REPORT ON

THE CONDITION OF SHELTERBELTS IN ALBERTA

WITH SPECIAL REFERENCE TO DISEASES, INSECTS AND CULTURAL PRACTICES

by

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INFORMATION REPORT

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ABSTRACT

A province-wide survey in 1963 revealed that cankers, caused by Cytospora chrysosperma (Pers.) Fr. and Septoria musiva Pk., are the most common infectious diseases of shelterbelts in Alberta. The survey recognized four regions on the basis of soil and climatic differences. Cytospora canker was about equally common in all regions, while Septoria canker was common only in the Parkland Region. Drought, grass competition and other non-infectious agents had predisposed trees to infection by C. chrysosperma, an otherwise weak parasite. S. musiva was found mainly on Russian hybrid poplar and mainly in the Parkland and Boreal regions.

Most insect damage was caused by defoliators, gall makers and leaf rollers. The more important defoliators were the grey willow leaf beetle (Galerucella decora Say) and the forest tent caterpillar (Malacosoma disstria Hbn.). The gall maker (Aceria parapopuli Kiefer) and the leaf roller (Nematus sp.), together with defoliators, were most damaging on Russian and Northwest poplars in the Dry Prairie and Parkland regions.

Drought, grass competition, livestock damage and soil drifting have been the most common causes of mortality in shelterbelts. As a result, the survival of poplar hybrids was as low as 20 per cent. More careful planning and better maintenance of shelterbelts than was evident from the survey would have prevented much of the disease and greatly increased their effectiveness.

INTRODUCTION

Suboptimal moisture in southern Alberta in recent years has adversely affected shelterbelts as attested by the many reports received in 1962 by the Calgary Forest Entomology and Pathology Laboratory of mortality to poplars. Examination of these reports showed that in many shelterbelts up to 75 per cent of the poplars had been killed (2). On request and with the aid of the Alberta Department of Agriculture, a survey was made in 1963 with the main objective being to determine the extent and nature of disease conditions in planted shelterbelts throughout the Province.

HISTORICAL BACKGROUND

The southern treeless area of the prairie provinces attracted settlers originally because of its proximity to the Canadian Pacific Railway and because the absence of trees offered some agricultural advantages. Most of the settlers came from eastern Canada and other countries where forests were natural beautifying parts of the landscape. The first attempts to plant trees were generally unsuccessful, mainly because of the foreign planting material used and the lack of planting experience. Based on these failures, the early general impression was that trees could not be grown successfully in the prairie region. The government of the time recognized the difficulties of establishing trees in the arid prairie region, and in 1901 inaugurated a co-operative tree planting program. Trees were supplied free of charge on the condition that each applicant could give evidence that pre-planting preparations had been made. To satisfy the rapidly growing demand for planting stock, the Canadian government in 1903 established a forest nursery station at Indian Head, Saskatchewan (14). Shortly afterward the Canadian Pacific Railway established a nursery at Wolseley, Saskatchewan (7). Government-Railway-sponsored demonstration railway cars were sent throughout the prairie region, and lectures were given to explain the benefits of tree planting to farmers. Another government-sponsored nursery was later established at Sutherland, Saskatchewan, and in 1919 the Canadian Forestry Association inaugurated a tree-planting program with the aid of a railway lecture car. This car has travelled more than 150,000 miles, and has hosted more than 1.3 million school children and adults in the 44 years that it has been operating.

The first supervised tree planting trials were on the whole satisfactory. The successes were largely due to proper soil preparation and the use of indigenous planting stock. Thirty-five years later the direct and indirect benefits from the establishment of farmstead windbreaks and field shelterbelts had become widely known and appreciated. Farmer-sponsored Field Shelterbelt Associations were organized in 1936 under the Prairie Farm Rehabilitation Act at Lyleton, Manitoba, Conquest and Aneroid, Saskatchewan, and Porter Lake, Alberta (11). The purpose of these associations was to promote the planting of suitable shelterbelts in an effort to control soil drifting, reduce wind damage, and to obtain maximum snow retention. The projects have been generally successful, and have formed the nucleus of an expanding field shelterbelt planting program. More than 1,500 miles of field shelterbelts, covering more than 800 square miles, have been planted to the present in Manitoba and Saskatchewan. The Porter Lake project in Alberta was discontinued in 1953.

The nurseries at Indian Head and Sutherland supplied all of Alberta's needs for planting stock until 1950. This amounted to about 24 per cent of the production of the two nurseries. Since 1950 the Alberta Department of Agriculture has developed its own shelterbelt program, with nurseries at Oliver and Brooks. Consequently, the distribution of planting stock from the Federal Government nurseries gradually decreased from 24 per cent to 2 per cent from 1950 to the present. The numbers of trees distributed in Alberta by different agencies during the period 1901-1963 are listed in Table I (9, 13 and 15).

Caragana has comprised approximately 50 per cent and poplar hybrids 7-10 per cent of the broadleaved stock distributed. Manitoba maple, green ash, American and Manchurian elm, willow and various shrubs have comprised the balance. White spruce and Colorado spruce have been the two most commonly distributed coniferous species, with Scots pine a minor species. Approximately 60 per cent of the material has been used for the establishment of farmstead windbreaks, 20 per cent for field

TABLE I. SOURCES OF FARM SHELTERBELT TREES DISTRIBUTED IN ALBERTA 1901-1963.

	Federal Government Nurseries in Saskatchewan	Provincial Government Nurseries in Alberta	Total
Broad-leaved	62,624,709	12,397,920	75,022,629
Coniferous	1,806,203	1,596,285	3,402,488
Total	64,430,912	13,994,205	78,425,117

shelterbelts, 14 per cent for roadside plantations and 6 per cent for replacements of all kinds.

The low proportion of poplar is not truly representative of the importance of this tree, for many farmers have rooted their own cuttings of poplar which today forms the backbone of most shelterbelts in Alberta.

SURVEY PROCEDURE

One hundred and seventy shelterbelts were examined in 1963. A list showing the locations and species compositions of farm shelterbelts that had been planted in the period 1955-62 was obtained from the Alberta Department of Agriculture, Field Crops Branch. Four to five shelterbelts were selected from this list for each of the Agricultural Districts, the selections being representative of age classes and species compositions (Fig. 1). While the list contained only young shelterbelts (1-8 years), older ones were examined whenever they could be located in close proximity to the young shelterbelts.

