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DISEASE AND DAMAGE PROBLEMS OF TREES AND SHRUBS IN NATIONAL AND PROVINCIAL PARKS IN NEWFOUNDLAND: STATUS AND CONTROL RECOMMENDATIONS

by Pritam Singh

NEWFOUNDLAND FOREST RESEARCH CENTRE
INFORMATION REPORT N-X-194

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1981

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CANADIAN FORESTRY SERVICE
ENVIRONMENT CANADA

ISSN No. 0704-7657
CAT. No. F046-15/194E
ISBN No. 0-662-12019-1

Copies of this report are available from:

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Telephone No. 709-772-4817

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ACKNOWLEDGEMENTS

I am grateful to Gordon C. Carew for technical assistance and to Mrs. Margaret Anderson of the Dept. of Culture, Recreation & Youth, Parks Division, Government of Newfoundland and Labrador, for the use of a negative for the picture on the cover of the report.

ABSTRACT

This report is the first comprehensive treatise of the disease and damage problems in two national and 46 provincial parks, and three scenic areas on the island of Newfoundland. It gives an up-to-date inventory of various problems and evaluates the status of the more important or more common diseases and other damage problems. The report also includes a summary description of important diagnostic features; recommendations for the control and prevention of these disease and damage problems, and discusses the role of forest insect and disease survey in the protection and management of parks on the Island. Some information on the history and geography of the parks, and a glossary of technical terms used in the report, are also included.

RÉSUMÉ

Ce rapport est la première étude complète des maladies et dommages que subissent les arbres de 2 parcs nationaux, 46 parcs provinciaux et 3 zones pittoresques de Terre-Neuve. Il donne une liste à jour des divers problèmes, et examine la situation des maladies les plus importantes et les plus répandues ainsi que d'autres dommages. En outre, il décrit brièvement les principales caractéristiques servant à porter un diagnostic, énonce des recommandations pour prévenir les maladies et les dommages en question et analyse la valeur du relevé des insectes et des maladies des arbres pour la protection et la gestion des parcs de l'île. On y trouve également des informations sur l'histoire et la géographie des parcs et un glossaire des termes techniques utilisés.

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INTRODUCTION

The Society of American Foresters (SAF) defines "natural areas as lands set aside to preserve permanently in unmodified condition a representative unit of virgin growth" (Shanklin 1968). Parks are one of those natural areas which have great potential for a variety of outdoor activities, including recreational and relaxing pursuits, and that at the same time conserve the natural environment.

An extensive park system has been developed in Newfoundland and Labrador during the past 26 years and there are now two national parks, 46 provincial parks, three scenic areas and 17 public beaches scattered on the island of Newfoundland, and two provincial parks in Labrador. Maintenance of healthy parks and other scenic and recreational areas is essential to the tourist industry in Newfoundland. Control of diseases of trees and shrubs form an integral part of maintaining healthy parks. Diseases and other damage problems are caused by fungi, other micro-organisms, phanerogamic plant parasites, animals and abiotic factors, such as snow, ice, frost, storms and high winds, and they affect all plant parts, including roots, stem and leaves. The resulting damage may kill or disfigure trees and thus result in the actual loss of the tree or destroy the aesthetic value of the area and deplete the environment.

Parks on the Island have been under surveillance of the Forest Insect & Disease Survey since 1954 for identification of damaging insects and diseases, assessment of damage caused by them, and for recommendation of control measures. However, the first aerial and ground surveys to determine the status and impact of various insects, diseases and other damage problems in the two national parks, Gros Morne and Terra Nova, were conducted in 1973.

During the past 26 years, the Canadian Forestry Service and the Newfoundland Forest Protection Association have accumulated considerable data on the distribution and severity of many diseases and

other types of damage, and their impact on trees and shrubs in various parks on the Island. To date a total of 187 records of diseases and other damage problems have been made. These include 22 host species and 42 species of fungi, one phanerogamic parasite (eastern dwarf mistletoe), three animals (moose, rabbit and beaver), and 25 different records of damage by frost, winter injury, snow and ice, high winds, heat, roadside and salt damage (Canadian Forestry Service, 1950-1979; 1954-1979; Singh & Carew, 1973).

This report combines all the information obtained from surveys, and provides a readily accessible up-to-date inventory of various disease and damage problems of trees and shrubs in the provincial and national parks, and scenic areas in Newfoundland. It also includes a discussion on the distribution and severity, status and impact, and recommendations for the control of major problems. Information on various disease and damage problems is organized into two main groups: (i) fungal diseases and (ii) damage caused by animals and abiotic factors. Fungal diseases are further divided into three main categories depending upon the plant part affected: root, stem and foliage diseases. The root diseases include root and butt rots; the stem diseases include cankers and diebacks, rusts, blights, and Witches' broom; and the foliage diseases include needle rusts, leaf (broad leaf) rusts, needle casts and leaf spots. Damage by animals and abiotic factors are discussed separately. Photographs of the important and common disease and damage problems are included to aid in their identification. A brief history and description of the location, site conditions and vegetation of the parks are also included. It is hoped that this publication will assist park supervisors and other personnel concerned with the protection and management of parks and scenic areas in identifying and controlling common disease and damage problems.

GEOGRAPHICAL DESCRIPTION OF THE PARKS AND SCENIC AREAS SURVEYED

All the parks and scenic areas (two national, 46 provincial and three scenic areas) on the island of Newfoundland (latitude 46°37'N-52°01'N, longitude 52°37'W-59°25'W) were surveyed for disease and damage conditions (Table 1, Fig. 1).

Provincial Parks: In Newfoundland and Labrador an extensive system of provincial parks has been developed during the past 26 years. The first park was established in 1954 at Big Falls on the Humber River. Through the late fifties and early sixties development of parks proceeded with the establishment of camping and picnic areas along the proposed Trans-Canada Highway. Later park development occurred in less well travelled

Table 1. List of parks and scenic areas on the island of Newfoundland.

Provincial Parks

1. Chance Cove
2. La Manche
3. Cochrane Pond
4. Butter Pot
5. Gushue's Pond
6. Father Duffy's Well
7. Northern Bay Sands
8. Holyrood Pond
9. Cataracts
10. Backside Pond
11. Fitzgerald's Pond
12. Bellevue Beach
13. Jack's Pond
14. Pipers Hole River
15. Lockston Path
16. Freshwater Pond
17. Frenchman's Cove
18. Jipujijkuei Kuespem
19. Windmill Bight
20. David Smallwood
21. Square Pond
22. Jonathan's Pond
23. Glenwood
24. Notre Dame
25. Dildo Run
26. Beothuck
27. Aspen Brook
28. Catamaran
29. Mary March
30. Indian River

31. Flatwater Pond
32. Sop's Arm River
33. Squire's Memorial
34. Pistolet Bay
35. River of Ponds
36. Sandbanks
37. Stag Lake
38. Blue Ponds
39. Blow Me Down
40. Barachois Pond
41. Piccadilly Head
42. Crabbes River
43. Otter Bay
44. Grand Codroy
45. Mummichog
46. Cheeseman

Scenic Areas

47. Rattle Falls
48. Northeast Arm
49. Jiggin' Head

National Parks

TNNP - Terra Nova National Park
GMNP - Gros Morne National Park

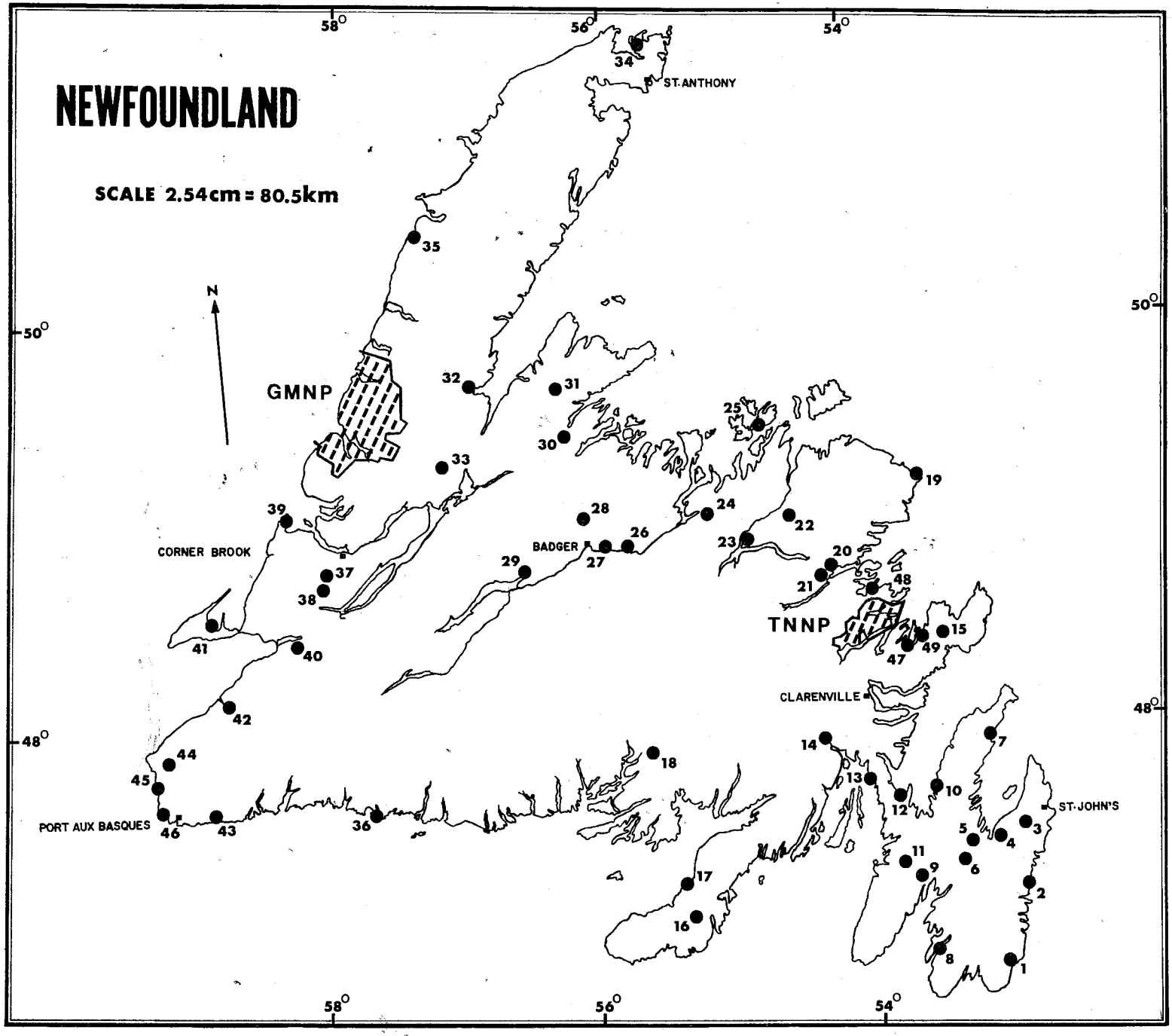

Fig. 1. Location of 46 provincial parks, three scenic areas and two national parks in *Newfoundland*.

parts of the Province for the purpose of attracting visitors to these areas. There are now 48 provincial parks (46 on the Island and two in Labrador), 17 public beaches, three scenic areas and many fishery access roads scattered throughout the Province. For this report only parks and scenic areas on the Island are taken into account.

Terra Nova National Park: This is the most easterly of Canada's national parks and is located on the east coast of the Island, on Bonavista Bay, about 77 km (= 48 miles) southeast of Gander and about 233 km (= 145 miles) northwest of St. John's (latitude 48°23'N-48°39'N, longitude 53°41'W-54°15'W). The development of the park was initiated in 1957 and its total area is about 246 km^2 (= 153 sq. miles). It is accessible and bisected by the Trans-Canada Highway. The park has rugged rocky points and deeply indented shorelines with spectacular inlets.

Cool summers, mild winters and considerable precipitation characterize the climate of the park. As a result the rolling terrain of the park is thickly covered with boreal or northern forest dominated by black spruce and balsam fir. Speckled alder and red maple thrive in stream valleys, and stands of white birch and trembling aspen are scattered throughout the park. Several bogs, thickly matted with wet, spongy sphagnum moss, are also common.

Gros Morne National Park: This park is located at the foot of the Northern Peninsula on the west coast of the Island, about 80 km (= 50 miles) northeast of Corner Brook (latitude 49°17'N-49°58'N, longitude 57°25'W-58°09'W). The development of the park was initiated in 1970 and its total area is 1110 km^2 (= 690 sq. miles). It is accessible by Highway #430 (for Northern Peninsula) off Trans-Canada Highway. It contains the most spectacular section of the Long Range Mountains which rise dramatically and abruptly from the low coastal plain. Many fjord-like lakes, dense forests, rugged seacoast and beautiful beaches form the terrain of the park. The park derives its name from Newfoundland's second highest mountain, Gros Morne (800 m = 2,644 ft.), which dominates the Bonne Bay area and a 72 km (= 45 miles) long coast facing the Gulf of St. Lawrence.

A northerly maritime climate, characterized by strong winds, a short growing season and high snowfall, influences the park's vegetation. Only hardy species can survive. Along the seacoast grows a thick "Krumholz forest" of stunted fir and spruce. Between the sea and the mountains is the flat coastal plain, which being poorly drained, has extensive bogs and prairie-like grassland broken occasionally by rows of spruce, balsam fir and white birch forests. Lush forests of balsam fir and black spruce, with scattered tamarack, white birch, mountain-ash, pin cherry, willows and red maple cover the lower mountain slopes.

Fig. 1. Location of 46 provincial parks, three scenic areas and two national parks in Newfoundland.

DIAGNOSIS AND EVALUATION OF DISEASE AND DAMAGE PROBLEMS

Surveys and examination have revealed that there are several disease and damage problems in parks; some are common, others are not; some are widespread, others are spotty in distribution. These problems are categorized into: (i) fungal diseases, and (ii) damage caused by animals and abiotic factors. All the fungal diseases, along with their causal organism(s), host(s), distribution and severity in parks and scenic areas are listed in Tables 2, 4 and 6. The animal and abiotic damage problems, along with their causal agent(s), host(s), distribution and severity are listed in Tables 3, 5 and 7. Figures 1, 2 and 3 show the locations and areas on the map where the disease and damage problems were observed.

FUNGAL DISEASES:

Root and Butt Rot:

Armillaria root rot, also known as "Shoe-string root rot", caused by Armillaria mellea (Vahl. ex Fr.) Kummer, was the only root disease found in parks, though it was never serious enough to cause any concern. The disease was observed in scattered patches and its incidence was trace to light. The root rot is, however, widely distributed in the forests of Newfoundland and Labrador and is considered as the most important disease of living trees on the Island. It has been recorded on trees of 25 native and introduced, softwood and hardwood species; on trees of all age classes. The pathogen can kill young trees in reproductions or plantations, and cause moderate to severe losses in mature and overmature trees through mortality, decay and deterioration. It attacks apparently healthy, vigorously growing trees, but is particularly destructive in stands or plantations which have been predisposed or weakened by factors, such as drought, water logging, malnutrition and those damaged or killed by insect pests. It is also highly damaging in plantations, particularly those established by bare root planting and those established on cutover sites.

The general symptoms of the disease are a decline in the vigour of the tree, progressive yellowing or browning, thinning, and eventual loss of the foliage. This condition is accompanied by an excessive flow of resin and formation of a canker at the point of infection on the root or at the base of the stem. These symptoms are followed by a reduction in the annual growth. Ultimately such trees die or become prone to windthrow. The death of younger trees takes place in a period varying from a few months to three years, but that of older trees may take several years. Infected trees may occur singly or in groups. The disease kills the cambium and the inner bark of trees, and causes decay of both sapwood and heartwood of the roots and the lower bole; it usually does not progress upward in the stem for more than a few feet above ground level.

Table 2. Fungal diseases with their causal organisms, hosts, distribution and severity in Terra Nova National Park.

Causal Organism	Disease/Damage	Host(s)	Distribution and Severity
STEM CANKER:			
Apiosporina morbosa (Schw.) Arx	Black knot	Cherry, pin	Common wherever the host occurs; trace to light, up to 10% trees affected; sometimes severe and affecting up to 60% of the trees.
STEM RUST:			
Cronartium ribicola J.C. Fischer	Blister rust	Pine, eastern white	Common wherever the host occurs, particularly conspicuous along Terra Nova Village Road; on young and older ornamental and naturally regenerating trees; usually up to 15% trees infected; in some severely infected areas up to 80% of the trees affected.
BROOM RUST:			
Melampsorella caryophyllacearum Schroet.	Broom rust or yellow Witches' broom	Fir, balsam	Conspicuous in many areas but mostly in traces and up to 2% of the trees infected; rarely up to 12% of the trees were affected.
BLIGHT:			
Fusicoccum abietinum (Hartig) Prill. & Del.	Red flag	Fir, balsam	Fairly common; trace to light; at times very conspicuous and affecting up to 40% of the foliage.

