THE EUROPEAN PINE SHOOT MOTH, *RHYACIONIA BUOLIANA* (LEPIDOPTERA: OLETHREUTIDAE), ANOTHER INTRODUCED FOREST PEST

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ABSTRACT

The European pine shoot moth has been reported from Newfoundland to Ontario, the northeastern U.S., Oregon, Washington and British Columbia, where it was first observed in 1927 near Victoria. Two years of intensive survey show that it is now present in the southwestern part of the province on southern Vancouver Island and in the Lower Fraser and Okanagan valleys. Although the pest has only been recorded on ornamental trees in urban areas and on nursery stock, there is a serious risk that it may attack ponderosa and lodgepole pines in natural growing stands. Five specific recommendations are made.

The European pine shoot moth, *Rhyacionia buoliana* Schiffermuller (Lepidoptera: Olethreutidae), which attacks the shoots of immature two- and three-needle pines, was introduced into North America from Europe. It has been reported from Newfoundland to southern Ontario in eastern Canada, the northeastern United States from Lake Michigan to the Atlantic coast, and at a few localities in Washington, Oregon, and British Columbia. The adult, a small orange-brown moth with silvery markings, appears about June and lays its eggs singly or in small clusters on twigs, buds and needles. A week or two later, tiny larvae emerge and feed on the buds and needles until fall when they overwinter within buds or under hardened pitch on the buds. In spring the mature larvae, light-brown caterpillars about 5/8 inch long with black heads, feed within shoots until May or early June when they become pupae then adults.

Attacked trees rarely die, but may develop spiked, crooked, forked, or bushy tops. In eastern North America, this insect has been responsible for considerable damage to plantations of red pine, *Pinus resinosa* Aiton, Scots pine, *Pinus sylvestris* Linnaeus, Austrian pine, *Pinus nigra* Arnold, and Mugho pine, *Pinus mugo* Turra, in fact most hard pines, including jack pine, *Pinus banksiana* Lambert, and lodgepole pine, *Pinus contorta* Douglas, have been attacked.

OCCURRENCE IN BRITISH COLUMBIA

The European pine shoot moth was first observed in British Columbia in 1927, in a nursery near Victoria. It was not recorded again until 1938 when about 25 infested trees, mostly lodgepole pine, were found in gardens in south Vancouver. The Canada Department of Agriculture undertook an eradication program in 1939, destroying 88 infested trees. Infested shoots were clipped on other trees, and the trees sprayed with arsenate of lead or nicotine sulphate. The area was re-examined in 1941 and infested shoots found at two locations were destroyed. Little attention was paid to shoot moth from then until 1961 and 1962, when it was detected at Kelowna. In 1963 the shoot moth was found on 30 trees in the Okanagan Valley; 28 trees were imported nursery stock; one was a Mugho pine grown from seed; and one was a mature ponderosa pine, *Pinus ponderosa* Lawson & Son, at the Summerland Experimental Farm. In the same year, the insect was again reported in the Greater Vancouver and Victoria areas in nurseries and gardens. In 1964, it was found at Yarrow, about 50 miles east of Vancouver.

In 1965 and 1966, in co-operation

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with the Plant Protection Division of the Canada Department of Agriculture, a more intensive survey was undertaken to determine the insect's distribution and to appraise the actual or potential hazard to natural stands. Areas of probable occurrence, based on previous surveys, were visited. The results of the survey are summarized in Table 1.

TABLE 1. Examinations for European pine shoot moth in British Columbia, 1965-1966.

Type of planting	No. localities examined		No. trees examined		No. trees infested	
	1965	1966	1965	1966	1965	1966
Natural stands	71	89	6,050	9,281	0	0
Gardens, parks, municipal plantings	1,038	2,092	9,153	7,986	26	491
Plantations		2	25,209	3,652	0	2
Nurseries		69	100,170	106,684	101	134

In the Interior, the area of greatest concern, inspections were made at Kamloops, Nelson, Trail, Creston, Grand Forks and in the Okanagan Valley from Vernon south to the U.S. border (Hamilton *et al.*, 1965; Ross *et al.*, 1966). The shoot moth was discovered in one newly established plantation at Westbank in the Okanagan Valley and at nurseries in Oliver, Kelowna, Vernon and Kamloops where Mugho, Scots, and Austrian pines were infested. Infestations were not found in natural stands of lodgepole or ponderosa pine.

In the Coastal area, examinations were made on Vancouver Island from Campbell River south and on the south coast mainland from Powell River up the Fraser River Valley to Lytton (Harris *et al.*, 1965; Holms *et al.*, 1966). The shoot moth was prevalent in parks and gardens throughout the Greater Vancouver and Victoria areas and occurred in the Lower Fraser River Valley at Sumas, Mission City, Yarrow, Chilliwack and Hope. It was in commercial nurseries at Wellington, Victoria, Burnaby, Richmond, Surrey, Aldergrove, Ocean Park, Langley, Yarrow, Sardis, and Pitt Meadows. The infested nursery stock had been imported recently from Ontario, Holland, and the U.S.A. Lodgepole, Mugho, and Scots pines were the principal species attacked but small numbers of Swiss stone pine, *Pinus cembra* Linnaeus, western white pine, *Pinus monticola* Douglas, Austrian pine, ponderosa pine, red pine, eastern white pine, *Pinus strobus* Linnaeus, and Japanese black pine, *Pinus thunbergii* Parlatore were also attacked. Attacks on sheared Christmas tree plantations and natural-growing lodgepole pine were not observed.