The general information taken for each shelterbelt was as follows: **age**, av. ht., av. d.b.h., and general vigor. Each tree in small farmstead windbreaks was classified as either healthy or infected and living or dead. In large shelterbelts, 50 to 100 trees were randomly selected and examined. Cankers and non-pathogenic diseases were noted in May and June and foliage diseases in August. The number of cankers per tree was counted and the average used as an index of infection. The intensity of foliage diseases was expressed as the estimate percentage of the crown that was infected. The causes of diseases were established immediately where possible, otherwise specimens were collected for later identification. The survival of poplar hybrids was surveyed in 83 shelterbelts of from 1 to 8 years of age.

A sketch was prepared of each shelterbelt showing the distances between trees and between rows, the species composition, and the locations of farm buildings in cases of farmstead plantings.

Figure 1.

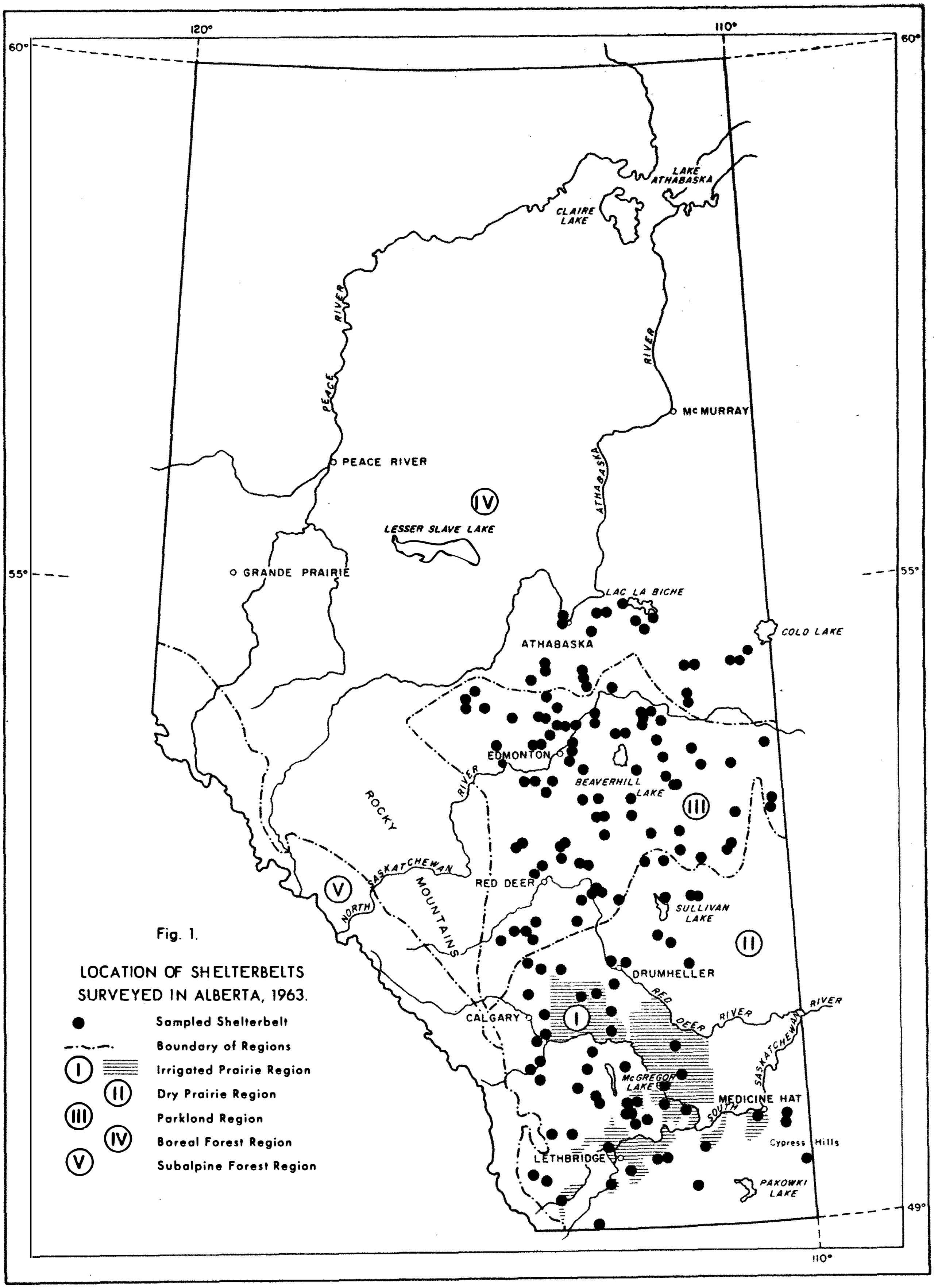

Fig. 1.

LOCATION OF SHELTERBELTS SURVEYED IN ALBERTA, 1963.

RESULTS AND DISCUSSION

Ninety-five per cent of the shelterbelts surveyed were farmstead plantings and only 5 per cent field shelterbelts. Most of them were predominantly poplar. Descriptive data for the 170 shelterbelts surveyed are given in Table II.

Four different regions were separated on the basis of Natural Vegetation and Flora of Canada (1) as follows: Irrigated Prairie, Dry Prairie, Parkland, and Boreal Forest regions. The Prairie Region covers the brown and dark brown soil regions. The climate is semi-arid and the region is a natural steppe without native trees. Since irrigation has changed conditions in certain parts of this region, it was divided into irrigated and dry-land. Black and degraded black soils, mixed prairie and wooded areas and a humid continental climate characterize the Parkland Region. In the Boreal Region grey wooded soils are dominant and the natural land cover is a climax forest of white spruce, pine and aspen. The climate is sub-arctic with short cool summers.

1. Survival

Survival of poplar hybrids was checked in 83 shelterbelts (see Table III). No definite trends of survival were apparent in comparing shelterbelts of the different regions. Survival was lowest in the Irrigated Prairie regions and Boreal regions where the conditions for tree growth are the most favourable. The poor survival of trees

TABLE II. BASIC DATA OBTAINED FROM A SURVEY OF SHELTERBELTS IN ALBERTA, 1963.

