, D.C. Gen. Tech. Rep. WO-51.

Summarizes previous studies on host resistance to *P. strobi* in eastern white pine.
217. Genys, J.B. 1979. Intraspecific variation in Himalayan white pine, *Pinus griffithii*. Pages 117-130 in Proc. 13th Lake States For. Tree Improv. Conf., August 17-18, 1977, St. Paul, Minnesota. U.S. Dep. Agric., For. Serv., North Cent. For. Exp. Stn., St. Paul, Minnesota, Gen. Tech. Rep. NC-50.

Pinus griffithii planted in New York and North Carolina were attacked by *P. strobi*. Seed sources from higher elevations were more resistant.
218. Genys, J.B. 1981. Preferences of *Pissodes strobi* in attacking different geographic strains of *Pinus strobus*. Pages 191-194 in Proc. XVII IUFRO World Congr., September 6-12, 1981, Kyoto, Japan. Div. 2. Forest plants and forest protection. Jpn. IUFRO Congr. Council, Ibaraki, Japan.

From 47 to 97 different geographic populations of trees were assessed in each of four states. Weevil damage incidence ranged from 14 to 57%. Several resistant families were noted.
219. Gerhold, H.D. 1962. Testing white pine for weevil resistance. Pages 44-50 in Proc. Ninth Northeast. For. Tree Improv. Conf., August 23-25, 1961, Syracuse, New York. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania.

It is usually difficult to adequately test for resistance in natural stands because of the low intensity and clumped distribution of weevil attacks. Therefore, artificial inoculation of trees may be required to increase the intensity and uniformity of infestations. The author argues that three types of resistance must be investigated: non-preference, antibiosis, and tolerance.
220. Gerhold, H.D.; Soles, R.L. 1967. Weevil attacks on caged seedlings of three white pine species. Pages 51-59 in Proc. 14th Northeast. For. Tree Improv. Conf., August 10-11, 1966, Toronto, Ontario. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania.

Pinus griffithii was less resistant than *P. strobus*, which were both less resistant than *P. monticola*. The advantages and disadvantages of using caged seedlings to assess resistance are discussed.
221. Gerhold, H.D.; Stroh, R.C. 1963. Integrated selection for white pine weevil resistance and its components. Pages 1-8 in Proc. World Consult. For. Genet. Tree Improv., August 23-30, 1963, Stockholm, Sweden. Food Agric. Organ. U.N., Rome, Italy.

Direct selection of resistant trees is often difficult because weevil attacks are usually clumped and of low intensity. The authors argue that indirect selection of trees with traits that are highly correlated with weevil resistance should be integrated with direct selection methods.

222. Germar, E.F. 1824. Insectorum species novae aut minus cognitae, descriptionibus illustratae. Vol. 1. J.C. Hendelii, Halae. [See pages 316–319.]
Gives the original description of the genus *Pissodes* and *P. nemorensis*. Several other *Pissodes* species are described, but these are no longer valid names.
223. Girault, A.A. 1917. New chalcid flies, with notes. Bull. Brooklyn Entomol. Soc. 12:86–89.
Describes *Eurytoma pissodis*, which parasitizes *P. strobi*.
224. Godwin, P.A.; Bean, J.L. 1956. Predicting emergence of the white-pine weevil from hibernation. For. Sci. 2:187–189.
It is possible to reliably predict *P. strobi* emergence based on degree days above 40°F. This information can be used to schedule pesticide application in the spring.
225. Godwin, P.A.; Jaynes, H.A.; Davis, J.M. 1957. The dispersion of radioactively tagged white-pine weevils in small plantations. J. Econ. Entomol. 50(3):264–266.
Weevils disperse readily by flight for distances of up to 724 ft.
226. Godwin, P.A.; Odell, T.M. 1967. Experimental hybridization of *Pissodes strobi* and *P. approximatus* (Coleoptera: Curculionidae). Ann. Entomol. Soc. Am. 60(1):55–58.
Pissodes strobi and *P. approximatus* (= *P. nemorensis*) readily hybridize. There was greater mortality in the pre-hatch stages of the hybrids. Measurements of various anatomical characters of hybrid adults were intermediate between those for the two pure-bred species.
227. Godwin, P.A.; Valentine, H.T.; Odell, T.M. 1982. Identification of *Pissodes strobi*, *P. approximatus*, and *P. nemorensis* (Coleoptera: Curculionidae) using discriminant analysis. Ann. Entomol. Soc. Am. 75:599–604.
A discriminant analysis of 8 morphological and one meristic variable allowed discrimination between *P. strobi* and *P. nemorensis* and between *P. strobi* and *P. approximatus* (= *P. nemorensis*), but not between *P. nemorensis* and *P. approximatus*.
228. Graber, R.E. 1988. Stem quality of white pine established by seeding in furrows and by planting. North. J. Appl. For. 5:128–129.
Seeded trees were the same height, had a smaller DBH, and less stem injury due to *P. strobi*, and smaller branches than planted trees. Direct-seeded trees were of higher quality and lower cost than planted trees.
229. Graham, K. 1951. The Sitka spruce weevil. Can. Dep. Agric., Sci. Serv., Div. For. Biol., Ottawa, Ontario. Bi-mon. Prog. Rep. 7(5):3–4.
No evidence for resistance of Sitka spruce to weevils was found.
230. Graham, S.A. 1916. Notes on the control of the white pine weevil. J. Econ. Entomol. 9:549–551.
Several pesticides were tested against *P. strobi*; creosote and carbolineum gave the best protection but also injured trees. Tanglefoot barriers on trees also showed promise for reducing weevil injuries to trees.
231. Graham, S.A. 1918. The white-pine weevil and its relation to second-growth white pine. J. For. 16:192–202.
General information is provided on damage to trees, life history, habits, natural enemies, distribution, host preferences, and control measures. It was noted that weevil damage decreases with stand density.
232. Graham, S.A. 1926. Biology and control of the white-pine weevil, *Pissodes strobi* Peck. Cornell Univ., Agric. Exp. Stn., Ithaca, New York. Bull. 449.
The amount of injury in relation to stand density, host species, tree age and height, crown class, and rate of growth is discussed. A thorough overview of the damage, life history, and habits is provided. Control using pesticides, pruning, manipulation of stand density and amount of shading, and natural enemies are evaluated.
233. Graham, S.A.; Satterlund, D.R. 1956. White pine weevil attacking red pine. J. For. 54:133–134.
The incidence of *P. strobi* damage to red pine was assessed. Twelve percent of trees growing in the open were attacked whereas only 2% of

those growing under shade were attacked. In food choice tests weevils reared from red pine preferred eastern white pine over red pine.

234. Gross, H.L. 1985. Impact of pests on the white pine resource of Ontario. Proc. Entomol. Soc. Ont. Suppl. 116:33-37.

Estimates that growth loss due to *P. strobi* in plantations is 8000 m³ per year. Annual losses due to cull was estimated at 10 400 m³ in plantations and 5000 m³ in natural stands.
235. Guise, C.H. 1945. The university forest plantations. Cornell Plantations 1945(1):43-46.

White pine was attacked and deformed by *P. strobi* in many plantations.
236. Hadley, B.L., Jr. 1952. Lead arsenate sprays to control white pine weevil. Penn. For. Waters 4(1):10-12.

Lead arsenate applied with a knapsack sprayer was effective at controlling *P. strobi*.
237. Hall, P.M. 1994. Ministry of Forests perspectives on spruce reforestation in British Columbia. Pages 1-6 in R.I. Alfaro, G. Kiss, and R.G. Fraser, eds. The white pine weevil: biology, damage, and management. Proc. Meet., January 19-21, 1994, Richmond, British Columbia. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 226.

Impact and management of *P. strobi* are among the most important issues related to spruce regeneration.
238. Hamel, M. 1995. Écologie de l'alimentation des adultes du charançon du pin blanc: variations interspécifiques et intraspécifiques. Ph.D. thesis, Univ. Laval, Laval, Québec.

The contents of this thesis was published in the primary literature. For content, see annotations for references 239-240.
239. Hamel, M.; Bauce, É. 1995. Choix de l'hôte par les adultes du charançon du pin blanc: rôle des stimuli gustatifs. Pages 35-56 in R.

Lavallée and G. Bonneau, eds. Compte-rendu du colloque sur le charançon du pin blanc. Proc. Symp., September 27-28, 1994, Ste.-Foy, Québec. Ressour. nat. Can., Serv. can. for., Rég. Qué., Cent. for. Laurentides, Ste-Foy (Québec), et Ressour. nat. Qué., Dir. conserv. for., Québec (Québec).

Bioassays under controlled and field conditions showed that Norway spruce was the preferred host of *P. strobi* in Quebec, and that host selection was based on gustatory cues. Monoterpene composition was apparently related to host preference. Norway spruce with high growth rates were more susceptible to weevil attacks than those with low growth rates.

240. Hamel, M.; Bauce, É.; Lavallée, R. 1994. Feeding and oviposition interspecific preferences of adult white pine weevil (Coleoptera: Curculionidae) in Quebec. Environ. Entomol. 23:923-929.

Weevils preferred Norway spruce over eastern white pine and white spruce in bioassays. Interspecific discrimination by weevils is more pronounced on spring than on late summer bark.
241. Hard, J.S. 1962. Bionomic investigations of the northern pine weevil, *Pissodes approximatus* Hopk. (Coleoptera: Curculionidae). M.Sc. thesis, N.Y. State Coll. For., Syracuse, New York.

A 1-year life cycle was reported for New York. Mortality was caused by woodpeckers, fungi, and parasitoids. Females preferred to oviposit in moist, resinous bark and bark shaded from direct sunlight. *P. approximatus* (= *P. nemorensis*) caused little seedling mortality in the study area. There was no correlation between crown closure and the density of chip cocoons. Adults did not infest bolts of *Larix leptolepis* and *L. decidua*, but did infest *Picea abies* bolts.
242. Harman, D.M. 1966. Biology and natural control of the white pine weevil, *Pissodes strobi* (Peck), in Virginia. Ph.D. thesis, Va. Polytech. Inst., Blacksburg, Virginia.

The contents of this thesis was published in the primary literature. For content, see annotations for references 244, 251-255, and 341.
243. Harman, D.M. 1969. White-pine weevil attack on naturally seeded Virginia pine in

a severely attacked white pine plantation. Chesapeake Sci. 10(2):120-122.

Attacks by *P. strobi* were observed on Virginia pine for the first time. Over 15% of the pines were attacked. However, only 13.6% of the attacked trees supported successful broods, which resulted in emergence of new adults from the stem. The remaining 86.4% of the broods were unsuccessful.

244. Harman, D.M. 1970. Determination of larval instars of the white-pine weevil by head-capsule measurements. Ann. Entomol. Soc. Am. 63(6):1573-1575.

Larvae of *P. strobi* were significantly smaller in each instar than those of *P. approximatus* (= *P. nemorensis*). A 5th instar, not previously reported for *P. strobi*, was recorded in 40% of the larvae that survived the 4th instar. No significant differences in head-capsule width were noted between male and female larvae.

245. Harman, D.M. 1971. White pine weevil attack in large white pines in Maryland. Ann. Entomol. Soc. Am. 64(6):1460-1462.

The incidence of current attack on trees 40-75 ft tall ranged from 79% to 94%.

246. Harman, D.M. 1975. Movement of individually marked white pine weevils, *Pissodes strobi*. Environ. Entomol. 4(1):120-124.

Movement of *P. strobi* adults in spring was monitored by mark-release-recapture. Over 57% of the weevils released changed trees only once, and none changed trees more than four times. Longest flights recorded in the study were 46.4 m for males and 53.0 m for females. Movement direction was significantly correlated with the direction of tree rows. A total of 75.9% of the marked weevils remained in or near the release area.

247. Harman, D.M.; Brown, M.L. 1974. Leader and bark characteristics in different growth categories of white pine (*Pinus strobus* L. and *Pinus monticola* Dougl.) in Maryland. Chesapeake Sci. 15(1):30-38.

Physical and chemical aspects of eastern white pine leaders and bark were investigated in tall (40-75 ft) and in smaller (12-25 ft) trees growing in the open and in shade. Leaders from the smaller, open-growing trees were the longest, thickest, and had the greatest bark thickness.

Light transmittance was higher for shoots than for bark from lateral branches and the main stem in both pine species.

248. Harman, D.M.; Harman, A.L. 1972. Stridulatory mechanisms in the white pine weevil, *Pissodes strobi*. Ann. Entomol. Soc. Am. 65(5):1076-1079.

The stridulatory apparatus and other distinguishable zones on the inner surface of the elytra of *P. strobi* are described. Differences between the sexes were noted.

249. Harman, D.M.; Harman, A.L. 1984. Comparison of stridulatory structures in North American *Pissodes* spp. (Coleoptera: Curculionidae). Proc. Entomol. Soc. Wash. 86:228-238.

The length:width ratio of the pars stridens appeared to have some taxonomic value for discriminating among *Pissodes* taxa.

250. Harman, D.M.; Kranzler, G.A. 1969. Sound production in the white-pine weevil, *Pissodes strobi*, and the northern pine weevil, *P. approximatus*. Ann. Entomol. Soc. Am. 62(1):134-136.

Differences in sound pattern were noted between males and females of both *P. strobi* and *P. approximatus* (= *P. nemorensis*). There was no significant difference in chirp rate between the two species.

251. Harman, D.M.; Kulman, H.M. 1966. A technique for sexing live white-pine weevils, *Pissodes strobi*. Ann. Entomol. Soc. Am. 59(2):315-317.

The key characters used in sex determination were: (1) the pygidium (8th tergite of the male, 7th tergite of the female), (2) the posterior view of the opened anogenital vestibule, which exposed the displaced eighth abdominal tergite and the apodeme fork of the 8th sternite in the female or a small projection of the 8th abdominal tergite in the male.

252. Harman, D.M.; Kulman, H.M. 1967a. An annotated list: parasites and predators of the white-pine weevil, *Pissodes strobi* (Peck). Univ. Maryland, Nat. Resour. Inst., College Park, Maryland. Contrib. 323.

Lists all known parasitoids and predators associated with *P. strobi*.

253. Harman, D.M.; Kulman, H.M. 1967b. Flight and dispersal of the white-pine weevil. J. Econ. Entomol. 60(6):1682-1687.
- Dispersal was studied using mark-release-recapture. Most weevils were recovered within 30 ft of the release point, but some were recaptured up to 330 ft away.
254. Harman, D.M.; Kulman, H.M. 1967c. Ovariole development in the white-pine weevil, *Pissodes strobi* (Coleoptera: Curculionidae). Ann. Entomol. Soc. Am. 60(6):1146-1150.
- Diapause is obligatory in *P. strobi*, and the temperature requirement for breaking diapause is satisfied by early November. Some adults mate in the fall before hibernation.
255. Harman, D.M.; Kulman, H.M. 1968. Biology and natural control of the white-pine weevil in Virginia. Ann. Entomol. Soc. Am. 61(2):280-285.
- The most common insect associated with *P. strobi* was the lonchaeid fly, *Lonchaea corticis*. Young, open stands were most favorable for weevil development. The highest number of associated insects were obtained from older, closed stands.
256. Harman, D.M.; Kulman, H.M. 1969. Dispersion of released white-pine weevils in intrastand growth types. Ann. Entomol. Soc. Am. 62(4):835-838.
- Released weevils were recovered in greatest numbers in areas where there was partial competition (shading) from grasses, shrubs, and trees, as compared to areas with bare mineral soil and those with heavy shading from hardwood overstory trees.
257. Harman, D.M.; Wallace, J.B. 1971. Description of the immature stages of *Lonchaea corticis*, with notes on its role as a predator of the white pine weevil, *Pissodes strobi*. Ann. Entomol. Soc. Am. 64(6):1221-1226.
- Descriptions are given for the three larval instars and puparium of *L. corticis*. The distribution and feeding of fly larvae within leaders is described.
258. Harrington, W.H. 1881. Rhynchophora - weevils. Entomol. Soc. Ont. Annu. Rep. 11:49-57. [See pages 52-53.]
- Gives a brief description of the phenology of *P. strobi* and its damage to trees.
259. Harrington, W.H. 1902. Note on insects injurious to pines. Entomol. Soc. Ont. Annu. Rep. 33:114-117.
- Gives a brief description of the damage caused by *P. strobi*.
260. Harris, J.W.E.; Brown, R.G. 1970. Observations on spruce weevil permanent sample plots at Green Timbers and Nitinat, B.C., 1959-69. Can. Dep. Fish. For., Can. For. Serv., For. Res. Lab., Victoria, British Columbia. Intern. Rep. BC-22.
- Annual incidence of attack is provided for each plot. Incidence of attack increased with height class. Insecticide application reduced damage incidence for a short period. At Green Timber, the highest incidence of attack was observed in the pure Sitka spruce stands. *Picea sitchensis* x *glauca* hybrids, *P. glauca*, and *P. abies* were attacked less.
261. Harris, J.W.E.; Holms, J.C.V.; Molnar, A.C. 1968. Status of the Sitka spruce weevil on Vancouver Island, 1967. Can. Dep. For. Rural Dev., For. Res. Lab., Victoria, British Columbia. Inf. Rep. BC-X-15.
- Incidence of *P. strobi* damage to natural and planted stands of Sitka spruce is summarized and analyzed with respect to influence of climatic zones, topography, and tree height.
262. Harris, L.J.; Alfaro, R.I.; Borden, J.H. 1990. Role of needles in close-range host selection by the white pine weevil on Sitka spruce. J. Entomol. Soc. B.C. 87:22-25.
- Needles contain feeding deterrents, but also have a positive thigmotactic effect on close range host selection.
263. Harris, L.J.; Borden, J.H.; Pierce, H.D., Jr.; Oehlschlager, A.C. 1983. Cortical resin monoterpenes in Sitka spruce and resistance to the white pine weevil, *Pissodes strobi* (Coleoptera: Curculionidae). Can. J. For. Res. 13:350-352.

Sitka spruce resistant to *P. strobi* had significantly lower β -phellandrene and higher β -pinene and 3-carene content than susceptible trees. The monoterpene profile could be used as an indicator of resistant trees.

264. Harris, T.W. 1826. Trees. N. Engl. Farmer 22:169-171.

This is one of the earliest accounts of the biology, damage, and control of *P. strobi*.

265. Harris, T.W. 1862. Treatise on some of the insects injurious to vegetation. Crosby and Nichols, Boston, Massachusetts. [See pages 72-73.]

Gives a description of the adult stage of *P. strobi* and discusses biology, damage, and control. This is an update of Harris (1826, 1841, 1852).

266. Harvey, G.T.; Gray, D.E.; Prebble, M.L. 1951. Summary of investigations of attack by the white pine weevil in plots at the Petawawa Forest Experimental Station 1936-1948. Can. Dep. Agric., Sci. Serv., For. Biol. Div., For. Insect Lab., Sault Ste. Marie, Ontario. Annu. Tech. Rep.

Attack incidence was much higher on open stands compared to shaded stands, and increased with greater length and diameter of terminal.

267. Harvey, G.T.; MacLauchlan, L.; Roden, P.M. 1991. Studies of isozymes of weevils on lodgepole pine in the Kamloops area of British Columbia. For. Can., Ont. Reg., Great Lakes For. Cent., Sault Ste. Marie, Ontario. Misc. Rep. 109.

Based on nine loci, it appeared that weevils breeding in the terminal leaders and root collar area were all *P. terminalis*. Isozyme variation for one population of *P. strobi* is also given.

268. Hastings, A.R. 1956. Granulated endrin for white-pine weevil control during hibernation. J. Econ. Entomol. 49(6):878.

Granulated endrin applied to the duff in the fall to target hibernating weevils gave good control.

269. Hastings, A.R.; Risley, J.H. 1962. White-pine weevil control with knapsack mistblower. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania. Stn. Pap. 167.

Application of lindane and malathion with a knapsack mistblower in the spring gave good control.

270. Hatch, M.H. 1971. The beetles of the Pacific Northwest. Part V. Rhipicerioidea, Sternoxi, Phytophaga, Rhynchophora, and Lamellicornia. Univ. Wash. Press, Seattle, Washington. Univ. Wash. Publ. Biol. 16. [See pages 311-314, 607-608.]

Provides a key to species of *Pissodes* in the Pacific Northwest.

271. Headlee, T.J. 1915. Report of the entomologist. Pages 339-363 in Thirty-fifth annual report of the New Jersey State Agricultural Experiment Station and the twenty-seventh annual report of the New Jersey Agricultural College Experiment Station for the year ending October 31st, 1914. News Print. Co., State Print., Paterson, New Jersey. [See page 349.]

The author recommends lead arsenate for control of *P. strobi*.

272. Hedlin, A.F. 1957. Insects associated with white pine, *Pinus monticola* Dougl., in British Columbia. Can. Dep. Agric., Sci. Serv., For. Biol. Div., For. Biol. Lab., Victoria, British Columbia. Interim Rep. 1956-6.

Pissodes curriei (= *P. affinis*) is recorded from western white pine.

273. Heimburger, C. 1967. Some observations on weevil resistance in *Pinus peuce*. Pages 64-69 in Proc. 14th Northeast. For. Tree Improv. Conf., August 10-11, 1966, Toronto, Ontario. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania.

Pinus peuce grafts to Scots pine were more resistant to weeviling than *P. strobus* grafts, likely due to more resin flow in the former.

274. Heimburger, C.C.; Sullivan, C.R. 1972a. Screening of Haploxylon pines for resistance to the white pine weevil. I. *Pinus peuce* and *P. strobus* grafted on Scots pine. Silvae Genet. 21:93-96.

Pinus peuce grafts to Scots pine were more resistant to weeviling than *P. strobus* grafts, likely due to more resin flow in the former.

275. Heimburger, C.C.; Sullivan, C.R. 1972b. Screening of Haploxylon pines for resistance to the white pine weevil. II. *Pinus strobus* and other species and hybrids grafted on white pine. *Silvae Genet.* 21:210-215.

Good weevil resistance, based on low frequency of attack and good recovery from attack, was found in one clone of *Pinus strobus* and one of *P. peuce*. Includes a discussion of strategies for breeding weevil resistant trees.

276. Heppner, D.G.; Wood, P.M. 1984. Vancouver region Sitka spruce weevil survey results (1982-1983) with recommendations for planting Sitka spruce. B.C. Minist. For., Burnaby, British Columbia. For. Serv. Intern. Rep. PM-V-5.