(Cont'd.)

Table 2. (Cont'd.)

Causal Organism	Disease/Damage	Host(s)	Distribution and Severity
Venturia macularis (Fr.) E. Muell. & Arx [= *Pollacia radiosa* (Lib.) Bald. & Cif.]	Shoot & leaf blight	Aspen, trembling	Common and scattered throughout the park, particularly conspicuous in regenerating sites; light to severe and killing up to 80% of the new shoots.
NEEDLE RUST:			
Chrysomyxa ledi de Bary	Needle rust	Spruce, black, white	Common, in scattered patches, trace to light, affecting up to 5% of the current year's needles and up to 10% of the young trees.
Chrysomyxa ledicola Lagerh.	Needle rust	Spruce, black, white	Common, in scattered patches; trace to light, affecting up to 5% of the current year's needles and up to 10% of the young trees.
Chrysomyxa species	Needle rust	Spruce, black	Common, in scattered patches, particularly conspicuous in Bonavista and Terra Nova area; generally trace to light; in severe cases 40% of the current year's needles and 25% of the young trees were infected.
Melampsora epitea Thüm	Leaf rust	Aspen, trembling	Rare, in scattered patches; sometimes common, and moderate to severe and affecting up to 60% of the foliage.

(Cont'd.)

Table 2. (Cont'd.)

Causal Organism	Disease/Damage	Host(s)	Distribution and Severity
NEEDLE CAST:			
Hypodermella laricis v. Tub.	Needle cast	Tamarack	Common, mostly in small patches; trace to light, up to 15% of the foliage infected.
Isthmiella crepidiformis (Darker) Darker	Needle cast	Spruce, black	Common, in patches, usually on a few trees; trace to light, up to 10% of the older and lower foliage affected.
Isthmiella faullii (Darker) Darker	Needle cast	Fir, balsam	Common in scattered patches, often conspicuous near Charlottetown and in eastern part of the park; trace to light, up to 20% of the lower foliage affected.
Lirula macrospora (Hartig) Darker	Needle cast	Spruce, black, white	Common, in scattered patches; trace, up to 5% of the lower foliage affected.
Lirula nervata (Darker) Darker	Needle cast	Fir, balsam	In scattered patches; trace to moderate, affecting up to 50% of the foliage.
Lophodermium nitens Darker	Needle cast	Pine, eastern white	Usually in scattered patches, wherever the white pine is growing; trace, affecting up to 10% of the foliage.

(Cont'd.)

Table 2. (Concl'd.)

Causal Organism	Disease/Damage	Host(s)	Distribution and Severity
Lophodermium pinastri (Schrad. ex Hook.) Chev.	Needle cast	Pine, Scots	Common wherever the host is grown; trace to light and affecting up to 15% of the foliage.
LEAF SPOT:			
Ciborinia whetzelii (Seav.) Seav.	Ink spot	Aspen, trembling	Common, wherever the host is growing, particularly conspicuous in the eastern and central part of the park; trace to moderate, affecting up to 60% of the foliage.
Kabatiella apocrypta (Ell. & Ev.) Arx	Large leaf spot or Anthracnose	Maple, mountain, red	Common wherever the hosts grow; trace to light, affecting up to 15% of the foliage.

Table 3. Animal and abiotic factor damage problems with their causal agents, hosts, distribution and severity in Terra Nova National Park.

Causal or Damaging Agent	Damage	Host(s)	Distribution and Severity
ANIMAL:			
Moose	Browsing	Birch, white Fir, balsam	Common, scattered; trace to moderate, affecting up to 42 and 16% of the new shoots of regenerating white birch and balsam fir, respectively.
Rabbit	Browsing	Birch, white Fir, balsam	Common, scattered; trace to moderate, affecting up to 42 and 16% of the new shoots of regenerating white birch and balsam fir, respectively.
FROST:			
Frost damage	Shoot mortality	Fir, balsam Spruce, black Tamarack	Common throughout the park, mostly on regeneration; trace to severe, affecting from 2-75% of the new shoots.
HEAT:			
Heat injury	Leaf scorch-burning of apices and margins of leaves/needles	Alder, speckled Aspen, trembling Spruce, black Tamarack Willow, pussy	Uncommon but at times it can be seen everywhere in the park; conspicuous in regeneration; light to severe and affecting up to 75% of the foliage.

(Cont'd.)

Table 3. (Concl'd.)

Causal or Damaging Agent	Damage	Host(s)	Distribution and Severity
ROADSIDE:			
Site disturbances Automobile emissions Dust	Uprooting, browning of foliage and shoot/branch mortality, tree mortality	Spruce, black	Common along the roads and highways, particularly the unpaved or woods roads.
WINTER:			
Winter injury or Winter drying	Shoot mortality	Fir, balsam	Common throughout the park, particularly in exposed areas; light damage and affecting from less than 1 to 15% of the shoots.

Table 4. Fungal diseases with their causal organisms, hosts, distribution and severity in Gros Morne National Park.

Causal Organism	Disease/Damage	Host(s)	Distribution and Severity
ROOT AND BUTT ROT:			
Armillaria mellea (Vahl. ex Fr.) Kummer	Root and butt rot or shoe-string root rot	Fir, balsam Spruce, black	Sporadic, more common in unfavourable sites or in stands damaged by insects, very damaging in Bonne Bay area of the park; light to moderate, affecting up to 20% of the trees in some areas.
Fomes igniarius (L. ex Fr.) Kickx	White trunk or heart rot	Birch, white Willow	Uncommon to sporadic, only found in some parts of the park; trace, affecting less than 1% of trees.
Fomes pini (Brot. ex Fr.) Karst	Red ring rot or white pocket rot	Fir, balsam Spruce, black	Conspicuous in South Arm - Bonne Bay area; trace.
STEM CANKER:			
Apiosporina morbosa (Schw.) Arx	Black knot	Cherry, pin Plum	On plums - localized, particularly common in Woody Point, Shoal Brook and Birchy Head areas; severe, resulting in tree mortality, on pin cherry - it was widespread in several areas; light to severe, affecting up to 40% of the trees and 75% of the shoots.

(Cont'd.)

Table 4. (Cont'd.)

Causal Organism	Disease/Damage	Host(s)	Distribution and Severity
Dothichiza populea Sacc. & Briard	Dothichiza canker	Poplar, lombardy	Widespread, in the urban communities and wherever lombardy poplar is grown; light to severe, affecting up to 100% of the branches.
STEM RUST:			
Cronartium ribicola J.C. Fischer	Blister rust	Currant, skunk Pine, eastern white	Scattered throughout the park, wherever the host occurs; trace to moderate; no tree mortality, only branch mortality.
Melampsorella caryophylla cearum Schroet.	Broom rust or yellow Witches' broom	Fir, balsam	In scattered patches throughout the park; trace to moderate.
BLIGHT:			
Fusicoccum abietinum (Hartig) Prill. & Del.	Red flag	Fir, balsam	Scattered patches in some parts of the park; trace to light, resulting in shoot mortality.

(Cont'd.)

Table 4. (Cont'd.)

Causal Organism	Disease/Damage	Host(s)	Distribution and Severity
Phaeocryptopus nudus (Pk.) Petrak [= Adelopus balsamicola (Pk.) Theiss.]	Needle blight	Fir, balsam	Near Lomond; trace.
Venturia macularis (Fr.) E. Muell. & Arx [= Pollacia radiosa (Lib.) Bald. & Cif.]	Shoot and leaf blight	Aspen, trembling	Common throughout the park, in scattered patches, more conspicuous near Bonne Bay, East Arm, Mill Brook and Baker's Brook; low to moderate, affecting as many as 60% of the new shoots.
NEEDLE RUST:			
Chrysomyxa ledi de Bary	Needle rust	Spruce, black	Scattered patches in some parts of the park; mostly light, affecting up to 25% of the foliage, but at some locations of a few acres each, up to 100% of the foliage was infected.
Chrysomyxa ledicola Lagerh.	Needle rust	Spruce, black	Scattered patches in some parts of the park; mostly light, affecting up to 25% of the foliage, but at some locations of a few acres each, up to 100% of the foliage was infected.
Milesia fructuosa Faull	Needle rust	Fir, balsam	Conspicuous near Wiltondale; trace, affecting up to 5% of the new foliage.

(Cont'd.)

Table 4. (Cont'd.)

Causal Organism	Disease/Damage	Host(s)	Distribution and Severity
Pucciniastrum epilobii Otth	Needle rust	Fir, balsam	Common throughout the park, in scattered patches, conspicuous near Belldowns Point; low and affecting up to 20% of the new foliage.
LEAF RUST:			
Gymnosporangium cornutum Arth. ex Kern	Rust galls or leaf rust	Mountain-ash, American	In scattered patches at a few locations in the park, particularly near Lomond; affecting less than 15% of the foliage.
Melampsora abieti-caprae-arum Tub.	Leaf rust	Willow	Sporadic, in scattered patches, particularly conspicuous near Lomond; trace to low.
NEEDLE CAST:			
Lirula nervata (Darker) Darker	Needle cast	Fir, balsam	Scattered in small patches, particularly near Lomond; trace.
Isthmiella faullii (Darker) Darker	Needle cast	Fir, balsam	Scattered patches throughout the park, more common on the lower shoots and in exposed areas, particularly at Rocky Harbour and Bonne Bay; trace to light, severe on some trees, affecting as much as 60% of the foliage.

(Cont'd.)

Table 4. (Concl'd.)

Causal Organism	Disease/Damage	Host(s)	Distribution and Severity
Rhizothyrium abietis Naum.	Needle cast	Fir, balsam	Rare; less than 1% foliage affected.
LEAF SPOT:			
Cylindrosporium betulae Davis	Leaf spot	Birch, white	Common, in scattered patches in birch stands along the coast and sometimes inland, more common near Birchy Harbour and Rocky Harbour; light to severe, affecting as much as 90% of the foliage.
Kabatiella apocrypta (Ell. & Ev.) Arx	Large leaf spot or Anthracnose	Maple, mountain	In scattered patches throughout the park, conspicuous in Bonne Bay area, near Lomond, Woody Point, Rocky Harbour and Norris Point; trace to light, affecting up to 25% of the foliage, rarely affecting up to 65% of the foliage.
Phleospora aceris (Lib.) Sacc.	Small leaf spot	Maple, mountain	Rare, near Lomond; trace.
Phyllosticta minima (Berk. & Curt.) Underw. & Earle	Purple eye spot	Maple, red, mountain	Common, in scattered patches, particularly conspicuous near Norris Point, Dick's Brook and Rocky Harbour; light, affecting up to 15% of the foliage.
LEAF BLISTER:			
Taphrina carnea Johans	Leaf blister	Birch, yellow	Rare, in patches, at Lomond; moderate and affecting up to 50% of the foliage.

Table 5. Animal and abiotic factor damage problems with their causal agents, hosts, distribution and severity in Gros Morne National Park.

Causal or Damaging Agent	Damage	Host(s)	Distribution and Severity
ANIMAL:			
Moose	Browsing	Birch, white Fir, balsam	Light browsing in several areas.
FROST:			
Frost damage	Shoot mortality	Fir, balsam	Light damage in regeneration and young natural stands, particularly in Rocky Harbour and Bonne Bay Road; killing up to 30% of new growth.
	Foliage damage in general and shoot mortality of apical leader and some shoots.	Maple, mountain	Light damage at several locations in the park, moderate damage at some locations and affecting up to 50% of the foliage.
	Shoot mortality	Spruce, black	Most conspicuous along and near Bonne Bay Road; light to moderate damage, affecting from 10 to 55% of the new shoots.
	Foliage damage as well as shoot mortality	Mountain-ash, American	Conspicuous near Deer Arm Brook; light damage.

(Cont'd.)

Table 5. (Concl'd.)

Causal or Damaging Agent	Damage	Host(s)	Distribution and Severity
WIND:			
Windthrow	Windthrow, uprooting and mortality of trees	Fir, balsam	Common in several areas of the park, usually affecting overmature, dead, insect-killed or insect-damaged trees, most trees were already decaying or deteriorating; light.
ROADSIDE:			
Site disturbances Automobile emissions Dust Exposure and high winds	Uprooting, browning of foliage, and shoots/branch mortality, and tree mortality	Alder, speckled Birch, white Cherry, pin Fir, balsam Spruce, black Several shrubs	Damage was most conspicuous and common along roads and highways, particularly the unpaved or woods roads
WINTER:			
Winter injury or Winter drying	Shoot mortality	Fir, balsam Spruce, black, white	Mostly at some exposed sites in and near Rocky Harbour, Bonne Bay, all coast areas, Wiltondale, Green Point, Shallow Bay, Deer Lake, Lomond, Daniels Harbour and Bellburns; affects trees and stands of all ages; light to severe damage, affecting up to 100% of the foliage.

Table 6. Fungal diseases with their causal organisms, hosts, distribution and severity in Provincial Parks.

Causal Organism	Disease/Damage	Host(s)	Distribution and Severity
ROOT AND BUTT ROT:			
Armillaria mellea (Vahl. ex Fr.) Kummer	Root and butt rot or shoe-string root rot	Fir, balsam	Common in two parks (Barachois Pond and Crabbes River); affected 75% of the aphid-infested trees.
STEM CANKER:			
Apiosporina morbosa (Schw.) Arx	Black knot	Cherry, pin	Common in several parks, particularly conspicuous in Notre Dame Jct. and Glenwood; light to severe; both new and old infections; induces shoot as well as tree mortality.
Cytospora chrysosperma (Pers.) Fr.	Cytospora canker and dieback	Willows	Scattered in Blue Pond and Piccadilly Head; light to moderate, rarely severe.
Cytospora salicis (Cda.) Rabh.	Cytospora canker and dieback	Willows	Scattered in Blue Pond and Piccadilly Head; light to moderate, rarely severe.
STEM RUST:			
Melampsorella caryophyllacearum Schroet.	Broom rust or yellow Witches' broom	Fir, balsam	On scattered trees in a few provincial parks, such as Bellevue Beach, Blue Pond and Frenchman's Cove; trace to moderate, affecting up to 20% of the trees; the infection was severe at one location and affected 30% of the trees and showed as many as 7 brooms on a tree.

(Cont'd.)

Table 6. (Cont'd.)

Causal Organism	Disease/Damage	Host(s)	Distribution and Severity
Chrysomyxa arctostaphyli Diet.	Broom rust or yellow Witches' broom	Spruce, black	Common, on scattered trees in a few provincial parks, such as Bellevue Beach, Blue Pond and Frenchman's Cove; trace to moderate, affecting up to 20% of the trees; the infection was severe at one location and affected 35% of the trees and showed as many as 9 brooms on a tree.
DECAY OR ROT:			
Lenzites saepiaria (Wulf. ex Fr.) Fr.	Brown cubical or pocket rot	Spruce, black	Scattered on a few trees in Sops Arm Prov. Park; light; causes sapwood decay of dead trees.
DWARF MISTLETOE:			
Arceuthobium pusillum Peck	Witches' broom (eastern dwarf mistletoe)	Spruce, black	Scattered patches in several parks, such as Barachois Pond, Little Barachois Brook Valley, Trout Brook and Crabbes River; trace to moderate, affecting as many as 15% of the trees.
BLIGHT:			
Rehmiellopsis balsameae Waterman	Tip blight	Fir, balsam	On new shoots of immature trees at Crabbes River Prov. Park; light.

(Cont'd.)

Table 6. (Cont'd.)

Causal Organism	Disease/Damage	Host(s)	Distribution and Severity
Venturia macularis (Fr.) E. Muell & Arx [= Pollacia radiosa (Lib.) Bald. & Cif.]	Shoot and leaf blight	Aspen, trembling	Common in scattered patches in many parks, including Barachois, Indian River or Flat Water; low to severe, affecting up to 80% of the foliage and up to 60% of the regeneration.
NEEDLE RUST:			
Chrysomyxa ledi de Bary	Needle rust	Spruce, black	Common, in scattered patches in some parks, such as Glenwood and Indian River; trace to severe, affecting up to 100% of the young trees and over 60% of the foliage.
Pucciniastrum epilobii Otth	Needle rust	Fir, balsam	Sporadic, in scattered patches in David Smallwood Memorial Prov. Park; light, affecting about 15% of the foliage.
LEAF RUST:			
Gymnosporangium cornutum Arth. ex Kern	Rust galls or leaf rust	Mountain-ash, American	Scattered in Notre Dame Jct. and Beothuck Prov. Parks; low to high and affecting up to 75% foliage.

(Cont'd.)

Table 6. (Cont'd.)