Region	Number of shelterbelts																	
	Surveyed	Living	Dead	Affected by														
				Diseases			Climatic damage				Cultural practice							
				Cytospora	Septoria	Insects & Mites	Drought	Wind	Hail	Frost	Herbaceous vegetation	Rabbit	Livestock	Soil drifting	Fire	Planter faulty	Cultivation	2 - 4 - D
Irrigated Prairie	15	12	3	7	-	7	5	-	4	-	7	1	5	-	-	1	2	-
Dry Prairie	45	37	8	33	1	18	20	3	8	4	19	2	6	5	2	-	-	-
Parkland	86	73	13	58	11	62	3	-	13	7	53	17	16	4	2	8	9	1
Boreal Forest	24	13	11	11	1	14	-	-	2	2	20	1	3	-	5	9	3	1
Total :	170	135	35	109	13	101	28	3	27	13	99	21	30	9	9	18	14	2

TABLE III. SURVIVAL OF POPLAR HYBRIDS IN ALBERTA SHELTERBELTS, 1963.

Region	No. of shelterbelts sampled	No. of trees			Average percentage of survival	No. of shelterbelts with	
		Distributed	Living 1963	Dead 1963		50 + per cent survival	75 + per cent survival
Irrigated Prairie	9	5,300	690	4,610	13	0	1
Dry Prairie	25	12,615	3,607	9,008	29	2	7
Parkland	34	15,542	3,039	12,503	20	1	2
Boreal	15	4,255	368	3,887	9	1	1
Total:	83	37,712	7,704	30,008	20	4	11

was rather the result of carelessness than from unfavourable conditions or damage by infectious diseases and insects. This was indicated by the high incidence of livestock damage, herbaceous competition, mechanical damage during cultivation, improper planning and planting and lack of maintenance. All of these factors, either directly or indirectly, had lowered the vigor of trees to the point of predisposing them to secondary infectious diseases and insects.

The lack of proper planning of shelterbelts had seriously affected tree survival in many instances. For example, rows of caragana and poplar hybrids often formed the initial plantings, the former usually on the windward side of the latter. When additional rows had been added these often had to be planted on the windward side because of lack of planting space. The natural result was that the caragana was seriously competing with poplar for moisture and light. Perhaps more serious were situations where white and Colorado spruce had been used in the secondary plantings. In these instances the spruce, which needs protection for survival and early growth, almost invariably was the most exposed element of the shelterbelt and had suffered accordingly. Serious errors in the spacing of trees in and between rows and the lack of maintenance were common. Overcrowding, e.g. 2-foot spacings within rows, had caused heavy competition and high mortality.

An attempt was made to determine the survival of other species in 39 shelterbelts of the Parkland and Boreal regions. Since the numbers of planting material distributed was unknown, the data obtained showed rather the stocking of rows than survival. It was impossible to find out whether these data represent conditions after the first planting, or after several replacements. Though their value is limited, some information may be obtained regarding the different species used (see Table IV).

TABLE IV. "SURVIVAL" OF OTHER THAN POPLAR SPECIES IN ALBERTA SHELTERBELTS, 1963.

Region	No. of shelter-belts surveyed	Species planted							
		Spruce	Green ash	Elm	Maple	Willow	Caragana	Lilac	Honey-suckle
		Av. percentage							
Parkland	21	75	75	70	69	70	87	47	75
Boreal	18	69	59	39	66	70	72	90	90
Total :	39	72	67	55	68	70	80	69	83

2. Diseases

a) Cytospora chrysosperma (Pers.) Fr. - Cytospora canker was the most common infectious disease of poplars and willows (Fig. 8). This pathogen usually attacks weakened trees. Trees growing out of their normal range and with consequent low vigour are particularly susceptible. Experiments have proven that the water content of the bark plays an important role in canker development and growth. C. chrysosperma has been successfully inoculated on Populus deltoides Marsh. only when the moisture content was below a certain level (6). Bloomberg (3) found that canker growth varied proportionally with temperature and inversely with shoot moisture content, relative humidity, and soil moisture content. In Alberta shelterbelts, drought, heavy competition of herbaceous vegetation, self competition caused by lack of thinning of initially densely planted shelterbelts and other non-infectious diseases are the predisposing factors. The damage caused by Cytospora canker in the different regions of the Province is presented in Table V. Sixty-four per cent of the surveyed shelterbelts were affected by C. chrysosperma, although 26 per cent had only a trace of damage. In 10 per cent of the shelterbelts more than 25 per cent of the crown was dead, usually the topmost branches. The effectiveness of such shelterbelts as windbreaks had been greatly reduced. Most of the heavily damaged shelterbelts were located in the Dry Prairie Region. Crossley (10) found that 65 to 80 per cent of roots of boxelder (Acer

TABLE V. INCIDENCE OF CYTOSPORA CANKER IN SHELTERBELTS OF ALBERTA, 1963.

Region	Number of shelter-belts sampled	Percentage of shelterbelts infected					
		Total	Percentage of shelterbelts in crown damage classes				
			0-1	1-10	11-25	26-50	50 +
Irrigated Prairie	15	47	13	27	7	-	-
Dry Prairie	45	73	22	18	11	13	9
Parkland	86	67	30	26	5	5	1
Boreal Forest	24	46	29	13	-	4	-
Total:	170	64	26	22	6	7	3

negundo L.) and green ash (Fraxinus pennsylvanica lanceolata. (Borkh.) Sarg.) may be found in the upper 12 to 18 inches of soil in the prairies. Examination of poplar roots in the present study showed the same rooting habit in compacted agricultural soils. Laycock (12) investigated the drought patterns in the Canadian prairies for a 30-year period (1921-1950). He states " . . . . in the drier regions, the fine textured soils can retain better moisture supplies than coarse soils, but they are rarely filled to capacity during fall, winter and spring and the storage advantage is frequently not used." According to Laycock's moisture deficit maps, the percentage of years with more than 8 ins. moisture deficit in areas with sandy soils was from 75 to 90 per cent in south-eastern Alberta during the 30-year period. In clay soils the percentage of years with the same moisture deficit was from 50 to 75 per cent. The top layer of the soil in this region, where most of the roots are located, suffers from water deficiency during most of the growing season. This adverse condition is increased considerably in uncultivated shelterbelts by the influence of herbaceous vegetation. The warmer climate and low relative humidity and soil moisture provide an optimum for C. chrysosperma (3) and explains the high incidence and damage in the Dry Prairie Region. In the Parkland and Boreal regions the heavily damaged shelterbelts had been predisposed to C. chrysosperma by a combination of factors including herbaceous vegetation, hail, frost, and mechanical damage.

b) Septoria musiva Pk. - Septoria canker occurs commonly as a leaf-spotting parasite on native poplars, and causes cankers on certain introduced poplar hybrids (Figs. 9 and 10). The only leaf spot caused by S. musiva in the Dry Prairie Region occurring on native balsam poplar (Populus balsamifera L.) was in the Cypress Hills which is an erosional remnant covered with forest. The climate of the area differs from the surrounding prairie. The leaf spot stage of S. musiva was common on native poplars in the Parkland Region.

