

Parasitic Microfungi of Western Trees

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Cover Photo: *Discocainia treleasei*, apothecia on stem of western hemlock.

Cover Inset: Apothecium in vertical section, x 100.

TO
R.H. HASKINS

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ABSTRACT

The descriptions of all known microfungi associated with stem diseases of western trees are presented. These microfungi are all from the Ascomycetes and the Deuteromycetes. The diseases induced by these microfungi are the cankers, diebacks and shoot blights. Approximately 200 species of microfungi are included. Notes on host range, disease symptoms and taxonomy are included. The descriptions are arranged alphabetically by genus name of the microfungi. Keys for identification appear in the front of the book; literature references, glossary, host index and general index appear in the back.

RÉSUMÉ

Nous présentons toutes les descriptions connues des microchampignons associés aux maladies de tige des arbres de l'ouest. Ces microchampignons font tous partie des Ascomycètes et des Deuteromycètes. Les maladies provoquées par ces microchampignons sont les chancres, les brûlures des pousses et les dépérissements. Inclus aussi sont des notes sur la zone d'hôte, les symptômes de maladies et la taxonomie. Environ 200 espèces de microchampignons sont incluses. Les descriptions sont arrangeées en ordre alphabétique selon le nom du genre du microchampignon.

Au début du livre se trouvent les clefs d'indentification; à la fin se trouvent les références littéraires, le lexique, l'index d'hôtes et l'index général.

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PREFACE

This book has been prepared in an attempt to fill a need in forest pathology in western North America. The host-fungus index of Shaw (revised 1973) and the check list of Lowe (revised 1977) have been used for many years as aids to identification of forest diseases; the handbook of Hepting (1971) is an indispensable guide to evaluation of the many problems in this area. The need for taxonomic treatment of the parasitic fungi themselves has been partially met by "The Tree Rusts of Western Canada", by W.G. Ziller (1974). In this present book, I have treated another group, viz., the microfungi associated with stem diseases of western trees, the Ascomycetes and the Deuteromycetes. It is hoped that this descriptive, taxonomic work will supplement these publications and give the forest pathologist an additional tool for identifying and diagnosing forest disease problems.

My interest in the microfungi began in 1951 when, as a research assistant in the Prairie Regional Laboratory, Saskatoon, I assisted various workers in mycological research, especially R.H. Haskins. During the same period, I was privileged to attend mycology classes given by Prof. T.C. Vanterpool at the University of Saskatchewan. In 1959, I entered the graduate school of the University of Toronto under Prof. R.F. Cain, whose instruction proved invaluable for the work I subsequently undertook in the forest microfungi. I owe a debt of gratitude to the mycologists of the Biosystematics Research Institute, Ottawa, and the Commonwealth Mycological Institute, Kew, for advice and help freely given over many years.

Members of this research centre, past and present, have also contributed immeasurably to the study of these fungi and associated diseases. I thank Dr. R.S. Hunt and Dr. J.R. Sutherland for reviewing the manuscript; Mrs. D.P. Lowe for proofreading and checking names and references; Mr. J. Wiens for assistance in presentation, Mr. A. MacEwan for editorial comments and Mr. A. Craigmyle and Mr. E.J. Chatelle for photographic work.

Illustrations in pen and ink were drawn by Susan Jill Funk.

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INTRODUCTION

Beginning with the work of the pioneer European mycologists, many microfungi of forest trees were identified and named, as early as the 18th century; some of these species are common to our native trees in western Canada. In the ensuing years, European and North American workers have greatly expanded our knowledge of parasitic microfungi and the panoramic picture of forest pathology has emerged. It has been my privilege since 1958, to add to this vast fund of knowledge, and apply it to the study of pathology of the trees native to western Canada.

The object of this book is to assemble descriptions of all known microfungi associated with stem diseases of western trees for the practical purpose of identification and assessment by the forest pathologist. The microfungi described are all from the Ascomycotina (Sac fungi) and their conidial states, or the Deuteromycotina for which no ascigerous state is known. Many orders and families in this large division of the fungus kingdom are represented. The species included here are the primary pathogens, secondary invaders and those that follow in the more immediate saprophytic succession following pathogenesis. Many species are included for which no conclusive evidence of pathogenicity has been found, but which consistently appear in a disease syndrome and therefore must be recognized with it. Some commensals and epiphytes frequently encountered in pathological studies are also included.