Causal Organism	Disease/Damage	Host(s)	Distribution and Severity
NEEDLE CAST:			
Hypodermella laricis v. Tub.	Needle cast	Tamarack	Common in many parks, particularly conspicuous in and around Cochrane Pond Prov. Park; severe browning and affecting up to 80% of the foliage.
Hypodermella species	Needle cast	Spruce, white	Rare, on scattered trees, in Northern Bay Sands Prov. Park.
Isthmiella crepidiformis (Darker) Darker	Needle cast	Spruce, black	Common, in scattered patches in Northern Bay Sands Prov. Park; light, affecting up to 15% of the lower foliage.
Isthmiella faullii (Darker) Darker	Needle cast	Fir, balsam	Common, in scattered patches in some parks, such as Northern Bay Sands and Blow Me Down; light to severe, affecting up to 70% of the lower foliage.
Lirula macrospora (Hartig) Darker	Needle cast	Spruce, black, white	Scattered on some trees in Northern Bay Sands Prov. Park; trace to light.
Lophodermium species	Needle cast	Fir, balsam	On scattered trees in River of Ponds Prov. Park; trace to light, affecting up to 15% of the lower foliage.

(Cont'd.)

Table 6. (Concl'd.)

Causal Organism	Disease/Damage	Host(s)	Distribution and Severity
LEAF SPOT:			
Ciborinia whetzelii (Seav.) Seav.	Ink spot	Aspen, trembling	Common in Indian River, Middle Brook and Flat Water Pond Prov. Parks; light to severe, affecting up to 70% of the young aspen trees and over 40% of their foliage.
Kabatiella apocrypta (Ell. & Ev.) Arx	Large leaf spot or Anthracnose	Maple, mountain, red	Common in regeneration in Aspen Brook, Notre Dame Jct., Blow Me Down, and Blue Pond Prov. Parks; mostly light, rarely moderate.
Phyllosticta minima (Berk. & Curt.) Underw. & Earle	Purple eye spot	Maple, mountain, red	Common in scattered patches on regeneration in Barachois Pond, River of Ponds, Square Pond and Freshwater Pond Prov. Parks; light, affecting from 2 to 15% of the foliage.
Rhytisma punctatum (Pers.) Fr.	Speckled tar spot	Maple, mountain	Common in Glenwood Prov. Park; light to moderate on regeneration, affecting up to 50% of the foliage and about 30% of the trees.
LEAF BLISTER:			
Taphrina robinsoniana Giesenh	Leaf blister	Alder, speckled	Rare, in Glenwood Prov. Park; in trace.

Table 7. Animal and abiotic factor damage problems with their causal agents, hosts, distribution and severity in Provincial Parks.

Causal or Damaging Agent	Damage	Host(s)	Distribution and Severity
ANIMAL:			
Beaver	Tree mortality as a result of flooding caused by a dam built by beaver	Several softwoods and hardwood species	In LeManche Prov. Park; serious damage.
FROST:			
Frost damage	Shoot mortality	Fir, balsam	Common in Aspen Brook and Mary March Prov. Parks; light damage, affecting up to 20% of the new shoots.
ROADSIDE:			
Site disturbances	Mortality of over-mature trees induced by site and stand disturbances which resulted in the lowering of water tables	Tamarack	In Aspen Brook Prov. Park; severe damage.
SALT:			
Salt injury	Shoot mortality and foliage injury	Juniper Spruce, black	On scattered trees near the shoreline in Northern Bay Sands Prov. Park; damage was light.

(Cont'd.)

Table 7. (Concl'd.)

Causal or Damaging Agent	Damage	Host(s)	Distribution and Severity
SNOW AND ICE:			
Snow and ice damage	Tree tops and branches broken or bent	Aspen, trembling Birch, white Spruce, black Tamarack	In Notre Dame Jct. Prov. Park; affected both the immature and mature trees; severe damage.
WINTER:			
Winter injury or Winter drying	Shoot mortality or foliage injury	Aspen, trembling Fir, balsam	Common in Frenchman's Cove, Squires Memorial, Holyrood Pond and Blow Me Down Prov. Parks; damage was light to severe and affected up to 75% of the trees.

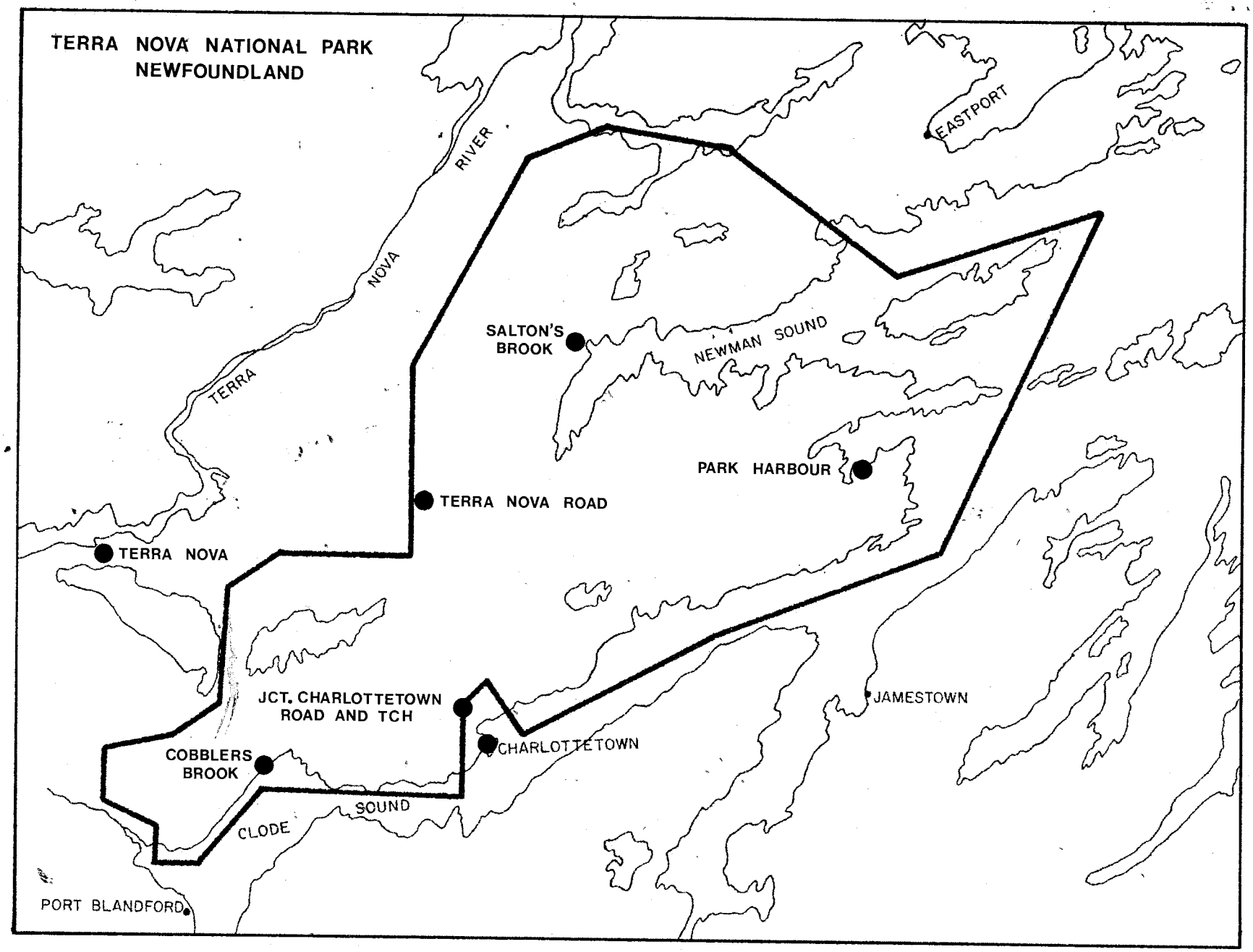

Fig. 2. Distribution of various disease and damage problems in Terra Nova National Park.

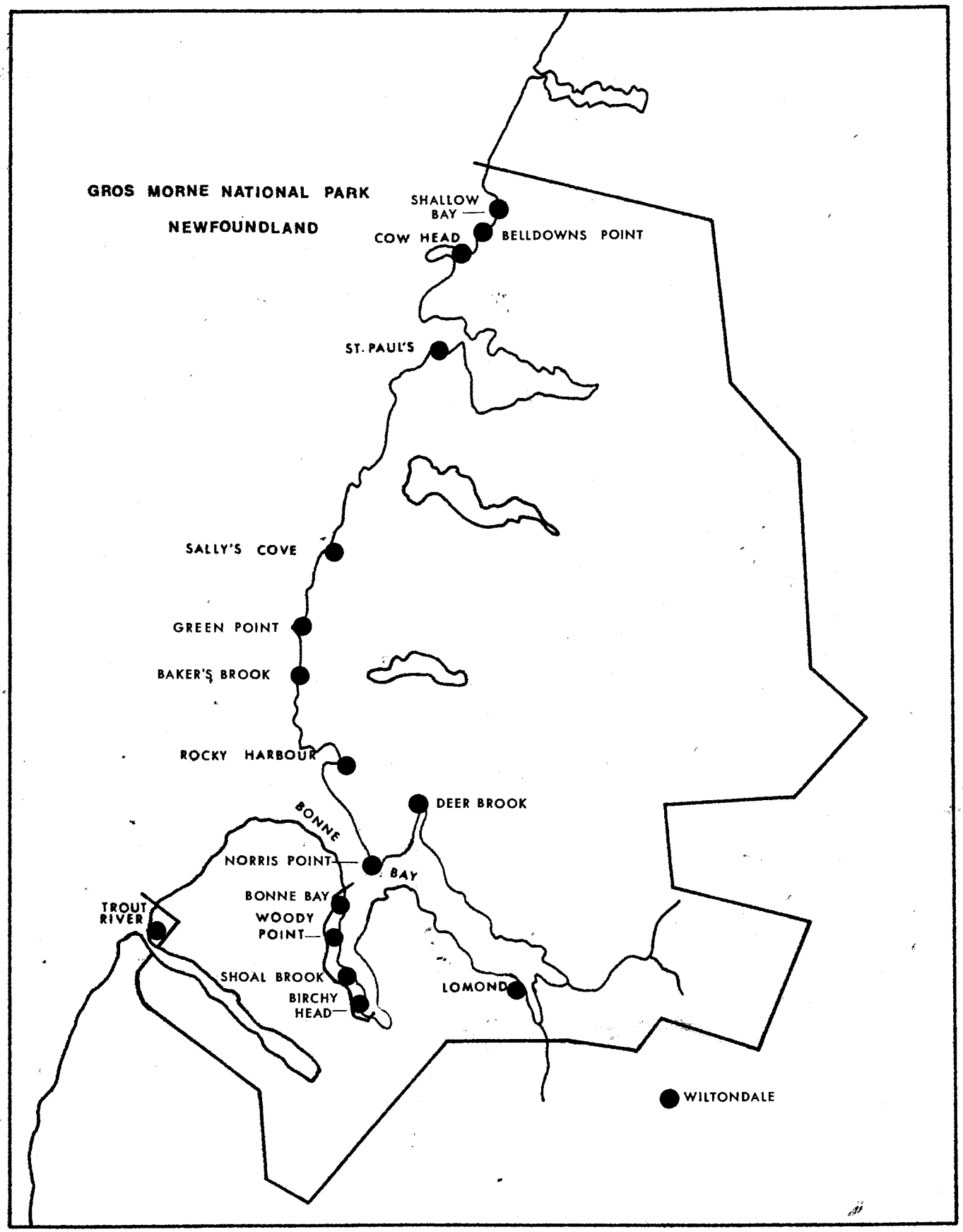

Fig. 3. Distribution of various disease and damage problems in Gros Morne National Park.

Important signs of the fungus are white or cream coloured fan-shaped mycelial growths on the wood under the bark, dark brown to black "shoe-string" like structures, the rhizomorphs, on or under the bark of infected roots, and honey-colored mushrooms which develop in groups on or around the base of infected trees.

Stem Canker and Dieback:

The term canker is broadly used to identify a fungus-induced disease that causes the death of definite and relatively localized areas on branches and trunks of trees. Cankers are sunken necrotic areas of dead bark, cambium and woody tissue, and are invariably accompanied or followed by dieback* of the shoot bearing the canker. If unnoticed or uncontrolled, the infection can eventually kill the tree or the seedling. The cankers may be annual or perrenial; the latter type are the most destructive and can create serious disease problems.

Some stem cankers and diebacks are common in Newfoundland parks, but they do not constitute any serious problem. They do, however, cause concern to park personnel because they disfigure trees, induce branch or shoot mortality, make the infected trees unsightly and contribute towards the decline in the aesthetic value of the park. Occasionally larger trees with trunk cankers constitute a hazard because such trees are weakened or decayed at the canker site and are highly susceptible to wind throw or snow and ice storm damage.

Three types of canker-producing diseases were most common in parks on the Island: (i) Black knot of cherry and plum, (ii) Dothichiza canker of lombardy poplar, and (iii) Cytospora canker of willows.

Black knot of cherry and plum, caused by Apiosporina morbosa (Schw.) Arx, is the most common disease of wild and cultivated, ornamental cherries and plums on the Island. It was unusually conspicuous in many parks. Its incidence varied from light to severe and affected up to 60% of the trees and up to 75% of the shoots. Although the disease caused considerable branch mortality and sometimes severe stunting and death of trees, it is not considered important because of low economic value of the hosts. However, the trees become unsightly, the area unattractive, and the aesthetic value of the park is reduced.

The name "black knot" describes the most conspicuous symptoms of the disease. These knots are black, charcoal-like, rough, cylindrical or spindle-shaped, cankerous overgrowths, usually occurring on one side of the branch, but often completely encircling it. The knots vary from 1 to 2 inches in diameter and tend to grow several inches along the length of the branch. Twigs and branches usually die beyond the knot. Knots are often hairy and the old ones may be riddled with insects.

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*Diebacks refer to rapid tip killing or girdling of shoots and branches.

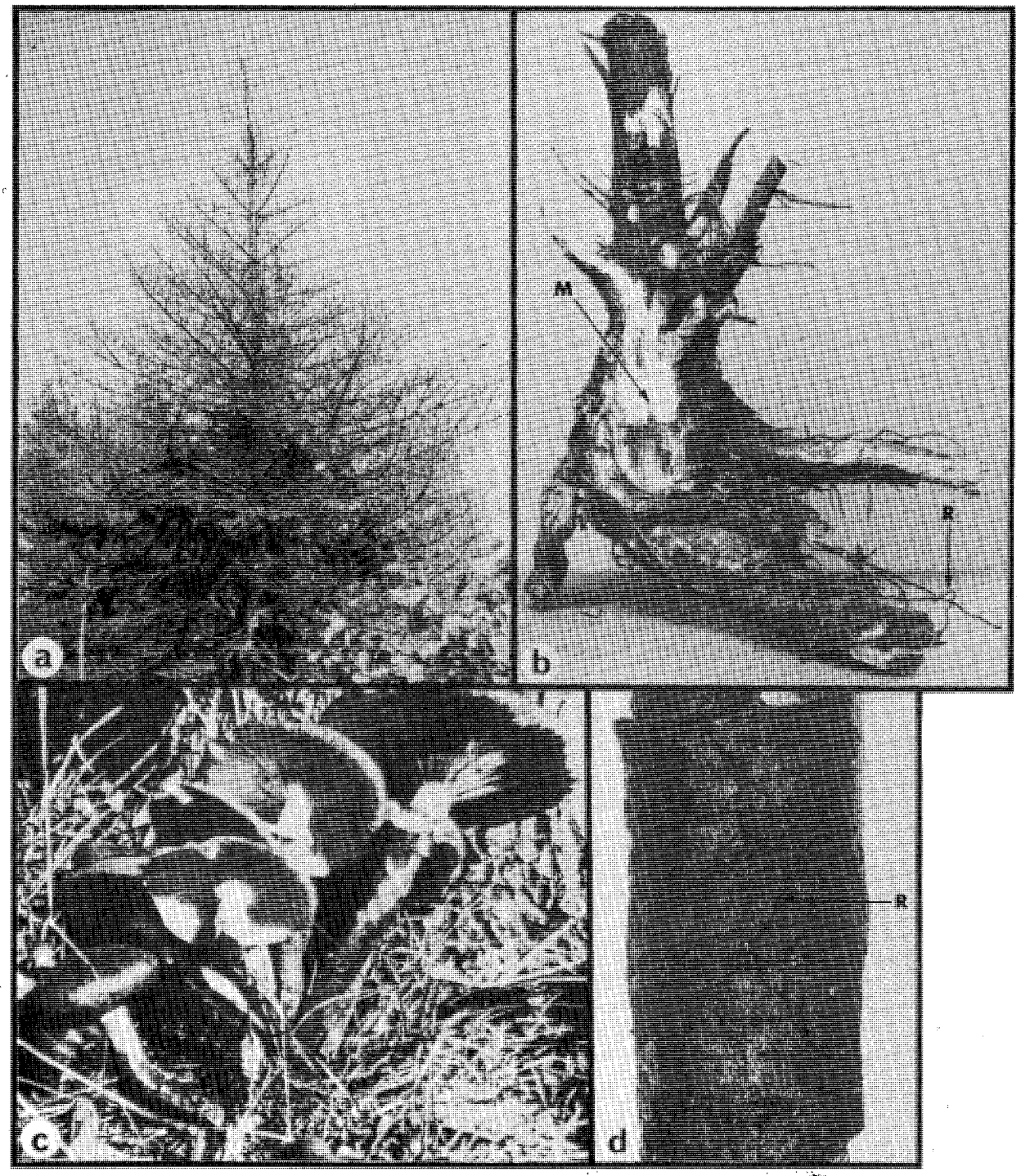

Fig. 4. Armillaria root rot of balsam fir. (a) A. mellea-killed tree. (b) White mycelium (M) and black rhizomorphs (R) on the base of an infected tree. (c) Mushrooms of A. mellea. (d) Rhizomorphs (R) on an infected root.