A low incidence of weevil infestation was found over the northern tip of Vancouver Island and the northern coast of the mainland, and a generally high incidence was found throughout the remaining portion of the region. It was recommended that Sitka spruce not be planted in high weevil-hazard zones.

277. Hibbard, B.E.; Webster, F.X. 1993. Enantiomeric composition of grandisol and grandisol produced by *Pissodes strobi* and *P. nemorensis* and their electroantennogram response to pure enantiomers. *J. Chem. Ecol.* 19(10):2129-2141.

Pissodes nemorensis produced nearly 100% (1R,2S)-grandisol and nearly 100% (1S,2R)-grandisol; *P. strobi* produced 99% (1R,2S)-grandisol and about 60% (1R,2S)-grandisol. In electroantennogram studies, there were no differences among sexes in response to racemic grandisol, racemic grandisol, or the 1R,2S and 1S,2R enantiomers of grandisol and grandisol.

278. Hodge, J.; Humphreys, N.; Van Sickle, G.A. 1994a. Surveys of forest health in managed stands in British Columbia, 1992. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 213.

Pissodes strobi infested 24% (range: 1-100%) of the trees in 46% of the 56 spruce plantations surveyed. An average of 3% of the lodgepole pine was attacked by *P. terminalis*.

279. Hodge, J.; Humphreys, N.; Van Sickle, G.A. 1994b. Surveys of forest health in managed stands in British Columbia, 1993. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 225.

Pissodes strobi infested 20% (range: 1-57%) of the spruce in 58% of the spruce plantations surveyed. An average of 2% of the lodgepole pine was attacked by *P. terminalis*.

280. Hodson, A.C.; French, D.W.; Jensen, R.A. 1986. Role of insects and diseases in a jack pine provenance study. *Great Lakes Entomol.* 19:239-247.

The incidence of *P. strobi* damage and its impact upon tree radial growth and stem form is summarized for two jack pine provenances in Minnesota.

281. Hodson, A.C.; French, D.W.; Jensen, R.A.; Bartelt, R.J. 1982. The susceptibility of jack pine from Lake States seed sources to insects and diseases. U.S. Dep. Agric., For. Serv., North Central For. Exp. Stn., St. Paul, Minnesota. Res. Pap. NC-225.

Several seed sources had very low incidence of attack by *P. strobi*.

282. Holdsworth, R.P. 1943. Some work on the white pine weevil. *J. For.* 41:143-144.

Leaders infested by *P. strobi* were pruned and placed in screened cages to allow escape of parasitoids.

283. Holst, M.J. 1955a. An observation of weevil damage in Norway spruce. Can. Dep. North. Affairs Natl. Res., For. Branch, For. Res. Div., Ottawa, Ontario. Tech. Note 4.

Slender trees with narrow brush-type crowns were lightly weeviled, whereas stout trees with broad comb-type crowns had heavy weevil damage.

284. Holst, M.J. 1955b. Breeding for weevil resistance in Norway spruce. *Z. Forstgenet. Forstpflanz. Zucht.* 4(2):33-37.
- It is suggested that breeding for weevil resistance in Norway spruce may be best accomplished by hybridization with more resistant spruce species.
285. Holst, M.J. 1956. Notes on the Norway spruce—white pine weevil relationship in the Adirondacks. *N.Y. State Ranger Sch. Alum. News* (1955):16-17, 40.
- There were some suggestions of weevil resistance in Norway spruce provenances.
286. Holst, M.J. 1963. Growth of Norway spruce (*Picea abies* (L.) Karst.) provenances in eastern North America. *Can. Dep. For., For. Res. Branch, Ottawa, Ontario. Publ.* 1022.
- There were some suggestions of weevil resistance in Norway spruce provenances.
287. Holt, W.R. 1956. Certain aspects of the biology of four weevils attacking coniferous plantations in central Pennsylvania. M.F. thesis, Penn. State Univ., University Park, Pennsylvania.
- Gives a summary of the phenology, feeding, flight, and damage caused by *P. approximatus* (= *P. nemorensis*).
288. Hopkins, A.D. 1893. Catalogue of West Virginia forest and shade tree insects. *W.Va. Agric. Exp. Stn., Morgantown, West Virginia. Bull.* 32. [See page 205.]
- Gives the phenology and distribution of *P. strobi* in West Virginia.
289. Hopkins, A.D. 1899. Report on investigations to determine the cause of unhealthy conditions of the spruce and pine from 1800 to 1893. *W.Va. Agric. Exp. Stn., Morgantown, West Virginia. Bull.* 56. [See pages 259-260, 284, 345, 427, 429, 441.]
- Describes the phenology of *P. strobi* and damage caused to eastern white pine.
290. Hopkins, A.D. 1902. Insect enemies in the Black Hills forest reserve. *U.S. Dep. Agric., Div. Entomol., Washington, D.C. Bull.* 32. [See pages 14-15.]
- The author describes the phenology of *P. strobi* and damage caused to trees.
291. Hopkins, A.D. 1906. Insect enemies of forest reproduction. Pages 249-256 in *Yearbook of the United States Department of Agriculture, 1905. U.S. Dep. Agric., Washington, D.C.* [See pages 252-253.]
- Information on the phenology and damage caused by six species of *Pissodes* is given.
292. Hopkins, A.D. 1907. The white-pine weevil. *U.S. Dep. Agric., Bur. Entomol., Washington, D.C. Circ.* 90.
- A review of the biology of *P. strobi*, including information on damage symptoms, impact, and control is given.
293. Hopkins, A.D. 1909a. Contributions toward a monograph of the scolytid beetles. I. The genus *Dendroctonus*. *U.S. Dep. Agric., Washington, D.C. Tech. Ser.* 17, part 1. [See pages 11, 16, 17.]
- A diagram of the head and mandibles of an adult *P. strobi* is given.
294. Hopkins, A.D. 1909b. Some insects injurious to forests. Pages 57-101 in *Insect depredations in North American forests and practical methods of prevention and control. U.S. Dep. Agric., Bur. Entomol., Washington, D.C. Bull.* 58, part 5. [See page 62.]
- States that *P. strobi* damage may reduce the value of eastern white pine by 20 to 50%.
295. Hopkins, A.D. 1910. Insect injuries to the wood of living trees. *U.S. Dep. Agric., Bur. Entomol., Washington, D.C. Circ.* 126.
- States that *P. strobi* damage may reduce the value of eastern white pine by 20 to 50%.
296. Hopkins, A.D. 1911. Technical papers on miscellaneous forest insects. I. Contributions toward a monograph of the bark-weevils of the genus *Pissodes*. *U.S. Dep. Agric., Bur. Entomol., Washington, D.C. Tech. Ser.* 20.
- A taxonomic revision of the genus *Pissodes* in North America. Includes descriptions of 21 new species, and a key to all 30 species. Descriptions and diagrams of the morphology of all life

stages are given. Information on the distribution, hosts, and biology is given for each species. Relationships among species are described.

Phenological asynchrony between *P. strobi* and Sitka spruce may explain why certain trees are more resistant to insect attack. The least damaged trees started spring development first.

297. Hopping, R. 1920. A new species of the genus *Pissodes* (Coleoptera). Can. Entomol. 52:132–134.

Gives original description of *P. terminalis* and notes on distribution and habits.

298. Hrutfiord, B.F.; Gara, R.I. 1989. The terpene complement of slow and fast growing Sitka spruce terminals as related to *Pissodes strobi* (Peck) (Col., Curculionidae) host selection. J. Appl. Entomol. 108:21–23.

Fast-growing, 1-year-old Sitka spruce terminals, the preferred material for oviposition by *P. strobi*, contained significantly less myrcene than slow growing terminals and current growth.

299. Hulme, M.A. 1989. Laboratory assessment of predation by *Lonchaea corticis* (Diptera: Lonchaeidae) on *Pissodes strobi* (Coleoptera: Curculionidae). Environ. Entomol. 18(6):1011–1014.

The feeding behavior of *L. corticis* is described and its predation on *P. strobi* larvae and pupae is assessed.

300. Hulme, M.A. 1994. The potential of *Allodorus crassigaster* for the biological control of *Pissodes strobi*. Pages 294–300 in R.I. Alfaro, G. Kiss, and R.G. Fraser, eds. The white pine weevil: biology, damage, and management. Proc. Meet., January 19–21, 1994, Richmond, British Columbia. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 226.

Summarizes the biology, host range, and distribution of the braconid parasitoid, *A. crassigaster*. The potential of this parasitoid and related Palearctic species for control of *P. strobi* is discussed.

301. Hulme, M.A. 1995. Resistance by translocated Sitka spruce to damage by *Pissodes strobi* (Coleoptera: Curculionidae) related to tree phenology. J. Econ. Entomol. 88(6):1525–1530.

302. Hulme, M.A.; Dawson, A.F. 1992. Serbian spruce is as vulnerable as Sitka spruce to damage by the Sitka spruce weevil. West. J. Appl. For. 7(1):5–6.

All Serbian spruce in the study area were attacked at least once by *P. strobi*.

303. Hulme, M.A.; Dawson, A.F.; Harris, J.W.E. 1986. Exploiting cold-hardiness to separate *Pissodes strobi* (Peck) (Coleoptera: Curculionidae) from associated insects in leaders of *Picea sitchensis* (Bong.) Carr. Can. Entomol. 118:1115–1122.

Pissodes strobi were more easily killed by cold treatments than associated parasitoids and predators.

304. Hulme, M.A.; Harris, J.W.E. 1989. How *Lonchaea corticis* Taylor may impact broods of *Pissodes strobi* (Peck) in *Picea sitchensis* (Bong.) Carr. Pages 161–166 in R.I. Alfaro and S.G. Glover, eds. Insects affecting reforestation: biology and damage. Proc. XVIII Int. Congr. Entomol., IUFRO Work. Group Insects Affecting Reforestation (S2.07-03), July 3–9, 1988, Vancouver, British Columbia. For. Can., Pac. Yukon Reg., Pac. For. Cent., Victoria, British Columbia.

Lonchaea corticis consumed pupae but not prepupal larvae of *P. strobi* in laboratory tests. The fly larvae were commonly found in weevil pupal cells in the field.

305. Hulme, M.A.; Harris, J.W.E.; Dawson, A.F. 1987. Exploiting adult girth to separate *Pissodes strobi* (Peck) (Coleoptera: Curculionidae) from associated insects in leaders of *Picea sitchensis* (Bong.) Carr. Can. Entomol. 119:751–753.

Pissodes strobi-infested terminals were clipped and placed in screened cages to contain weevil adults but allow emergence of natural enemies.

306. Humble, L.M.; Humphreys, N.; Van Sickle, G.A. 1994. Distribution and hosts of the white pine weevil, *Pissodes strobi*, in Canada. Pages 68–75 in R.I. Alfaro, G. Kiss,

- and R.G. Fraser, eds. The white pine weevil: biology, damage, and management. Proc. Meet., January 19–21, 1994, Richmond, British Columbia. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 226.
- Provides distribution maps for *P. strobi* in Canada. The percentage of collections from different host species is also provided.
307. Humphreys, N.; Ferris, R. 1994. Spruce weevil population monitoring plots in the Prince George Forest Region. Pages 90–97 in R.I. Alfaro, G. Kiss, and R.G. Fraser, eds. The white pine weevil: biology, damage, and management. Proc. Meet., January 19–21, 1994, Richmond, British Columbia. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 226.
- Describes a study established in 1993 to monitor *P. strobi* in the Region. Permanent sample plots were established for monitoring of population fluctuations, and to monitor susceptibility of spruce in different biogeoclimatic zones.
308. Ilnytzky, S. 1973. Evaluation of residual toxicity of six insecticides for control of Sitka spruce weevil. Environ. Can., Can. For. Serv., Ottawa, Ontario. Bi-mon. Res. Notes 29(2):9–10.
- Fenitrothion and Methyl Trithion® were the most promising for control of *P. strobi*.
309. Ives, W.G.H.; Rentz, C.L. 1993. Factors affecting the survival of immature lodgepole pine in the foothills of west-central Alberta. For. Can., Northwest Reg., North. For. Cent., Edmonton, Alberta. Inf. Rep. NOR-X-330.
- Annual incidence of *P. terminalis* for 1981 to 1990 ranged from near 0 to 6%. The highest incidences were found in 10- to 20-year-old stands.
310. Jacobi, W.R. 1992. Potential insect vectors of black stain root disease pathogen on southern Vancouver Island. J. Entomol. Soc. B.C. 89:54–56.
- Pissodes fasciatus* was identified as a potential vector.
311. Jaynes, H.A. 1958. Some recent development in white-pine weevil research in the Northeast. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania. Stn. Pap. NE-105.
- Summarizes ongoing studies on the phenology, dispersal, mating, oviposition, and chemical control of *P. strobi*.
312. Jaynes, H.A.; Godwin, P.A. 1957. Sterilization of the white-pine weevil with gamma radiation. J. Econ. Entomol. 50(4):393–395.
- Sterilization is best with an exposure of 5000 to 10 000 roentgens of radioactive cobalt. This exposure did not affect longevity, but diminished feeding and oviposition rates were observed.
313. Jeklin, E. 1979. Management procedures for control of spruce terminal weevil on Nootka Island. B.C. Minist. For., For. Serv., Victoria, British Columbia. Intern. Rep.
- Clipping and destruction of infested leaders was evaluated for control of *P. strobi*. Up to 30% of infested leaders were overlooked during the pruning operation. An economic assessment is included.
314. Johnson, N.E. 1965a. A test of 12 insecticides for the control of the Sitka-spruce weevil, *Pissodes sitchensis* Hopkins. J. Econ. Entomol. 58(3):572–574.
- Dieldrin was the most effective pesticide. Meta-Systox-R was most effective at penetrating the bark to kill developing larvae.
315. Johnson, N.E. 1965b. Distribution of Sitka spruce weevil eggs on leaders of open-grown Sitka spruce in southwest Washington. Weyerhaeuser For. Res. Cent., Centralia, Washington. Weyerhaeuser For. Pap. 3.
- Oviposition commenced at the tip of the terminal and progressed downward. Most eggs were laid on the side of the terminal facing away from the afternoon sun.

316. Johnson, N.E.; Zingg, J.G. 1966. Test of several systemic insecticides for postoviposition control of Sitka-spruce weevil. *J. Econ. Entomol.* 59(3):765-766.
- Bidrin and oxydemetonmethyl were the most effective pesticides.
317. Johnson, N.E.; Zingg, J.G. 1968. Field tests of systemic insecticides for the control of Sitka-spruce weevil. *J. Econ. Entomol.* 61(6):1650-1652.
- Bidrin and oxydemetonmethyl were effective at post-oviposition control of *P. strobi*.
318. Jones, B.F. 1965. The biology of the deodar weevil *Pissodes nemorensis* Germ. M.Sc. thesis, Univ. Ark., Fayetteville, Arkansas.
- A 1-year life cycle is reported and notes are provided on behavior, feeding, oviposition, sex ratio, larval head capsule widths, adult snout and body lengths, and population dynamics.
319. Kang, H.-C. 1976. Correlation between white pine weevil damage and tree height and monoterpenes in a Norway spruce plantation. M.Sc. thesis, State Univ. N.Y., Syracuse, New York.
- The concentration of monoterpenes, particularly limonene, and tree height were correlated with incidence of weevil damage.
320. Katovich, S.A.; Morse, F.S. 1992. White pine weevil response to oak overstory girdling—results from a 16-year-old study. *North. J. Appl. For.* 9:51-54.
- Maintaining 30-50 ft² basal area/acre of hardwood overstory appeared to be a good compromise between increased growth of understory white pine and reduced weevil damage.
321. Kenis, M.; Mills, N.J. 1994. Parasitoids of European species of the genus *Pissodes* (Col.: Curculionidae) and their potential for the biological control of *Pissodes strobi* (Peck) in Canada. *Biol. Control* 4:14-21.
- The parasitoid complex of five species of *Pissodes* was investigated in Europe. The parasitoids *Eubazus* spp. and *Coeloides sordidator* (Ratz.) are considered the best candidates for introduction against *P. strobi* in North America.
322. Kerr, T.W., Jr. 1971. Aldicarb for control of the white pine weevil. *J. Econ. Entomol.* 64:771-772.
- Application of the systemic pesticide aldicarb to the soil around the bases of eastern white pine trees in late spring gave good control of *P. strobi*.
323. Khalil, M.A.K. 1969. Scotch pine: variation and performance in Minnesota. *J. Minn. Acad. Sci.* 35:114-117.
- Seed sources from north of 50° latitude suffered the highest damage from *P. strobi* compared to seed sources from more southerly latitudes.
324. King, J.N. 1994. Delivering durable resistant Sitka spruce for plantations. Pages 134-149 in R.I. Alfaro, G. Kiss, and R.G. Fraser, eds. *The white pine weevil: biology, damage, and management*. Proc. Meet., January 19-21, 1994, Richmond, British Columbia. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 226.
- Presents and discusses a quantitative genetic model of Sitka spruce resistance to *P. strobi*. The fundamental feature of the model is the accrual of incremental improvements in tree resistance through successive cycles of selection.
325. King, J.P. 1971. Pest susceptibility variation in Lake States jack pine seed sources. U.S. Dep. Agric., For. Serv., North Cent. For. Exp. Stn., St. Paul, Minnesota. Res. Pap. NC-53.
- There were significant differences among seed sources in *P. strobi* resistance. Trees from Lower Michigan sources have good height growth and good resistance to weevils. There was no relationship between weeviling and seed source latitude.
326. Kirby, C.S.; Harnden, A.A. 1964. Small scale trial with a systemic insecticide against *Pissodes strobi* Peck and *Eucosma gloriola* Heinr. Can. Dep. For., For. Entomol. Pathol. Branch, Ottawa, Ontario. Bi-mon. Prog. Rep. 20(5):2-3.

- Phosphamidon was applied with a hand sprayer as a fine foliar spray to young eastern white pines in late May. The insecticide was not translocated in adequate amounts to provide effective control of *P. strobi*.
327. Kirby, C.S.; Harnden, A.A.; MacLeod, L.S. 1962. Control of white pine weevil. Can. Dep. For., For. Entomol. Pathol. Branch, Ottawa, Ontario. Bi-mon. Prog. Rep. 18(5):2.

Aerial application of DDT in the spring gave good control of *P. strobi* in eastern white pine stands.
 328. Kirby, C.S.; McPhee, H.; Harnden, A. 1963. Field trials with helicopter spraying for control of white pine weevil. Can. Dep. For., For. Entomol. Pathol. Branch, Ottawa, Ontario. Bi-mon. Prog. Rep. 19(3):1-2.

Application of DDT in the spring did not give good control of *P. strobi*.
 329. Kiss, G.K.; Yanchuk, A.D. 1991. Preliminary evaluation of genetic variation of weevil resistance in interior spruce in British Columbia. Can. J. For. Res. 21(2):230-234.

Pissodes strobi damage in three interior spruce open-pollinated progeny tests in north central British Columbia was evaluated to examine the patterns of attack among families. Data suggest that there is a moderate genetic basis for resistance to weevil attack, and that selection for height and diameter growth may improve resistance.
 330. Kiss, G.K.; Yanchuk, A.D.; Alfaro, R.I. 1994. Recent advances in white pine weevil research in British Columbia. Pages 150-157 in R.I. Alfaro, G. Kiss, and R.G. Fraser, eds. The white pine weevil: biology, damage, and management. Proc. Meet., January 19-21, 1994, Richmond, British Columbia. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 226.

Some families of interior spruce are clearly resistant to *P. strobi*. There is a significant inverse relationship between tree height and weevil damage.
 331. Kissinger, D.G. 1964. Curculionidae of America north of Mexico: a key to the genera. Taxon. Publ., South Lancaster, Massachusetts.

Pissodes is included in a key to weevil genera.
 332. Klein, J.I. 1971. Performance of Russian Scots pine populations in Manitoba and Ontario. Environ. Can., Can. For. Serv., North. For. Res. Cent., Edmonton, Alberta. Inf. Rep. NOR-X-2.

Incidence of *P. strobi* damage on trees from each seed source varied from 14 to 32%. There was a significant negative correlation between weevil incidence and tree height.
 333. Klepzig, K.D.; Raffa, K.F.; Smalley, E.B. 1991. Association of an insect-fungal complex with red pine decline in Wisconsin. For. Sci. 37:1119-1139.

A *Pissodes* sp. was associated with red pine decline. A fungus, *Ophiostoma ips* (Rumb.) Nannfeldt, was isolated from this weevil species.
 334. Kovacs, E. 1988. Terminal weevils of lodgepole pine and their parasitoid complex in British Columbia. M.Sc. thesis, Univ. B.C., Vancouver, British Columbia.

The contents of this thesis was published in the primary literature. For content, see annotations for references 335-336.
 335. Kovacs, E.; McLean, J.A. 1990a. Emergence of terminal weevils (Coleoptera: Curculionidae) and their parasitoids from lodgepole pine in the interior of British Columbia, Canada. J. Entomol. Soc. B.C. 87:75-79.

The emergence patterns of three weevil species, *P. terminalis*, *Magdalis gentilis* LeConte, and *Cylindrocopturus* sp., and their parasitoids from lodgepole pine terminals is described. Emergence of most parasitoids preceded that of *P. terminalis*.
 336. Kovacs, E.; McLean, J.A. 1990b. Notes on the longevity, fecundity and development of *Pissodes terminalis* Hopping (Coleoptera: Curculionidae) in the interior of British Columbia, Canada. J. Entomol. Soc. B.C. 87:68-73.

The phenology of *P. terminalis* is described.
Average longevity of females was 112.8 days.
Mean lifetime fecundity was 115 eggs.

337. Krebs, C.F. 1972. A procedure for sampling jack pine damaged by the white pine weevil and several notes on the insect's effect on stand development. Ph.D. thesis, Univ. Mich., East Lansing, Michigan.

Describes a sampling procedure for surveying incidence of *P. strobi* damage to jack pine. It was recommended that stands be surveyed no earlier than mid-August so as to not miss infested terminals that had not yet faded. The impact of weevil attacks with respect to tree growth and form was evaluated. Biological notes are provided regarding weevil spring activity and adult emergence from infested terminals.

338. Kriebel, H.B. 1954. Bark thickness as a factor in resistance to white pine weevil injury. J. For. 52:842-845.

Eastern white pine trees with thin bark were less susceptible to *P. strobi* attack than those with thick bark.