The class of diseases induced by these microfungi are the cankers, diebacks and shoot blights; also included are those causing bud necrosis, moulding and bark proliferations, although this is a smaller group. Cankers are localized, necrotic areas on stems or branches that may be annual or perennial. The same fungi that cause cankers may also cause the death of tops or branches and this is known as dieback. Initial infection may produce a localized infection which subsequently girdles the stem, causing dieback, or there may be a direct invasion and killing of the terminal portion of the branch or leader.

Disease may be looked upon as an ecological event that frequently has a sere; i.e., a succession of fungi. A primary pathogen is the pioneering organism in a sere leading toward decomposition, but in forest pathology many other organisms may be involved before the climax is reached. Therefore, the pioneering species, the causal agent, and the disease could be regarded as separate concepts. Secondary agents may speed up or slow down the ensuing pathogenesis, mortality and decomposition.

Many disease syndromes of the stem disorders occur in the western forests, but most are sporadic and only rarely reach epidemic proportions. Most of the diseases occur at a low, indigenous level on unthrifty or predisposed trees and may indeed act as selective agents to eliminate the non-vigorous members of a stand. Some also occur on understory branches to hasten the demise of limbs that no longer "earn their keep". However, the varying and often complex interaction of the forest, the fungi and the environment may produce conditions that result in epidemics and serious economic losses. For example, a prolonged summer drought or a severe early winter