Thirteen shelterbelts were infected by the canker stage of this fungus, 11 of which were located in the Parkland Region (Table VI). The only shelterbelt in the Prairie Region in which Septoria cankers were found was north of Drumheller, a few miles from the border of the Parkland Region. Distributional data suggest that the prairie is too dry for the development of this fungus.

Russian hybrid poplar (Populus deltoides Russian ?) seems to be more susceptible than the Northwest hybrid poplar (P. deltoides balsam ?), as 12 of the 13 infected shelterbelts consisted of Russian poplar. The average number of cankers per tree was 2, ranging from 1 to 6. In 6 shelterbelts 0 to 25 per cent of the trees were infected, in 5 shelterbelts from 26-50 per cent, while in the remaining 2 more than half of the trees were infected by S. musiva. Mortality caused by the fungus was low. In addition to the 13 surveyed shelterbelts, 2 others have been reported independently (2). One was at St. Albert, north of

TABLE VI. DEGREE OF DAMAGE CAUSED BY SEPTORIA CANKER IN INFECTED POPLAR SHELTERBELTS IN ALBERTA, 1963.

Region and location	Species	Plantation age	No. of trees planted	Percentage of trees infected	Av. no. of cankers/tree	Max. no. of cankers/tree
<u>Dry Prairie Region</u>						
Drumheller	Northwest	9	650	50	2	3
<u>Parkland Region</u>						
Bruderheim	Russian	8	100	40	2	3
Chigwell	Russian	7	600	20	1	1
Edmonton (south)	Russian	6	450	35	1	2
Gwynne	Russian	8	5500	88	4	8
Hercules	Russian	7	300	20	1	1
Leduc	Russian	8	200	100	6	10
Mirror	Russian	8	800	12	1	1
Olds	Russian	7	750	28	3	-
Ryley	(Northwest and Russian)	3	150	12	1	1
Willingdon	Russian	2	210	4	2	2
Willingdon	Russian	3	1000	32	1	2
<u>Boreal Region</u>						
Athabasca	Russian	3	130	11	2	2

Edmonton, where all of the trees had many stem and branch cankers. This shelterbelt had sustained hail damage and the cankers were most prevalent on the side exposed to the hail. A moderate occurrence of S. musiva was found on Russian hybrid poplar in a shelterbelt in the Oliver Nursery. Since the rooted cuttings are distributed from this nursery the introduction of the fungus into disease free areas is highly probable. An indication of this could be the young age and comparatively large number of cankers per tree in the Willingdon and Athabasca shelterbelts (see Table VI).

Comparative data, included in Table VII, show that C. chrysosperma is more abundant in each region than S. musiva.

c) Other noteworthy diseases - In addition to the two canker diseases, the leaf rust Melampsora occidentalis Jacks. was common throughout the regions but had caused only minor damage. No other infectious diseases were found, either on coniferous or on hardwood species.

TABLE VII. COMPARISON OF THE INCIDENCE OF CYTOSPORA AND SEPTORIA CANKERS IN SHELTERBELTS IN ALBERTA, 1963.

Region	Number of shelterbelts sampled	Percentage of shelterbelts infected by	
		Cytospora	Septoria
Irrigated Prairie	15	47	-
Dry Prairie	45	73	0.07
Parkland	86	67	0.13
Boreal	24	46	0.04
Total	170	64	0.08

3. Insects and Mites

The most important insects and the damage caused by them are listed in Table VIII.

a) Defoliators - Defoliating insects were common. The grey willow leaf beetle (*Galerucella decora* Say) occurred in each region. Adult beetles were very numerous in the spring causing damage to poplar and willow (Fig. 11). During the summer the larvae caused heavy defoliation of native willow throughout the foothills and agricultural land in the Province. In the Calgary area chemical spray was used to prevent heavy defoliation of shelterbelts (4). The forest

TABLE VIII. INCIDENCE OF INSECT DAMAGE IN THE SHELTERBELTS SURVEYED IN ALBERTA, 1963.

Species	Host	No. of shelterbelts infested in the: Irrigated Prairie regions			Dry Prairie			Parkland			Boreal		
		Hvy.	Med.	Lt.	Hvy.	Med.	Lt.	Hvy.	Med.	Lt.	Hvy.	Med.	Lt.
Defoliators:													
Galerucella decora Say	NWP.;RP.	1	1	1	1	4	5	2		26			1
Itame loricaria Evers.	P.									2			
Malacosoma disstria Hbn.	NWP.;RP.							1		23	7	1	5
Malacosoma lutescens (N.& D.)	C.									1			
Nymphalis antiopa (L.)	P.									1			
Orthosia hibisci Gr.	NWP.						1			1			
Pikonema alaskensis (Roh.)	S.										1		
Pristiphora erichsonii (Htg.)	Sl.									1			
Gall makers:													
Aceria parapopuli (Kiefer)	NWP.;RP.	2		1	1	1				6			4
Adelges spp.	S.									3			3
Aphids:													
Eriosoma americanum (Riley)	E.												2
Periphyllus negundinus Thos.	Mn.									2			
Leaf roller:													
Nematus sp.	NWP.;RP.						4			6			
Borers:													
Agrilus granulatus (Say)	RP.		1							3			
Saperda sp.	A.									1			