DISCUSSION

The European pine shoot moth is currently confined to ornamental trees in urban areas and to stock in commercial nurseries in the southwest part of the Province. Damage to ornamental trees generally does not result in serious deformation, and is seldom visible on bushy species such as Mugho pine. However, significant damage to forest values could occur if the shoot moth were to spread to forest stands where loss of increment and tree deformity are important. The potential loss may be high in the Interior, where ponderosa pine is an important timber tree. On the Coast the potential loss is relatively low, since lodgepole pine is economically unimportant and is sparsely distributed.

The native hard pines, lodgepole and ponderosa, are susceptible to attack when planted, but the shoot moth has evidently not spread into natural-growing stands. Possibly the insect fails to become established in

natural stands because the trees have not been subjected to unnatural stresses that result from planting or because the natural stands are too distant from focal points of infestation. The majority of infested ornamental plantings are in larger cities, where natural growing pines are uncommon. Knowledge of the effective range of the insect is inadequate, however, and we cannot disregard the possibility of eventual spread to natural stands. Green and Pointing (1962) showed that the moths were potentially capable of flights of several miles and that they can be stimulated to fly under wind conditions favouring their dispersal.

Shoot moth survive winter temperatures that occur on the Coast and probably can persist in some parts of the Interior. Green (1962) reported that, with "cold hardening" and adequate snow cover, shoot moths survive winter temperatures down to approximately -22 F. Although in the Okanagan Valley occasional lower winter minimums have been recorded, favourable temperatures have existed near Okanagan Lake over extended periods. At one station in Kelowna, the minimum temperature recorded over a period of 16 years was -20 F and at another in Penticton the minimum over 58 years was -16 F (Meteorological Branch, Air Services Division, Department Transport (Canada), 1966). Ross (1966) reared nine shoot moth pupae on several recently transplanted caged trees at Vernon during the 1965-1966 winter when temperatures dropped to -4 F.

The European pine shoot moth was accidentally introduced into British Columbia and, like other introduced forest insects and diseases in the Province, such as balsam woolly aphid, *Adelges piceae* (Ratzburg), poplar-and-willow borer, *Sternochetus lapathi* (Linnaeus), lecanium scale, *Eulecanium coryli* (Linnaeus), white pine blister rust, *Cronartium ribicola* J. C. Fischer and trellis rust, *Gymnosporangium fuscum* Hedwig f. in DC., it probably entered on nursery stock. Shoot moth in B.C. nurseries occurred on trees imported from eastern Canada, the U.S., or Europe, and most of the infested trees in gardens and parks had been recently purchased from nurseries. Movement of their living hosts doubtless affords many pests an ideal opportunity for transport to distant localities. In the spring and fall, when plants are usually moved, detection of dormant insects, often hidden within plant parts, is extremely difficult. Moreover, inadequate inspection of and restrictions on movement of nursery stock enhances the possibility of spread of damaging organisms.

RECOMMENDATIONS

The following safeguards should be considered to prevent possible infestation of economically important trees by European pine shoot moth imported on ornamental pines:

1. Inspections of trees entering the country should be intensified and inspections of trees moved from one province to another as nursery stock should be imposed.
2. Imported stock should be kept under post-entry quarantine for at least 1 year so that symptoms not visible initially could be detected.
3. Requirements for nurseries to control pests on their trees should be more strictly enforced.
4. Pines should be grown locally from seed.
5. An educational programme emphasizing the dangers of introducing forest insect pests should be implemented.

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RESISTANCE TO ORGANOCHLORINE INSECTICIDES IN THE TUBER FLEA BEETLE, *EPITRIX TUBERIS* GENT. (COLEOPTERA: CHRYSOMELIDAE), IN BRITISH COLUMBIA[1]

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ABSTRACT

Laboratory and field experiments showed that **Epitrix tuberis** Gent. had developed strains that were highly resistant to dieldrin and less so to DDT. Both adults and larvae were resistant to the cyclodiene insecticides. Strains resistant to cyclodienes were centered in the Salmon Arm and Vernon areas. Strains resistant to DDT had a wider range and were present as far north as Pavilion. All tuber flea beetles tested in the province were highly susceptible to diazinon and presumably to other organophosphorus compounds.

INTRODUCTION

In the southern interior of British Columbia the tuber flea beetle, *Epitrix tuberis* Gent., has been controlled effectively since 1953 by incorporating into the soil the cyclodiene organochlorine insecticides: aldrin, chlordane, dieldrin and heptachlor (Banham, 1960). These insecticides gained a ready acceptance and were widely used because one low-cost application gave broad-spectrum insecticidal effectiveness. In 1963, laboratory tests were conducted to determine the susceptibility of *E. tuberis* to dieldrin and DDT. Dieldrin was included because of the reported failure in 1960 of soil applications of the cyclodiene insecticides to control *E. tuberis* in Clackamas County, Oregon, (Morrison, 1962). DDT was included because it was used in British Columbia as a foliar treatment against this pest after 1948 following investigations by Finlayson and Neilson (1954); it remains an alternative to soil treatments with the cyclodienes.

The first suspicion that resistant *E. tuberis* were present in British Columbia came at harvest in 1964, in the Salmon River Valley. Six growers reported excessive larval tunneling damage in their potatoes in spite of the use of aldrin or dieldrin at recommended rates. This paper reports the initial laboratory experiments in 1963 and further tests in 1965. Data are reported also from a field experiment in the Salmon River Valley in 1965 to confirm the occurrence of resistance.

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