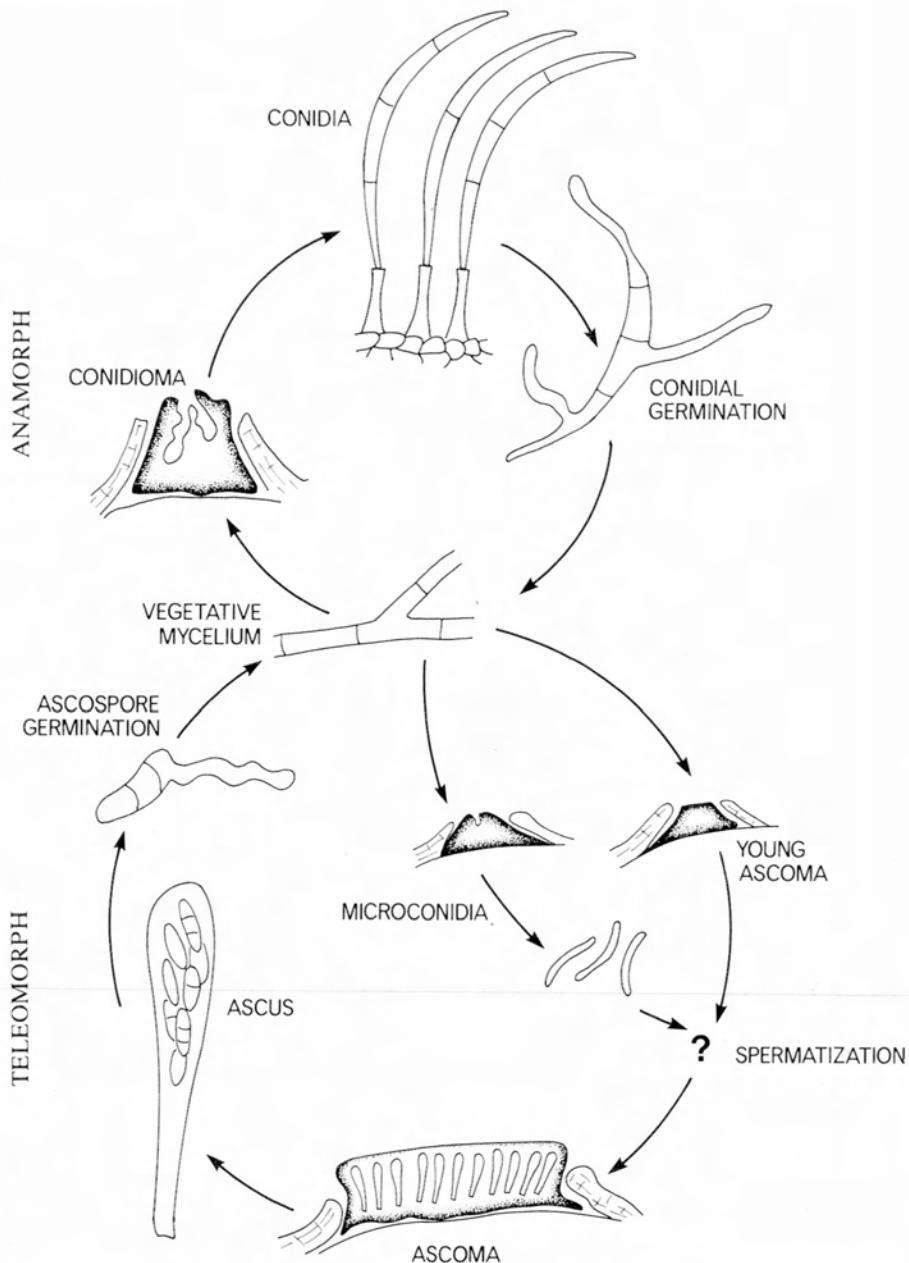


Fig. 1. Life cycle of *Dermea pseudotsugae*, a typical ascomycete, with teleomorph, anamorph and microconidial states.

frost may predispose trees to invasion by fungi that normally occur only on shaded branches. Overcrowding of a stand may reduce vigor of the trees to the point where facultative parasites gain entry. Disease fungi introduced from other countries may not be thus restricted in attacking the native trees. Direct control of the native diseases by fungicides is usually not feasible, except in nurseries and seed orchards, but must be attained by proper site selection, regulation of density, etc.

Criteria of classification of the fungi, especially at the generic level, are somewhat arbitrary and undefined. The taxonomic value of a characteristic may vary greatly — in some cases dividing genera, and in other cases being overshadowed by other common structures or mechanisms. Because of this non-uniformity, differences of opinion exist among workers, resulting in a plurality of names (synonyms) for some species. This can lead to confusion of the identity of a fungus. Differences of opinion also exist regarding the higher levels of classification and the placing of genera within families, orders and classes. For the purpose of this book, the general outlines of classification given in **The Fungi: An Advanced Treatise**. Vol. IVa (1973) will be followed.

Advances in microscopy and mycochemistry have led to refinements in classification of many microfungi. The ontogeny and arrangement of tissues now observed in the ascocarp is highly rated in separating 'look-alike' genera of the Ascomycotina. In the Deuteromycotina, the nature of the conidiogenous cell, i.e., the cell that produces the conidium, is sometimes considered a factor in taxonomy (Kendrick 1979). The refinements in taxonomic criteria are leading to a greater stability in classification, but they place a greater onus for accurate observation on the worker.

The iodine reaction of the ascus tip is a useful tool in identification. It consists of a bluing of the pore apparatus in some species or its absence in others. Some species require pretreatment with dilute KOH (potassium hydroxide) for bluing to occur. The reagents used are Melzer's Iodine or iodine dissolved in lactophenol (Nannfeldt 1976). In some cases, closely related genera may be differentiated by this method (Ziller and Funk 1973), but sometimes species of the same genus vary in response to iodine (Groves 1969; Parker and Reid 1969).

Note on Index and Arrangement

It is general practice in mycology to refer to a fungus by the name of its teleomorph; i.e., the perfect or sexual state, and this is usually done throughout this book. In cases where the anamorph, i.e., the imperfect or asexual state, only is found in western Canada, or where the anamorph is much more prominent, the fungus is listed under that name. In both cases, the name of the corresponding state is given directly below, and also appears in the index. **All genera, regardless of classification, are arranged alphabetically in the text, and appear in the index only under their specific epithet.** The index also contains important synonyms.

A separate HOST INDEX precedes the general index.