Host abbreviations:
A. = aspen
C. = caragana
E. = elm
Mn. = manitoba maple
NWP. = northwest poplar
P. = poplar sp.
RP. = russian poplar
S. = spruce
Sl. = siberian larch

tent caterpillar (Malacosoma disstria Hbn.) caused considerable damage in the Parkland and Boreal regions where high populations were present on native aspen (Fig. 12). Feeding was noted on hybrid poplars in shelterbelts and was also observed on elm. There are indications that populations of this insect are declining after causing heavy defoliation in aspen stands over the last 6 years (4).

b) Gall makers - The poplar bud-gall mite, (Aceria parapopuli (Kiefer)), (Fig. 13) was present as far north as the town of Athabasca. The heaviest concentration of infested shelterbelts occurred in the southern Prairie Region and northern Parkland Region (4). Northwest hybrid poplar appears to have been more susceptible to poplar bud-gall mite than the Russian hybrid poplar.

c) Other noteworthy insects - Among the other insects listed in Table VIII a leaf folding sawfly (Nematus sp.) caused light damage to Russian poplar in several shelterbelts in the Dry Prairie and Parkland regions. The yellow-headed spruce sawfly, (Pikonema alaskensis (Roh.)), caused severe damage to one spruce shelterbelt.

4. Climatic Damage

In the Prairie Region, southeast of the line of Chauvin, Hanna, Vulcan, Fort Macleod, Raymond and Milk River, precipitation is usually less than combined evaporation and transpiration, i.e., is less than the amount of water needed. The water deficits of the area usually exceed 8 inches in the driest quarter of the year. While drought is more frequent and of greater intensity in this normally dry region, the more humid northern part of Alberta also suffers from drought in some years (12).

Drought is the most important factor which affects tree growth in the Dry Prairie Region. Unprotected young white and Colorado spruce plantations that have been exposed to dry winds have been either severely damaged or killed. Poplars have suffered also, and in the process were predisposed to insects and diseases. Some drought damage was observed in the Irrigated Prairie Region, but in most of these instances the owner had neglected to use available water. Warm drying winds during August increased the effects of drought and caused premature defoliation of deciduous species.

Other noteworthy climatic agents are listed in Table II. Minor hail damage was observed almost everywhere, and in one location appeared to have predisposed trees to Septoria infection. Frost damage was common to Manitoba maple (Acer negundo L.), resulting in dieback and adventitious sprouting from year to year. This injury resulted in low effectiveness and an unsightly form to maple rows in shelterbelts (Fig. 2). Hybrid poplar and especially willow were also damaged by frost.

5. Cultural Practices

In a region where moisture is always in short supply, proper cultural practices are important. Invasion of shelterbelts by herbaceous vegetation is serious, because of the excessive competition for soil moisture. Fifty-eight per cent of the surveyed shelterbelts showed no evidence of cultivation at the time of the examination. Slower tree growth because of poor soil, and favourable climatic conditions for herbaceous vegetation combined to make shelterbelts in the northern regions more weedy than those in the south. Trees in the southern part of the Prairie under irrigation grow faster and are able to control herbaceous vegetation earlier by the effects of shade. More than 50 per cent of the shelterbelts in the Parkland and Boreal regions were dominated by herbaceous vegetation. The heavy competition had caused high tree mortality and had suppressed height growth (Fig. 3). Heavy grass around the trees had apparently provided good shelter for rabbits during the winter as rabbit damage was common in these shelterbelts, especially in the Parkland Region (Fig. 4).

Livestock damage was recorded in 18 per cent of the shelterbelts, being most prevalent in the Parkland Region. Some young shelterbelts had been completely eradicated by livestock, while the effectiveness of others had been considerably decreased by browsing of lower level foliage (Fig. 5). In addition, compacting of the soil had reduced aeration and water penetration.

Soil drifting was common in the sandy soils of the Dry Prairie and Parkland regions. This occurs most commonly during the winter and early spring, when vegetation is not adequate to anchor the soil. Light top soil had usually been deposited in ditches, along fences and in shelterbelts, smothering trees in the latter (Fig. 6). Fire damage was more prevalent in the Boreal Region from uncontrolled burning of weeds and grass during the spring. Young plantations were killed while older trees had sustained fire scars that had lowered their vigor.

Other noteworthy forms of damage caused by cultivation were: faulty planting, mechanical damage, and careless application of 2-4-D. Many farmers attributed shelterbelt failures to faulty planting. It was apparent that the planter had not compacted the soil properly around the cuttings and seedlings. This resulted in the fast desiccation and ultimate waste of planting material. Deep and too close cultivation, and the use of large machinery where the spacing of rows was not adequate had caused considerable mechanical damage.

6. Evaluation of Species

Climatic and soil conditions vary considerably between the 4 different regions and, therefore, valid evaluations of species are best done on a regional basis.

In the Irrigated Prairie Region, water is not a limiting factor. Hybrid poplars showed very good growth and had a much longer life-span than in the Dry Prairie Region, justifying the wide cultivation of poplars here. Forty-five - to fifty-year old shelterbelts were common without any sign of decline. However, the larger trees often overshade gardens and are hazardous to nearby buildings in high winds. It is a common but undesirable practice to cut such trees back to a height of 30 to 40 feet and to prune the branches back to the main stem. The resulting large wounds provide excellent entry points for decay fungi and such trees usually do not exist very long after this kind of treatment.

Willows grow well in moist conditions but exposed rows had very often been frost killed. The substitution for willow with frost hardy, low, bushy species is desirable. American elm, green ash, white and Colorado spruce grew well with irrigation.

Poplars have a much shorter life-span and are not suitable in the form of either pure shelterbelts or as the backbone of shelterbelts in the Dry Prairie Region. As fast growing species they provide early valuable shelter, and also protection for the development of drought hardy slower growing, but longer living, hardwoods and conifers. Mr. W. Stronski's shelterbelt (Turin, land location 19-12-19-W.4) is an excellent example of how poplar can be used as a pioneer species and to protect and help the growth of other trees. He had pruned his poplars back from year to year to about 8 feet, thereby providing shade and a stimulus for increased height growth of elm, ash and Colorado spruce.

The result has been that the elm and green ash reached a height of 8 feet within 8 years and should eventually overtop the poplar.