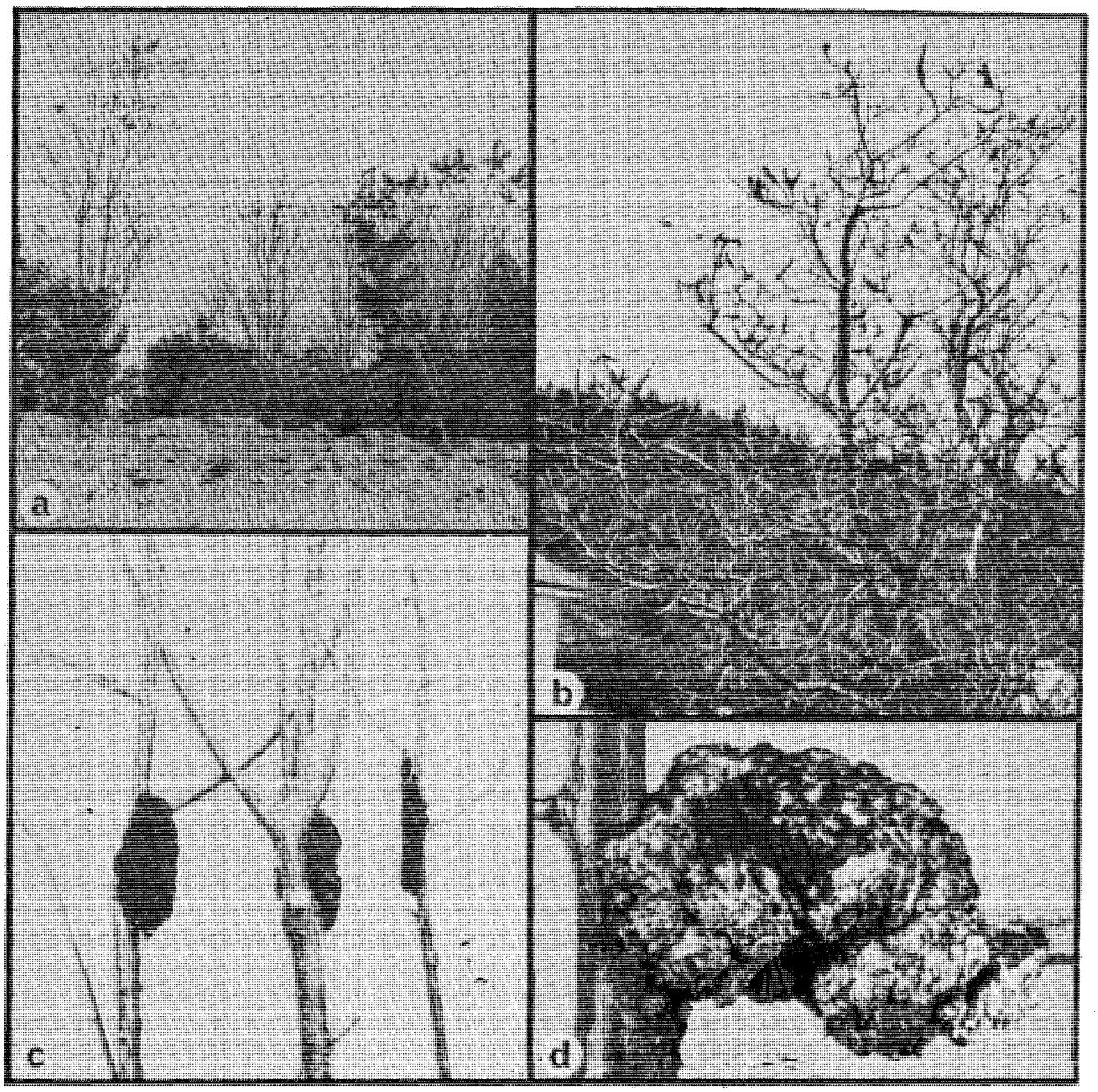

Fig. 5. Black knot of pin cherry and plum. (a) Severely infected pin cherry trees. (b) A severely infected plum tree. (c) Twigs with black knots. (d) A typical black knot on a twig.

Dothichiza canker of lombardy poplar, caused by Dothichiza populea Sacc. & Briard., caused considerable branch and tree mortality in a few urban communities within the Gros Morne National Park. It affected up to 100% of the shoots of several trees and killed up to 60% of the infected shoots.

Aesthetically the disease is important because it makes the trees unsightly. Economically the disease is important to individual homeowners.

It is an important disease of lombardy poplar in North America. In Newfoundland it is a devastating disease of ornamental trees of this species in several urban communities; lombardy poplar is one of the most popular ornamental trees on the Island.

The fungus can attack the tree trunk, branches or twigs, and result in the dieback of the infected shoot. It is followed by the production of several small, brown, rounded to elliptical spots on the bark which later on develop into sunken areas. Eventually the diseased bark becomes darker in color than the healthy bark and the sunken areas form the cankers. During this process, the bark and the cambium are killed, and the canker girdles the infected shoot or the stem, eventually causing its death. The sunken areas, on the dead shoots, produce minute pustules, known as the pycnidia and give a roughened appearance to the bark. Ultimately, the rough bark cracks and sloughs off leaving open wounds. Most cankers are formed at nodes and spread either way. On young branches or trees, the cankers girdle the branches rapidly, causing dieback. Trees planted as windbreaks or fence are particularly susceptible.

Cytospora canker of willow, caused by Cytospora salicis (Cda.) Rabh. and C. chrysosperma (Pers.) Fr., were common in scattered patches in some parks, particularly those on unhealthy or wet sites. The incidence of the disease was trace to light. The disease caused shoot mortality but no tree or shrub mortality. There is no economic impact of the disease because of extremely low incidence and because of no economic value of the host. However, the trees or bushes become unsightly because of several dead shoots; this reduces the aesthetic value of the park or the scenic area.

The most conspicuous symptoms of the disease and signs of the pathogen are the dieback of shoots; brownish, oval to circular, small cankers with sunken bark; and dark brown to black fruiting bodies. The cankers gradually enlarge, coalesce and girdle the shoot, which is ultimately killed.

Stem Rust:

Two kinds of stem rusts were common in parks on the Island: (i) Blister rust of eastern white pine, and (ii) Broom rusts of balsam fir and black spruce.

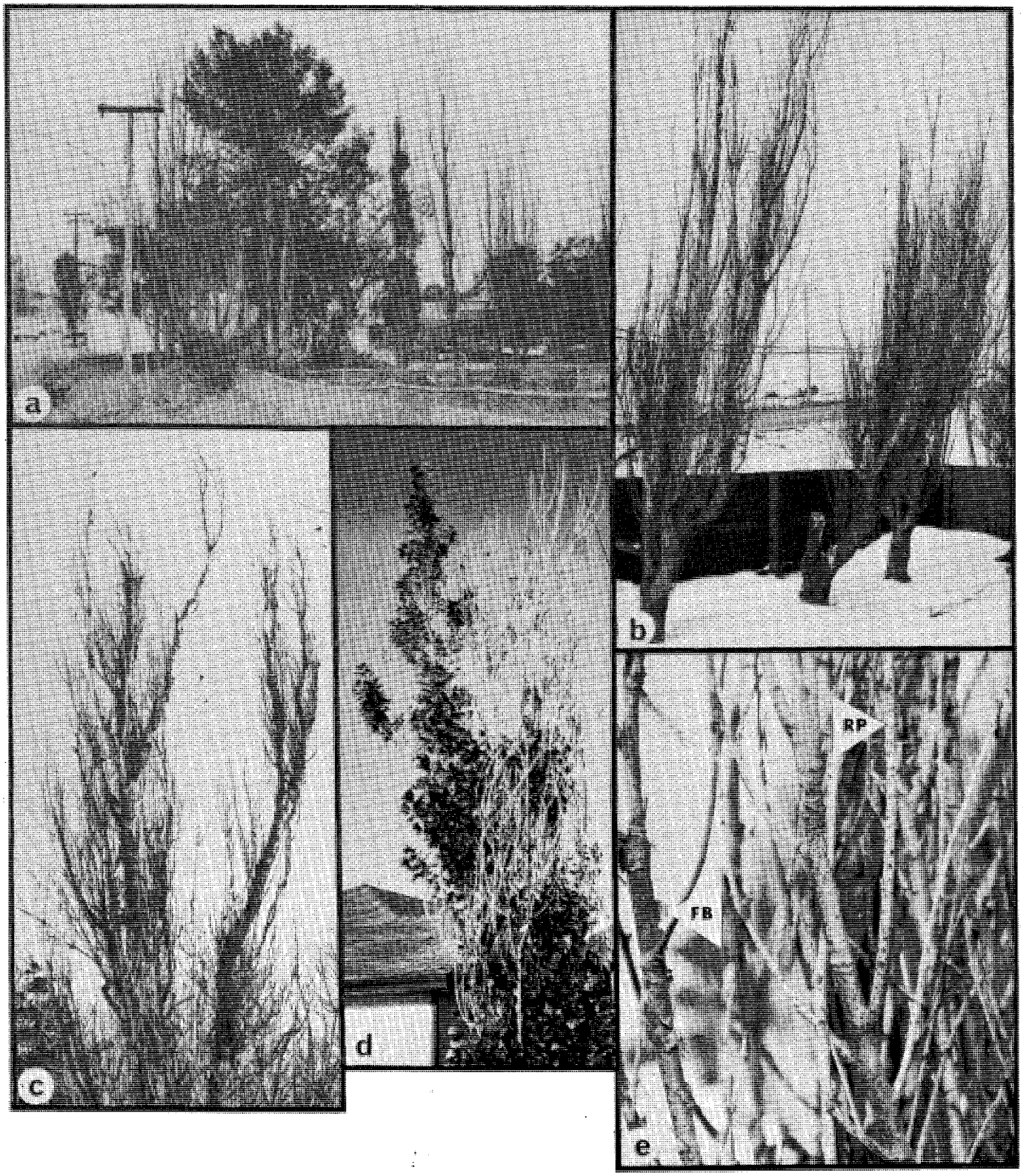

Fig. 6. Dothichiza canker of lombardy poplar. (a) & (b) D. populea-killed trees of lombardy poplar. (c) Completely dead tree top. (d) Partially dead tree. (e) Ruptured pycnidia (RP) and flaking bark (FB) on diseased shoots.

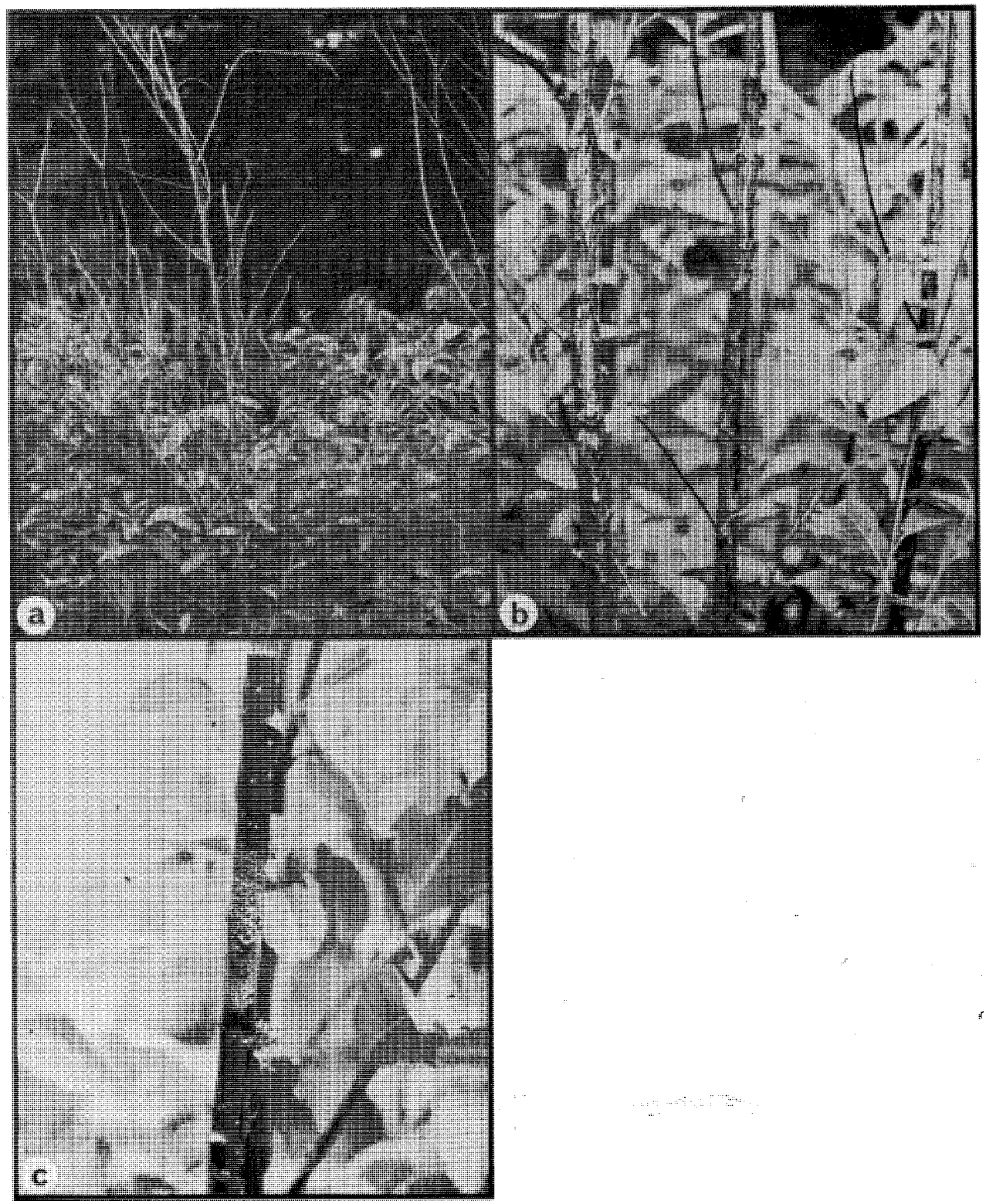

Fig. 7. Cytospora canker of pussy willow. (a) Canker-killed shoots. (b) Canker-induced rupturing of the bark on dead shoots. (c) Fruiting bodies of the fungus, Cytospora salicis.

Blister rust of eastern white pine, caused by Cronartium ribicola J.C. Fischer ex Rabh., is one of the most common, perennial fungal diseases of eastern white pine on the Island. The disease was observed in scattered patches wherever the host occurred, and its incidence varied from trace to light.

The disease affects pine trees of all ages, and ultimately causes tree mortality. Natural regeneration is particularly susceptible. In middle-aged or pole-size stands the rust infection results in an undesirable thinning. The rust is relatively harmless to its alternate hosts, Ribes bushes; leaves are cast prematurely when infection is heavy and fruit production may be reduced.

Since the disease completes its life cycle on two hosts, the native eastern white pine and a variety of wild and domestic currants and gooseberries, belonging to the genus Ribes, important diagnostic symptoms on the two hosts are given separately.

On pines the most prominent symptoms are spindle-shaped cankers or swellings on the infected trunk or branch, yellowish discoloration of the bark around the edges of the cankers, and blisters with their brilliantly orange colored spore masses. When a branch is girdled, foliage beyond the canker ultimately becomes red. This condition is known as "flagging" and is an important diagnostic characteristic. The flagged branches remain attached throughout the summer and often during the following season. The disease results in branch or tree mortality. Branch infection spreads to the trunk, girdles it and kills the tree. The smaller the pines, the more quickly they are killed. In larger trees the trunk cankers girdle the trees, retard their growth, weaken the stem, and finally the tops of the trees break at the point of girdling. Sometimes the larger trees are killed by multiple branch cankers.