339. Krombein, K.V.; Hurd, P.D., Jr.; Smith, D.R.; Burks, B.D., editors. 1979. Catalog of Hymenoptera in America north of Mexico. Vol. 1. Symphyta and Apocrita (Parasitica). Smithsonian Inst. Press, Washington, D.C. [See pages 157, 158, 166, 169, 170, 270, 272, 330, 356, 798-800, 853, 857, 870, 883, 1213, 1731.]

Lists many species of parasitoids reared from *Pissodes* species.

340. Kulman, H.M.; Harman, D.M. 1965. Unsuccessful attacks by the white pine weevil in Virginia. Va. Agric. Exp. Stn., Blacksburg, Virginia. Res. Rep. 100.

Five categories of damage caused by unsuccessful attack by *P. strobi* on eastern white pine are described. From one-third to one-half of infested terminals did not produce weevils. Some unsuccessful attacks did not kill the leader.

341. Kulman, H.M.; Harman, D.M. 1967. Unsuccessful brood development of the white-pine weevil. J. Econ. Entomol. 60(5):1216-1220.

Five categories of damage caused by unsuccessful attack by *P. strobi* on eastern white pine are described. From one-third to one-half of infested terminals did not produce weevils. Some unsuccessful attacks did not kill the leader.

342. Kuo, P.C. 1971. Genetic variability in eastern white pine from Michigan: implications for Taiwan. Exp. For. Taiwan Univ. Tech. Bull. 94.

Copy not seen.

343. Kuschel, G. 1987. The subfamily Molytinae (Coleoptera: Curculionidae): general notes and descriptions of new taxa from New Zealand and Chile. N.Z. Entomol. 9:11-29.

Pissodes was placed in the tribe Pissodini, which was placed in the subfamily Molytinae.

344. Lackner, A.L.; Alexander, S.A. 1983. Root disease and insect infestations on air-pollution-sensitive *Pinus strobus* and studies of pathogenicity of *Verticicladiella procera*. Plant Dis. 67:679-681.

Verticicladiella procera and two other species of fungi were associated with *P. approximatus* (= *P. nemorensis*) and *Hylobius* sp. larvae and damage in air-pollution-sensitive eastern white pine.

345. Langor, D.W.; Drouin, J.A.; Wong, H.R. 1992. The lodgepole terminal weevil in the prairie provinces. For. Can., Northwest Reg., North. For. Cent., Edmonton, Alberta. For. Manage. Note 55.

Pissodes terminalis has a 2-year life cycle in lodgepole pine and a 1-year life cycle in jack pine. Mortality in lodgepole pine is very high. The distribution in the prairie provinces is given. Data on annual and yearly incidence of attack are given; incidence is much higher in thinned stands. Management options are discussed.

346. Langor, D.W.; Sperling, F.A.H. 1994. Diagnostics of the *Pissodes strobi* species group in western Canada, using mitochondrial DNA. Pages 174-183 in R.I. Alfaro, G. Kiss, and R.G. Fraser, eds. The white pine weevil: biology, damage, and management. Proc. Meet., January 19-21, 1994, Richmond, British Columbia. Nat. Resour. Can., Can. For. Serv., Pac. For.

- Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 226.
- A 1585-bp segment of mitochondrial DNA was amplified using the ploymerase chain reaction, and variation was sampled using restriction enzymes, in *P. strobi*, *P. terminalis*, *P. schwarzi*, and *P. nemorensis*. It was possible to discriminate unambiguously among most species. Details of protocols are provided.
347. Langor, D.W.; Sperling, F.A.H. 1995. Mitochondrial DNA variation and identification of bark weevils in the *Pissodes strobi* species group in western Canada (Coleoptera: Curculionidae). Can. Entomol. 127:895-911.
- A 1585-bp segment of mitochondrial DNA was amplified using the polymerase chain reaction, and variation was sampled using restriction enzymes, in *P. strobi*, *P. terminalis*, *P. schwarzi*, *P. nemorensis*, and *P. affinis*. It was possible to discriminate unambiguously among most species. Data suggest intermediate levels of gene flow. Phylogenetic relationships were reconstructed. A diagnostic protocol using three restriction enzymes is recommended.
348. Lanier, G.N. 1983. Integration of visual stimuli, host odorants, and pheromones by bark beetles and weevils in locating and colonizing host trees. Pages 161-171 in S. Ahmad, ed. Herbivorous insects: host-seeking behavior and mechanisms. Acad. Press, New York, New York.
- Reviews information on host selection in *P. strobi*.
349. Lanier, G.N.; Abrahamson, L.P.; Shoeneck, H. 1984. The role of insects in the dynamics of scleroderris canker in New York. Pages 114-121 in P.D. Manion, ed. Scleroderris canker of conifers. Proc. Intl. Symp. Scleroderris Canker Conifers, Syracuse, New York. Kluwer Acad. Publ., New York, New York.
- Pissodes approximatus* (= *P. nemorensis*) was associated with cankers on red pine.
350. Lavallée, A. 1986. Zones de vulnérabilité du pin blanc à la rouille vésiculeuse au Québec. [Zones of vulnerability of white pine to blister rust in Quebec.] For. Chron. 62:24-28.
- Zones of vulnerability to blister rust were also assessed for damage by *P. strobi*.
351. Lavallée, A. 1989. Note sur la réduction de la déformation des tiges de pin blanc attaquées par le charançon du pin blanc. [Note on the reduction of deformation of white pine stems attacked by the white pine weevil.] Phytoprotection 70:25-28.
- Three different ways of clipping *P. strobi*-infested leaders were evaluated. Clipping of the leader and all lateral branches except the one located at the upper part of the whorl favored recovery of that lateral to become the new terminal leader.
352. Lavallée, A. 1992. Observations on the evolution of damage by *Pissodes strobi* Peck and characterization of young white pine plantations affected by this weevil. For. Can., Qué. Reg., Laurentian For. Cent., Ste-Foy, Québec. Inf. Rep. LAU-X-98E.
- Incidence of *P. strobi* damage in 5- to 10-year-old eastern white pine plantations is presented and analyzed with respect to site conditions. Weevil epidemiology and prediction of weevil damage is discussed.
353. Lavallée, R. 1994. The effects of water stress and insect attack on the development and behaviour of the white pine weevil, *Pissodes strobi* (Peck) (Coleoptera: Curculionidae) on white pine, *Pinus strobus* L. Ph.D. thesis, Concordia Univ., Montréal, Québec.
- The contents of this thesis was published in the primary literature. For content, see annotations for references 354-356.
354. Lavallée, R.; Albert, P.J.; Kapoor, N.N. 1993. Techniques for sexing live adults of the white pine weevil *Pissodes strobi* Peck (Coleoptera: Curculionidae). Can. Entomol. 125:745-747.
- Morphological characters on the terminal abdominal segments are useful for sex discrimination.
355. Lavallée, R.; Albert, P.J.; Mauffette, Y. 1994a. Influence of white pine watering regimes on feeding preferences of spring and fall

adults of the white pine weevil *Pissodes strobi* (Peck). J. Chem. Ecol. 20:831–847.

Weevils could discriminate between bark from water-stressed and non-stressed plants, and they preferred the latter.

356. Lavallée, R.; Albert, P.; Mauffette, Y. 1994b. Larval development and adult feeding preferences of the white pine weevil, *Pissodes strobi* (Peck), on water stressed white pine, *Pinus strobus* L. Pages 54–67 in R.I. Alfaro, G. Kiss, and R.G. Fraser, eds. The white pine weevil: biology, damage, and management. Proc. Meet., January 19–21, 1994, Richmond, British Columbia. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 226.

There were no differences in rate of weevil development and number of larvae per leader under different watering regimes. In feeding tests, adults preferred bark from non-stressed trees over water-stressed trees, and bark from non-stressed trees previously exposed to weevil damage over those not previously exposed.

357. Lavallée, R.; Archambault, L.; Morissette, J. 1996. Influence of drainage and edge vegetation on levels of attack and biological performance of the white pine weevil. For. Ecol. Manage. 82:133–144.

White spruce plantations growing on poorly drained soils supported higher levels of weevil infestations than those growing on well-drained soils. The presence of adjacent shelterbelts was associated with higher levels of infestation. Adult mean weight was lower on well-drained soils than on poorly drained ones, but the number of insects per leader was not affected by drainage regime.

358. Lavallée, R.; Comtois, B.; Morissette, J. 1989. Le charançon du pin blanc: un insecte à surveiller. [The white pine weevil: an insect to watch.] L'Aubelle 69:10–15.

Summarizes *P. strobi* incidence and damage to several conifer species in Quebec.

359. Lavallée, R.; Guertin, C.; Morissette, J.; Comtois, B. 1990. Observations sur le développement du charançon du pin blanc

chez l'épinette de Norvège au Québec. [Observations on the development of the white pine weevil on Norway spruce in Quebec.] Rev. Entomol. Qué. 35:31–44.

Gives information on the phenology and development of *P. strobi* in Norway spruce. Damage is summarized with respect to tree species, locality, tree height, and tree age. Epidemiology was studied in one plantation.

360. Lavallée, R.; Mauffette, Y.; Albert, P.J. 1993. Development of the white pine weevil (Coleoptera: Curculionidae) on cut leaders of white pine. Environ. Entomol. 22(4):824–830.

Pissodes strobi development was studied in cut leaders that were set directly in water or kept dry. Development was completed on cut leaders; however, the dry treatment significantly reduced the weight and number of emerged weevils compared with the wet treatment.

361. Lavallée, R.; Plourde, A.; Daoust, G.; Larochelle, F. 1995. Étude de la résistance génétique de l'épinette de Norvège et du pin blanc au charançon du pin blanc. [A study of genetic resistance of Norway spruce and white pine to the white pine weevil.] Pages 57–68 in R. Lavallée and G. Bonneau, eds. Compte-rendu du colloque sur le charançon du pin blanc. Proc. Symp., September 27–28, 1994, Ste.-Foy, Québec. Ressour. nat. Can., Serv. can. for., Rég. Qué., Cent. for. Laurentides, Ste-Foy (Québec), et Ressour. nat. Qué., Dir. conserv. for., Québec (Québec).

Reviews the literature on resistance of trees to *P. strobi* and provides some information on the resistance of Norway spruce in Quebec.

362. LeConte, J.L.; Horn, G.H. 1876. The Rhynchophora of America north of Mexico. Proc. Am. Philos. Soc. 15(96):1–455. [See pages 142–144.]

Gives original descriptions of *P. fasciatus* and *P. rotundatus* and provides a key to the six described species of *Pissodes* in North America.

363. Ledig, F.T.; Smith, D.M. 1981. The influence of silvicultural practices on genetic improvement: height growth and weevil resistance in eastern white pine. Silvae Genet. 30:30–36.

Results show that by using selective thinning of stands it is possible to select for weevil resistance without sacrificing height growth.

364. Lemmien, W.; Wright, J.W. 1963. Himalayan white pine in southern Michigan. Mich. Agric. Exp. Stn., Orono, Maine. Q. Bull. 45(4):618–621.

The average number of *P. strobi*-damaged weevils per tree on Himalayan pine was three times higher than on eastern white pine.

365. Leng, C.W. 1920. Catalogue of the Coleoptera of America north of Mexico. Mount Vernon, New York.

Provides a list of 30 *Pissodes* species known to occur in North America.

366. Leonard, M.D. 1928. A list of the insects of New York with a list of the spiders and certain other allied groups. Cornell Univ., Agric. Exp. Stn., Ithaca, New York. Mem. 101. [See pages 495–496.]

Six species of *Pissodes* were recorded from the state.

367. Lewis, K.G. 1995. Genetic variation among populations of *Pissodes strobi* (white pine weevil) reared from *Picea* and *Pinus* hosts as inferred from RAPD markers. M.S. thesis, Univ. B.C., Vancouver, British Columbia.

Populations of *P. strobi* from Sitka spruce on Vancouver Island were distinct from the same host species on the mainland, and populations from white and Engelmann spruce formed a distinct complex. Weevils from jack pine in Ontario were most similar to populations from white and Engelmann spruce.

368. Lewis, K.G.; Carlson, J.E.; McLean, J.A. 1994. Using RAPD markers to investigate genetic diversity of the white pine weevil (*Pissodes strobi*). Pages 184–202 in R.I. Alfaro, G. Kiss, and R.G. Fraser, eds. The white pine weevil: biology, damage, and management. Proc. Meet., January 19–21, 1994, Richmond, British Columbia. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 226.

Random amplified polymorphic DNA markers were employed to investigate genetic diversity of *P. strobi* from Sitka, white, and Engelmann spruce in British Columbia. Details of protocols and preliminary results are included.

369. Lewis, K.J.; Alexander, S.A. 1986. Insects associated with the transmission of *Verticicladiella procera*. Can. J. For. Res. 16:1330–1333.

A *Pissodes* species was found to be contaminated with *V. procera* and thought to be a vector.

370. Lindquist, E.E.; Hunter, P.E. 1965. Some mites of the genus *Proctolaelaps* Berlese (Acarina: Blattisociidae) associated with forest insect pests. Can. Entomol. 97:15–32. [See page 18.]

Proctolaelaps bickleyi (Bram) was collected from a culture of *P. strobi* in Connecticut.

371. Linit, M.J. 1975. Establishing plantations of eastern white pine and hybrid poplar for a shading study on white pine weevil control. M.Sc. thesis, Univ. Maine, Orono, Maine.

Incidence of *P. strobi* increased with increased spacing of white pine and with decreased shading by overstory hardwoods. Experiments were set up to expose white pine seedlings to various degrees of shade by hybrid poplars. Herbicides were also tested to facilitate establishment of pine seedlings.

372. Linit, M.J.; Kondo, E.; Smith, M.T. 1983. Insects associated with the pinewood nematode, *Bursaphelenchus xylophilus* (Nematoda: Aphelenchoididae), in Missouri. Environ. Entomol. 12:467–470.

P. approximatus (= *P. nemorensis*) was found to carry nematodes.

373. Lintner, J.A. 1888. Fourth report on the injurious and other insects of the state of New York. James B. Lyon Print., Albany, New York. [See page 24.]

Describes the damage caused by *P. strobi* and provides drawings of the life stages and damage.

374. Littlefield, E.W. 1942. White pine weevil damage reduced by close spacing. N.Y. State Conserv. Dep. Notes For. Invest. 37.

The incidence of *P. strobi* damage to eastern white pine decreased with decreased spacing of crop trees.

375. Logan, K.T.; Farrar, J.L. 1953. An attempt to grow white pine under an aspen stand. Can. Dep. Resour. Dev., For. Branch, Div. For. Res., Ottawa, Ontario. Silv. Leaflet 77.

Overstory shading by aspen showed promise of protecting understory white pine from *P. strobi* attacks.

376. MacAloney, H.J. 1925. Preliminary observations on the control of white pine weevil injury by forest management. M.F. thesis, N.Y. State Univ., Syracuse, New York.

Attack of white pine by *P. strobi* caused 35% loss in radial increment during the year of attack. Attacked trees were observed to straighten out somewhat more in dense stands than in sparse stands. Inter-planting of Scots pine with white pine in some locations decreased the incidence of weevil attacks on white pine; however, inter-planting of larch, red pine, or western yellow pine did not decrease incidence. Stands of pure white pine experienced the lowest incidence of attacks on western and northern slopes. It was hypothesized that odor from trees may have influence on attraction and deterrence of weevils.

377. MacAloney, H.J. 1926. The white pine weevil problem in the New England states. Pages 31–43 in Forest Protection Conference. N.Y. State Coll. For., Syracuse Univ., Syracuse, New York.

Provides information on phenology, damage symptoms, and incidence. Control methods, including pruning, manual removal of beetles, physical barriers, pesticides, manipulation of stand composition and density, and natural enemies (parasitoids, insect predators, and birds), are discussed.

378. MacAloney, H.J. 1929. The white pine weevil (*Pissodes strobi* (Peck)), its biology and control. Ph.D. thesis, N.Y. State Univ., Syracuse, New York.

The contents of this thesis was published in the primary literature. For content, see annotation for reference 379.

379. MacAloney, H.J. 1930. The white pine weevil (*Pissodes strobi* Peck)—its biology and control. N.Y. State. Coll. For., Syracuse Univ., Syracuse, New York. Tech. Publ. 28.

A morphological descriptions of all life stages is included. The life history and habits are reviewed, including information on hibernation, feeding, mating, oviposition, fecundity, development, phenology, and flight. Weevil damage symptoms are described and the impacts of weeviling on tree growth and timber quality are discussed. A survey of weevil incidence in plantations showed that degree of damage was related to stand density, tree species composition in stands, tree age, tree height, tree vigor, weather factors (chiefly temperature), soil conditions, and exposure. Natural enemies, including insect parasitoids and predators and birds, are listed and their biology and impact summarized. Control methods are reviewed and include some original data on pesticides, physical barriers on trees stems, manual collection of beetles, pruning of infested leaders, and silvicultural control by manipulation of stand density and species composition.

380. MacAloney, H.J. 1930. Weather conditions a factor in white pine weevil injury. For. Worker 6(1):18.

Adverse weather during the winter and early spring caused high mortality of hibernating beetles and reduced weevil damage for 1 year afterward.

381. MacAloney, H.J. 1940. Weevils which may attack the bases and roots of conifers in the Lake States, and methods of preventing injury. U.S. Dep. Agric., Bur. Entomol., Plant Q., Washington, D.C. Circ. E-500.

Pissodes approximatus (= *P. nemorensis*) are sometimes found in trees attacked by pine root-collar weevils, *Hylobius radicis*. Control measures are usually not required.

382. MacAloney, H.J.; Johnston, J.W. 1933. White-pine weevil attack on Scotch pine. J. For. 31:26–28.

Only about 1% of Scotch pine leaders attacked by *P. strobi* were killed in plantations in New York and Massachusetts. The high tree vigor and copious pitch flow in response to weevil feeding was thought to be the major reason for high resistance.

383. MacArthur, J.D. 1961. A note on Canada's oldest white pine plantation. *Timber of Canada* 22(6):38, 40.
- Incidence of *P. strobi* damage ranged from 0 to 82% for different height classes of trees.
384. MacArthur, J.D. 1964. Norway spruce plantations in Quebec. *Can. Dep. For., For. Res. Branch, Ottawa, Ontario. Dep. For. Publ.* 1059.
- Incidence of *P. strobi* damage ranged from 72 to 82% for different height classes of trees.
385. MacLauchlan, L.E. 1992a. Attack dynamics, impact, and biology of *Pissodes terminalis* Hopping in regenerating lodgepole pine stands. Ph.D. thesis, Simon Fraser Univ., Burnaby, British Columbia.
- See also annotations for references 267, 386–390. Additionally, information is given on phenology, fecundity, and parasitoids of *P. terminalis*. Biogeoclimatic zone, stand density, and tree age were important components of a hazard rating system. In food choice experiments *P. terminalis* preferred ponderosa pine and lodgepole pine over western larch. Leader clipping did not appear to be a viable option for weevil control.
386. MacLauchlan, L.E. 1992b. Impacts of the lodgepole terminal weevil, *Pissodes terminalis*, in regenerating lodgepole pine: silvicultural implications. Pages 94–102 in G. Boiteau, ed. *Proc. 38th Annu. Meet. Can. Pest Manage. Soc.*, July 27–31, 1991, Fredricton, New Brunswick. *Agric. Can., Agassiz Res. Stn., Agassiz, British Columbia*.
- Pissodes terminalis* displays an aggregated attack pattern around natural aggregations of its host and chooses trees that are taller. The highest probability of attack and tree defect severity is found in natural and spaced stands in the Interior Douglas-fir biogeoclimatic zone, and in spaced stands in the Montane spruce zone.
387. MacLauchlan, L.E.; Borden, J.H. 1994. Spatial attack dynamics and impact of *Pissodes terminalis* in three biogeoclimatic zones in southern B.C. Pages 76–89 in R.I. Alfaro, G. Kiss, and R.G. Fraser, eds. *The white pine weevil: biology, damage, and management. Proc. Meet.*, January 19–21, 1994, Richmond, British Columbia. *Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep.* 226.
- Includes information on incidence of *P. terminalis* damage by stand and biogeoclimatic zone, incidence of various weevil-caused tree defects, and impacts of weevil attack on tree growth. Host selection by weevils is influenced by tree height and diameter, growing space, and genetic factors. The spatial attack patterns of weevils is related to the spatial distribution of trees in the stand.
388. MacLauchlan, L.E.; Borden, J.H. 1995. Discrimination between pine shoots with and without oviposition by *Pissodes terminalis* Hopping (Coleoptera: Curculionidae). *Can. Entomol.* 127:267–269.
- In choice experiments adult females of *P. terminalis* preferred to feed and oviposit on sections of pine leaders on which there had not been previous feeding or oviposition.
389. MacLauchlan, L.E.; Borden, J.H. 1996. Spatial dynamics and impacts of *Pissodes terminalis* (Coleoptera: Curculionidae) in regenerating stands of lodgepole pine. *For. Ecol. Manage.* 82:103–113.
- Incidence of weevil attacks increased with spacing of trees. The largest trees were most likely to be attacked, and the most common defect was a crook. Height loss due to weevil attack was 31.4% of the annual potential height increment in the year of attack, and 17% in the year following attack. Delaying of spacing until trees are >15 years old is recommended to reduce the impact of weevil attack.
390. MacLauchlan, L.E.; Borden, J.H.; Price, I. 1993. Life history and pheromone response in *Pissodes schwarzi* Hopk. (Coleoptera: Curculionidae). *J. Entomol. Soc. B.C.* 90:30–35.
- A male-produced aggregation pheromone is apparent for *P. schwarzi*. Includes notes on phenology.
391. Maher, T.F. 1982. The biology and impact of the lodgepole terminal weevil in the Cariboo Forest Region. M.F. thesis, Univ. B.C., Vancouver, British Columbia.

Provides data on the phenology and mortality of *P. terminalis*. Leader dimensions were more important than tree dimensions in determining individual tree susceptibility to attack. Damage incidence is higher in stands with lower stem density. Height growth is reduced by 42% in the year of attack.

392. Mallett, K.I.; Langor, D.W. 1996. The association of young weevil-killed pine and spruce terminals with *Phellinus pini* in western Canada. *Can. J. For. Res.* 26:2224–2226.

Phellinus pini was not evident in terminals of pine and spruce killed by *Pissodes strobi* and *P. terminalis*. A list of fungus species commonly associated with weevils is provided.

393. Manna, G.K.; Smith, S.G. 1959. Chromosomal polymorphism and inter-relationships among bark weevils of the genus *Pissodes* Germar. *Nucleus* 2:179–208.
Describes the chromosome complement of 12 species of *Pissodes* and discusses chromosomal polymorphism in *P. canadensis* (= *P. nemorensis*) and *P. approximatus* (= *P. nemorensis*).