KEYS FOR IDENTIFICATION OF THE MICROFUNGI

The following keys are simplified, branched arrangements of characteristics to allow identification of the genera of microfungi found in this book. Wherever possible, the keys are based ultimately on the characteristics of the ascospores or conidia, because in a limited treatment such as this, it is feasible to limit complexity. Most genera are represented by only one or two species; if more numerous, a table of characteristics is included in the text for quick comparison. Sometimes only one member of a genus is fully described if the basic structure is similar in all members. In certain rare instances, several genera key out at the same point; separation must then be accomplished by using the text.

KEYS TO THE MICROFUNGI

Two main subdivisions of the fungi (Eumycota) are represented, the ASCOMYCOTINA and the DEUTEROMYCOTINA.

CLASSES OF ASCOMYCOTINA (teleomorph bearing ascospores)

- 1. Ascocarp an ascostroma, asci bitunicate LOCULOASCOMYCETES
- 1. Ascocarp a perithecium, asci unitunicate and inoperculate.....
..... PYRENOMYCETES
- 1. Ascocarp an apothecium, asci unitunicate and either operculate or inoperculate DISCOMYCETES

CLASSES OF DEUTEROMYCOTINA (anamorph bearing conidia)

- 1. Conidia in pycnidia or acervuli COELOMYCETES
- 1. Conidia on hyphae or specialized conidiophores which may be variously aggregated HYPHOMYCETES

Key to the genera of Loculoascomycetes

(Asci bitunicate, ascocarps ascostromatic)

- 1. Ascomata gelatinous, composed of toruloid hyphae... *Atichia*, *Hemimyriangium*
- 1. Ascomata apothecoid 2
- 2. Ascospores ellipsoid, brown, 1-septate *Eutryblidiella*
- 2. Ascospores ellipsoid, brown, multiseptate *Leciographa*
- 2. Ascospores fusoid, hyaline *Lecanidion*

1. Ascomata mussel-shaped (hysterothecia)	3
3. Ascospores filiform	<i>Lophium</i>
3. Ascospores cylindric	<i>Mytilidion</i>
1. Ascomata spherical to pulvinate (pseudothecia)	4
4. Ascomata without ostiole	5
5. Ascospores 1-celled, asci 8-spored	<i>Botryosphaeria</i>
5. Ascospores 2-celled, asci many-spored	<i>Delphinella</i>
5. Ascospores many-celled or muriform, asci many-spored	<i>Sydiowia</i>
4. Ascomata with ostiole	6
6. Ascomata on a subiculum or stroma, ascospores various	7
7. Stroma very large, on Rosaceae	<i>Apiosporina (Dibotryon)</i>
7. Basal stroma parenchymatous, ascospores muriform	<i>Cucurbitaria</i>
7. Basal stroma plectenchymatous, ascospores muriform or multicelled	<i>Cucurbitodothis</i>
7. Basal stroma immersed, ascospores brown, 2-celled	<i>Dothidea</i>
7. Basal stroma immersed, ascospores hyaline, 2-celled	<i>Xenomeris</i>
7. Subiculum a loose weft, ascospores hyaline, 2-4-celled	<i>Herpotrichia</i>
6. Ascomata separate, single	8
8. Ascospores acicular, multiseptate	<i>RhytidIELLA</i>
8. Ascospores ellipsoid to fusoid	9
9. Ascospores nonseptate	<i>Botryosphaeria</i>
9. Ascospores 1-septate, ellipsoid, hyaline	10
10. Pseudoparaphyses present	<i>Didymosphaeria</i>
10. Pseudoparaphyses absent	<i>Mycosphaerella</i>
9. Ascospores 1-septate, ellipsoid, colored	11
11. Ascospores greenish	<i>Venturia</i>
11. Ascospores dark brown	<i>Kirschsteiniella</i>
9. Ascospores fusoid, 2-3-septate	<i>Keissleriella</i>
9. Ascospores muriform, brown	<i>Pleospora</i>

Key to the Genera of Pyrenomycetes

(Asci unitunicate, ascocarp a perithecium)