On Ribes, yellow blisters on the underside of leaves indicate the presence of rust infection.

Broom rusts of balsam fir and black spruce, caused by Melampsorella caryophyllacearum Schroet, and Chrysomyxa arctostaphyli Diet., respectively, were common, although scattered in small patches or individual trees in several parks.

Trees of all ages and heights are infected. Although branch mortality is frequent, no associated tree mortality is observed. Broomed trees and dead branches make the trees in the parks disfigured and unattractive and thus lower the aesthetic value of the parks. Besides, the infected trees offer entry avenues or substrates for decay fungi.

The most conspicuous symptoms of the disease are the yellow Witches' brooms which are formed by abnormal development and compaction of lateral shoots and are usually upright. They are noticeable from

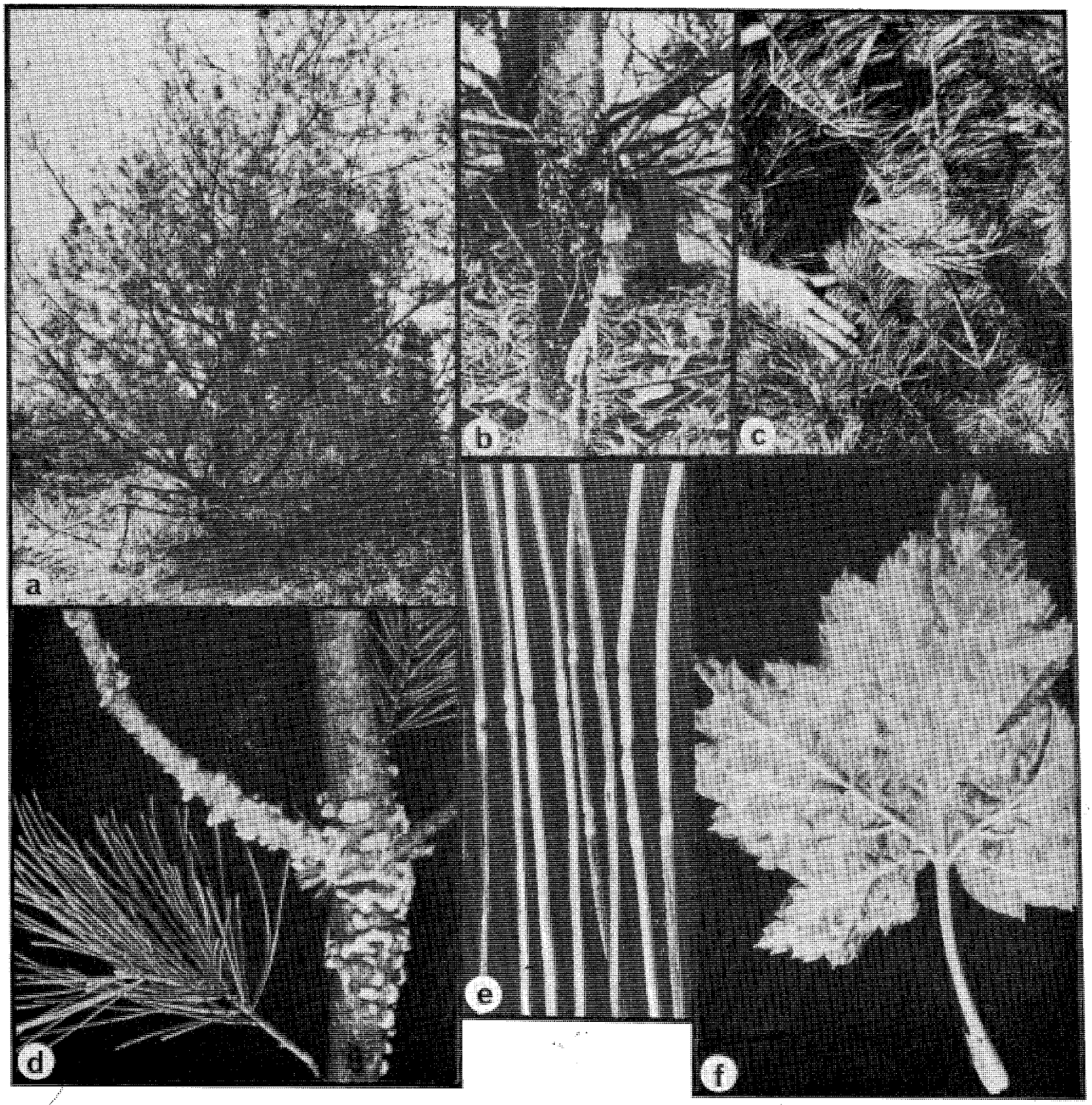

Fig. 8. Blister rust of eastern white pine. (a) Infected dying tree. (b) Trunk canker with blisters. (c) Flagging of branches. (d) Ruptured blisters and discharged aeciospores. (e) Infected needles. (f) Infected Ribes leaf.

early summer to fall. The yellowish-orange color of the brooms is the result of the loss of chlorophyll in the infected, shortened and thickened needles and the production of yellowish-orange aeciospores on these needles. In late fall the infected needles shrivel and fall off leaving behind the bare and dead-looking broom during winter.

Stem or Shoot Blight:

Only four types of stem or shoot blights were observed in the parks of Newfoundland: (i) Shoot and leaf blight of trembling aspen, (ii) Tip blight of balsam fir, (iii) Red flag of balsam fir, and (iv) Needle blight of balsam fir.

The shoot and leaf blight of trembling aspen also known as "Shepherd's Crook", is caused by Venturia macularis (Fr.) E. Muell. & Arx [= Venturia tremulae Aderh., imperfect stage - Pollacia radiosa (Lib.) Balk. & Cif.]. It was one of the most common diseases of trembling aspen in parks. The disease was sporadic in occurrence, but it did cause serious damage to aspen regeneration at some locations. Generally the incidence was low, but in some parks the disease caused considerable mortality of new shoots or small saplings. Repeated loss of current growth resulted in stag-headed trees. The dead black shoots and the stag-headed trees were unsightly and made the area unattractive.

The diagnostic features of the disease are small to large, black, angular, necrotic areas produced on leaves in spring and summer. These areas enlarge and coalesce, and ultimately result in the killing and blackening of the leaves. The necrotic areas are soon overgrown by olive-brown mycelia bearing conidia. The tips of the infected leaves later become curled, brittle and truncated. The infection spreads from the leaf blade down the petiole into young succulent branches. These infected shoots are also killed, become black and curl into characteristic hooks, resembling "Shepherd's crooks". Complete defoliation occurs in late stages of infection or in severe attacks and the affected trees are seen with leafless, closed, stunted and decadent crowns. The older or larger trees may be relatively unaffected, while many seedlings, saplings and suckers dieback when severely attacked. This results in deformation of saplings, delay of one or more years in establishing new stands, or complete loss of the regeneration.

Red flag of balsam fir, caused by Fusicoccum abietinum (Hartig) Prill. & Del., was another problem of softwood trees in some parks, which was spotty in occurrence and never serious enough to cause any concern.

Important symptoms of the disease are reddish-browning of branch tips and formation of a slight constriction or canker on small twigs and branches.

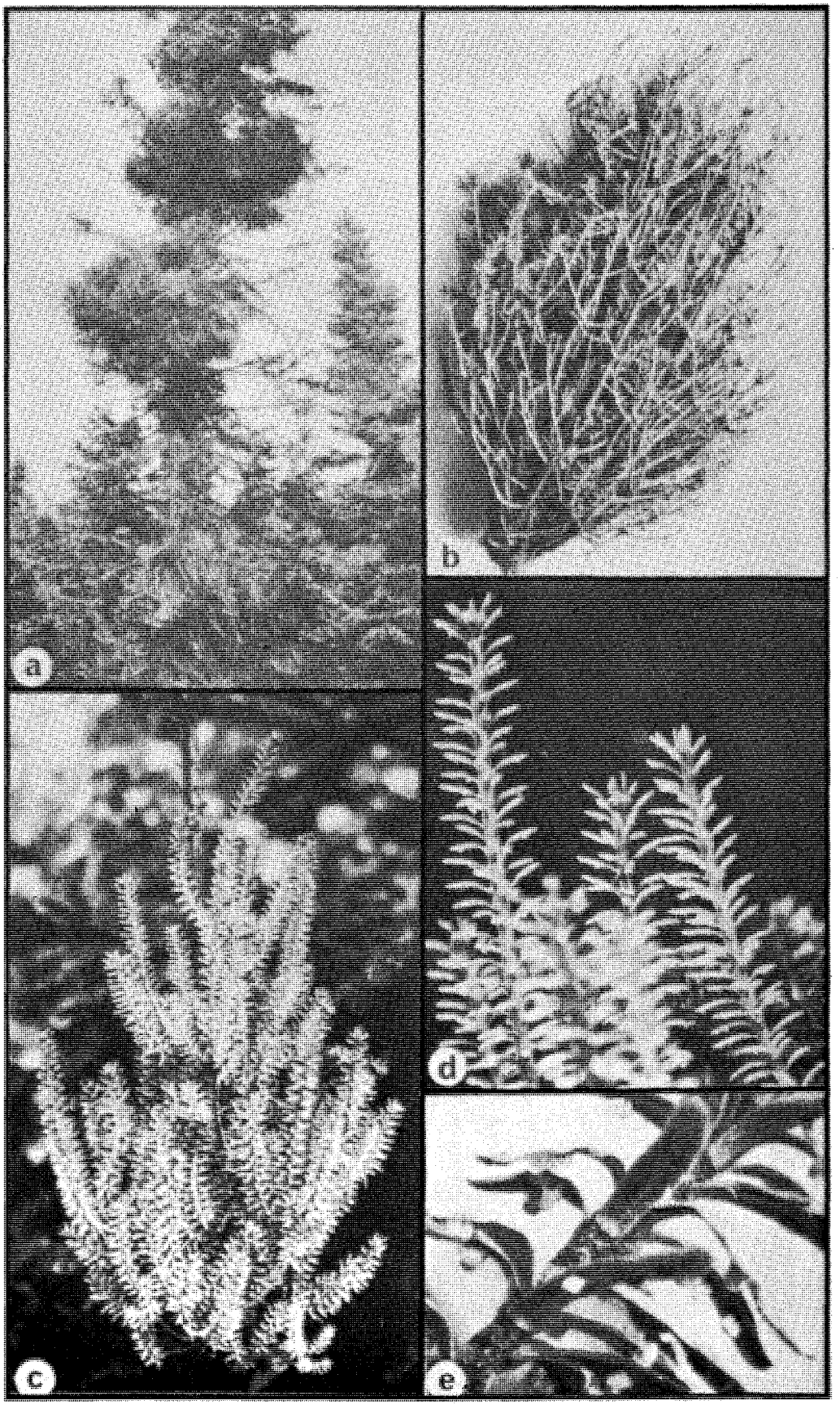

Fig. 9. Broom rust of balsam fir. (a) Brooms on a tree. (b) An old broom. (c) A young broom. (d) & (e) Needles with aecia.

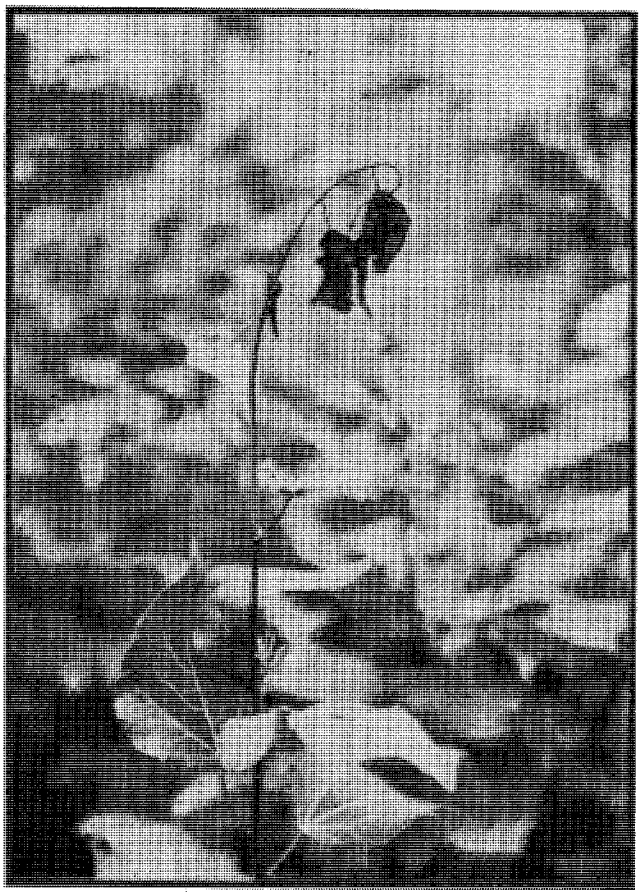

Fig. 10. Shoot and leaf blight of trembling aspen.

Tip blight of balsam fir, caused by Rehmiellopsis balsameae Waterman, was a common shoot and foliage problem of balsam fir in some parks. Like 'Red flag', it was spotty in distribution and was never severe enough to pose any serious threat to the species.

Important symptoms include browning, shrivelling, characteristic curling and death of current year's needles and shoots. Repeated attacks can kill small saplings.

Witches' Broom:

Witches' broom of black spruce, caused by eastern dwarf mistletoe, Arceuthobium pusillum Peck., is a native parasite of the eastern part of North America and has been recorded from many parts of the Island during the past several years. It was observed in a few parks in western Newfoundland; it affected up to 15% of the trees and induced mortality of a few trees.

The most striking symptom of the disease is the formation of Witches' brooms which are dark green in color unlike the brooms of broom rust. These brooms are produced through proliferation and compaction of numerous dwarfed, upright or distorted infected branches developed from a point. They remain throughout the year. Needles on these branches are dark green and reduced in size. Several brooms on a tree can sap considerable vigour and induce its mortality. The other diagnostic feature of the disease is the presence of mistletoe plants scattered on the branches of the broom. The mistletoe is seen as inconspicuous, slender, yellowish to brownish green aerial shoots extending 1/2-3/4 inch from the infected branch, and bearing green, reduced, scale-like, foliage and olive-green to dark blue berries. Mistletoe plants appear in summer from June to September. A less obvious symptom is the formation of spindle-shaped swellings on infected branches and stems. These are often covered with the aerial shoots of the parasite.

Needle Rust:

Needle rusts comprise an important group of foliage diseases of softwoods in eastern Canada. They have not been known to cause any conspicuous damage in Newfoundland, although they have been recorded from many parts of the Island. Five species of needle rusts were collected from the parks: (i) Chrysomyxa ledi de Bary on black and white spruces, (ii) Chrysomyxa ledicola Lagerh on black and white spruces, (iii) Chrysomyxa species on black and white spruces, (iv) Pucciniastrum epilobii Otth on balsam fir, and (v) Milesia fructuosa Faull on balsam fir. They were common in scattered patches. Their incidence varied from trace to light. In most cases these rusts only induced premature defoliation of the current year's needles; no associated tree or shoot mortality, was ever observed. Hence the rusts are considered of little or no economic significance. Aesthetically the infected trees do become unsightly because of yellow foliage and premature defoliation.