394. Mannerheim, G.C.G. 1852. Zeiter Nachtrag zur Käfer-Fauna der Nord Amerikanischen Laender des Russischen Reiches. [Second supplement to the beetle fauna to the North American territory of the Russian Republic.] *Bull. Soc. Imp. Nat. Moscow* 25:283–387. [See page 353.]

Original description of *P. costatus*.

395. Manville, J.F.; Nault, J.; von Rudloff, E.; Yanchuk, A.; Kiss, G.K. 1994. Spruce terpenes: expression and weevil resistance. Pages 203–217 in R.I. Alfaro, G. Kiss, and R.G. Fraser, eds. *The white pine weevil: biology, damage, and management*. Proc. Meet., January 19–21, 1994, Richmond, British Columbia. *Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep.* 226.

Terpene analysis shows promise as a method of screening trees for weevil resistance.

396. Martin, J.L. 1961. *Pissodes affinis* Randall on pine in Ontario. *Can. Dep. For., For. Biol. Div., Ottawa, Ontario. Bi-mon. Prog. Rep.* 17(6):2.

The hosts, life history, and habits of *P. affinis* in northern Ontario are summarized.

397. Martin, J.L. 1964. The insect ecology of red pine plantations in central Ontario. II. Life history and control of Curculionidae. *Can. Entomol.* 96(11):1408–1417.

The hosts, life history, and habits of *P. affinis* and *P. approximatus* (= *P. nemorensis*) in northern Ontario are summarized.

398. Martin, J.L. 1965. Living stumps aid insect control. *Can. For. Ind.* 85(7):40–43.

Stumps kept alive by natural root grafting to living trees are immune to insect attack. Several measures are suggested for reducing populations of bark- and wood-boring insects, including *P. approximatus* (= *P. nemorensis*), in stumps and logging slash.

399. Marty, R.J. 1959. Predicting weevil-caused volume loss in white pine. *For. Sci.* 5:269–274.

Equations are presented for predicting volume loss in eastern white pine based on tree size and number and location of *P. strobi* injuries.

400. Marty, R.J.; Allison, G.R. 1960. Appraising white-pine weevil control opportunities. *J. For.* 58:203–206.

Presents a method of assessing the economic returns of weevil control in eastern white pine.

401. Marty, R.J.; Mott, G.D. 1964. Evaluating and scheduling white-pine weevil control in the Northeast. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania. *Res. Pap. NE-19*.

Presents an economic evaluation procedure to help in deciding where to practice control methods targeting *P. strobi* in eastern white pine plantations, and to provide information about weevil injury dynamics that can help in deciding when to begin control treatments.

402. Mason, W.R.M. 1978. A synopsis of the Nearctic Braconini, with revisions of Nearctic species of *Coeloides* and *Myosoma*

- (Hymenoptera: Braconidae). Can. Entomol. 110:721-768.
- The parasitoid, *Coeloides pissodis*, attacks *P. strobi* and *P. nemorensis*, and *C. secundus* attacks *P. dubius* (= *P. striatulus*) and *P. fraseri* (= *P. striatulus*).
403. Massé, A. 1921. Insectes nuisibles des forêts. III. Le charançon des pins. [Pest insects of the forests. III. The pine weevil.] Nat. Can. 47:218-224.
- Outlines the life history and habits of *P. strobi* in Quebec and gives information on damage symptoms and control methods.
404. Massey, C.L. 1971. Nematode associates of several species of *Pissodes* (Coleoptera: Curculionidae) in the United States. Ann. Entomol. Soc. Am. 64(1):162-169.
- Gives original descriptions of eight new species of nematodes reared from four *Pissodes* species.
405. Matthews, R.W. 1970. A revision of the genus *Spathius* in America north of Mexico (Hymenoptera, Braconidae). Contrib. Am. Entomol. Inst. 4(5):1-86. [See pages 18, 29, 46, 55-56.]
- Spathius brachyurus* Ashm., *S. pallidus* Ashm., and *S. sequoiae* Ashm. were reared from various *Pissodes* species.
406. Maughan, W. 1930. Control of the white pine weevil on the Eli Whitney Forest. Yale Univ., Sch. For., New Haven, Connecticut. Bull. 29.
- Pruning of eastern white pine infested leaders reduced damage by *P. strobi*, but was more effective when applied to stands on good growing sites than those on poor sites. Weeviled trees also recovered better on good growing sites. Weeviling subsequent to the time of stand closure was less injurious to the form of trees than prior to stand closure.
407. Mayo Jiminez, P. 1983. Algunas observaciones biológicas sobre el picudo de los pinos (*Pissodes* spp.), en la región de la Meseta Tarasca de Michoacán. [Some biological observations on a pine weevil (*Pissodes* spp.) in the Meseta Tarasca region of Michoacán.] Cienc. For. 8(45):46-64.
- Gives data on the hosts, distribution, phenology, mortality, and chemical control of *P. zitacuarensis*. Descriptions of the life stages are also included.
408. McCain, A.H.; Keohler, C.S.; Tjosvold, S.A. 1987. Pitch canker threatens California pines. Calif. Agric. 41(11-12):22-23.
- Pissodes nemorensis* was found to be contaminated with pitch canker fungus, *Fusarium subglutinans*.
409. McConkey, T.W.; Swett, C.E. 1967. Light-weight extension tubes for compressed-air garden sprayers. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania. Res. Note NE-73.
- Extension tubes are useful for spraying pesticides on the leaders of tall trees for *P. strobi* control.
410. McGalliard, L.D. 1985. Efficacy of ground insecticidal spraying for fall suppression of the white pine weevil, *Pissodes strobi* (Peck), in Maine. M.Sc. thesis, Univ. Maine, Orono, Maine.
- Of five pesticides tested, Pounce was the most effective at controlling *P. strobi* when manually applied to eastern white pine leaders in the fall.
411. McGregor, M.D.; Quarles, T. 1971. Damage to spruce regeneration by a terminal weevil, Flathead National Forest, Montana. U.S. Dep. Agric., For. Serv., North. Reg., Div. State Priv. For., Missoula, Montana. Rep. 71-9.
- Reports an increase in damage caused by *P. strobi* in the region over the previous two decades. Engelmann spruce between 5 and 10 ft tall were most frequently attacked by weevils. A list of insect parasitoids, predators, and associates is included.
412. McGugan, B.M.; Coppel, H.C. 1962. A review of the biological control attempts against insects and weeds in Canada. Part 2. Biological control of forest insects, 1910-1958. Commonw. Agric. Bur., Farnham Royal, England. [See pages 53, 137.]
- A parasitoid, *Coeloides* sp., was introduced from Europe into southern Quebec in 1950 and released against *P. strobi*. It is not known if establishment occurred.

413. McIntosh, R.L.; McLean, J.A.; Alfaro, R.I.; Kiss, G.K. 1996. Dispersal of *Pissodes strobi* in putatively resistant white spruce in Vernon, B.C. For. Chron. 72(4):381–387.
- Seasonal and diurnal weevil movement was monitored using mark-recapture techniques. Feeding occurred at dawn in the leader and upper laterals, after which weevils moved down the tree to the forest floor. On average, weevils did not move farther than the adjacent tree throughout the season after mating and oviposition.
414. McKnight, M.E.; Aarhus, D.G. 1973. Notes on weevils from trees and shrubs in North Dakota. U.S. Dep. Agric., For. Serv., Rocky Mt. For. Range Exp. Stn., Fort Collins, Colorado. Res. Note RM-230.
- Pissodes strobi* was reported from North Dakota for the first time.
415. McLean, J.A. 1989. Effect of red alder overstory on the occurrence of *Pissodes strobi* (Peck) during the establishment of a Sitka spruce plot. Pages 167–176 in R.I. Alfaro and S.G. Glover, eds. Insects affecting reforestation: biology and damage. Proc. XVIII Int. Congr. Entomol., IUFRO Work. Group Insects Affecting Reforestation (S2.07-03), July 3–9, 1988, Vancouver, British Columbia. For. Can., Pac. Yukon Reg., Pac. For. Cent., Victoria, British Columbia.
- Sitka spruce planted under an overstory of red alder grew more slowly but sustained much less damage due to *P. strobi* than trees planted in the open.
416. McLean, J.A. 1994. Silvicultural control of the white pine weevil at the UBC Malcolm Knapp Research Forest. Pages 248–253 in R.I. Alfaro, G. Kiss, and R.G. Fraser, eds. The white pine weevil: biology, damage, and management. Proc. Meet., January 19–21, 1994, Richmond, British Columbia. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 226.
- Sitka spruce planted under an overstory of red alder sustained about half the *P. strobi* damage than trees planted in the open. Continuous weevil infestation in the open stand has reduced average height growth at age 35 years to about half that of unattacked trees.
417. McLean, J.A.; Kovacs, E.; Hulme, M. 1990. Emergence patterns of the parasitoid complex of the lodgepole terminal weevil, *Pissodes terminalis* Hopping (Coleoptera: Curculionidae) and recommendations for enhancing parasitoid survival in leader clipping operations in British Columbia. For. Can., Pac. Yukon Reg., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. For. Resour. Dev. Agreement Res. Memo 139.
- Adult parasitoids of *P. terminalis* feed on the pollen of flowering plants.
418. McMullen, L.H. 1976a. Effect of temperature on oviposition and brood development of *Pissodes strobi* (Coleoptera: Curculionidae). Can. Entomol. 108:1167–1172.
- In the laboratory, maximum rate of *P. strobi* oviposition occurred at 20 to 26°C. Brood development from egg to emergence took 888 and 785 degree-days above a threshold of 7.2°C for the weevil from Sitka and white spruce, respectively.
419. McMullen, L.H. 1976b. Spruce weevil damage: ecological basis and hazard rating for Vancouver Island. Environ. Can., Can. For. Serv., Pac. For. Res. Cent., Victoria, British Columbia. Inf. Rep. BC-X-141.
- A hazard rating system for *P. strobi* damage, based on temperature and heat accumulation, was developed for Vancouver Island.
420. McMullen, L.H.; Condrashoff, S.F. 1973. Notes on dispersal, longevity, and overwintering of adult *Pissodes strobi* (Peck) (Coleoptera: Curculionidae) on Vancouver Island. J. Entomol. Soc. B.C. 70:22–26.
- Observations show that adult *P. strobi* may live for up to 4 years, move at least 1.2 km, and may overwinter in the leaders or in the litter.
421. McMullen, L.H.; Sahota, T.S. 1974. Effect of a juvenile hormone analogue on developmental rate and growth rate of progeny in *Pissodes strobi* (Coleoptera:

- Curculionidae). Can. Entomol. 106: 1015–1018.
- A juvenile hormone analogue (ZR-777) applied to adults or to host foliage retarded the development and growth rates of progeny.
422. McMullen, L.H.; Thomson, A.J.; Quenet, R.V. 1987. Sitka spruce weevil (*Pissodes strobi*) population dynamics and control: a simulation model based on field relationships. Can. For. Serv., Pac. For. Cent., Victoria, British Columbia. Inf. Rep. BC-X-288.
- A simulation model is presented, which provides the background necessary for understanding the interaction of *P. strobi* and Sitka spruce, and for examining the relative merits of various control strategies.
423. McNamara, J. 1991. Family Curculionidae. Pages 329–355 in Y. Bousquet, ed. Checklist of beetles of Canada and Alaska. Agric. Can., Res. Branch, Ottawa, Ontario. Publ. 1861/E. [See pages 338–339.]
- Gives a list of the 12 species of *Pissodes* found in Canada, and their general distribution.
424. McNeel, W., Jr. 1964. Beaver cuttings in aspen indirectly detrimental to white pine. J. Wildl. Manage. 28(4):861–863.
- In a stand where beavers removed overstory *Populus* and released understory eastern white pine, incidence of *P. strobi* greatly increased.
425. Mehary, T. 1981. Studies on the integrated pest management of the Sitka spruce weevil, *Pissodes strobi* (Peck) (Coleoptera: Curculionidae), in western Washington. Ph.D. thesis, Univ. Wash., Seattle, Washington.
- Three pesticides, acephate, chlorpyrifos methyl, and oxydemeton methyl, were released against *P. strobi* gave adequate control for only 1 year post-application. Field and laboratory olfactometer studies indicated that females produced aggregation pheromones in the spring but not in the fall. Females did not oviposit above oviposition punctures plugged with a fecal pellet, indicating the presence of a marking pheromone in the fecal plug. Females dispersed more readily than males in the autumn. Sex ratios were variable from year to year.
426. Mehary, T.; Gara, R.I.; Greenleaf, J. 1994. Host selection behavior of *Pissodes strobi* and implications to pest management. Pages 43–53 in R.I. Alfaro, G. Kiss, and R.G. Fraser, eds. The white pine weevil: biology, damage, and management. Proc. Meet., January 19–21, 1994, Richmond, British Columbia. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 226.
- Females appear to be responsible for host selection and release of an aggregation pheromone in the spring. Twice as many females as males disperse in the autumn. Plantations in which weevil populations were eradicated were re-colonized very slowly. A hardwood overstory in Sitka spruce plantations provided good protection against weevil attacks.
427. Miller, W.J. 1969. Pupae of the white-pine weevil survive freeze-drying. Can. Dep. Fish. For., For. Branch, Ottawa, Ontario. Biomon. Res. Notes 25(3):22.
- In two separate tests pupae of *P. strobi* survived freeze-drying.
428. Mitchell, R.G.; Johnson, N.E.; Wright, K.H. 1974. Susceptibility of 10 spruce species and hybrids to the white pine weevil (= Sitka spruce weevil) in the Pacific Northwest. U.S. Dep. Agric., For. Serv., Pac. Northwest For. Res. Stn., Portland, Oregon. Res. Note PNW-225.
- Lutz spruce grew well in the coastal environment and had low susceptibility to *P. strobi* attack.
429. Mitchell, R.G.; Wright, K.H.; Johnson, N.E. 1990. Damage by the Sitka spruce weevil (*Pissodes strobi*) and growth patterns for 10 spruce species and hybrids over 26 years in the Pacific Northwest. U.S. Dep. Agric., For. Serv., Pac. Northwest Res. Stn., Portland, Oregon. Res. Pap. PNW-RP-434.
- Lutz spruce grew well in the coastal environment and had low susceptibility to *P. strobi* attack.

430. Morissette, J.; Lavallée, R.; Archambault, L. 1995. Dynamique et impact des attaques du charançon du pin blanc sur l'épinette de Norvège en plantation. [Dynamics and impact of white pine weevil attacks on Norway spruce in plantations.] Pages 11–20 in R. Lavallée and G. Bonneau, eds. Compte-rendu du colloque sur le charançon du pin blanc. Proc. Symp., September 27–28, 1994, Ste.-Foy, Québec. Ressour. nat. Can., Serv. can. for., Rég. Qué., Cent. for. Laurentides, Ste-Foy (Québec), et Ressour. nat. Qué., Dir. conserv. for., Québec (Québec).

From 1983 to 1993, over 99% of young Norway spruce in a plantation in southern Quebec were attacked. Estimates of height growth loss range from 83 to 123 cm over a 6-year period.
431. Morris, O.N.; Olsen, P. 1970. Insect disease survey in British Columbia 1964–1969. Can. Dep. Fish. For., Can. For. Serv., For. Res. Lab., Victoria, British Columbia. Inf. Rep. BC-X-47.

An unidentified polyhedrosis virus was isolated from a *Pissodes* species.
432. Morrow, R.R. 1965. Height loss from white pine weevil. J. For. 63:201–203.

Presents two methods of estimating the impact of *P. strobi* attack on height loss in eastern white pine. Minimum height growth loss appears to be 60–70% for each attack.
433. Morse, F.S. 1958. The white-pine weevil in Wisconsin jack pine plantations. M.Sc. thesis, Univ. Wis., Madison, Wisconsin.

Gives a description of height loss in jack pine plantations as a result of *P. strobi* attacks. Economic impact is discussed.
434. Mott, P.B. 1930. An annotated bibliography of the white pine weevil, *Pissodes strobi* (Peck), for white pine blister rust workers and others. N.J. Dep. Agric., Trenton, New Jersey. Circ. 177.

Includes papers published on *P. strobi* from 1817 to 1930.
435. Muesebeck, C.F.W. 1925. A revision of the parasitic wasps of the genus *Microbracon* occurring in America north of Mexico. Proc. U.S. Natl. Mus. 67, art. 8. [See pages 52–53.]

Original description of *Microbracon pini* Muesebeck which was reared from *P. strobi* in Massachusetts.
436. Nettles, W.C. 1943. Plant stimulation aids in control of *Pissodes nemorensis* on *Cedrus deodara*. J. Econ. Entomol. 36:345.

Fertilization and watering of trees increased resistance to *P. nemorensis*.
437. Nevill, R.J. 1990. The association and transmission of *Leptographium procerum* (Kendr.) Wing., by root feeding insects in Christmas tree plantations. Ph.D. thesis, Va. Polytech. Inst. State Univ., Blacksburg, Virginia.

The contents of this thesis was published in the primary literature. For content, see annotations for references 438–441.
438. Nevill, R.J.; Alexander, S.A. 1992a. Distribution of *Hylobius pales* and *Pissodes nemorensis* (Coleoptera: Curculionidae) within Christmas tree plantations with procerum root disease. Environ. Entomol. 21(5):1077–1085.

Pissodes nemorensis was found to vector procerum root disease in eastern white pine.
439. Nevill, R.J.; Alexander, S.A. 1992b. Pathogenicity of three fungal associates of *Hylobius pales* and *Pissodes nemorensis* (Coleoptera: Curculionidae) to eastern white pine. Can. J. For. Res. 22:1438–1440.

Isolates of two fungi species, *Leptographium procerum* (Kendrick) and *Ophiostoma piceae* (Munch) Syd. & Syd., vectored by *P. nemorensis* were pathogenic to eastern white pine seedlings. A third fungus, *Graphium* sp., was not pathogenic.
440. Nevill, R.J.; Alexander, S.A. 1992c. Root- and stem-colonizing insects recovered from eastern white pines with procerum root disease. Can. J. For. Res. 22:1712–1716.

Pissodes nemorensis was commonly associated with eastern white pine with procerum root disease, and it is thought to be a vector.

441. Nevill, R.J.; Alexander, S.A. 1992d. Transmission of *Leptographium procerum* to eastern white pine by *Hylobius pales* and *Pissodes nemorensis* (Coleoptera: Curculionidae). Plant Dis. 76:307–310.
- Pissodes nemorensis* vectored *L. procerum* to eastern white pine seedlings.
442. Nevill, R.J.; Humphreys, N.; Van Sickle, A. 1995. Three-year overview of forest health in young managed stands in British Columbia, 1992–1994. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 236.
- This report summarizes data from 3 years (1992–94) of surveys in young stands. *Pissodes strobi* infested 18% of the spruce trees, and was present in 20% of the spruce plantations surveyed. An average of 2% of the lodgepole pine was attacked by *P. terminalis*, and 6% of plantations contained this species. Damage was analyzed by biogeoclimatic zone. This summary includes data published by Hodge et al. (1994a, b).
443. Nichols, J.O. 1968. White-pine weevil control in plantations with heptachlor granules. J. Econ. Entomol. 61(6):1543–1546.
- Application of heptachlor granules to the ground within a 2-ft radius of the bases of eastern white pines provided adequate control of overwintering *P. strobi* adults for at least 5 years. Incidence of weevil damage was reduced by 95% 2 years after application.
444. Nielsen, D.G.; Balderston, C.P. 1975. Evaluation of insecticides for preventing reproduction of pales and northern pine weevils in pine stumps. J. Econ. Entomol. 68(2):205–206.
- Carbofuran in water or kerosene and chlorpyrifos and lindane in kerosene essentially eliminated *P. approximatus* (= *P. nemorensis*) activity and survival in Scots pine stumps.
445. Nigam, P.C. 1969. Summary of laboratory evaluation of insecticides against various species of forest insect pests—1969. Can. Dep. Fish. For., Can. For. Serv., Chem. Control Res. Inst., Ottawa, Ontario. Inf. Rep. CC-X-3.
- Of six pesticides tested, methyl trithion was the most effective contact insecticide against *P. sitchensis* (= *P. strobi*).
446. Nigam, P.C. 1971. Summary of laboratory evaluation of insecticides against forest insect pests during 1971. Environ. Can., Can. For. Serv., Chem. Control Res. Inst., Ottawa, Ontario. Inf. Rep. CC-X-12.
- Of 15 pesticides tested, methyl trithion was the most effective contact insecticide against *P. strobi*.
447. Nigam, P.C. 1972a. Contact and residual toxicity studies of fenitrothion against twenty-one species of forest insect pests. Environ. Can., Can. For. Serv., Chem. Control Res. Inst., Ottawa, Ontario. Inf. Rep. CC-X-28.
- The LD₅₀ (48 hours) for this pesticide was 0.673 µg/cm² when targeted against *P. strobi*.
448. Nigam, P.C. 1972b. Contact and residual toxicity studies of Zectran® against eighteen species of forest insect pests. Environ. Can., Can. For. Serv., Chem. Control Res. Inst., Ottawa, Ontario. Inf. Rep. CC-X-29.
- The LD₅₀ (48 hours) for this pesticide was 0.081 µg/cm² when targeted against *P. strobi*.
449. Nigam, P.C. 1972c. Contact toxicity of insecticides against adult white-pine weevil, *Pissodes strobi* (Peck). Environ. Can., Can. For. Serv., Chem. Control Res. Inst., Ottawa, Ontario. Inf. Rep. CC-X-17.
- Fourteen pesticides were tested against adults of *P. strobi*. Data from nine pesticides were analyzed. Phoxim was the most effective and methoxychlor the least effective.
450. Nigam, P.C. 1972d. Toxicity of Dursban®, Gardona®, and seven other insecticides to white-pine weevil, *Pissodes strobi* (Peck) and other components of the forest ecosystem. Proc. Entomol. Soc. Ont. 103:55–59.
- Of the nine pesticides tested, Phoxim was the most effective and methoxychlor the least effective.