1. Perithecia without true ostiole, asci long-stalked, developing at different levels	2
2. Ascospores allantoid, nonseptate	<i>Nitschzia</i>
2. Ascospores cylindrical, septate	<i>Bertia</i>
2. Ascospores falcate, septate	<i>Parkerella</i>
1. Perithecia with true ostiole, asci evanescent or persistent	3
3. Asci evanescent, ascospores becoming free	4
4. Ascospores in slime	<i>Ceratocystis, Europhium</i>
4. Ascospores in dry mass	<i>Caliciopsis</i>
3. Asci with persistent walls	5
5. Perithecia dark, separate; ascospores hyaline	<i>Glomerella, Grifospshaeria</i>

5. Perithecia bright red, superficial, clustered, ascospores hyaline 6
 6. Ascospores 2-celled *Nectria*
 6. Ascospores many-celled, fusiform *Scoleconectria*
 6. Ascospores muriform *Thyronectria*
5. Perithecia dark, immersed in host tissue, clustered, with beaks collectively erumpent through stromatic disc, ascospores hyaline 7
 7. Ascospores large, subcylindric, nonseptate *Cryptospora*
 7. Ascospores small, allantoid, nonseptate *Valsa, Leucostoma*
 7. Ascospores 1-septate, fusoid *Cryptodiaporthe*
 7. Ascospores 1-septate, ellipsoid *Diaporthe*
5. Perithecia dark, immersed in stroma or host tissue, with beaks separately erumpent, ascospores hyaline 8
 8. Stroma superficial, ascospores subglobose *Hypocrea*
 8. Stroma erumpent, ascospores allantoid *Eutypella*
 8. Stroma immersed, with blackened crust, ascospores allantoid *Eutypa*
 8. Stroma immersed, crust lacking, ascospores allantoid *Cryptosphaeria*
5. Perithecia in a stroma or on a subiculum, ascospore dark, ovoid 9
 9. Stroma crust-like to globose *Hypoxyylon*
 9. Stroma erect, clavate *Xylaria*
 9. Perithecia surrounded by hyphal subiculum *Rosellinia*
 9. Stroma a clypeus *Amphisphaerella*

Key to the Genera of Discomycetes

(Asci unitunicate, ascocarp an apothecium)

1. Apothecia relatively large, exceeding 5 mm, fleshy or stromatic 2
 2. Apothecia fleshy, orange *Pithya*
 2. Apothecia fleshy, purple *Ascocoryne*
 2. Apothecia stromatic, blackish brown *Cryptomyces*
 2. Apothecia leathery, green *Chlorociboria*
1. Apothecia usually less than 5 mm 3
 3. Apothecia bright colored or white, ascospores hyaline 4
 4. Apothecia sessile, asci multisporous, ascospores nonseptate *Biatorella*
 4. Apothecia sessile, asci 4-8-spored, ascospores multiseptate *Pezicula, Neofabrea, Dermea*
 4. Apothecia stalked, smooth, ascospores nonseptate *Helotium, Pezizella*
 4. Apothecia stalked, hairy, ascospores nonseptate *Lachnellula (Dasyscyphus)*
 4. Apothecia stalked, ascospores 1-septate *Bisporella*
 3. Apothecia black or dark brown, ascospores hyaline 5
 5. Apothecia clustered on a stromatic base, excipulum smooth 6
 6. Apothecia parenchymatous, asci J- *Ascocalyx, Gremmeniella*
 6. Apothecia plectenchymatous, asci J- or J+ *Durandiella, Pragmopora*
 6. Apothecia plectenchymatous, asci J- with numerous secondary

- spores *Tymanis, Claussenomyces*
6. Apothecia of 3 tissues, asci J+ *Grovesiella*
5. Apothecia separate, with powdery or furfuraceous excipulum 7
7. Ascospores brown, broadly ellipsoid *Velutarina, Pestalopezia*
7. Ascospores hyaline, broadly ellipsoid, simple *Cenangium*
7. Ascospores hyaline, narrowly ellipsoid, simple, small *Encoelia, Nipterella*
7. Ascospores hyaline, ellipsoid, multiseptate *Encoeliopsis*
7. Ascospores hyaline, muriform *Sageria*
7. Ascospores hyaline, filiform *Godronia*
5. Apothecia separate, with hymenial cover formed from ectal excipulum ... 8
8. Apothecia sessile, ascospores fusoid, nonseptate, sheathed *Coccomyces*
8. Apothecia sessile, ascospores fusoid, septate, unsheathed *Therrya*
8. Apothecia stalked, ascospores fusoid, sheathed (on *Picea*) *Tryblidiopsis*
8. Apothecia stalked, ascospores ellipsoid, unsheathed *Pseudophacidium*
8. Apothecia stalked, bluing KOH solution, ascospores ellipsoid to fusiform *Atropellis*
8. Apothecia stalked with delimited medulla, ascospores clavate *Discocainia*
8. Apothecia intraperidermal, ascospores ellipsoid *Potebniamyces*
5. Apothecia separate or clustered, asci with numerous secondary ascospores
9. Secondary ascospores allantoid *Tymanis*
9. Secondary ascospores rod-shaped *Pragmopora*
9. Secondary ascospores globose *Retinocyclus*