All these rusts produce white to yellowish-white to orange-yellow aecial and pycnidial pustules or blisters on new needles. In

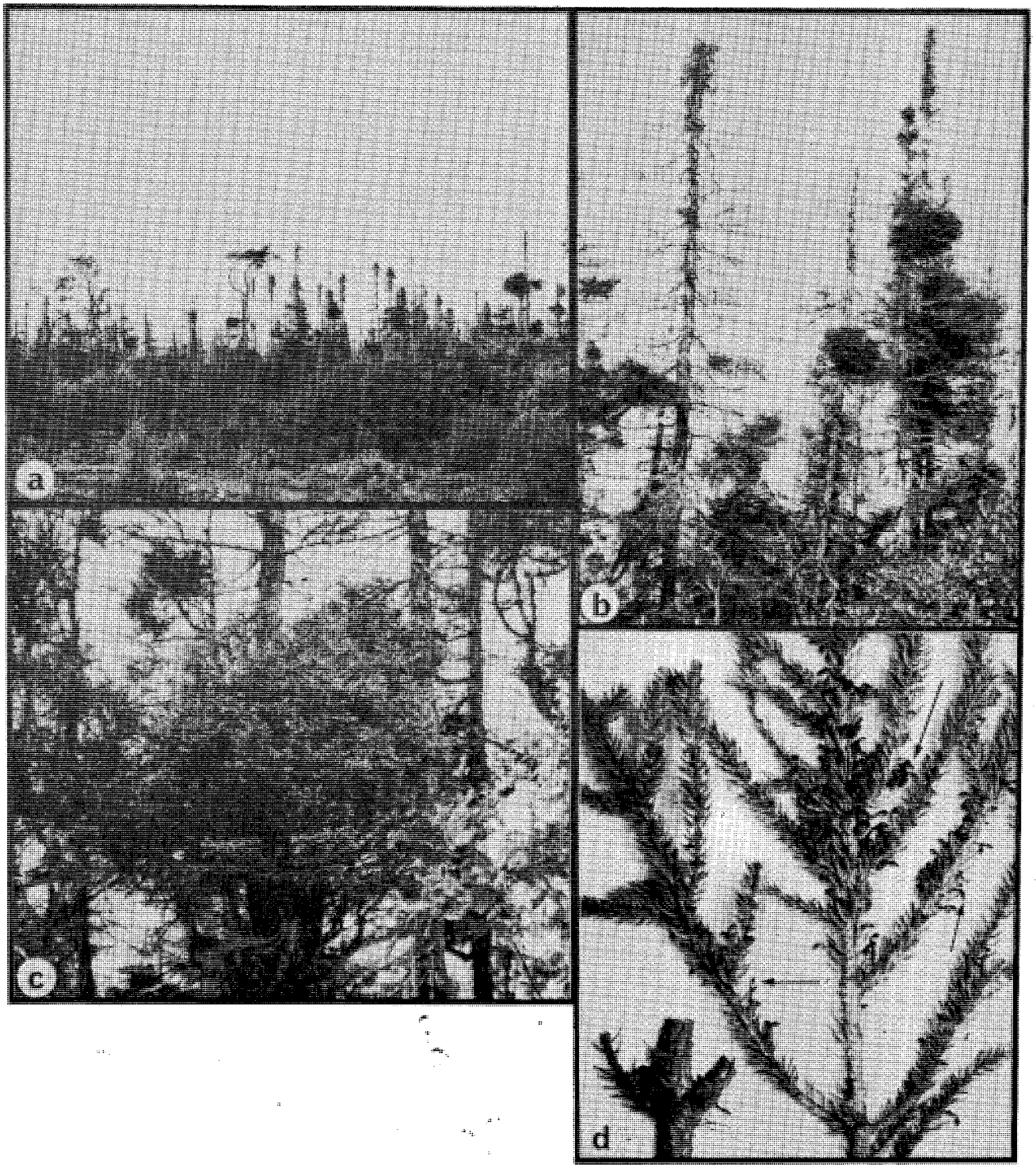

Fig. 11. Witches' broom of black spruce. (a) Groups of trees damaged by mistletoe. (b) Brooms on dead and dying trees. (c) Close-up of a broom. (d) Mistletoe (arrows) on a black spruce shoot.

severe cases the infected conifers appear yellow or prematurely defoliated.

Leaf Rust:

Leaf rusts of hardwoods are not common in Newfoundland although a few have been reported during the years. Three types of leaf rusts were observed in scattered patches in many parks: (i) Leaf rust or leaf rust galls of American mountain-ash, caused by Gymnosporangium cornutum Arth. ex Kern., (ii) Leaf rust of willow, caused by Melampsora abieti-capraearum Tub., and (iii) Leaf rust of trembling aspen, caused by Melampsora epitea Thüm. The incidence of infection was trace to light and no conspicuous damage was observed. In severe cases, premature defoliation resulted.

The diagnostic characteristics of leaf rusts are small, yellow to orange pustules or spots, or brown to black patches, or yellow to orange galls on the undersurface of leaves. The spots or pustules may occur individually or in clusters.

Needle Cast:

About nine species of needle cast fungi have been recorded from the parks of Newfoundland. Most of these pathogens were common although only on scattered trees. Their incidence varied from trace to severe, affecting up to 80% of the lower foliage. No associated tree mortality was ever observed, although shoot or branch mortality were common.

Characteristic symptoms of the needle cast disease are the browning of foliage and development of black fruiting bodies, known as hysterothecia. The hysterothecia may be in the form of one or two, long or short streaks, or one or two rows of ellipsoidal or round, black bodies on the lower and/or upper surface of the brown needles. Since the disease affects individual needles, one would find healthy needles intermingled with infected ones. Also, healthy trees may be adjacent to heavily infected trees of the same species, age, and apparently same vigour.

Leaf Spot:

Leaf spots of broad-leaved trees are common on the Island. The most common leaf spots in parks were: (i) Ink spot of trembling aspen, caused by Ciborinia whetzelii (Seav.) Seav.; (ii) Large leaf spot or Anthracnose of red and mountain maples, caused by Kabatiella apocrypta (Ell. & Ev.) Arx; (iii) Speckled tar spot of mountain maple, caused by Rhytisma punctatum (Pers.) Fr.; and (iv) Purple eye spot of red and mountain maples, caused by Phyllosticta minima (Berk. & Curt.) Underw. & Earle.

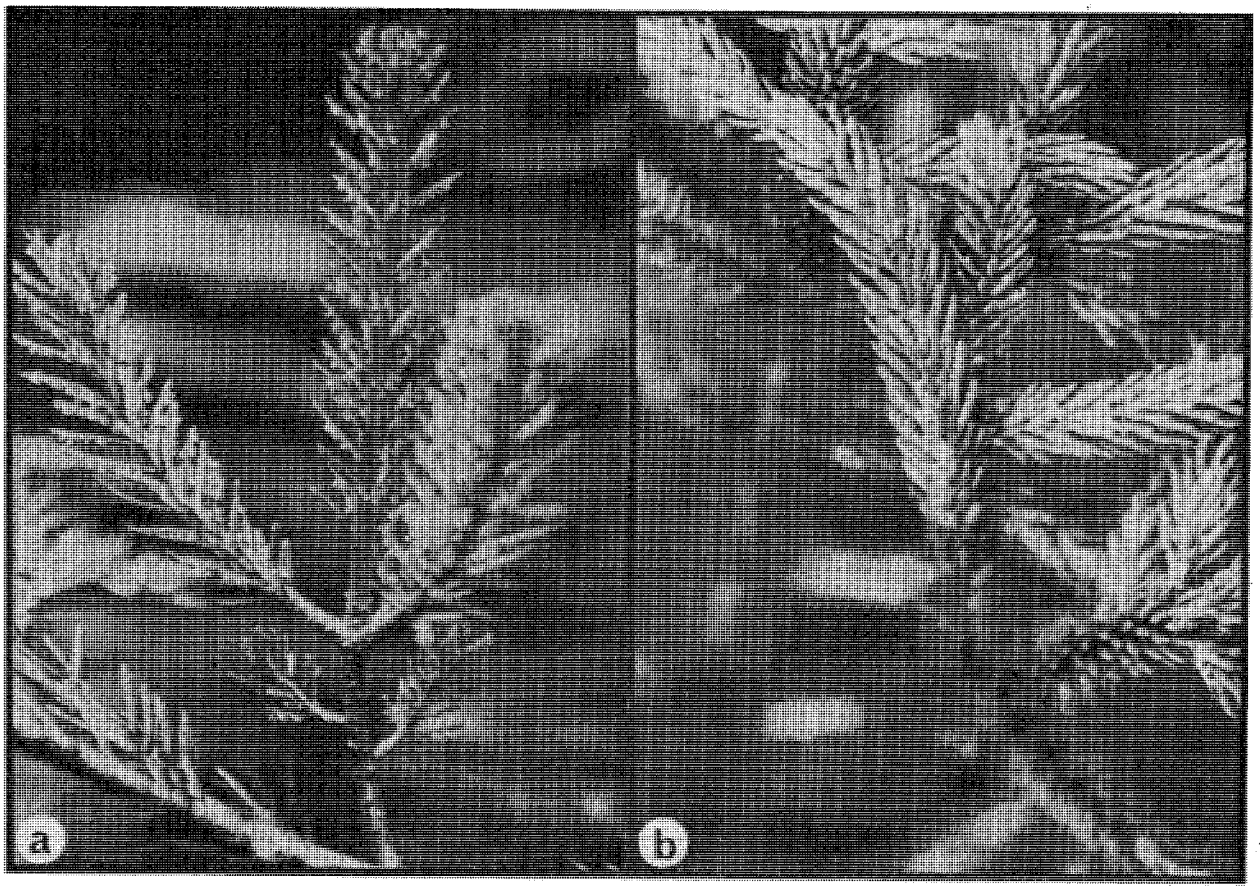

Fig. 12. Needle rusts of conifers. (a) Needle rust of balsam fir. (b) Needle rust of black spruce.

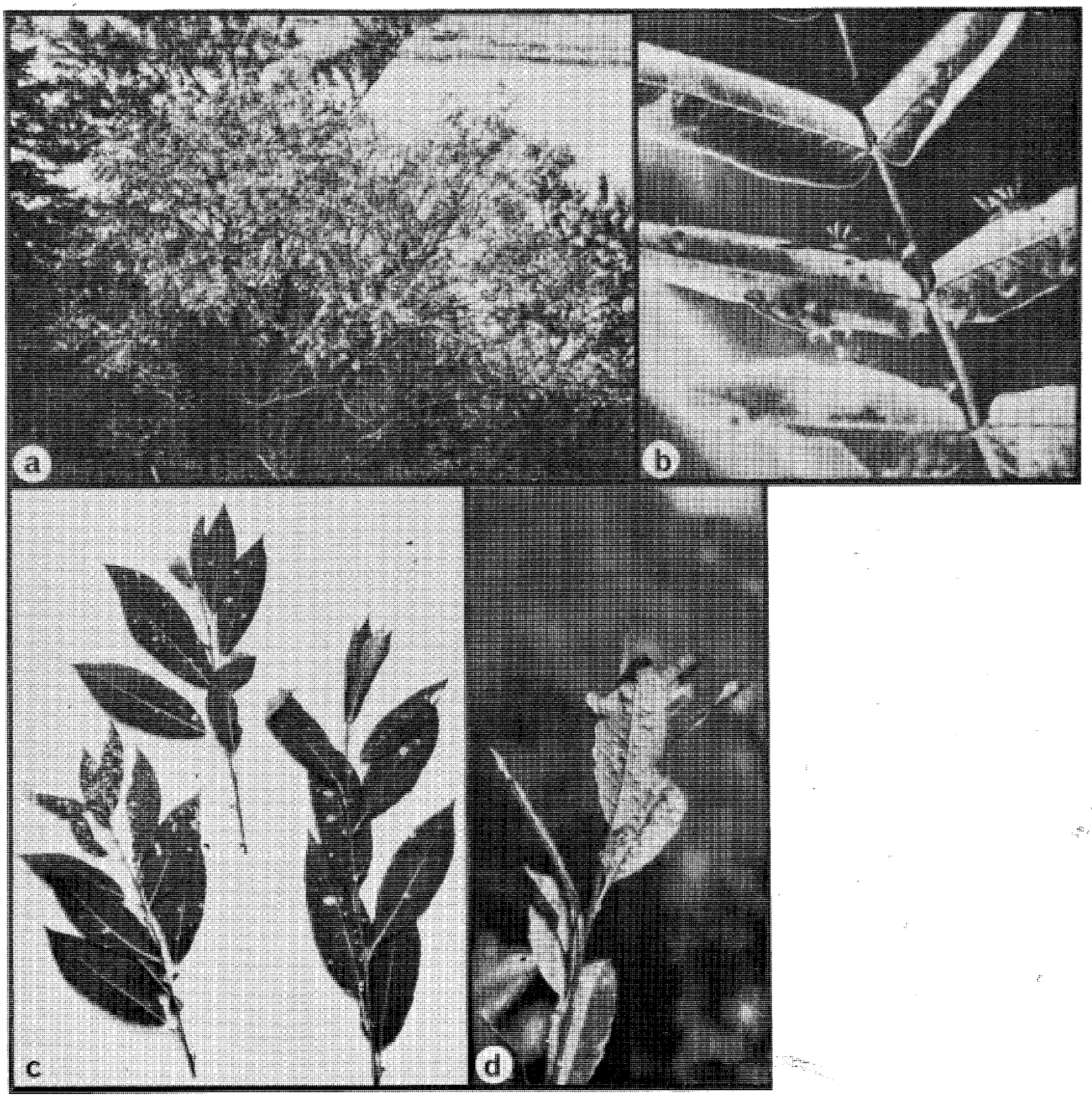

Fig. 13. Leaf rusts of hardwoods. (a) American mountain-ash tree severely infected with rust galls. (b) Close-up of rust galls on the leaflets of American mountain-ash. (c) Leaf rust of pussy willow. (d) Close-up of the leaf rust of pussy willow.

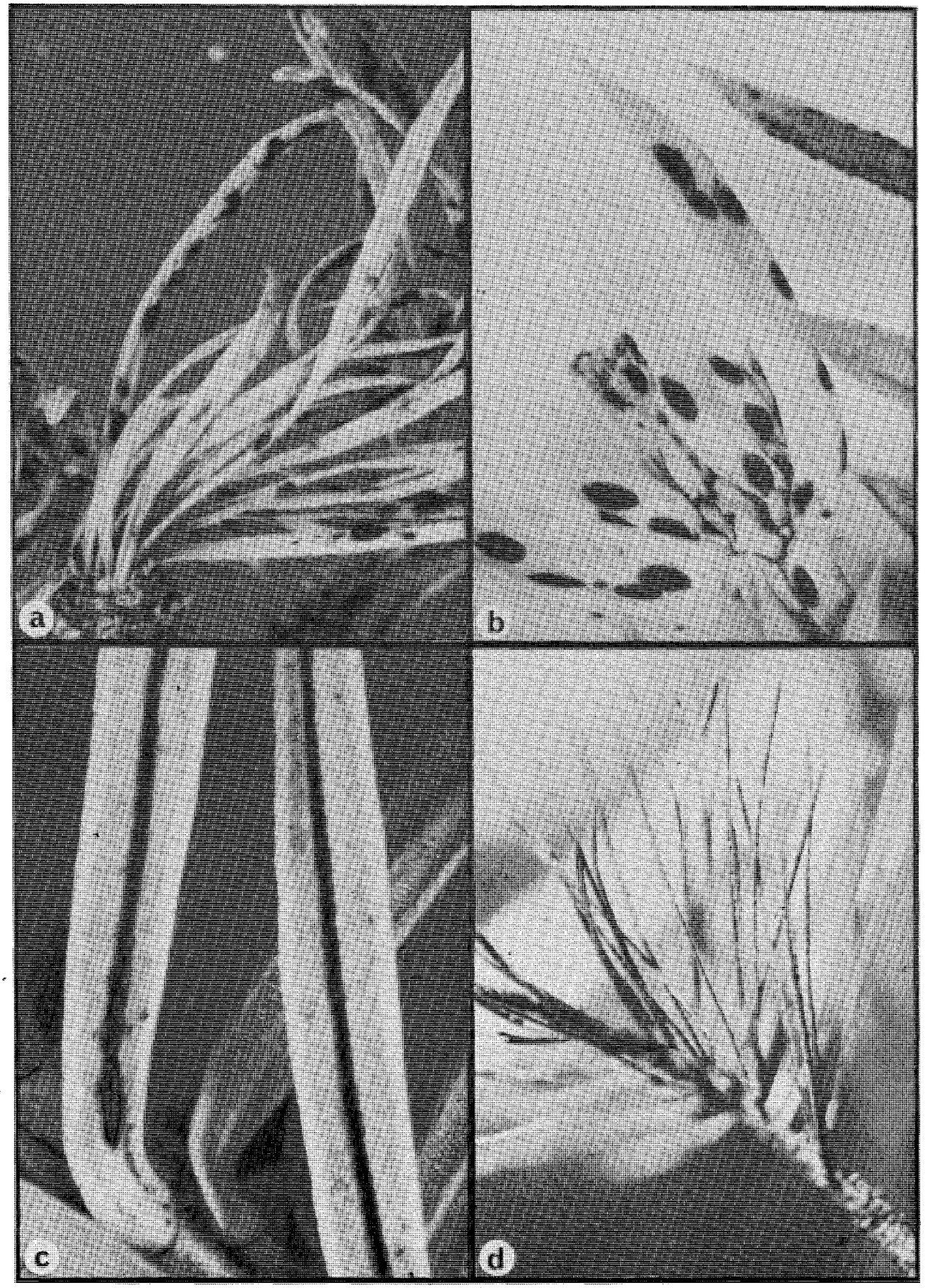

Fig. 14. Needle casts of conifers. (a) Needle cast of tamarack. (b) Needle cast of black spruce. (c) Needle cast of balsam fir. (d) Needle cast of red pine.

Most of these leaf spots occurred in scattered patches. Their incidence varied from trace to light. However, ink spot of aspen, was found unusually conspicuous and severe in a few parks. Leaf spots induced browning and premature defoliation, and in severe cases caused shoot mortality. Rarely they caused tree mortality. Hence their impact was mostly on the aesthetic value of parks.

The most conspicuous symptoms of leaf spots are the production of chlorotic, brown, purple or reddish-brown spots, which is followed by browning of the whole leaf, and production of black, dot-like spore-producing bodies.