451. Nigam, P.C. 1975. Summary of contact, stomach and residual toxicity of insecticides against forest insect pests during 1974. Environ. Can., Can. For. Serv., Chem. Control Res. Inst., Ottawa, Ontario. Rep. CC-X-100.
- Of the pesticides tested, methyl trithion and Gardona® were the most effective.
452. O'Brien, C.W. 1989. Revision of the weevil genus *Pissodes* in Mexico with notes on Neotropical *Pissodini* (Coleoptera: Curculionidae). Trans. Am. Entomol. Soc. 115:415-432.
- Describes three new species (*P. championi*, *P. cibriani*, and *P. mexicanus*) from Mexico and gives a key to all five *Pissodes* species recorded from Mexico.
453. O'Brien, C.W.; Thompson, R.T. 1986. *Curculio striatulus*, a North American *Pissodes* (Coleoptera: Curculionidae). Entomol. News 97:198-200.
- Study of the type of *Curculio striatulus* Fab., showed that it is conspecific with and a senior synonym of *P. dubius*.
454. O'Brien, C.W.; Wibmer, G.J. 1982. Annotated checklist of the weevils (Curculionidae *sensu lato*) of North America, Central America, and the West Indies (Coleoptera: Curculionidae). Mem. Am. Entomol. Soc. 34.
- Gives a list of all *Pissodes* species in North and Central America and their general distribution.
455. O'Brien, L.B. 1989. A catalogue of the Coleoptera of America north of Mexico, family: Curculionidae, subfamily: Pissodinae. U.S. Dep. Agric., Washington, D.C. Agric. Handb. 529-143d.
- Gives a list of all species along with information on location of type specimens and host species.
456. O'Dell, T.M. 1972. The relationship between the fecundity of the white pine weevil, *Pissodes strobi* (Peck), and the relative water content of its host, *Pinus strobus*. In Proc. 2nd North Am. For. Biol. Workshop, Ore. State Univ., Corvallis, Oregon.
- Copy not seen.
457. Ollieu, M.M. 1971. Damage to southern pines in Texas by *Pissodes nemorensis*. J. Econ. Entomol. 64(6):1456-1459.
- An outbreak of *P. nemorensis* in Texas is reported along with cursory life-history observations and damage symptoms.
458. Omule, S.A.Y. 1988. Early growth of four species planted at three spacings on Vancouver Island. Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Econ. Reg. Dev. Agreement Rep. 9.
- Damage by *P. strobi* was not correlated with spacing of Sitka spruce. Weevils preferred larger, more vigorous trees.
459. Osella, G. 1977. Curculionidi dannosi ai *Pinus* nella repubblica Centro-Americana di El Salvador (Coleoptera). [Curculionids harmful to *Pinus* in the central American Republic of El Salvador (Coleoptera).] Boll. Mus. Civ. Stor. Nat. Verona 4:451-459.
- Describes three new species (*P. schmutzenhoferi*, *P. ayacahuite*, and *P. incavatus*) from El Salvador.
460. Ostrander, M.D. 1957. Weevil attacks apparently unrelated to height of eastern white pine. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania. For. Res. Notes 67.
- Attacks by *P. strobi* were common on all sizes of trees to 85 ft tall.
461. Ostrander, M.D. 1971. Identification and evaluation of defects in eastern white pine logs and trees. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania. Res. Pap. NE-190.
- Crooking and branching of the stem, cross grain, bark-encased knots, and red rot are common defects caused by weevil attack.
462. Ostrander, M.D.; Foster, C.H. 1957. Weevil-red rot associations in eastern white pine. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania. For. Res. Notes 68.
- Red rot caused by the fungus *Fomes pini* is commonly associated with weevil injuries on eastern white pine.

463. Ostrander, M.D.; Stoltenberg, C.H. 1957. Value loss from weevil-caused defects in eastern white pine lumber. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania. For. Res. Notes 73.
- Defects to eastern white pine caused by *P. strobi* attacks reduces value of wood by about 4%.
464. Overgaard, N.A.; Nachod, L.H. 1971. Deodar weevil causes pine mortality in Louisiana. J. Econ. Entomol. 64(5):1329-1330.
- Pissodes nemorensis* attacked and killed about 200 young loblolly pine. Notes are included on phenology and mortality due to woodpeckers, insect predators, and parasitoids.
465. Overhulser, D.L. 1973. Flight and seasonal activity of the Sitka spruce weevil, *Pissodes strobi* (Peck) (Coleoptera: Curculionidae), in western Washington. M.Sc. thesis, Univ. Wash., Seattle, Washington.
- Most of the data presented here were published in reference 468. Additionally, the pattern and depth of oviposition punctures on leaders was examined with respect to the resin canal arrangement.
466. Overhulser, D.L. 1980. Studies on the behavior of the Sitka spruce weevil, *Pissodes strobi* (Peck), and host responses to attack. Ph.D. thesis, Univ. Wash., Seattle, Washington.
- Most of the data presented here were published in references 468-469. Additionally, it was shown that a coastal environment both delayed and shortened the activity period of adult weevils, and resulted in lower damage to spruce compared to inland environments.
467. Overhulser, D.L.; Gara, R.I. 1975. Spring flight and adult activity of the white pine weevil, *Pissodes strobi* (Coleoptera: Curculionidae), on Sitka spruce in western Washington. Can. Entomol. 107:251-256.
- Flight patterns, sex ratios, and ovipositional activity of *Pissodes strobi* in Sitka spruce are described. There is an aggregation of adults on spruce leaders early in the flight season during which sexual maturation and mating take place.
468. Overhulser, D.L.; Gara, R.I. 1981a. Occluded resin canals associated with egg cavities made by shoot infesting *Pissodes*. For. Sci. 27(2):297-298.
- Occlusions resembling tylosoids were found in cortical resin canals that border ovipositional punctures of *P. strobi* and *P. terminalis*.
469. Overhulser, D.L.; Gara, R.I. 1981b. Site and host factors affecting the Sitka spruce weevil, *Pissodes strobi*, in western Washington. Environ. Entomol. 10(5):611-614.
- Adult *P. strobi* activity started about 30 days earlier in heavily infested Sitka spruce plantations compared to lightly infested ones. Brood mortality was significantly higher at the plantations with low weevil damage. Poor brood survival was attributed mainly to resinosis.
470. Overhulser, D.L., Gara, R.I., Hrutfiord, B.J. 1974. Site and host factors as related to attack of the Sitka spruce weevil on *Picea sitchensis*. Univ. Wash., Cent. Ecosystem Studies, Coll. For. Resour., Seattle, Washington. Annu. Rep.
- This paper is a progress report, which includes some of the information published in references 468-469. Also included are some preliminary data on host resistance and weevil aggregation.
471. Overhulser, D.L.; Gara, R.I.; Johnsey, R. 1972. Emergence of *Pissodes strobi* (Coleoptera: Curculionidae) from previously attacked Sitka spruce. Ann. Entomol. Soc. Am. 65(6):1423-1424.
- More *P. strobi* emerged from previously unweeviled Sitka spruce than from previously attacked trees.
472. Overhulser, D.L.; Hrutfiord, B.; Gara, R.I. 1972. The Sitka spruce weevil—host relationship. In Proc. 2nd North Am. For. Biol. Workshop, Ore. State Univ., Corvallis, Oregon.
- Copy not seen.
473. Packard, A.S., Jr. 1881. Insects injurious to forest and shade trees. U.S. Dep. Inter., U.S. Entomol. Comm., Washington, D.C. Bull. 7. [See pages 185-188, 228-229, 236, 241.]
- Gives a report of the life history, habits, damage, and control of *P. strobi*.

474. Packard, A.S. 1890. Fifth report of the United States Entomological Commission on insects injurious to forest and shade trees. U.S. Dep. Agric., Washington, D.C. [See pages 734–741, 829–830, 861, 872.]
Gives a report of the life history, habits, damage, and control of *P. strobi*. This is an update of reference 473.
475. Paradis, C. 1995. Évaluation des dégâts causés par le charançon du pin blanc, *Pissodes strobi* (Peck), dans les plantations—relevé de 1993. [Evaluation of damage caused by the white pine weevil, *Pissodes strobi* (Peck), in plantations—1993 survey.] Pages 1–10 in R. Lavallée and G. Bonneau, eds., *Compte-rendu du colloque sur le charançon du pin blanc*. Proc. Symp., September 27–28, 1994, Ste.-Foy, Québec. Ressour. nat. Can., Serv. can. for., Rég. Qué., Cent. for. Laurentides, Ste-Foy (Québec), et Ressour. nat. Qué., Dir. conserv. for., Québec (Québec).
Gives a summary of a survey of *P. strobi* damage in Quebec, with respect to region and host.
476. Parr, T.J. 1934. Practical control work on European pine shoot moth and white pine weevil in C.C.C. camps in Connecticut. Pages 92–94 in Proc. Ninth Annu. Meet. Natl. Shade Tree Conf., September 7–8, 1933, N.Y. Bot. Gard., New York, New York.
Pruning of infested leaders can reduce weevil populations but not eliminate them.
477. Parton, W.J. 1988a. Relationship between stand height and white pine weevil damage in young jack pine plantations in the Gogama District (1988). Ont. Minist. Nat. Resour., Ottawa, Ontario. Intern. Rep.
Jack pine stands between 1.5 and 3.0 m tall show the highest incidence of *P. strobi* damage.
478. Parton, W.J. 1988b. Results of a survey for white pine weevil in young jack pine stands in the Upper Spanish Forest and Gogama District (1988). Ont. Minist. Nat. Resour., Ottawa, Ontario. Intern. Rep.
Surveys revealed that 86% of jack pine stands contained *P. strobi* damage, and the overall incidence of damaged terminals was 2.6%.
479. Parton, W.J. 1988c. White pine weevil clipping in a young jack pine plantation in the Gogama District (1988). Ont. Minist. Nat. Resour., Ottawa, Ontario. Intern. Rep.
Manual clipping and burning of *P. strobi*-infested jack pine terminals cost \$486 per ha.
480. Patterson, W.A., III; Aizen, M.A. 1989. Hardwood competition and weevil infestation in white pine: lessons from a long-term study. North. J. Appl. For. 6:186–188.
Hardwood competition reduced growth of eastern white pine and incidence of *P. strobi*. Damage by *P. strobi* was partly responsible for poor growth and survival of pine.
481. Pauley, S.S.; Spurr, S.H.; Whitmore, F.W. 1955. Seed source trials of eastern white pine. For. Sci. 1(3):244–256.
Damage by *P. strobi* was high for all seed sources. Incidence of damage per seed source seemed positively correlated with tree size (diameter).
482. Peck, O. 1963. A catalogue of the Nearctic Chalcidoidea (Insecta: Hymenoptera). Can. Entomol. Suppl. 30. [See page 959.]
Lists several parasitoids associated with *Pissodes*.
483. Peck, W.D. 1817. On the insects which destroy the young branches of the pear tree, and the leading shoot of Weymouth-pine. Mass. Agric. J. 4:205–211.
Original description of *P. strobi*.
484. Peckham, D.J. 1969. A serological comparison of *Pissodes strobi* and *P. approximatus* (Coleoptera: Curculionidae). Can. Entomol. 101:78–90.
Pissodes strobi and *P. approximatus* (= *P. nemorensis*) were serologically indistinguishable.
485. Peirson, H.B. 1922. Control of the white pine weevil by forest management. Harvard For. Petersham, Massachusetts. Bull. 5.
Describes damage caused by *P. strobi* and gives evidence that damage can be minimized by manipulation of stand density and overstory shading.

486. Peirson, H.B. 1928. State of Maine, report of the Forest Commissioner for 1927–1928. Maine For. Serv., Augusta, Maine. [See pages 74, 78.]
 Recommends that tree species, spacing, and soil conditions be taken into consideration when planting to minimize damage by *P. strobi*. Physical barriers (collars, tanglefoot) placed on the bole did not prevent weevil infestations.
487. Peterson, L.O.T. 1945. The Engelmann spruce weevil, (*Pissodes engelmanni* Hopk.). Can. Dep. Agric., Sci. Serv., Div. Entomol., Ottawa, Ontario. For. Insect Invest. Bi-mon. Prog. Rep. 1(6):3.
 The incidence of *P. engelmanni* (= *P. strobi*) damage is reported for white spruce and Colorado blue spruce near Lacombe, Alberta.
488. Phillips, T.W. 1981. Aspects of host preference and chemically mediated aggregation in *Pissodes strobi* (Peck) and *P. approximatus* Hopkins (Coleoptera: Curculionidae). M.Sc. thesis, State Univ. N.Y., Syracuse, New York.
 The contents of this thesis was published in the primary literature. For content, see annotations for references 490–491 and 495.
489. Phillips, T.W. 1984. Ecology and systematics of *Pissodes* sibling species (Coleoptera: Curculionidae). Ph.D. thesis, State Univ. N.Y., Syracuse, New York.
 See also annotations for references 493–495. Additionally, allozyme variation was assessed in eight species of *Pissodes*. The four species in the *P. strobi* group were most similar to each other.
490. Phillips, T.W.; Lanier, G.N. 1983a. Biosystematics of *Pissodes* Germar (Coleoptera: Curculionidae): feeding preference and breeding site specificity of *P. strobi* and *P. approximatus*. Can. Entomol. 115:1627–1636.
 Host and breeding site preference differed for the two species. Cross-breeding experiments produced hybrids, but success of breeding depended on breeding site (leaders versus logs).
491. Phillips, T.W.; Lanier, G.N. 1983b. White pine weevil, *Pissodes strobi* (Coleoptera: Curculionidae), attack on various conifers in New York. Can. Entomol. 115:1637–1640.
 Field studies in which adult *P. strobi* were confined on the leaders of six different conifer species indicated that eastern white pine was the most susceptible to attack and the most suitable for brood production. White spruce leaders proved to be the least suitable for production of brood.
492. Phillips, T.W.; Lanier, G.N. 1985. Genetic divergence among populations of the white pine weevil, *Pissodes strobi* (Coleoptera: Curculionidae). Ann. Entomol. Soc. Am. 78(6):744–750.
 Allozyme variation was assessed across the range of *P. strobi*. Genetic similarity among populations was not closely dependent on geographic distance between them. Genetic variation was lower in western than in eastern populations.
493. Phillips, T.W.; Lanier, G.N. 1986. Interspecific activity of semiochemicals among sibling species of *Pissodes* (Coleoptera: Curculionidae). J. Chem. Ecol. 12(7):1587–1601.
Pissodes approximatus (= *P. nemorensis*) and *P. nemorensis* were cross attractive, but different photoperiod conditioning was required for pheromone production in the two species. *Pissodes strobi* produced a chemical that interrupted the response of *P. approximatus* to its aggregation pheromone.
494. Phillips, T.W.; Teale, S.A.; Lanier, G.N. 1987. Biosystematics of *Pissodes* Germar (Coleoptera: Curculionidae): seasonality, morphology, and synonymy of *P. approximatus* Hopkins and *P. nemorensis* Germar. Can. Entomol. 119:465–480.
 Based on ecological, behavioral, and morphological data, *P. approximatus* and *P. nemorensis* were found to be conspecific. *Pissodes approximatus* is the junior synonym.
495. Phillips, T.W.; West, J.R.; Foltz, J.L.; Silverstein, R.M.; Lanier, G.N. 1984. Aggregation pheromone of the deodar weevil, *Pissodes nemorensis* (Coleoptera: Curculionidae): isolation and activity of grandisol and grandisal. J. Chem. Ecol. 10(10):1417–1423.

Males produce grandisol and grandisal, which are components of the aggregation pheromone. In field tests these compounds acted synergistically with pine bolts to attract adults of both sexes.

496. Pierce, W.D. 1907. On the biologies of the Rhynchophora of North America. Pages 249–273 in W.R. Mellor, comp. Annual report, Nebraska State Board of Agriculture for the year 1906–1907. State J. Co., Lincoln, Nebraska. [See page 259.]

Biological notes are provided for *P. strobi*, *P. costatus*, *P. fasciatus*, *P. affinis*, and *P. dubius* (= *P. striatulus*).

497. Pierce, W.D. 1908. A list of parasites known to attack American Rhynchophora. J. Econ. Entomol. 1:380–396. [See page 387.]

Bracon pissodis Ashm. parasitizes *P. strobi*.

498. Pineda Torres, M. del C.; Guerrero Alarcon, M.E. 1983. Bionomia de *Pissodes* n. sp. (Coleoptera: Curculionidae), un descortezador de *Pinus patula* Schl. & Cham. [Bionomics of *Pissodes* n. sp. (Coleoptera: Curculionidae), a bark beetle of *Pinus patula* Schl. & Cham.] Thesis, Univ. Nac. Auton. Méx., San Juan Iztacala, México.

Morphological descriptions of the life stages are provided along with information on the life cycle, habits, mortality, predators, and parasitoids. Damage symptoms and relationship to tree height and diameter are discussed.

499. Plank, G.H. 1964. Evaluating host resistance to white pine weevil, *Pissodes strobi* Peck, using feeding preference tests. M.Sc. thesis, Penn. State Univ., University Park, Pennsylvania.

The contents of this thesis was published in the primary literature. For content, see annotation for reference 500.

500. Plank, G.H.; Gerhold, H.D. 1965. Evaluating host resistance to the white-pine weevil, *Pissodes strobi* (Coleoptera: Curculionidae) using feeding preference tests. Ann. Entomol. Soc. Am. 58:527–532.

Adults preferred feeding on eastern white pine over jack pine and red pine. Cut leaders of

western white pine were fed upon readily by adults.

501. Plumb, G.H.; Hicock, H.W. 1934. Insect control work by the Civilian Conservation Corps in Connecticut. J. Econ. Entomol. 27:344–345.

Over 35 000 *P. strobi*-infested leaders of eastern white pine were pruned and destroyed.

502. Plummer, C.C.; Pillsbury, A.E. 1929. The white pine weevil in New Hampshire. Univ. N.H., Exp. Stn., Durham, New Hampshire. Bull. 247.

Gives descriptions of life stages, damage to trees, rearing methods, phenology and habits, dispersal, and natural enemies of *P. strobi*. Various direct and indirect control methods are discussed.

503. Potts, S.F.; Cline, A.C.; McIntyre, H.L. 1942. The white pine weevil and its control by the application of concentrated sprays. J. For. 40:405–410.

Of 13 pesticides tested, calcium arsenate, copper arsenate, lead arsenate, and cryolite were the most effective against weevils.

504. Powell, J.M. 1971. The arthropod fauna collected from the comandra blister rust, *Cronartium comandrae*, on lodgepole pine in Alberta. Can. Entomol. 103:908–918.

Adults of *P. schwarzi* fed within cankers.

505. Powell, J.M. 1974. The role of natural biological agents in controlling a pine stem rust (*Cronartium comandrae*). Blue Jay 32(2):75–79.

Adults of *P. schwarzi* fed within cankers.

506. Price, D.S. 1980. The major entomological pests affecting young lodgepole pine in the Cariboo. B.S.F. thesis, Univ. B.C., Vancouver, British Columbia.

The life history and damage of *P. terminalis* is reviewed. This species was found more commonly in natural stands.

507. Randall, J.W. 1838. Descriptions of new species of Coleopterous insects inhabiting the state of Maine. Boston J. Nat. Hist. 2(1):34–52.

Original descriptions of *P. affinis* and *P. dubius* (= *P. striatulus*) are provided on pages 24–25.

508. Rankin, L.J.; Lewis, K. 1994. Effectiveness of leader clipping for control of the white pine weevil, *Pissodes strobi*, in the Cariboo Forest Region of British Columbia. Pages 262–269 in R.I. Alfaro, G. Kiss, and R.G. Fraser, eds. The white pine weevil: biology, damage, and management. Proc. Meet., January 19–21, 1994, Richmond, British Columbia. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 226.

Clipping did not reduce *P. strobi* infestation level significantly over a 5-year period, but did limit an increase in infestation level compared to unclipped plantations.
509. Reeks, W.A.; Kirby, C.S.; MacDonald, J.; Harnden, A. 1960. A survey of white pine weevil infestation in the Kirkwood Management Unit, 1960. Can. Dep. For., For. Insect Lab., Sault Ste. Marie, Ontario. Intern. Rep.

Incidence of *P. strobi* damage is summarized, and generally increased with decreased shading.
510. Reid, R.W. 1951. Forest insect survey. Can. Dep. Agric., Sci. Serv., Div. For. Biol., Ottawa, Ontario. Bi-mon. Prog. Rep. 7(2):3.

Reports heavy parasitism of *P. strobi*.
511. Retnakaran, A. 1973. Ovicidal effect in the white pine weevil, *Pissodes strobi* (Coleoptera: Curculionidae), of a synthetic analogue of juvenile hormone. Can. Entomol. 105:591–594.

Topical application of a synthetic juvenile hormone analogue to eggs of *P. strobi* inhibited embryo development and caused mortality.
512. Retnakaran, A. 1974. Induction of sexual maturity in the white pine weevil, *Pissodes strobi* (Coleoptera: Curculionidae), by some analogues of juvenile hormone. Can. Entomol. 106:831–834.
- Topical application of three juvenile hormone analogues to pre-diapause adults induced ovarian development and resorption of fat bodies.
513. Retnakaran, A.; Harris, J.W.E. 1995. Terminal weevils. Pages 233–240 in J.A. Armstrong and W.G.H. Ives, eds. Forest insect pests in Canada. Nat. Resour. Can., Can. For. Serv., Ottawa, Ontario.

Reviews control methods for *P. strobi*. Gives original data on the use of Dimilin for weevil control.
514. Retnakaran, A.; Jobin, L. 1994. New observations on adult behavior of the white pine weevil and implications on control with Diflubenzuron. Pages 270–284 in R.I. Alfaro, G. Kiss, and R.G. Fraser, eds. The white pine weevil: biology, damage, and management. Proc. Meet., January 19–21, 1994, Richmond, British Columbia. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 226.

Summarizes *P. strobi* development with respect to temperature and photoperiod. Application of Dimilin at the rate of 30 g/ha early in the spring gives good weevil control.
515. Retnakaran, A.; Smith, L. 1982. Reproductive effects of insect growth regulators on the white pine weevil, *Pissodes strobi* (Coleoptera: Curculionidae). Can. Entomol. 114:381–383.

Laboratory and field data suggest that two insect growth regulators, Dimilin and BAY SIR-8514, are effective as ovicides or sterilants, and may be effective in reducing weevil populations.
516. Rhodes, A.D. 1956. Comparison of lead arsenate, methylchlor and benzene hexachloride for control of white pine weevil. J. For. 54:134–135.

All three pesticides appear to be equally effective at controlling *P. strobi*.
517. Rhodes, A.D. 1963. Reducing trunk malformation caused by injury to eastern

white pine by the white pine weevil. J. For. 61:374-378.