White spruce has little success in dry conditions. If it survives at all, its growth is very slow and the life-span is short. Scots pine is more tolerant and faster growing than white spruce in dry conditions. Green ash, Manchurian elm, Russian olive, caragana, and Tartarian honeysuckle seem to be the most drought hardy species available.

In the Parkland and Boreal regions hybrid poplars, native conifers and introduced species such as Norway spruce, and Siberian larch have done well in shelterbelts.

RECOMMENDATIONS

Most of the disease and insect problems discussed have been either initiated or aggravated by human negligence. Consequently, they can be controlled within reasonable limits by long term planning, proper planting, and good maintenance.

Elimination or modification of predisposing factors are most important in the control of Cytospora canker, e.g., mechanical damage, livestock damage, herbaceous competition, and drought. Trees with Cytospora infections should be pruned, sometimes to ground level. Sprouts from the roots will replace the infected tree. The prunings should be burned to reduce spore sources. The planting of less susceptible hybrids is the most important preventative measure. Cram (8) found that 3 of 17 poplar clones tested for survival over a 6-year period demonstrated resistance to Cytospora and provided better survival and height growth than the widely propagated Northwest or Russian hybrids.

There is no known effective control for Septoria canker. Since Russian hybrid appears highly susceptible, the propagation of this hybrid is not recommended. Infected shelterbelts should be replaced by non-susceptible hardwoods and by conifers. The existing shelterbelt could be used for shelter until the new one establishes itself. The major source of Septoria infection arises from dead foliage on the ground; the fungus overwinters in the dead foliage and the infective spores are produced the following spring. To avoid a build up of the disease within lightly infected shelterbelts, the foliage should be gathered and burned in the fall.

Malathion 10 EC was used to control the grey willow leaf beetle in the Calgary area in 1963. The same formula that is recommended for the control of young grasshoppers proved to be effective. An initial ground spray is recommended because the beetles drop to the ground with the slightest disturbance of the leaves. Malathion can also be used to control severe infestations of the forest tent caterpillar. The only known control of poplar bud-gall mite is pruning of individual galls on small trees and infested branches on larger trees during the winter or early spring (5). Wound dressings should be applied to trees with pruning cuts which are larger than 3/4 to 1 inch in diameter to prevent fungus infection.

The effect of drought can be minimized through propagation of drought hardy species, proper spacing, good maintenance and careful cultivation. Selection of species for a given site and climate is essential. Despite the fact that we have a variety of species for the most severe conditions, new species, especially conifers, which have proved to be effective in the Great Plains shelterbelts of the United States should be introduced and evaluated. More extensive propagation of conifers in Alberta shelterbelts would be beneficial because of the year-around foliage and greater density which would give protection from wind in the winter and early spring. Conifers also retain their lower branches and therefore control herbaceous vegetation more effectively than hardwoods. Mixed and multi-rowed shelterbelts would likely reduce the hazards from insects and diseases. It is important to consider that under unfavourable conditions any of the described canker diseases can destory a pure poplar shelterbelt in a short time. A mixed shelterbelt is a form of defence against this kind of loss. The single-row shelterbelt is also vulnerable, and does not provide a safety factor to overcome gaps that occur with the death of individual trees.

The importance of proper shelterbelt maintenance should be emphasized in every possible way. According to the earlier concepts trees were closely planted to provide early protection. The fast growing poplar species became overcrowded soon and the self competition caused early mortality within dry conditions. Thinning of these shelterbelts is essential to provide ample growing space and reduce competition.

The beneficial effects of field shelterbelts on crop yields are well known, but surprisingly few shelterbelts of this kind were found in the course of the survey of the Dry Prairie Region. It is in this region where the beneficial effects of field shelterbelts against drought and wind erosion would be the most pronounced. While strip farming is common in parts of the Dry Prairie, the proper execution of a well planned shelterbelt network would further decrease the effects of wind and drought.

Considerable research and field trials are needed to obtain further information on the ideal structure, composition, maintenance for shelterbelts in the 4 different regions of Alberta. As the information is obtained it should be made available to land owners in the form of well prepared and illustrated bulletins dealing with the planning, planting, and maintenance of shelterbelts designed for specific purposes. In addition, there appears to be ample justification for the employment of an extension forester by the Provincial Department of Agriculture who could act in an advisory capacity in all aspects of shelterbelt work.

The need for shelterbelts in the northern parts of Alberta, where active homesteading is in progress, has not been appreciated, and there is a growing danger that indiscriminate clearings will create future problems. Legislative incentive for the development of a shelterbelt network in these areas might be considered, whereby strips of natural forest are reserved from cutting. This sort of planning could bring lasting benefits to homestead areas.

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Plate I.

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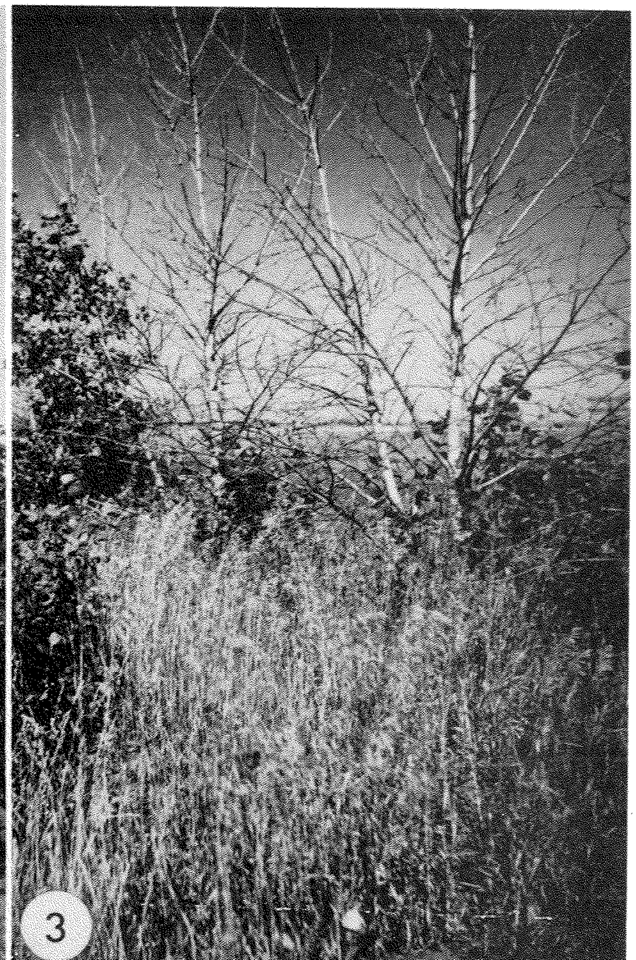