DAMAGE CAUSED BY ANIMALS AND ABIOTIC FACTORS:

Animal Damage:

This type of damage was scattered and inconspicuous in parks. In most cases the damage was caused by moose browsing. Its incidence varied from trace to light. However, once damage by beaver did cause concern in one of the provincial parks where the animal built a dam and caused flooding, resulting in considerable tree mortality.

The browsed trees usually exhibit ragged, torn and defoliated shoots and terminals. Where the damage is old, cankers and lesions often develop beneath the browsed areas.

Damage by Abiotic Factors:

This was common, but the most conspicuous and in certain cases the most severe damage in Newfoundland parks was caused by inclement weather conditions. Death or injury to shoots, buds or seedlings occurred as a direct consequence of various types of climatic stress. The incidence of damage by abiotic factors varied from trace to severe and they were generally found in patches. However, they were most common and conspicuous in low lying or wind-exposed parts of the parks.

Damage caused by frost and winter drying or winter injury were most common. On conifers the frost damage kills the newly developing shoots and induces characteristic curling. Frost damage to hardwoods is usually confined to the succulent new leaves which die, turn black and shrivell, and eventually drop off; the older leaves are damaged only along the edges. Winter injury takes place during winter and cold spring when water in the ground is frozen and winds cause excessive transpiration. It affects the entire tree above the snow line. All conifers are susceptible. Drying effect of wind causes foliage to die and turn red or brown.

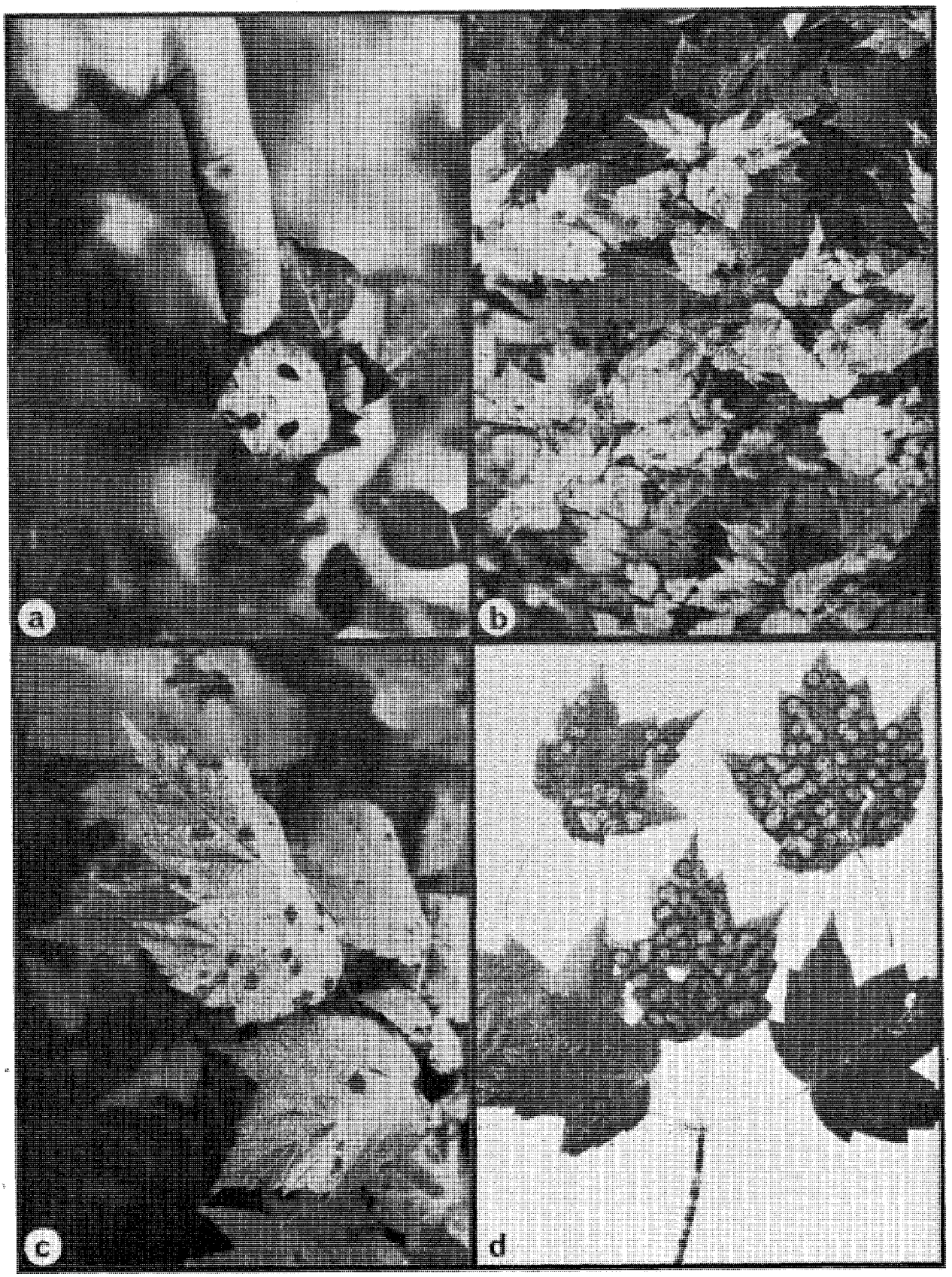

Fig. 15. Leaf spots of hardwoods. (a) Ink spot of trembling aspen. (b) Anthracnose of red and mountain maples. (c) Speckled tar spot of mountain maple. (d) Purple eye spot of red and mountain maples.

High winds and snow and ice storm also caused moderate to severe damage in some parks through wind throw and breakage of tree-tops, branches, and in some cases breakage of the main trunk. All tree species were susceptible to wind damage, but those with shallow root system were most affected.

RECOMMENDATIONS FOR CONTROL AND PREVENTION OF DISEASES*

General considerations: National and provincial parks do not have any particular disease problems peculiar to themselves as compared to their surrounding forests because they are created by preserving and maintaining portions of forested areas. It is realized that the pathogen oriented problems can be identified and sometimes controlled quickly, but problems created by inclement weather conditions become difficult, particularly when they permit the otherwise innocuous fungi to infect trees and proliferate thereon. Unfortunately, in several of these situations the primary and even the secondary causes of damage are sometimes no longer evident by the time extensive damage is apparent, and only the most tenuous association between the disease and the causal agent(s) can be diagnosed. Although actual loss of the tree in such situations can be important, the failure of the problem to recur in the next season often minimizes the overall effect. Increased knowledge of the particular factors inciting the proliferation of these fungi will permit predictions to be made as to their probable occurrence as active pathogens, allowing reasonable precautions to be suggested in advance.

One of the prerequisites for successful disease control in the parks is constant vigilance in order to detect small problems before they become amplified. Protection of parks from a disease can be achieved after proper detection of the problem and assessment of the damage. It can be accomplished by chemical means or by sanitation practices.

Chemical control methods rely mainly on timely treatment before the disease becomes established, either by eradicating the pest from the area (soil fumigation) or by protecting the plant with a chemical barrier (foliage sprays). Chemical protection can also be given by eradicating fungi that grow on/in seedlings or soil (Anonymous 1971).

Specific recommendations: Present investigations have revealed that there are no serious disease or damage problems in the national and provincial parks on the Island, but some measures would be advisable to control the existing diseases, and prevent their recurrence and their spread to the neighbouring healthy plants. The recommendations given in most cases are only applicable on a small scale to very localized conditions. On a large scale in forests many of the recommendations are not practical.

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*Anonymous, 1971; Boyce, 1966; Hepting, 1971; Peace, 1962; Peterson and Smith, 1975; Singh, 1974, 1976a, 1976b, 1976c, 1976d; Singh and Clarke, 1974; Shurtleff, 1966; and Turner, Kirby and Dance, 1975.

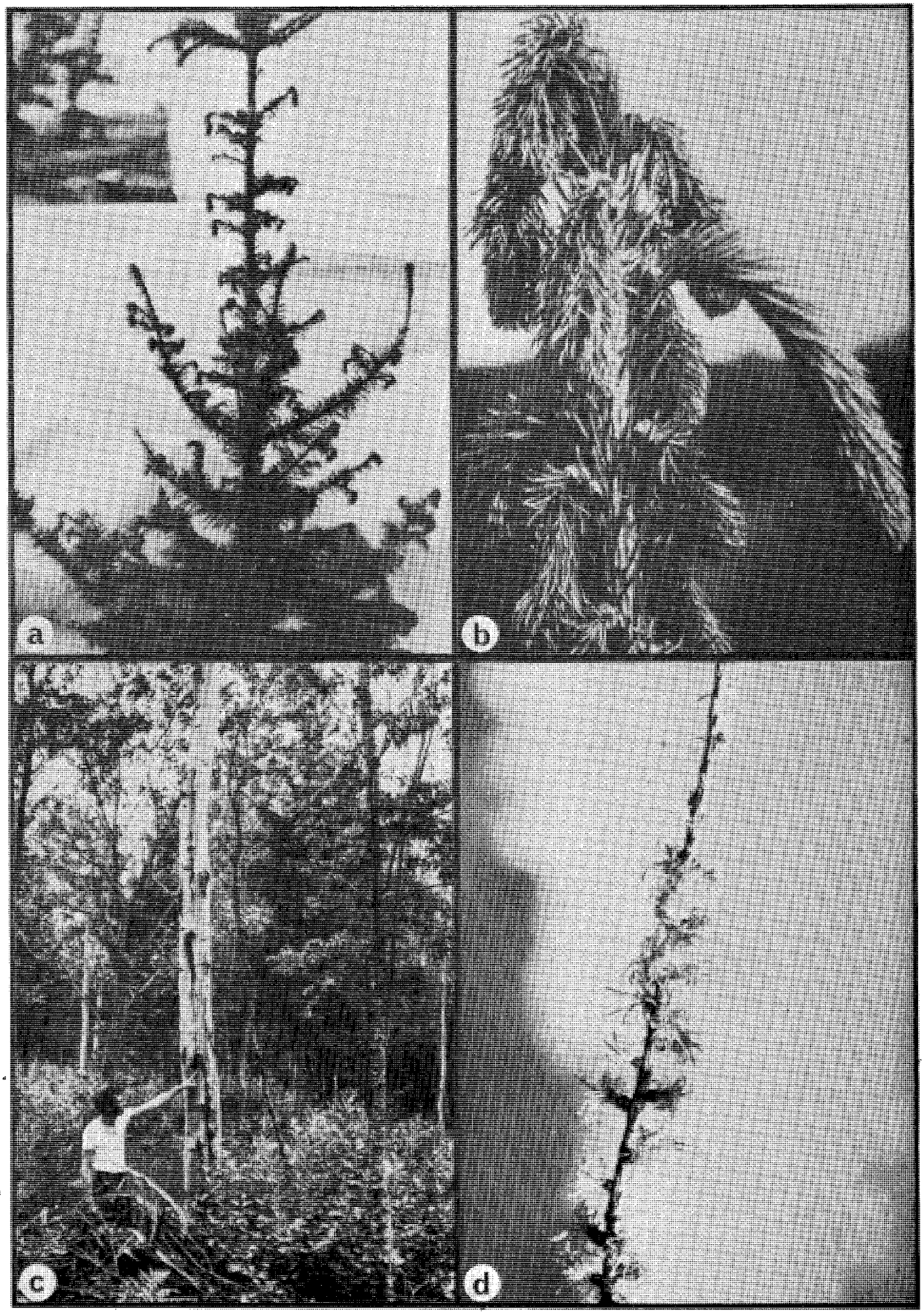

Fig. 16. Damage by abiotic factors. (a) Frost damage, shoot mortality, of balsam fir. (b) Frost damage, shoot mortality, of white spruce. (c) Frost cracks in trembling aspen. (d) Frost damage, shoot mortality, of tamarack.

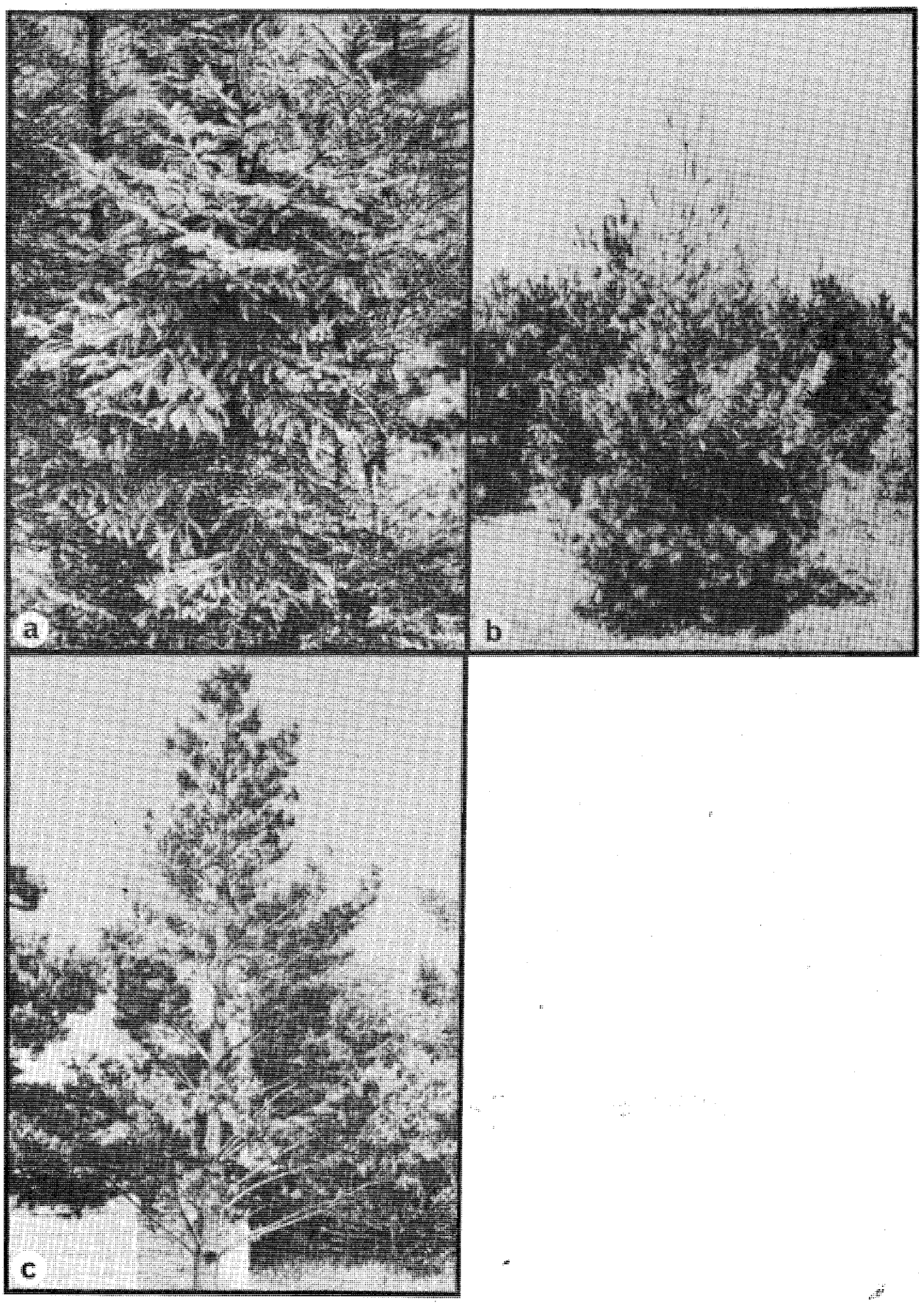

Fig. 17. Damage by abiotic factors. (a) Winter drying of balsam fir. (b) Winter drying of eastern white pine. (c) Winter drying of Scots pine.