Removal of all but one lateral in the live whorl below a *P. strobi*-attacked leader resulted in a smaller crook in the stem than in untreated trees.

518. Rieske, L.K.; Raffa, K.F. 1993. Use of ethanol- and turpentine-baited flight traps to monitor *Pissodes* weevils (Coleoptera: Curculionidae) in Christmas tree plantations. Great Lakes Entomol. 26(2):155-160.

Baited flight traps effectively captured *P. nemorensis* and *P. strobi*. More females than males were captured. Baited pitfall traps were ineffective at trapping *Pissodes*.

519. Riley, C.V. 1885. The white pine weevil, and its injury to shade and forest trees (*Pissodes strobi* Peck). Pages 322-325 in Report of the Commissioner of Agriculture. Gov. Print. Off., Washington, D.C.

Gives an account of the life history and habits of *P. strobi*, and describes damage caused to trees by this species.

520. Riley, C.V.; Howard, L.O. 1890. Insect life: devoted to the economy and life habits of insects, especially in their relations to agriculture. U.S. Dep. Agric., Div. Entomol., Washington, D.C. Period. Bull. Vol. II, nos. 11-12. [See page 348], and Vol. III, no. 1. [See page 468.]

Lists *Bracon pissodis* Ashm. (Hymenoptera: Braconidae) as a parasitoid of *P. strobi*.

521. Roberts, D.R. 1994. Somatic embryogenesis for mass propagation of weevil resistant spruce. Pages 169-173 in R.I. Alfaro, G. Kiss, and R.G. Fraser, eds. The white pine weevil: biology, damage, and management. Proc. Meet., January 19-21, 1994, Richmond, British Columbia. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 226.

Describes somatic embryogenesis of interior spruce as a means of propagating *P. strobi*-resistant families.

522. Rudolph, V.J.; Lemmien, W.; Day, M.W. 1956. Growth of white pine in some pure and mixed plantings in Michigan. Mich. Q. Bull. 38(4):538-546.

Attacks by *P. strobi* is contributing factor to poor growth of eastern white pine in pure and mixed plantings.

523. Ruppel, D.H.; Harvey, E.G. 1965. A compilation of forest insects collected from plantations and reproduction stands in coastal British Columbia. Can. Dep. For., For. Entomol. Pathol. Branch, For. Insect Lab., Victoria, British Columbia. Inf. Rep. [See pages 33-35.]

Pissodes alascensis (= *P. rotundatus*), *P. curriei* (= *P. affinis*), *P. engelmanni* (= *P. strobi*), *P. fasciatus*, and *P. radiatae* are recorded and general notes on distribution, hosts, and biology are given.

524. Sahota, T.S.; Manville, J.F.; White, E. 1994. Interactions between Sitka spruce weevil and its host, *Picea sitchensis* (Bong) Carr.: a new mechanism for resistance. Can. Entomol. 126:1067-1074.

Evidence is presented to show that resistant trees can sufficiently affect *P. strobi* reproduction and progeny development and survival to reduce the ability of weevils to kill leaders. An explanation is given as to how weevils avoid resistant trees in which their progeny would fail.

525. Sahota, T.S.; Manville, J.F.; White, E.; Ibaraki, A. 1994. Towards an understanding of Sitka spruce resistance against *Pissodes strobi*. Pages 110-116 in R.I. Alfaro, G. Kiss, and R.G. Fraser, eds. The white pine weevil: biology, damage, and management. Proc. Meet., January 19-21, 1994, Richmond, British Columbia. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 226.

Evidence is presented to show that resistant trees can sufficiently affect *P. strobi* reproduction and progeny development and survival to reduce the ability of weevils to kill leaders.

526. Sahota, T.S.; McMullen, L.H. 1979. Reduction in progeny production in the spruce

- weevil, *Pissodes strobi* Peck, by two insect growth regulators. Environ. Can., Can. For. Serv., Ottawa, Ontario. Bi-mon. Res. Notes 35(6):32-33.
- Dimilin and precocene significantly reduced progeny production in *P. strobi*, but neither were deemed effective enough to warrant testing in the field.
527. Salman, K.A. 1935. The effects of attack by *Pissodes terminalis* Hopping on lodgepole pine in California. J. Econ. Entomol. 28:496-497.
- Attack kills terminals, which sometimes results in stem deformities. Trees between 6 and 25 ft tall and those growing in open stands were most heavily attacked.
528. Santamour, F.S., Jr. 1964. Is there genetic resistance to the white pine weevil in *Pinus strobus*? Pages 49-51 in Proc. 11th Northeast. For. Tree Improv. Conf., August 6-7, 1963, New Brunswick, New Jersey. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania.
- Seed sources were highly variable with respect to apparent susceptibility to weevil attacks.
529. Santamour, F.S., Jr. 1965a. Insect-induced crystallization of white pine resins. I. White-pine weevil. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania. Res. Note NE-38.
- Crystallization of resin in response to presence of *Pissodes* differed among tree species. Resin from shoots crystallized more readily than that from wood.
530. Santamour, F.S., Jr. 1965b. Leucoanthocyanins of white pine in relation to weevil attack. Nature 208:407-408.
- There was no apparent relationship between leucoanthocyanin content and weevil attack.
531. Santamour, F.S., Jr.; Zinkel, D.F. 1976. Weevil-induced resin crystallization related to resin acids in eastern white pine. Pages 52-56 in Proc. 23rd Northeast. For. Tree Improv. Conf., August 4-7, 1975, New Brunswick, New Jersey. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania.
532. Santamour, F.S., Jr.; Zinkel, D.F. 1977. Resin acids, resin crystallization, and weeviling in Balkan x eastern white pine hybrids. Pages 165-175 in Proc. 25th Northeast. For. Tree Improv. Conf. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania.
- The cortical resins of some trees of *Pinus peuce* do not contain strobic acid and do not crystallize in contact with *P. strobi*. The effects of grafting to and hybridization with *Pinus strobus* on resin acid composition is discussed. Recommendations for breeding weevil-resistant white pines are given.
533. Say, T. 1831. Description of North American Curculionides and an arrangement of our own species agreeably to the method of Schoenherr. New Harmony, Indiana. [See page 14.]
- Includes *P. strobi* in the list of species.
534. Schmiede, D.C. 1963. The feasibility of using a Neoplectanid nematode for control of some forest insect pests. J. Econ. Entomol. 56(4):427-431.
- Adults of *P. strobi* were not infected by *Neoplectana* nematodes.
535. Schuder, D.L. 1967. Three pine weevils new to Indiana. Proc. Indiana Acad. Sci. 76:270-271.
- Pissodes strobi* and *P. affinis* are reported from Indiana. Information on distribution and biology is provided.
536. Schwarz, E.A. 1888. Coleopterological notes. Proc. Entomol. Soc. Wash. 1:174-176. (See page 176.)
- The sexes of *P. affinis* are easily distinguishable on the basis of characters on the hind tibia of males.

537. Schwerdtfeger, F. 1954. Curculionidae (Col.) aus *Pinus* arten in Guatemala. [Curculionidae (Col.) from *Pinus* species in Guatemala.]. Z. Angew. Entomol. 36:178–184.
- Notes on the phenology, biology, and behavior of *P. guatemaltecus* in Guatemala is provided. A brief morphological description of the species is given and some comments on taxonomy are included. Photographs of life stages and damage are provided. Mites, possibly *Pediculoides ventricosus*, apparently caused some mortality.
538. Shenefelt, R.D. 1951a. A further note on the control of the white pine weevil. J. For. 49:575–576.
- Further tests corroborated earlier evidence (Shenefelt 1951b) that lead arsenate applied to eastern white pine leaders in the spring gave good control of *P. strobi*.
539. Shenefelt, R.D. 1951b. Control of the white pine weevil. Wis. Conserv. Bull. 16:20–22.
- Lead arsenate applied to eastern white pine leaders in the spring gave good control of *P. strobi*.
540. Sieben, B.G.; Spittlehouse, D.L.; Benton, R.A.; McLean, J.A. 1994. A first approximation of the effect of climatic warming on the white pine weevil hazard in the MacKenzie River drainage basin. Pages 316–328 in S.J. Cohen, ed. MacKenzie Basin Impact Study (MBIS) Inter. Rep. 2. Proc. Sixth Biennial Atmos. Environ. Serv./Dep. Indian Aff. North. Dev. Meet. North. Climate Mid Study Workshop MacKenzie Basin Impact Study, April 10–14, 1994, Yellowknife, Northwest Territories. Environ. Canada, Ottawa, Ontario.
- Growing degree day accumulations above 7.2°C during summer can be used as an indicator of the potential range of *P. strobi*. Accumulations were classified into hazard classes of high, medium, and low to indicate the potential for weevil development. A projected scenario of a 2.2°C warming across the basin resulted in the high hazard class increasing from 24 to 51%, and the range of the weevil moving northward in latitude and upward in elevation.
541. Silver, G.T. 1968. Studies of the Sitka spruce weevil, *Pissodes sitchensis*, in British Columbia. Can. Entomol. 100:93–110.
- The life history of *P. sitchensis* (= *P. strobi*) is described. Natural control factors reduced the population level but were incapable of controlling a population. Satisfactory control was obtained by applying DDT and phosphamidon to leaders with a hand-sprayer early in the spring.
542. Silver, G.T.; Ruth, D.S. 1966. Studies on spruce plantations at Green Timbers. Can. Dep. For., For. Res. Lab., Victoria, British Columbia. Inf. Rep. BC-X-2.
- Only one attack by *P. strobi* occurred up until 1964.
543. Simpson, L.J. 1952. Control of white-pine weevil with DDT. Can. Dep. Agric., Sci. Serv., Div. For. Biol., Ottawa, Ontario. Biomon. Prog. Rep. 8(1):1.
- Application of DDT to leaders in the spring gave good control of *P. strobi*.
544. Sleeper, E.L. 1969. New Neotropical Curculionidae (Coleoptera). Bull. South. Calif. Acad. Sci. 68:241–247.
- Original description of *P. zitacuarensis* from Mexico.
545. Smith, J.B. 1910. The insects of New Jersey. In Annual report of the New Jersey State Museum for 1909. Trenton, New Jersey. [See pages 383, 615, 627.]
- Pissodes strobi* occurs throughout the state more or less commonly on pine and spruce. Pruning is recommended as a method of control. *Bracon pissodes* Ashm. and *Ephialtes comstockii* Cress. are listed as parasitoids.
546. Smith, J.H.G.; McLean, J.A. 1993. Methods are needed to prevent devastation of Sitka spruce plantations by the Sitka spruce weevil *Pissodes strobi* (Peck). Pages 81–93 in C.C. Ying and L.A. McKnight, eds. Proc. IUFRO Int. Sitka Spruce Provenance Exp. (Sitka Spruce Work. Group S2.02.12), Edinburgh, Scotland, 1984. B.C. Minist. For., Victoria, British Columbia, and Irish For. Board, County Wicklow, Ireland.

Growth and yield of Sitka spruce in British Columbia is compared to that in the United Kingdom and with other species in British Columbia. The impacts of *P. strobi* on Sitka spruce are discussed and several control tactics are assessed.

547. Smith, S.G. 1956. Chromosomal polymorphism in a bark weevil. *Nature* 177:386.

The number of chromosomes in *P. approximatus* (= *P. nemorensis*) varies from 30 to 32 with lower numbers resulting from centric fusion of non-homologous autosomes.
548. Smith, S.G. 1962a. Chromosomal polymorphism and inter-relationships among bark weevils of the genus *Pissodes* Germar: an amendment. *Nucleus* 5:65-66.

Presents a correction to reference 393.
549. Smith, S.G. 1962b. Cytogenetic pathways in beetle speciation. *Can. Entomol.* 94:941-955.

Discusses the cytology of hybrids between several *Pissodes* species.
550. Smith, S.G. 1965. Two rare species of *Pissodes* weevils. *Can. Dep. For., Ottawa, Ontario. Bi-mon. Prog. Rep.* 21(4):2.

Pissodes utahensis (= *P. similis*) were collected from a witches' broom on alpine fir near Vernon, B.C. Specimens of *P. similis* were collected from witches' brooms on balsam fir in northern Ontario. These collections represent significant range extensions and provide new information about hosts.
551. Smith, S.G. 1969. Chromosomal polymorphism in *Pissodes* weevils: further on the incompatibility in *P. terminalis*. *Can. J. Genet. Cytol.* 11:481.

Gives a further analysis of the semi-incompatibility system in *P. terminalis*.
552. Smith, S.G. 1970. Chromosomal polymorphism in North American *Pissodes* weevils: structural isomerism. *Can. J. Genet. Cytol.* 12:506-540.

Describes patterns of chromosome variation in *P. approximatus* (= *P. nemorensis*) across its range.
553. Smith, S.G. 1973a. Chromosomal polymorphism and inter-relationships in *Pissodes* weevils: additional cytogenetic evidence of synonymy. *Can. J. Genet. Cytol.* 15:83-100.

Based on cytogenetic and cross breeding studies, several species of *Pissodes* are synonymized.
554. Smith, S.G. 1973b. Karyotype analyses of *Pissodes* weevils: evidence for two additional putative taxa. *Can. J. Genet. Cytol.* 15:215-222.

Cytogenetic data and cross-breeding studies suggest two new *Pissodes* taxa, but both lack distinctive morphological characters.
555. Smith, S.G.; MacDonald, J.A. 1972. Occurrence of *Pissodes fiskei* (Coleoptera: Curculionidae) in Canada: cytology and geographic distribution. *Can. Entomol.* 104:785-796.

Pissodes fiskei has a transcontinental distribution. Males have 2N = 25 chromosomes and females have 2N = 24. *P. nigrae*, *P. alascensis*, and *P. rotundatus* are conspecific.
556. Smith, S.G.; Sugden, B.A. 1969. Host trees and breeding sites of native North American *Pissodes* bark weevils, with a note on synonymy. *Ann. Entomol. Soc. Am.* 62:146-148.

Summarizes synonymies within *Pissodes* based on cytogenetic data, and discusses hosts of various species.
557. Smith, S.G.; Takenouchi, Y. 1962. Unique incompatibility system in a hybrid species. *Science* 138:36-37.

All males of *P. terminalis* are heterozygous for an autosomal fusion; all females are homozygous. *Pissodes yosemite* (= *P. schwarzi*) was implicated in the putative hybrid origin of *P. terminalis*.
558. Smith, S.G.; Takenouchi, Y. 1967. Chromosomal polymorphism in *Pissodes* weevils: further on incompatibility in *P. terminalis*. *Can. J. Genet. Cytol.* 11:761-782.

All males of *P. terminalis* are heterozygous for an autosomal fusion; all females are homozygous. Results of cross breeding studies suggest a hybrid origin of *P. terminalis*.

559. Smith, S.G.; Virkki, N. 1978. Animal cytogenetics, Vol. 3. Insecta 5, Coleoptera. Gebrüder Borntraeger, Berlin, Germany. [See pages 175–187.]
Gives a review of all cytogenetic work on *Pissodes*.
560. Soles, R.L. 1967. Laboratory investigations of the vapor and contact repellency of terpenes to the adult pine weevil, *Pissodes strobi* Peck. M.Sc. thesis, Penn. State Univ., University Park, Pennsylvania.
Copy not seen.
561. Soles, R.L. 1970. Development and evaluation of methods for selecting pines for resistance to the white-pine weevil, *Pissodes strobi* (Peck). Ph.D. thesis, Penn. State Univ., University Park, Pennsylvania.
The contents of this thesis was published in the primary literature. For content, see annotations for references 563–565.
562. Soles, R.L.; Gerhold, H.D. 1968. Caged white pine seedlings attacked by white-pine weevil, *Pissodes strobi*, at five population densities. Ann. Entomol. Soc. Am. 61(6):1468–1473.
Seedlings from 80 provenances were exposed to *P. strobi* adult feeding. Provenances differed significantly in number of feeding punctures at two of the population densities. Results show that screening small trees in cages for weevil resistance may be feasible.
563. Soles, R.L.; Gerhold, H.D. 1976. Development and evaluation of methods for selecting pines for resistance to white-pine weevil. Res. Briefs 4:49–52.
Advocates comparison of host selection among eastern and western white pines to discern mechanisms of resistance in western white pine. Laterals can be substituted for leaders under conditions of forced attack to study differences in susceptibility among individual eastern white pines. The use of females results in a reduction of variation in the indexes of weevil attack and an increase in the likelihood of detecting differences among seedlings in weevil resistance.
564. Soles, R.L.; Gerhold, H.D.; Palpant, E.H. 1969. Testing white pine seedlings for weevil resistance. Pages 580–583 in Second FAO/IUFRO World Consult. For. Tree Breeding, August 7–16, 1969, Washington, D.C.
Caged eastern white pine seedlings facilitate easy testing for resistance to *P. strobi*. However, the effectiveness of this method is affected by weevil population density, sex ratio, length of seedling exposure to weevil feeding, and the combination of seedling species in cages.
565. Soles, R.L.; Gerhold, H.D.; Palpant, E.H. 1970. Resistance of western white pine to white-pine weevil. J. For. 68:766–768.
Results suggest that the resistance mechanism of western white pine either inhibits weevils from traveling to the trees or induces them to leave after landing.
566. Speers, C.F.; Ebel, B.H. 1971. Pales and pitch-eating weevils: ratio and period of attack in the south. U.S. Dep. Agric., For. Serv., Southeast. For. Exp. Stn., Asheville, North Carolina. Res. Note SE-156.
Pissodes spp. accounted for 3% of total weevil catch, and peaks of activity were April to early May and mid-August to early October.
567. Spittlehouse, D.L.; Adams, R.S.; Sieben, B. 1994. Measuring and modelling spruce leader temperatures. Pages 33–42 in R.I. Alfaro, G. Kiss, and R.G. Fraser, eds. The white pine weevil: biology, damage, and management. Proc. Meet., January 19–21, 1994, Richmond, British Columbia. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 226.
Techniques for assessing hazard of *P. strobi* attacks were developed based upon measurements of leader temperature and air temperature to estimate heat accumulation sums for weevil development. An energy balance model of spruce leaders was formulated that adequately simulated the trends in leader temperature as a function of weather conditions.

568. Spittlehouse, D.L.; Sieben, B. 1994. Mapping the effect of climate on spruce weevil infestation hazard. Pages 448–450 in Preprints 21st Conf. Agric. For. Meteorol. and 11th Conf. Biometeorol. Aerobiology, March 7–11, 1994, San Diego, California. Am. Meteorol. Soc., Boston, Massachusetts. Copy not seen.
569. Spittlehouse, D.L.; Sieben, B.G.; Taylor, S.P. 1994. Spruce weevil hazard mapping based on climate and ground survey data. Pages 23–32 in R.I. Alfaro, G. Kiss, and R.G. Fraser, eds. The white pine weevil: biology, damage, and management. Proc. Meet., January 19–21, 1994, Richmond, British Columbia. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 226.
- Growing degree-day data were used to assess *P. strobi* hazard. Hazard predictions compared well with ground survey data.
570. Spurr, S.H.; Friend, R.B. 1941. Compression wood in weeviled northern white pine. J. For. 39:1005–1006.
- Weeviled eastern white pine in which the stems have straightened out still have stem defects in the form of compression wood, cross-grain, and large knots.
571. Stark, R.W.; Wood, D.L. 1964. The biology of *Pissodes terminalis* Hopping (Coleoptera: Curculionidae) in California. Can. Entomol. 96:1208–1218.
- The phenology and development of *P. terminalis* in central California is described and compared with development on jack pine in Canada. Mortality is high and is caused by resin flow and parasitoids.
572. Steiner, G. 1930. *Neodiplogaster pinicola*, n. sp., a nema associated with the white pine weevil in terminal shoots of the white pine. J. Agric. Res. 41(2):125–130.
- A new nematode is described. This species may be a predator of eggs and larvae of *P. strobi*.
573. Stevens, R.E. 1966. Observations on the Yosemite bark weevil in California (Coleoptera: Curculionidae). Pan-Pac. Entomol. 42(3):184–189.
- The phenology, habits, and parasitoids of *P. yosemite* (= *P. schwarzi*) are described.
574. Stevens, R.E. 1973. Association of *Pityophthorus opimus* with *Pissodes terminalis* in Colorado lodgepole pine (Coleoptera: Scolytidae & Curculionidae). Coleopt. Bull. 27:141–142.
- Pityophthorus opimus* Blackman is reported as an associate of *Pissodes terminalis*. These observations constitute new host and locality records for *P. opimus* and also indicate an example of commensalism between the two beetle species.
575. Stevens, R.E.; Knopf, J.A.E. 1974. Lodgepole terminal weevil in interior lodgepole pine forests. Environ. Entomol. 3(6):998–1002.
- Gives information on phenology and parasitoids of *P. terminalis*. Infestations were heaviest in stands 5–20 ft tall and in dense stands.
576. Stevenson, R.E. 1963. Insects associated with the Engelmann spruce weevil, *Pissodes engelmanni* Hopkins. Can. Dep. For., For. Entomol. Pathol. Branch, Ottawa, Ontario. Bi-mon. Prog. Rep. 19(5):2–3.
- Provides a list of parasitoids and predators of *P. engelmanni* (= *P. strobi*).
577. Stevenson, R.E. 1967. Notes on the biology of the Engelmann spruce weevil, *Pissodes engelmanni* (Coleoptera: Curculionidae), and its parasites and predators. Can. Entomol. 99(2):201–213.
- Provides information on the distribution, phenology, and habits of *P. engelmanni* (= *P. strobi*). Mortality due to insect predators and parasitoids and birds was assessed. Biological information is provided for the most important parasitoids and predators.
578. Stevenson, R.E.; Petty, J.J. 1968. Lodgepole terminal weevil (*Pissodes terminalis* Hopping) in the Alberta/Northwest Territories region. Can. Dep. For. Rural Dev., For. Branch, Ottawa, Ontario. Bi-mon. Res. Notes 24(1):6.

Describes phenology of *P. terminalis* and lists parasitoids. Open-growing stands have higher incidences of attack than denser stands.

579. Stewart, W.E.; Bright, D.E. 1982. Notes on *Pissodes fiskei* (Coleoptera: Curculionidae) with a redescription of the species. *Coleopt. Bull.* 36:445-452.

Gives a morphological description of *P. fiskei*.

580. Stiehl, W.M. 1968. Thinning technique improves quality of white pine stands. *Can. For. Ind.* 88(3):54-56.

Close planting seemed to reduced damage by *P. strobi* and allowed enough trees to develop satisfactorily for at least one log length. Manual thinning of these stands was expensive.