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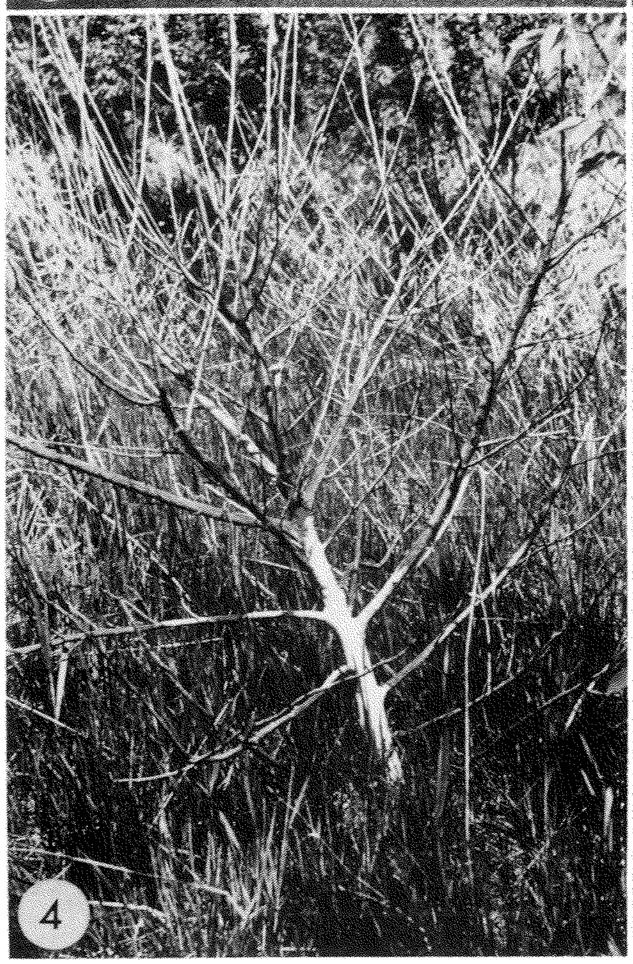

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Plate II.

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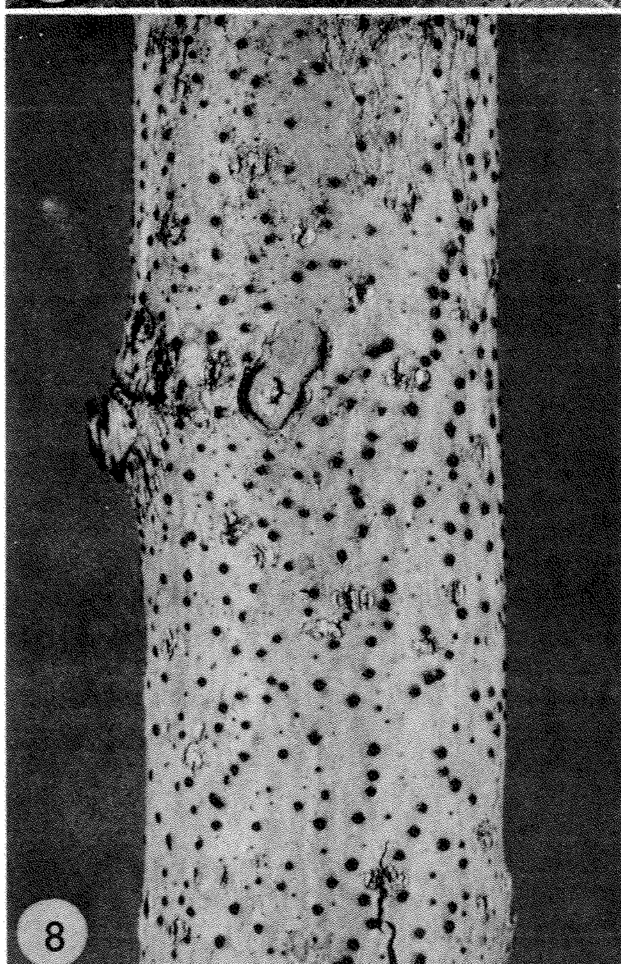

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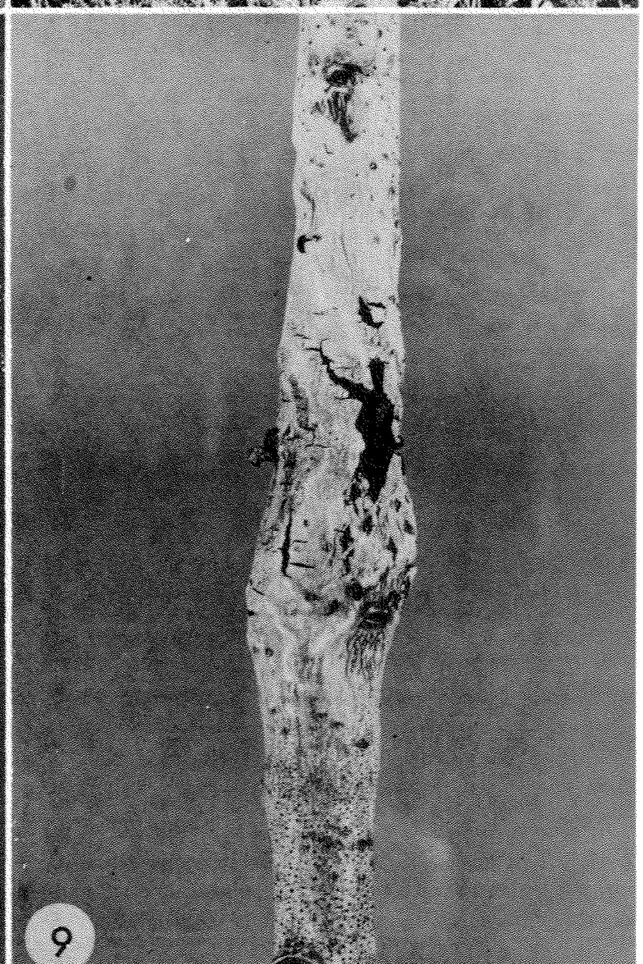