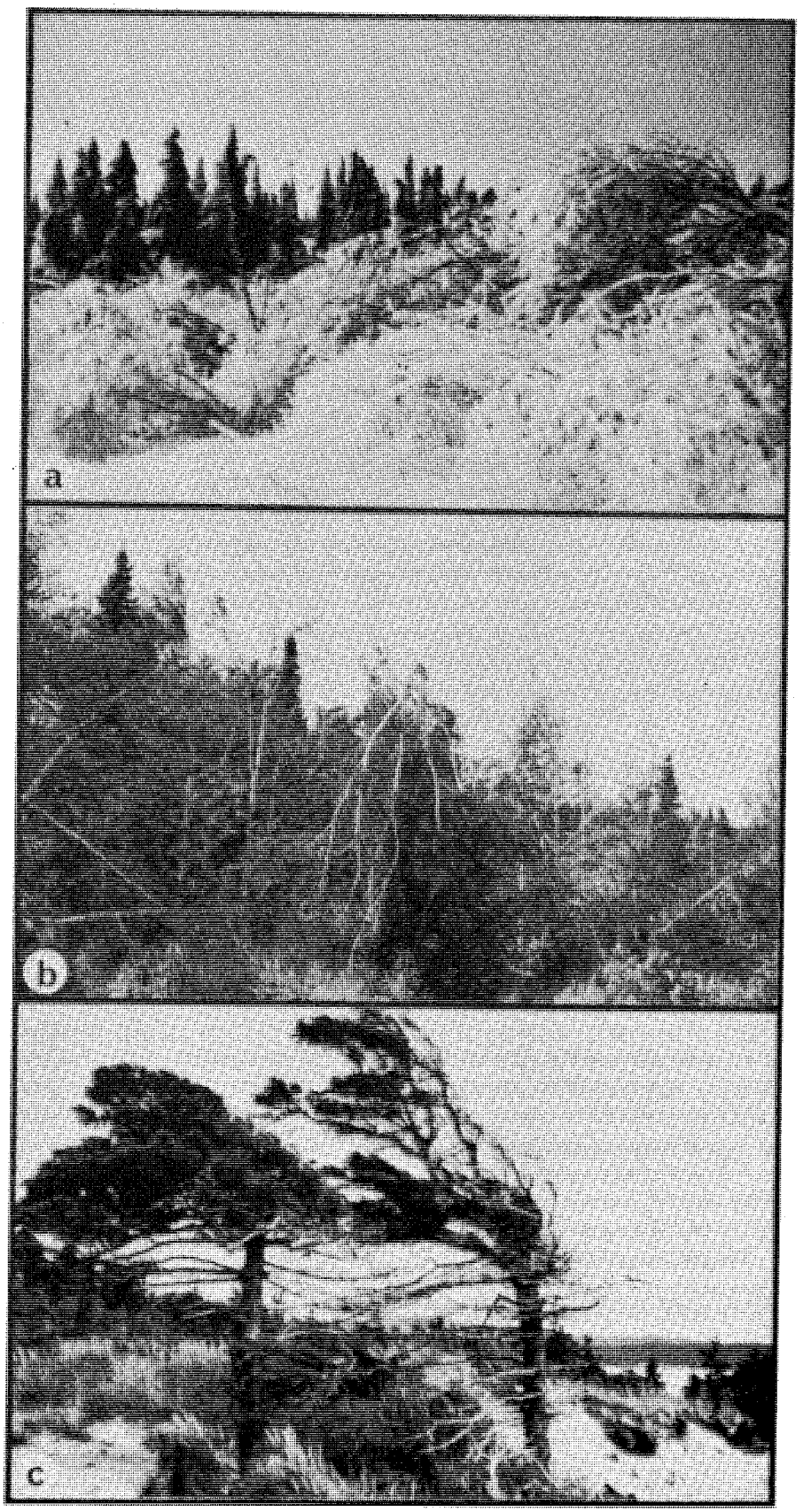

Fig. 18. Damage by abiotic factors. (a) Damage by ice storm. (b) Damage by snow and ice storm and by wind storm. (c) Damage by strong winds.

Armillaria root rot is a difficult disease to control in forests. However, some preventive measures are suggested for parks. These include: (i) Careful removal of all infected material, such as stumps and roots from the site. Care should be taken to avoid injuring the roots of adjacent healthy trees. (ii) Maintain the trees in good health by applying a general purpose fertilizer to trees every two to three years. (iii) If possible, the soil around trees should be cultivated to reduce the establishment of grasses and other herbs, and the accumulation of litter. This procedure will also discourage attack of the roots of coniferous trees by the Hylobius weevils; damage caused by these weevils increases the incidence of the root rot.

Black knot is relatively easy to control in parks and small valuable areas. It can be achieved by removing and destroying all severely infected trees and shrubs. In case of light or moderate infection, prune and destroy all cankered twigs and branches during the dormant season. The cut should be made with a sterile shear or knife about 10 cm to 15 cm below the knot. The pruning wounds should be covered with some form of commercial tree wound dressing.

There is no effective chemical control known for stem cankers and dieback diseases in forests. However, in parks and landscape areas it is recommended that all the infected and dead trees or trees with large wounds should be cut at ground level, removed and destroyed. All infected twigs and branches should be pruned and burned. Pruning should be followed by covering the wound with some kind of commercial tree wound dressing. All pruning tools should be clean and sterilized with 70% ethyl alcohol before use.

Over large natural stands blister rust is virtually impossible to control. However, in small high value stands or in individual ornamental trees, the disease can be controlled by taking the following measures: (i) Prune and burn all the diseased branches and stem cankers. Pruning should be done 20 to 25 cm below the diseased area in spring when the orange-yellow blisters make rust detection easy. Trunk cankers should be treated by removing all diseased bark around the canker. The pruning wounds should be covered with a commercial tree wound dressing. The treated trees should be inspected yearly. (ii) Remove and destroy all Ribes bushes growing within 305 metres (1000 ft) of the white pine stands or trees. Common methods of destroying Ribes are - (a) digging or pulling the bushes by hand, (b) spraying with herbicidal chemicals, and (c) judicious use of fire.

Broom rust or yellow Witches' broom is difficult to control in forest stands. In plantations and small high value stands, removal of trees with main stem infections or pruning of infected branches early in life of the stand is considered practical.

For shoot and leaf blight, no large scale control is possible. However, the following suggestions are made for parks and recreation areas: (i) Prune off and burn the blighted shoots or trees. (ii) The blighted fallen leaves should be raked and disposed of by burning. (iii) Copper fungicides, such as Bordeaux mixture or Zineb are known to provide effective control of the disease in home gardens, nurseries, parks, small plantations or on landscape trees. (iv) Avoid overcrowding and fertilize and water plants to maintain vigour.

Like broom rust, Witches' broom, caused by the eastern dwarf mistletoe, is also difficult to control. Silviculture treatments, such as thinning and pruning of infected trees or branches, are the only feasible and practical recommendations. Prescribed burning or wildfires were recommended, but are no longer considered practical to combat the problem.

Needle rusts do not warrant any control measures under forest conditions because of economically insignificant effect on the forest wealth. Although spraying with fungicides has been suggested in nurseries and Christmas tree plantations, methods and spray procedures remain to be determined.

No fungicides are registered to control leaf rusts of hardwoods, although some silvicultural practices are recommended for small scale control, such as wide spacing of trees, removal of alternate hosts, and removal and burning of fallen infected foliage.

There is no economical control of needle casts in forests or parks. Chemical control is recommended only in nurseries or in Christmas tree plantations. Needle cast of pine can be prevented in nursery beds by repeated applications of Maneb, Dithane or Chlorothalonil (Bravo W-74 or 6F). Needle casts of spruce and larch can be controlled by maintaining a high vigour of trees by watering and fertilizing them, by collecting and burning the fallen needles, and by spraying with Bordeaux mixture (4:4:50), Maneb or Thiram at 2-3 week intervals during the months of July, August and September. On small trees, infections may be reduced by removing and burning severely infected branches and trees.

Control of leaf spots is generally not considered practical for forest trees. However, for valued trees some sanitation and silvicultural practices are recommended: (i) Raking and burning of all fallen infected leaves. (ii) Pruning of all infected twigs and branches. (iii) Increasing the vigour of trees by providing fertilizers. (iv) Spraying of certain high valued trees with Zineb or Dithane Z-78, or Bordeaux mixture.

There is no control for the injury caused by frost. However, certain preventive measures can be taken to avoid shoot mortality and to insure that seedlings and trees remain healthy. The most effective measure is to avoid frost pockets or frost susceptible areas while establishing park or while selecting an area for park.

Frost heaving of seedlings can be prevented or reduced by: (i) Avoiding heavy clay soils or modifying characteristics of the soil before planting, (ii) Providing brush or ground cover by mulching.

There is no control for winter drying. However, the following measures are recommended to prevent the damage for valuable trees: (i) Valuable plants should be watered during the fall to insure an adequate moisture supply before the winter begins. (ii) Fertilize and aerate the soil by spading the open soil around the valuable trees. Digging should be shallow so that the feeding roots growing near the surface are not disturbed. One of the best materials for fertilizing small trees is 'well-rotted' manure. However, commercial fertilizers can also be very useful. (iii) Trees should be heavily mulched with leaves, straw or peat moss in the fall, about 15 cm deep around the base of the tree. This prevents freezing of the soil water. (iv) Small, highly susceptible trees or shrubs should be protected by loosely wrapping them in burlap or placing foliage and branches around them in the fall. This will help to hold off snow, partly shade the trees from direct sunlight, and protect them from desiccating winds. (v) Seriously injured trees and shrubs should be removed. However, if injury is slight the dead portion may be cut off. If pruning is delayed until after the buds open in the spring, the dead parts can be detected more readily. It is impractical to prune winter injured needles from evergreens, but all dead branches should be removed. Pruning should be followed by covering the wound with some kind of commercial tree wound dressing.

In areas of extensive wind storm damage, rapid salvage of damaged timber helps to reduce financial losses, prevent pest buildup, and thus prevent a decline in aesthetic value.

CAUTION

FUNGICIDES ARE POISONOUS TO MAN AND ANIMALS

Read and strictly adhere to all manufacturers directions. DO NOT use concentrations greater than recommended by the manufacturer or as registered with the Federal Government. In case of accidental poisoning, contact a DOCTOR or the nearest POISON CONTROL CENTRE.

ROLE OF FOREST INSECT AND DISEASE SURVEY

The role of Forest Insect & Disease Survey Unit of the Canadian Forestry Service at St. John's is to detect and monitor the pest populations, and locate and define the distribution of insects and disease outbreaks in forest areas, including areas which are now encompassed by parks. In recent years, with increasing concern for the environment and natural areas, greater emphasis has been given to pest problems associated with parks and other recreational areas. Damage caused by road and other constructions; changes in site conditions; soil compaction; intensive use of facilities by a large number of people; inclement weather conditions, including snow, ice and high wind storms; and grazing and browsing animals are also taken into account. All these factors are known to cause actual loss of trees and shrubs as well as predispose the trees to varying kinds of pest and other damaging factors.

Since the Forest Insect & Disease Survey is responsible for identification, evaluation and recommendations of control measures for disease and damage problems of trees and shrubs in forests and parks, it solicits enquiries about these problems from persons associated with the health, protection and management of trees and shrubs in parks. The Survey also advise park personnel to maintain a close contact with its field technicians in the area.

Generally the Survey field technicians collect samples of diseased and damaged plants and send them to the Disease Survey Laboratory in St. John's where the causal agent associated with the disease or the damage is identified. The technician is then informed of the diagnosis and provided with recommendations for control which he, in turn, transmits to the park supervisor. The park supervisor can then take direct action to alleviate the problem before the pathogen spreads further.

Disease diagnosis: Accurate diagnosis of a disease or damage and their control is an important part of the park protection and management and it is an integral role of the Forest Insect & Disease Survey. The symptoms (expressions of the diseased host), signs (evidence of the cause), and patterns of occurrence, are the clues upon which the determinations are based. It is recommended that the field staff and the park personnel should provide as much information as possible on the damage and the problem. The following information may be helpful in the identification of a disease problem:

1. Determine as accurately as possible the part of the plant which is actually affected. The death of only the needles indicates a needle disease. Death of the stem and/or branches may indicate a canker or dieback disease. Death of the whole tree indicates a root disease, frost, winter injury or drought, or some other problem. Note the pattern of the disease in the tree/shrub and whether the damage is limited to the south side or north side, to the lower or upper crown.

2. Note the apparent symptoms/damage and signs.

3. Note what species are affected. Are there any individuals with a similar problem, which are affected less than the others?

4. Has the problem arisen recently? Note the pattern of occurrence, including the areas which show the most severe problem. How do these areas differ from those areas which are free of the problem? Are these problem areas in any particular portion of the park or related to any particular management activity?

5. If the cause of the disease is not immediately evident, look first for the simplest causes, such as animal damage, site, water table level, exposure, winter injury, strong winds, snow and ice, frost, simple physical injuries, site disturbances, construction, road development, or other obvious causes of trouble. Has the plant or the area received any special chemical (insecticide, fungicide or herbicide) or mechanical treatment?

6. Look for the presence of fungi, insects, or other parasites. Observe accurately, and try to judge whether the organisms found are the main cause of the trouble or just secondary causes.

7. If the whole tree is dead or is suffering and nothing is found above ground to indicate the cause of the disease, gently expose the base of the stem, roots and root crown for examination. Check for any outward flaring of roots.

8. Learn about the history of the problem and the area. Is the problem of recent origin? When was it first noted? What cultural or management practices have been used in the area, such as the use of herbicides, insecticides, fungicides, fertilizers, irrigation, or any special mechanical treatment? Can these be related through pattern or time of appearance to the injuries?

CONCLUSION

There are several disease and damage problems in parks on the Island, but only a few cause any concern. Although they do not create any serious problem in the protection and management of parks, they do have potential to become damaging if they remain unnoticed and uncontrolled. Such problems include Armillaria root rot, Witches' broom (dwarf mistletoe), broom rust, stem canker and ink spot. Besides, other diseases and physical damage problems can predispose or weaken the trees to other pathogens and cause additional damage or deterioration. However, it should also be realized that most of these diseases and damage problems

LIST OF HOST PLANTS AND THEIR BOTANICAL NAMES

Alder, speckled	*Alnus rugosa* (Du Roi) Spreng.
Aspen, trembling	*Populus tremuloides* Michx.
Birch, white	*Betula papyrifera* Marsh
yellow	*B. lutea* Michx. f.
Cherry, pin	*Prunus pennsylvanica* L.f.
Currant	*Ribes* sp.
skunk	*R. glandulosum* Grauer
Fir, balsam	*Abies balsamea* (L.) Mill.
Juniper	*Juniperus* sp.
Maple, mountain	*Acer spicatum* Lam.
red	*A. rubrum* L.
Mountain-ash, American	*Sorbus americana* Marsh
Pine, eastern white	*Pinus strobus* L.
Scots	*P. sylvestris* L.
Plum, common	*Prunus domestica* L.
Poplar, lombardy	*Populus nigra* var. *italica* Muenchh.
Spruce, black	*Picea mariana* (Mill.) B.S.P.
white	*P. glauca* (Moench) Voss
Tamarack	*Larix laricina* (Du Roi) K. Koch.
Willow	*Salix* sp.
pussy	*S. discolor* Muhl.

GLOSSARY OF TECHNICAL TERMS

Aeciospore	spore produced in chains in a cup-like structure, aecium, embedded within the host tissue.
Alternate host	either of the two hosts of a 'heteroecious' rust.
Blight	Any atmospheric or soil condition, or a parasitic organism that kills, withers, or checks the growth of a plant or a shoot.
Canker	A localized, often callused wound or a necrotic area of dead tissue on a stem or branch.
Defoliation	Loss of current year's or past year's foliage.
Dieback	The death of shoots or parts of a tree or plant usually from top downward.
Disease	An injurious condition or an abnormality of morphology, physiology of a plant induced by the action of a pathogen; it may lead to death of the tree or reduction in its yield.
Flag, flagging	A dying, or recently dead twig or branch, its foliage contrasts in color with the normal green foliage of living trees.
Fruiting body	A fungal organ specialized for producing spores.
Fungus	A non-flowering plant without chlorophyll that lives on either another organism (causing disease) or dead organic matter.
Gall	A swelling of plant tissue caused by the attack of an insect or a disease-causing organism.
Heartwood	The older, non-living central portion of the tree bole that is usually darker and more durable than the surrounding sapwood.

Host	An organism or plant that serves as a food base, shelter or resting site for an unrelated organism, the pathogen or the parasite.
Hysterothecium	The elongate fruiting body of a fungal group 'Hysteriales', which opens at maturity by a long slit along the line of dehiscence, almost completely uncovering the spore mass.
Mycelium	Collective term for a group or mass of vegetative hyphae or filaments of a fungus.
Necrotic	Dead plant cells or tissue, usually resulting in darkening of affected tissue.
Pathogen	A disease-causing organism.
Phanerogamic parasite ...	Parasitic plants which produce flowers and seeds
Pustule	A small, sometimes colored, blister-like swelling.
Pycnidium	The spore case of certain fungi in which certain minute spores, known as the pycniospores, are produced.
Rhizomorph	A thick, visible dark colored, root-like strand or cord of compacted somatic hyphae or mycelium in which the hyphae have lost their individuality (rhizo = roots, morph = appearance).
Sapwood	The outer softwood region of xylem of tree trunks just beneath the bark of a tree, and containing living cells.
Sign	Any observable part or expression of a pathogen or causal agent.
Spore	Reproductive cell (or multiple cells) of a fungus that serves the same purpose as the seed of higher plants.
Symptom	Plant response to injury or infection.
Witches' broom	An abnormal cluster of twigs and branches caused by certain pathogens/parasite.

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