581. Stiehl, W.M. 1979. Releasing unweeviled white pine to ensure first-log quality of final crop. *For. Chron.* 55:142-143.

Eastern white pine planted in close spacings to reduce damage by *P. strobi* require release of selected crop trees, unweeviled within the first 5-m log.

582. Stiehl, W.M.; Berry, A.B. 1985. Limiting white pine weevil attacks by side shade. *For. Chron.* 61:5-9.

It was concluded that clear-cut strips in conifers or mixed woods, where the ratio of strip width to stand height was 0.66 to 1.00 (admitting a nominal 50 to 75% of full light), will allow adequate numbers of eastern white pine to reach a height of one log length (5.2 m) free from weevil damage. This method is not effective in hardwood stands.

583. Streett, D.A.; Sprague, V.; Harman, D.M. 1975. Brief study of microsporidian pathogens in the white pine weevil *Pissodes strobi*. *Chesapeake Sci.* 16(1):32-38.

A *Nosema* species was found in living and dead larvae and adults of *P. strobi* and was believed to cause mortality.

584. Stroh, R.C. 1964a. Genetic variation of white pine characteristics related to weevil attack. Ph.D. thesis, Penn. State Univ., University Park, Pennsylvania.

The contents of this thesis was published in the primary literature. For content, see annotations for references 585-586.

585. Stroh, R.C. 1964b. Racial variation of the leader characteristics of *Pinus strobus* L. correlated with feeding by the white pine weevil. Pages 41-48 in *Proc. 11th Northeast. For. Tree Improv. Conf.*, August 6-7, 1963, New Brunswick, New Jersey. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania.

Bark thickness and depth of inside and outside cortical resin ducts are significantly positively correlated with extent of feeding by adult *P. strobi*.

586. Stroh, R.C.; Gerhold, H.D. 1965. Eastern white pine characteristics related to weevil feeding. *Silvae Genet.* 14(5):160-169.

Bark thickness and depth of inside and outside cortical resin ducts are significantly positively correlated with extent of feeding by adult *P. strobi*.

587. Sullivan, C.R. 1953. Use of radioactive cobalt in tracing the movements of the white-pine weevil, *Pissodes strobi* Peck (Coleoptera: Curculionidae). *Can. Entomol.* 85(8):273-276.

Cellulose acetate cement proved to be an effective cement for attaching the Co⁶⁰ label to insects. Treated beetles suffered twice as high mortality over the winter as untreated beetles.

588. Sullivan, C.R. 1957. A biological study of the white pine weevil *Pissodes strobi* Peck, with special reference to the effect of physical factors on its activity and behavior. Ph.D. thesis, McGill Univ., Montréal, Québec.

The contents of this thesis was published in the primary literature. For content, see annotations for references 589, 591, and 593-594.

589. Sullivan, C.R. 1959a. The effect of light and temperature on the behaviour of adults of the white pine weevil, *Pissodes strobi* Peck. *Can. Entomol.* 91(4):213-232.

Adults are usually photopositive but become photonegative when overheated and when starved and subjected to low temperatures in the fall.

590. Sullivan, C.R. 1959b. White pine weevil. *Can. Dep. Agric., Res. Branch, For. Biol. Div., Ottawa, Ontario. Bi-mon. Prog. Rep.* 15(2):1.

In open stands weevils show a definite preference for vigorous leaders. Terminal leaders of trees in shaded stands are unsuitable for weevil development.

591. Sullivan, C.R. 1960a. The effect of physical factors on the activity and development of adults and larvae of the white pine weevil, *Pissodes strobi* (Peck). Can. Entomol. 92(10):732-745.

Summarizes the effect of bark temperature and relative humidity on *P. strobi* adult activities including movement, feeding, mating, and oviposition.

592. Sullivan, C.R. 1960b. The white pine weevil, *Pissodes strobi*, Peck. Pages 125-131 in K.W. Horton and G.H.D. Bedell, eds. White and red pine—ecology, silviculture, and management. Can. Dep. North. Aff. Natl. Resour., For. Branch, Ottawa, Ontario. Bull. 124.

Gives a review of *P. strobi* damage, life history, habits, and control.

593. Sullivan, C.R. 1961a. The effect of weather and the physical attributes of white pine leaders on the behaviour and survival of the white pine weevil, *Pissodes strobi* Peck, in mixed stands. Can. Entomol. 93(9):721-741.

Microenvironment and the size of leaders determine the degree of protection from weevil attack. The relative importance of these factors varies with the level of sun exposure on the stands.

594. Sullivan, C.R. 1961b. The survival of adults of the white pine weevil, *Pissodes strobi* (Peck), labelled with radioactive cobalt. Can. Entomol. 93(1):78-79.

Mortality of adult weevils increased with increased level of exposure and with increased time post-treatment.

595. Sullivan, C.R. 1966. Testing pre-selected pine grafts for resistance to the white pine weevil, *Pissodes strobi* Peck. Pages 145-150 in Proc. 10th Meet. Comm. For. Tree Breeding Can. Part 2, September 7-10, 1966, Vancouver, British Columbia. Can. Dep. Fish. Rural Dev., For. Branch, Ottawa, Ontario.

The amount of *P. strobi* damage to grafts varied greatly with the source (species and locality) of the clone.

596. Sullivan, C.R. 1967. The white pine weevil in Ontario: recent and current studies related to the improvement of white pine quality. Pages 59-62 in Proc. 14th Northeast. For. Tree Improv. Conf., August 10-11, 1966, Toronto, Ontario. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania.

Summary of previous and ongoing work on white pine improvement with respect to *P. strobi*.

597. Sundaram, K.M.S. 1973. Persistence studies of insecticides. I. Aerial application of methoxychlor for control of white pine weevil in Ontario, 1973. Environ. Can., Can. For. Serv., Chem. Control Res. Inst., Ottawa, Ontario. Inf. Rep. CC-X-57.

Aerial application of methoxychlor in eastern white pine stands reduced incidence of damage by *P. strobi* by 80%.

598. Sundaram, K.M.S. 1974. Persistence studies of insecticides. II. Degradation of Gardona® on white pine leaders (*Pinus strobus* L.) after aerial application for control of white pine weevil (*Pissodes strobi* Peck) in Ontario, 1973. Environ. Can., Can. For. Serv., Chem. Control Res. Inst., Ottawa, Ontario. Inf. Rep. CC-X-62.

Aerial application of Gardona® in eastern white pine stands reduced incidence of damage by *P. strobi* by 56%.

599. Sundaram, K.M.S. 1975. Persistence studies of insecticides. VI. Degradation of methoxychlor on white pine leaders (*Pinus strobus* L.) after aerial application for control of white pine weevil (*Pissodes strobi* Peck) in Ontario, spring 1974. Environ. Can., Can. For. Serv., Chem. Control Res. Inst., Ottawa, Ontario. Rep. CC-X-99.

Aerial application of methoxychlor in an oil formulation in eastern white pine stands reduced incidence of damage by *P. strobi* by 55%.

600. Sundaram, K.M.S. 1977. A study on the comparative deposit levels and persistence of two methoxychlor formulations used in white pine weevil control. Environ. Can., Can. For. Serv., Chem. Control Res. Inst., Ottawa, Ontario. Rep. CC-X-142.
- Spring and fall aerial applications of two formulations (oil and emulsion) of methoxychlor in *P. strobi*-infested eastern white pine stands were applied. Data on weevil damage incidence after treatment are not yet available.
601. Sundaram, K.M.S.; LeCompte, P.E. 1975. Persistence studies of insecticides. V. Degradation of carbaryl on white pine leaders (*Pinus strobus* L.) after aerial application for control of white pine weevil (*Pissodes strobi* Peck) in Ontario, 1974. Environ. Can., Can. For. Serv., Chem. Control Res. Inst., Ottawa, Ontario. Rep. CC-X-98.
- Aerial application of carbaryl in eastern white pine stands reduced incidence of damage by *P. strobi* by 45%.
602. Sundaram, K.M.S.; Smith, G.G.; O'Brien, W.; Bonnett, D. 1972. A preliminary report on the persistence of methoxychlor for the control of white pine weevil in plantations. Environ. Can., Can. For. Serv., Chem. Control Res. Inst., Ottawa, Ontario. Inf. Rep. CC-X-31.
- Methoxychlor applied as an aqueous emulsion provided adequate protection of leaders of eastern white pine from attack by *P. strobi*. Methoxychlor had low persistence; 50% had disappeared off leaders after 26 days.
603. Sutherland, B.G.; DeBoo, R.F. 1973. White pine weevil bibliography. Environ. Can., Can. For. Serv., Chem. Control Res. Inst., Ottawa, Ontario. Inf. Rep. CC-X-40.
- Includes a listing of publications (not annotated) relating to *P. strobi* published between 1817 and 1973.
604. Sutherland, C.; Newsome, T. 1988. Field performance of five interior spruce stock types with and without fertilization at time of planting. Pages 195-198 in Proc. Comb. Meet. West. For. Nursery Council, and For. Nursery Assoc. B.C., August 8-11, 1988, Vernon, British Columbia. U.S. Dep. Agric., For. Serv., Rocky Mt. For. Range Exp. Stn., Fort Collins, Colorado, Gen. Tech. Rep. RM-167.
- Pissodes strobi* attacked all stocks of seedlings. Attack was concentrated on taller stock types and where frequency of taller seedlings was high.
605. Syme, P.D. 1985. Eastern white pine in Ontario: its entomological, pathological, physiological and other problems. Proc. Entomol. Soc. Ont. Suppl. 116:21-31.
- The incidence of *P. strobi* damage in eastern white pine plantations surveyed in Ontario in 1980 and 1983 is given.
606. Syme, P.D. 1990. Insect pest problems and monitoring in Ontario conifer plantations. Rev. Entomol. Qué. 35(1/2):25-30.
- Gives data on incidence of *P. strobi* in black spruce, white spruce, and eastern white pine plantations.
607. Syme, P.D.; Nystrom, K.L. 1988. Insects and mites associated with Ontario forests: classification, common names, main hosts and importance. Can. For. Serv., Great Lakes For. Cent., Sault Ste. Marie, Ontario. Inf. Rep. 0-X-392.
- Six species of *Pissodes* are recorded from Ontario.
608. Szuba, K.; Pinto, F. 1991. Natural history of the white pine weevil and strategies to decrease its damage to conifers in Ontario. Cent. Ont. For. Tech. Dev. Unit, North Bay, Ontario. Tech. Rep. 13.
- Copy not seen.
609. Talerico, R.L.; Wilson, R.W., Jr. 1973. Sampling plantations to determine white-pine weevil injury. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania. Res. Note NE-173.
- Describes the use of 0.1-acre plots to obtain the proportion of trees free of weevil damage in plantations.

610. Taylor, R.L. 1927a. A new species of parasitic Hymenoptera (Chalcidoidea, Eupelmidae). Bull. Brooklyn Entomol. Soc. 22:205–207.
Describes *Eupelmus pini* reared from *P. strobi*.
611. Taylor, R.L. 1927b. Notes on the mite *Pediculoides ventricosus* Newport. Psyche (Camb.) 34:157–163.
Mites attacked prepupae of *Eurytoma pissodis* Gir., a hymenopterous parasitoid of *P. strobi*.
612. Taylor, R.L. 1928a. A new species of *Lonchaea* Fallen (Lonchaeidae, Diptera). Bull. Brooklyn Entomol. Soc. 23:191–194.
Gives the original description of *Lonchaea corticis*, a predator of *P. strobi*.
613. Taylor, R.L. 1928b. The arthropod fauna of coniferous leaders weeviled by *Pissodes strobi* (Peck). Psyche (Camb.) 35:217–225.
Gives a list of arthropods associated with *P. strobi*.
614. Taylor, R.L. 1929. The biology of the white pine weevil, *Pissodes strobi* (Peck), and a study of its insect parasites from an economic viewpoint. Entomol. Am. 9(4):167–246 and Entomol. Am. 10(1):1–86.
A detailed review of the biology of *P. strobi* is given, including information on distribution, hosts, damage to trees, descriptions of life stages, phenology, behavior, and control. Details on rearing of parasitoids are provided. Major species of natural enemies are described with respect to morphology and biology. The feasibility of biological control of *P. strobi* using native and exotic parasitoids is discussed.
615. Taylor, R.L. 1930a. A new host record for the white pine weevil. J. Econ. Entomol. 23:640.
Swiss mountain pine, *Pinus montana*, was attacked by *P. strobi*.
616. Taylor, R.L. 1930b. The natural control of forest insects. I. The white pine weevil, *Pissodes strobi* Peck. J. For. 28:546–551.
Discusses sources of mortality for *P. strobi*.
617. Taylor, S.P.; Alfaro, R.; Delong, C.; Rankin, L. 1994. The effects of overstory shading on white pine weevil damage to interior white spruce. Pages 254–261 in R.I. Alfaro, G. Kiss, and R.G. Fraser, eds. The white pine weevil: biology, damage, and management. Proc. Meet., January 19–21, 1994, Richmond, British Columbia. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 226.
Current weevil attacks decreased significantly with increasing overstory cover. Shading also decreased leader growth. Suggests that an optimum level of overstory removal may be a compromise between volume loss due to overstory competition and volume gain due to decreased weevil attacks.
618. Taylor, S.P.; Alfaro, R.I.; Delong, C.; Rankin, L. 1996. The effects of overstory shading on white pine weevil damage to white spruce and its effects on spruce growth rates. Can. J. For. Res. 26:306–312.
See also abstract for previous reference. This publication provides more detail and data about findings reported in reference 617.
619. Taylor, S.; Alfaro, R.I.; Lewis, K. 1991. Factors affecting the incidence of white pine weevil damage to white spruce in the Prince George Region of British Columbia. J. Entomol. Soc. B.C. 88:3–7.
The average percentage attack on white spruce was 3.2% (range 0 to 26.6%). Attacks increased with increasing biogeoclimatic subzone moisture. There was no correlation between percentage attack and site quality or tree age.
620. Taylor, S.P.; Cozens, R.D. 1994. Limiting white pine weevil attacks by side and overstory shade in the Prince George Forest Region. J. Entomol. Soc. B.C. 91:37–42.
Results indicate that up to 6% reductions in annual attack rates could be expected for at least 5 years following treatment, but that differences in attack rates between treatments took at least 3 years to appear.
621. Taylor, S.P.; Lindgren, B.S.; Johnson, J. 1995. Detection of *Pissodes strobi* (Coleoptera: Curculionidae) using large-scale 70 mm color photography. J. Entomol. Soc. B.C. 92:81–86.

Large-scale 70-mm photography can detect currently attacked spruce leaders with an accuracy approaching 90% providing at least 30% of the red needles remain on the damaged leader and experienced photo-interpreters assess the photos.

622. Teich, A.H. 1972. Some characteristics of selected and unselected populations of Norway spruce. *For. Chron.* 48(4):198–200.

The progeny from a Norway spruce population selected for weevil resistance and frost tolerance was taller and had less leader and frost damage than other unselected trees. No significant differences were found between progenies from populations of white and Norway spruce subjected to selection.

623. Therrien, P. 1995. La répression naturelle du charançon du pin blanc: les organismes impliqués et leur impact. [Natural control of the white pine weevil: organisms involved and their impact.] Pages 70–78 in R. Lavallée and G. Bonneau, eds. *Compte-rendu du colloque sur le charançon du pin blanc*. Proc. Symp., September 27–28, 1994, Ste.-Foy, Québec. Ressour. nat. Can., Serv. can. for., Rég. Qué., Cent. for. Laurentides, Ste-Foy (Québec), et Ressour. nat. Qué., Dir. conserv. for., Québec (Québec).

The population dynamics of *P. strobi* were studied over 3 years. Major sources of mortality were *Lonchaea corticis*, birds, resin, and hymenopterous parasitoids.

624. Thomas, J.B. 1964. A key to the larvae and pupae of three weevils (Coleoptera: Curculionidae). *Can. Entomol.* 96(11):1417–1420.

A key is provided to larvae and pupae of *P. approximatus* (= *P. nemorensis*), *P. affinis*, and *Hylobius congener*, all common in red pine plantations in central Ontario.

625. Thomas, J.B.; Krywienczyk, J. 1966. Preliminary results of a serological examination of some Scolytidae and Curculionidae. *Can. Entomol.* 98(10):1094–1099.

Pissodes approximatus (= *P. nemorensis*) and *P. affinis* were included in the serological survey. Both species showed strong affinity to antiserum from both beetle families.

626. Timonin, M.; Morris, O.N. 1974. Pathogenicity of some entomogenous fungi, their compatibility and integrated activity with chemical insecticides against *Pissodes strobi* (Peck). *Environ. Can., Can. For. Serv., Chem. Control Res. Inst., Ottawa, Ontario. Inf. Rep. CC-X-69.*

Larvae, pupae, and to a lesser extent adults, were highly susceptible to the fungi *Beauveria bassiana* and *Metarrhizium anisopliae*. Low concentrations of chemical insecticides enhanced the virulence of the pathogens.

627. Tomlin, E.S.; Borden, J.H. 1994a. Development of a multicomponent resistance index for Sitka spruce resistance to the white pine weevil. Pages 117–133 in R.I. Alfaro, G. Kiss, and R.G. Fraser, eds. *The white pine weevil: biology, damage, and management*. Proc. Meet., January 19–21, 1994, Richmond, British Columbia. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 226.

Describes a multi-component resistance index for Sitka spruce based on numbers of outer resin ducts and resin composition.

628. Tomlin, E.S.; Borden, J.H. 1994b. Relationship between leader morphology and resistance or susceptibility of Sitka spruce to the white pine weevil. *Can. J. For. Res.* 24:810–816.

Some weevil-resistant provenances had higher numbers of outer resin ducts than other provenances. Other resistant provenances clearly do not rely on resin system morphology for resistance.

629. Tomlin, E.S.; Borden, J.H. 1996. Feeding responses of the white pine weevil, *Pissodes strobi* (Peck) (Coleoptera: Curculionidae), in relation to host resistance in British Columbia. *Can. Entomol.* 128(4):539–549.

In laboratory bioassays, fall weevils were deterred from feeding up to 80%, and spring weevils up to 60%, by resistant clones of Sitka spruce. Fall males were more consistently deterred than spring males. Trees from the Big Qualicum and Green Timbers provenances caused the most consistent feeding or

oviposition deterrence. Lack of deterrence in some resistant clones and provenances suggested presence of other mechanisms of resistance.

630. Tomlin, E.S.; Borden, J.H.; Pierce, H.D., Jr. 1996. Relationship between cortical resin acids and resistance of Sitka spruce to the white pine weevil. *Can. J. Bot.* 74:599–606.

Trees in 5 of 11 resistant genotypes had significantly greater amounts of cortical resin acid than susceptible trees. Six of the seven cortical resin acids measured were found in greater amounts in trees from resistant than susceptible provenances.

631. Townes, H. 1983. Revisions of twenty genera of Gelini (Ichneumonidae). *Mem. Am. Entomol. Inst.* 35. [See page 154.]

Helcostizus contortae, a hymenopterous parasitoid of *P. terminalis* in lodgepole pine, is described.

632. Townes, H.; Townes, M. 1960. Ichneumonflies of America north of Mexico. 2. Subfamilies Ephialtinae, Xoridinae, Acaenitinae. *U.S. Natl. Mus. Bull.* 216, part 2. [See pages 11–13, 122–124.]

Describes *Exeristes comstockii* (Cresson) and *Dolichomitrus terebrans nubilipennis* (Viereck) which were reared from several species of *Pissodes*.

633. Townes, H.; Townes, M. 1962. Ichneumonflies of America north of Mexico. 3. Subfamily Gelinae, tribe Mesostenini. *U.S. Natl. Mus. Bull.* 216, part 3. [See page 518.]

Describes *Helcostizus albator* (Thunberg) reared from *Pissodes* (probably *terminalis*) infested lodgepole pine tips.

634. Trefts, H. 1958. Red pine and white pine weevil. M.Sc. thesis, Univ. Mich., Ann Arbor, Michigan.

Copy not seen.

635. Trudel, R.; Lavallée, R.; Baucé, É.; Cabana, J.; Guertin, C. 1994. Variations in ground white pine bark concentration in artificial diet in relation to egg laying, feeding, and mortality of *Pissodes strobi* (Coleoptera: Curculionidae). *J. Econ. Entomol.* 87(1):96–100.

Concentration of bark in artificial diet influenced oviposition, feeding, and mortality but not development time.

636. Valentine, B.D.; Valentine, B.S. 1957. Some injurious weevils in Haiti (Curculionidae). *Coleopt. Bull.* 11:29–32.

An undescribed species of *Pissodes* was collected from pine in Haiti.

637. van Buijtenen, J.P.; Santamour, F.S., Jr. 1972. Resin crystallization related to weevil resistance in white pine (*Pinus strobus*). *Can. Entomol.* 104:215–219.

Differences in crystallization properties between successfully and unsuccessfully attacked trees are significant and indicate that non-crystallization is associated with resistance to weevil attack.

638. Van Dyke, E.C. 1927. New species of North American Rhynchophora (Coleoptera). *Pan-Pac. Entomol.* 4:11–17.

Gives original descriptions of *P. robustus* and *P. ochraceus* collected in California.

639. VanderSar, T.J.D. 1977a. Aspects of host selection behavior in *Pissodes strobi* (Peck) (Coleoptera: Curculionidae). Ph.D. thesis, Simon Fraser Univ., Burnaby, British Columbia.

The contents of this thesis was published in the primary literature. For content, see annotations for references 640–646.

640. VanderSar, T.J.D. 1977b. Overwintering survival of *Pissodes strobi* (Peck) (Coleoptera: Curculionidae) in Sitka spruce leaders. *J. Entomol. Soc. B.C.* 74:37.

Pissodes strobi can successfully overwinter in the larval stage in Sitka spruce terminals in coastal British Columbia.

641. VanderSar, T.J.D. 1978a. Emergence of predators and parasites of the white pine weevil, *Pissodes strobi* (Coleoptera: Curculionidae) from Engelmann spruce. *J. Entomol. Soc. B.C.* 75:14–18.

The fly, *Lonchaea corticis*, was the most abundant species associated with *P. strobi*. Twelve other species emerged from infested terminals, four of which were parasitoids of *P. strobi*.