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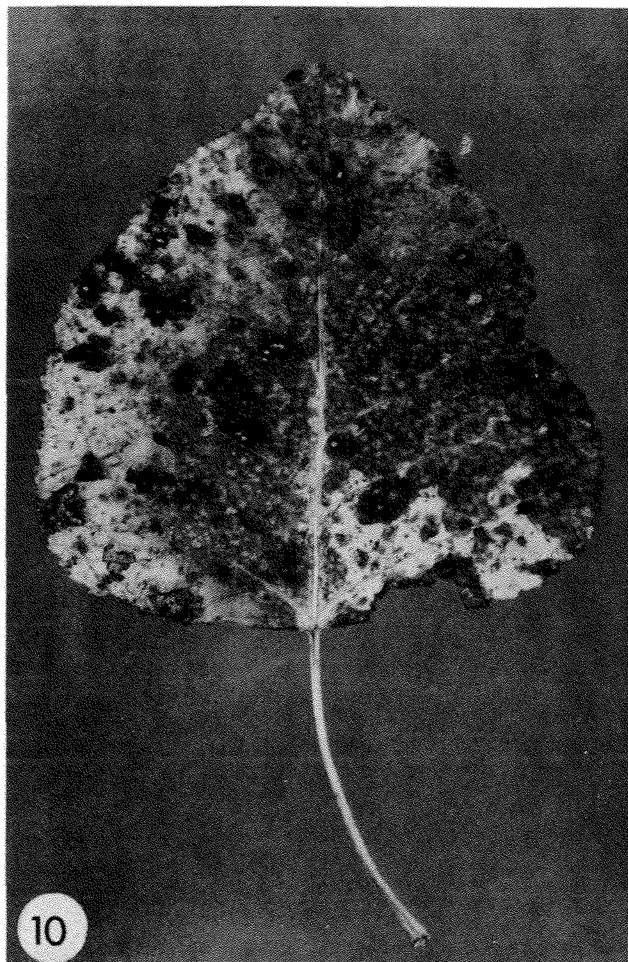
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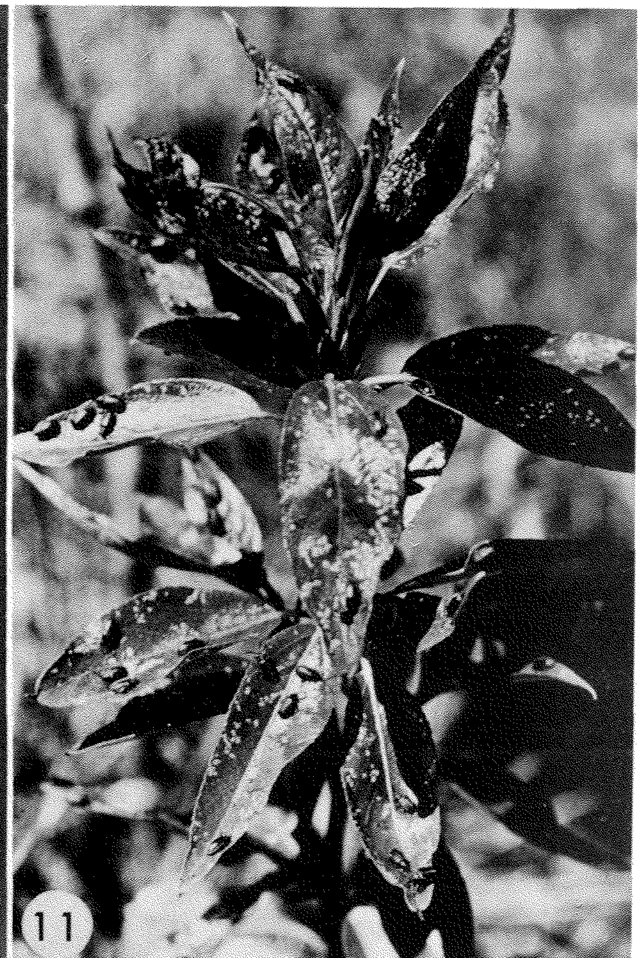
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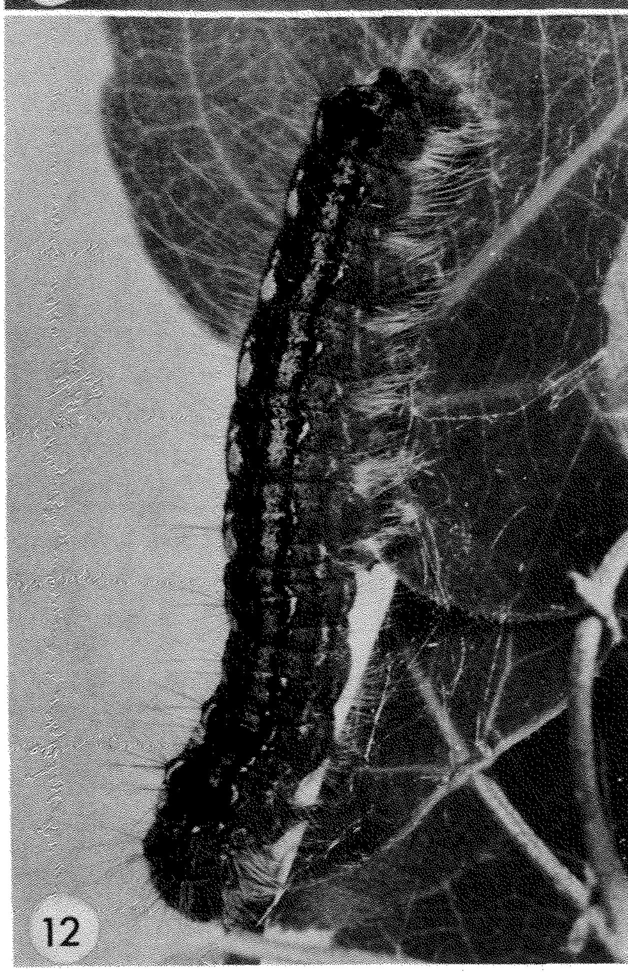
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