642. VanderSar, T.J.D. 1978b. Resistance of western white pine to feeding and oviposition by *Pissodes strobi* Peck in western Canada. *J. Chem. Ecol.* 4(6):641–647.
- In choice experiments, female *P. strobi* preferred to feed on Engelmann spruce rather than western white pine; males did not show a preference. Females oviposited only on Engelmann spruce.
643. VanderSar, T.J.D.; Borden, J.H. 1977a. Aspects of host selection behaviour of *Pissodes strobi* (Coleoptera: Curculionidae) as revealed in laboratory feeding bioassays. *Can. J. Zool.* 55:405–414.
- Adult *P. strobi* preferred Sitka spruce over Douglas-fir, western hemlock, and western red cedar. Females may have a more prominent role than males in host selection. Western red cedar contains repellents or feeding deterrents.
644. VanderSar, T.J.D.; Borden, J.H. 1977b. Role of geotaxis and phototaxis in the feeding and oviposition behaviour of overwintered *Pissodes strobi*. *Environ. Entomol.* 6(5):743–749.
- Choice of oviposition sites by overwintered *P. strobi* females on excised Sitka spruce leaders and lateral branches is governed primarily by positive phototaxis and negative geotaxis. These orientation mechanisms, however, exert comparatively little influence on the selection of feeding sites along the length of excised host materials.
645. VanderSar, T.J.D.; Borden, J.H. 1977c. Visual orientation of *Pissodes strobi* Peck (Coleoptera: Curculionidae) in relation to host selection behaviour. *Can. J. Zool.* 55:2042–2049.
- Visual orientation plays an important role in short-range host selection. Adult weevils prefer the longest and thickest Sitka spruce terminals.
646. VanderSar, T.J.D.; Borden, J.H.; McLean, J.A. 1977. Host preference of *Pissodes strobi* Peck (Coleoptera: Curculionidae) reared from three native hosts. *J. Chem. Ecol.* 3(4):377–389.
- In forced feeding bioassays, *P. strobi* reared from eastern white pine, Engelmann spruce, or Sitka spruce failed to discriminate between these hosts. Data suggest that eastern white pine is the ancestral host of *P. strobi*.
647. Viereck, H.L. 1916. Guide to the insects of Connecticut. Part 3. The Hymenoptera, or wasp-like insects, of Connecticut. *Conn. State Geol. Nat. Hist. Surv.*, Hartford, Connecticut. Bull. 22. [See page 210, 765.]
- Coeloides pissodis* Ashmead is reported as a parasitoid of *P. strobi*.
648. von Dalla Torre, K.W.; Schenkling, S.; Marshall, G.A.K. 1932. Curculionidae: Subfam. Pissodinae. *Coleopterorum Catalogus*, part 125.
- A catalogue of all species of *Pissodes* in the world, with general distributions, references, and synonyms.
649. Voss, E. 1955. Eine in Guatemala aufgefunden *Pissodes*-Art. [A new *Pissodes* species found in Guatemala.] *Mitt. Muench. Entomol. Ges.* 44–45:240–241.
- Gives the original description of *P. guatemalteucus*.
650. Walden, B.H. 1914. Experiments in controlling the white pine weevil. Pages 173–176 in *Thirty-seventh annual report of the Connecticut Experiment Station, 1913*. State Conn., Hartford, Connecticut. Public Doc. 24.
- Discusses three control strategies: 1) pruning infested terminals and placing them in screened cages to allow emergence of natural enemies but not weevils; 2) application of lime-sulfur and lead arsenate pesticides; and 3) collection of feeding weevils from terminals in the spring using sweep nets. All three were effective methods of control.
651. Walden, B.H. 1916. Experiments in controlling the white pine weevil in 1915. Pages 134–136 in *Thirty-ninth annual report of the Connecticut Experiment Station, 1915*. State Conn., Hartford, Connecticut. Public Doc. 24.
- Application of lime-sulfur and lead arsenate and sweeping of feeding adults from terminals in the spring were all somewhat effective at reducing damage.

652. Wall, R.E. 1988. Deterioration of severely defoliated balsam fir in relation to stand age, spacing, and foliar protection. *Can. J. For. Res.* 18:490–497.
- Pissodes dubius* (= *P. striatulus*) was associated with decaying balsam fir.
653. Wallace, D.R.; Sullivan, C.R. 1985. The white pine weevil, *Pissodes strobi* (Coleoptera: Curculionidae): a review emphasizing behavior and development in relation to physical factors. *Proc. Entomol. Soc. Ont. Suppl.* 116:39–62.
- The development and behavior of *P. strobi* are reviewed in detail. Particular attention is paid to those features of biology that may be exploited in devising management schemes, especially the less favorable nature of shaded (cool) environments for adult activity and brood development.
654. Warkentin, D.L.; Gara, R.I.; Mehary, T. 1984. Aerial field trials of two organophosphorus insecticides against Sitka spruce weevil. *Int. Pest Control* 26(5):66–67.
- Aerial application of acephate and oxydemeton methyl to Sitka spruce canopy in the spring did not give effective control of *P. strobi*.
655. Warkentin, D.L.; Overhulser, D.L.; Gara, R.I.; Hinckley, T.M. 1992. Relationships between weather patterns, Sitka spruce (*Picea sitchensis*) stress, and possible tip weevil (*Pissodes strobi*) infestation levels. *Can. J. For. Res.* 22(5):667–673.
- High vapor pressure deficit (VPD) regimes in inland sites resulted in high water stress and decreased photosynthesis in Sitka spruce, which may have contributed to lower defenses against *P. strobi* attack. Coastal sites generally experienced lower VPD regimes, infrequent water stress, and lower amounts of weevil attack.
656. Warner, R.E. 1971. Synonymy in the genus *Pissodes* (Coleoptera: Curculionidae). *U.S. Dep. Agric., Washington, D.C., Coop. Econ. Insect Rep.* 21(10):106.
- Summarizes synonymies in the genus *Pissodes* based on recent taxonomic work by S.G. Smith.
657. Waters, W.E. 1962. Uninjured trees—a meaningful guide to white pine weevil control decisions. *U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania. For. Res. Note* 129.
- Argues that *P. strobi* control decisions should be based on number of uninjured trees rather than number of injured trees.
658. Waters, W.E. 1969. The life table approach to analysis of insect impact. *J. For.* 67:300–304.
- Recommends that a life table approach be used to assess impact of insects on trees. A life table is presented for eastern white pine and includes information on impact of *P. strobi*. Weevil damage was greatest in the 3–20 year age class.
659. Waters, W.E.; McIntyre, T. 1953. Airplane spraying for white pine weevil control in New York—1952. Analysis of DDT deposit data. *U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., New Haven, Connecticut. Spec. Rep. NH-1.* [Unpublished.]
- Copy not seen.
660. Waters, W.E.; McIntyre, T.; Crosby, D. 1955. Loss in volume of white pine in New Hampshire caused by white-pine weevil. *J. For.* 53:271–274.
- White pine weevil damage accounted for 40% loss in board-foot volume of saw-timber trees and 70% loss in merchantable volume.
661. Watson, E.B. 1936. Preliminary notes on the white pine weevil situation in the Petawawa Forest Reserve, Ontario. *Entomol. Soc. Ont. Annu. Rep.* 66:7–8.
- The response of *P. strobi* to tree vigor, stand density, inter-planting of tree species, and overstory shading is briefly discussed.
662. Weetman, G.F.; Fournier, R.; Barker, J.; Schnorbus-Panozzo, E.; Germain, A. 1989. Foliar analysis and response of fertilized chlorotic Sitka spruce plantations on salal-dominated cedar-hemlock cutovers on Vancouver Island. *Can. J. For. Res.* 19:1501–1511.
- Sitka spruce fertilized with N and P showed a high incidence of attack by *P. strobi*.
663. Weir, H.J. 1964. Susceptibility of natural stands of white pine to the white pine weevil, *Pissodes strobi* Peck. *Can. Dep. For.,*

For. Entomol. Pathol. Branch, Ottawa,
Ontario. Bi-mon. Prog. Rep. 20(3):2.

Pissodes strobi damage was common to the tops
of 110 ft tall trees. It appears that the effect of
shading rather than the height of the leading
shoots limited attack by weevils.

664. Wells, A.B. 1926. Notes on *Hylobius pales*
Boh. and *Pissodes strobi* Peck as nursery
pests. J. Econ. Entomol. 19:412-413.

Reports finding *P. strobi* and *Hylobius pales* in the
root collar area of dead pines, spruces, and firs
in nurseries. [Author's note: this is likely *P.*
nemorensis rather than *P. strobi*.]

665. West, A.S., Jr. 1947. The effect of the white
pine weevil on plantations on the
University of New Brunswick Forest. For.
Chron. 23:291-296.

Almost 86% of eastern white pine in plantations
were weeviled between 1932 and 1945. The
frequency of weevil attacks and resulting
impacts on tree height and diameter growth
and stem deformities was higher in the 4 x 8 ft
spacings than in the 4 x 4 ft spacings.

666. Whitney, E.G.; Godwin, P.A. 1979. Changes
in the gross morphology of the ventral
nerve cord during metamorphosis of the
white-pine weevil *Pissodes strobi* (Peck)
(Coleoptera: Curculionidae). Int. J. Insect
Morphol. Embryol. 8:229-236.

The morphology of the ventral nerve cord, and
the fusion of ganglia during metamorphosis are
described.

667. Whitton, R.R.; Parker, D.E. 1946.
Experimental control of shade tree insects
with DDT. Pages 13-17 in P.E. Tilford, ed.
Proc. 21st Natl. Shade Tree Conf., 1945.
Collier Print. Co., Wooster, Ohio.

Copy not seen.

668. Wilkinson, R.C. 1975. Silicone antitranspirant
increases susceptibility of eastern white
pine to the white-pine weevil. U.S. Dep.
Agric., For. Serv., Northeast. For. Exp. Stn.,
Upper Darby, Pennsylvania. Res. Pap. NE-
326.

Application of silicone antitranspirant increased
internal water content of trees. Treated trees
sustained much higher damage by *P. strobi*. The

higher leader mortality of treated trees may
have resulted from increased egg production by
weevils. The higher number of treated trees
attacked suggests that these are more attractive
than control trees.

669. Wilkinson, R.C. 1979a. Cortical strobic acid
concentrations in eastern white pine
resistant and susceptible to the white-pine
weevil. Pages 121-132 in Proc. 26th
Northeast. For. Tree Improv. Conf. U.S.
Dep. Agric., For. Serv., Northeast. For. Exp.
Stn., Broomall, Pennsylvania.

Weevil-resistant and susceptible trees did not
differ with respect to concentrations of nine
resin acids.

670. Wilkinson, R.C. 1979b. Oleoresin
crystallization in eastern white pine:
relationships with chemical components of
cortical oleoresin and resistance to the
white-pine weevil. U.S. Dep. Agric., For.
Serv., Northeast. For. Exp. Stn., Broomall,
Pennsylvania. Res. Pap. NE- 438.

Variation in crystallization reactions is not
useful as a selection criterion for weevil
resistance.

671. Wilkinson, R.C. 1980. Relationship between
cortical monoterpenes and susceptibility of
eastern white pine to white-pine weevil
attack. For. Sci. 26(4):581-589.

Trees with high alpha-pinene or low limonene
concentrations were attacked least frequently by
P. strobi.

672. Wilkinson, R.C. 1981a. Analyses of
susceptibility of eastern white and other
haploxylon pines to white-pine weevil
attack in the northeastern United States.
Page 199-203 in Proc. XVII IUFRO World
Congr., September 6-12, 1981, Kyoto,
Japan. Div. 2. Forest plants and forest
protection. Jpn. IUFRO Congr. Council,
Ibaraki, Japan.

No provenance of eastern white pine exhibited
an acceptable amount of weevil resistance.
Western white pine and hybrids between the
eastern and western white pines have higher
weevil resistance and acceptable growth rates.

673. Wilkinson, R.C. 1981b. White-pine weevil
attack susceptibility of western white pine

in the Northeast. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Broomall, Pennsylvania. Res. Pap. NE-483.

Pissodes strobi killed the leaders on <13% of the western white pine and 63% of the eastern white pine that were interplanted. Although eastern white pine grew faster, this was likely not the reason for the higher incidence of attack.

674. Wilkinson, R.C. 1983a. A reexamination of the relationship between bark thickness and susceptibility of eastern white pines to white-pine weevil attack. Pages 134–139 in Proc. 28th Northeast. For. Tree Improv. Conf., July 7–9, 1982, Durham, New Hampshire. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Broomall, Pennsylvania.

Bark thickness at breast height is not a reliable criterion for distinguishing weevil resistant trees.

675. Wilkinson, R.C. 1983b. Leader and growth characteristics of eastern white pine associated with white pine weevil attack susceptibility. Can. J. For. Res. 13:78–84.

Tree diameter and early height growth were more strongly correlated with numbers of past weevil attacks than leader characteristics were. Only 13.1% of tree to tree variation in numbers of successful attacks was attributed to variation in leader and growth characteristics.

676. Wilkinson, R.C. 1983c. Seed source variation in susceptibility of eastern white pine to white-pine weevil attack. Pages 126–133 in Proc. 28th Northeast. For. Tree Improv. Conf., July 7–9, 1982, Durham, New Hampshire. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Broomall, Pennsylvania.

There was much variation in susceptibility of 21 seed sources to *P. strobi*. Two seed sources exhibited relatively low susceptibility and were fast growing. These were recommended for planting in high risk areas of New England.

677. Wilkinson, R.C. 1985. Comparative white-pine weevil attack susceptibility and cortical monoterpene composition of western and eastern white pines. For. Sci. 31(1):39–42.

Although there were differences in cortical monoterpene composition between the two pine species, it is unlikely that any of the individual monoterpenes is a primary factor responsible for differences in weevil attack susceptibility among the two species.

678. Wilson, G.G. 1984. Observations of a microsporidian parasite in the white pine weevil *Pissodes strobi* (Peck) (Coleoptera: Curculionidae). Environ. Can., Can. For. Serv., Ottawa, Ontario. Res. Notes 4(3):33–35.

Describes a microsporidian parasite, probably *Nosema*, associated with adults and larvae of *P. strobi*. Over a 10 year period 15.8% of larvae and 9.0% of adults were infested.

679. Wilson, R.W., Jr.; Hough, A.F., compilers. 1966. A selected and annotated bibliography of eastern white pine (*Pinus strobus* L.), 1890–1954. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania. Res. Pap. NE-44.

Includes a number of references to literature on *Pissodes*.

680. Wingfield, M.J. 1983. Association of *Verticicladiella procera* and *Leptographium terrebrantis* with insects in the Lake States. Can. J. For. Res. 13:1238–1245.

These fungi were not isolated from *P. approximatus* (= *P. nemorensis*).

681. Witcosky, J.J. 1985. The root insect—black-stain root disease association in Douglas fir: vector relationships and implications for forest management. Ph.D. thesis, Ore. State Univ., Corvallis, Oregon.

The contents of this thesis was published in the primary literature. For content, see annotations for references 682–685.

682. Witcosky, J.J. 1989. Root beetles, stand disturbance, and management of black-stain root disease in plantations of Douglas-fir. Pages 58–70 in R.I. Alfaro and S.G. Glover, eds. Insects affecting reforestation: biology and damage. Proc. XVIII Int. Congr. Entomol., IUFRO Work. Group Insects Affecting Reforestation (S2.07-03), July 3–9, 1988, Vancouver,

British Columbia. For. Can., Pac. Yukon Reg., Pac. For. Cent., Victoria, British Columbia.

Pissodes fasciatus is a vector of *Ceratocystis (Verticicladiella) wagneri* in Douglas-fir.

683. Witcosky, J.J.; Hansen, E.M. 1985. Root-colonizing insects recovered from Douglas-fir in various stages of decline due to black-stain root disease. *Phytopathology* 75:399-402.

Pissodes fasciatus was commonly associated with diseased trees, and may act as a vector of *Verticicladiella wagneri*.

684. Witcosky, J.J.; Schowalter, T.D.; Hansen, E.M. 1986a. *Hylastes nigrinus* (Coleoptera: Scolytidae), *Pissodes fasciatus*, and *Steremnius carinatus* (Coleoptera: Curculionidae) as vectors of black-stain root disease of Douglas-fir. *Environ. Entomol.* 15(5):1090-1095.

This study demonstrates that *P. fasciatus* is a vector of *Verticicladiella wagneri*. Weevils are associated with diseased hosts, wound and create suitable infection courts in susceptible hosts, carry inoculum in the field, and transmit the pathogen to hosts under laboratory conditions.

685. Witcosky, J.J.; Schowalter, T.D.; Hansen, E.M. 1986b. The influence of time of precommercial thinning on the colonization of Douglas-fir by three species of root-colonizing insects. *Can. J. For. Res.* 16:745-749.

Abundance of *P. fasciatus* was significantly higher in thinned plots relative to unthinned plots. However, numbers of weevils were much lower in plots thinned in September or January compared to those thinned in May.

686. Wood, P.M. 1987. Development of Sitka spruce phenotypes resistant to the spruce weevil: a summary of recent and planned research projects in British Columbia. B.C. Minist. For., Burnaby, British Columbia. Intern. Rep. PM-V-10.

Gives brief summaries of various research projects related to weevil resistance in Sitka spruce. Most research was concerned with elucidation of the mechanisms of *P. strobi* host selection behavior.

687. Wood, R.O. 1964. Notes on the distribution and hosts of the weevils *Pissodes schwarzi* Hopk. and *Pissodes curriei* Hopk. in British Columbia and Yukon Territory. *Proc. Entomol. Soc. B.C.* 61:42-44.

A distribution map and a list of host tree species are included.

688. Wright, J.W.; Gabriel, W.J. 1959. Possibilities of breeding weevil-resistant white pine strains. U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Upper Darby, Pennsylvania. Stn. Pap. 115.

Several introduced species of pine showed promise as sources of resistance to *P. strobi*. There was evidence of weevil resistance among geographic ecotypes of eastern white pine. Discussed criteria used for selection of eastern white pine for weevil resistance.

689. Wright, J.W.; Pauley, S.S.; Polk, R.B.; Jokela, J.J.; Read, R.A. 1965. Performance of Scotch pine varieties in the North Central Region. *Silvae Genet.* 15(4):101-110.

The slowest growing seed sources were attacked less than the faster growing varieties. There was little evidence of genetic resistance.

690. Wright, K.H.; Baisinger, D.H. 1955. The silvicultural importance of the Sitka spruce weevil in coastal Oregon and Washington. Pages 64-67 in *Proc. Soc. Am. For.*, October 16-21, 1955, Portland, Oregon. Soc. Am. For., Washington, D.C.

At the Youngs River plantation, the annual percentage of Sitka spruce attacked by *P. strobi* from 1949-54 ranged from 3% to 35%. Data on the effect of weeviling on height growth of Sitka spruce is provided. Pruning was not a useful control. Closely grown trees recovered better from weevil attacks than open grown trees. Hemlock will eventually dominate Sitka spruce in this plantation, mainly because of the adverse effects of weeviling on spruce height growth.

691. Xydias, G.K.; Leaf, A.L. 1964. Weevil infestation in relation to fertilization of white pine. *For. Sci.* 10(4):428-431.

Nitrogen, phosphorus, and potassium fertilizer treatments in an eastern white pine plantation were related to tree growth and incidence of white pine weevil damage. In this plantation, growing on deep coarse sandy potash-deficient

soil, potassium significantly increased tree growth and weevil damage while nitrogen caused decreases. A nitrogen-potassium interaction is indicated.

692. Ying, C.C. 1991. Genetic resistance to the white pine weevil in Sitka spruce. B.C. Minist. For., Res. Branch, Victoria, British Columbia, Res. Note 106.

There were large differences between Sitka spruce provenances with respect to percent of trees attacked by *P. strobi* and number of attacks per tree. There appears to be a genetic basis to weevil resistance. Two provenances, Haney and Big Qualicum, showed especially high resistance to weevils and were fast growing.

693. Ying, C.C.; Ebata, T. 1994. Provenance variation in weevil attack in Sitka spruce. Pages 98–109 in R.I. Alfaro, G. Kiss, and R.G. Fraser, eds. The white pine weevil: biology, damage, and management. Proc. Meet., January 19–21, 1994, Richmond, British Columbia. Nat. Resour. Can., Can. For. Serv., Pac. For. Cent., Victoria, British Columbia, and B.C. Minist. For., Victoria, British Columbia. Can.-B.C. Partnership Agreement For. Resour. Dev. FRDA II Rep. 226.

There were large differences between Sitka spruce provenances with respect to percent of trees attacked by *P. strobi* and number of attacks per tree. There appears to be a genetic basis to weevil resistance. The Haney and Big Qualicum provenances, and those from the area of hybridization between Sitka and white spruce, showed especially high resistance to weevils and were fast growing.

694. Zeng, X.-N. 1983. Acid catalyzed rearrangement of grandisal, a component of the aggregation pheromone of several *Pissodes* species and following the course of resolution of carboxylic acids by ^{13}C NMR spectrometry of amine salts. M.Sc. thesis, State Univ. N.Y., Syracuse, New York.

Describes the acid catalyzed rearrangement of grandisal and a method for determining the enantiomeric ratio of the resulting carboxylic acids.

695. Zerillo, R.T. 1975. A photographic technique for estimating egg density of the white pine weevil, *Pissodes strobi* (Peck). U.S. Dep. Agric., For. Serv., Northeast. For. Exp. Stn., Broomall, Pennsylvania. Res. Pap. NE-318.

Compares a photographic technique with visual and dissection techniques for estimating egg density of *P. strobi*. The relative high correlations (0.67 and 0.79) between counts from photographs and those obtained by dissection indicate that the non-destructive photographic technique could be a useful tool for determining egg density.

696. Zerillo, R.T.; Odell, T.M. 1973. White pine weevil: a rearing procedure and artificial medium. J. Econ. Entomol. 66(3):593–594.

A rearing technique and a semi-artificial medium for rearing *P. strobi* from egg through adult is described. Data on survival, fecundity, and adult size are included.

697. Zsuffa, L. 1985. The genetic improvement of eastern white pine in Ontario. Proc. Entomol. Soc. Ont. Suppl. 116:91–94.

The genetic improvement of eastern white pine with respect to *P. strobi* is reviewed.

698. Zsuffa, L. 1986. The genetic improvement of eastern white pine. Pages 32–39 in D. Funk, comp. Eastern white pine: today and tomorrow. Proc. Symp., June 12–14, 1985, Durham, New Hampshire. U.S. Dep. Agric., For. Serv., Washington, D.C. Gen. Tech. Rep. WO-51.

The genetic improvement of eastern white pine with respect to *P. strobi* is reviewed.

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