Key to the Coelomycetes

(conidia produced within a fruit body)

- Conidia produced in pycnidia *Sphaeropsidales*
- Conidia produced in acervuli *Melanconiales*

Key to the Genera of Sphaeropsidales

1. Conidia nonseptate 2
2. Conidia globose *Zythia*
2. Conidia ellipsoid to ovoid, small *Phoma, Sclerophoma, Phyllostictina, Myxofusicoccum*
2. Conidia rectangular, large *Macrophoma, Hendersonula, Diplodia*
2. Conidia angled or acute, biguttulate *Phomopsis, Phacidiopycnis*
2. Conidia rod-like, very small *Sirodothis, Pragmopycnis (Pleurophomella), Ceuthospora*
2. Conidia allantoid *Cytospora, Zythiostroma*
2. Conidia filiform, curved *Libertella, Neofuckelia*
2. Conidia falcate (some species of) *Gelatinosporium (Micropora), Corniculariella (Chondropodium), Foveostroma*

1. Conidia 1-septate	3
3. Conidia fusoid, small	<i>Sirococcus</i>
3. Conidia rectangular, large	<i>Diplodia</i>
1. Conidia multiseptate	4
4. Conidia cylindric	<i>Septoria</i>
4. Conidia fusoid, curved or straight . . .	<i>Brunchorstia, Bothrodiscus, Topospora</i>
4. Conidia falcate	<i>Gelatinosporium, Foveostroma, Corniculariella</i>
1. Conidia muriform	5
5. Conidia hyaline	<i>Dichomera</i>
5. Conidia colored, rounded	<i>Pseudodichomera</i>
5. Conidia colored, rectangular	<i>Camarosporium</i>
5. Conidia colored, clathrate (lattice-like)	<i>Camarographium</i>

Key to the Genera of Melanconiales

(conidia produced in acervuli)

1. Conidia hyaline	2
2. Conidia nonseptate	3
3. Conidia ovoid to ellipsoid	<i>Kabatina, Tubularia, Gloeosporium</i>
3. Conidia small, allantoid to rod-shaped	<i>Pirobasidium, Naemospora</i>
3. Conidia large, cylindric-fusiform, curved	<i>Cryptosporiopsis</i>
2. Conidia septate	4
4. Conidia fusoid, 1-septate	<i>Discella</i>
4. Conidia cylindrical, many-septate	<i>Cylindrocarpon</i>
4. Conidia rectangular, 0-several-septate	<i>Cryptosporiopsis</i>
1. Conidia colored	5
5. Conidia nonseptate	<i>Melanconium</i>
5. Conidia septate	6
6. Conidia round to ovoid	<i>Bactrodesmium</i>
6. Conidia ellipsoid with truncate base	<i>Pollaccia</i>
6. Conidia rectangular, plain	<i>Seimatosporium</i>
6. Conidia broadly fusoid, with short, simple, apical appendages . . .	<i>Seiridium</i>
6. Conidia with branched appendages	7
7. Conidia 3-septate	<i>Truncatella</i>
7. Conidia 4-septate	<i>Pestalotiopsis</i>
7. Conidia 5-septate	<i>Seiridium, Pestalotia</i>

Key to the Genera of Hyphomycetes

(conidia on hyphae or on specialized conidiophores)

1. Conidia nonseptate, hyaline	2
2. Conidiophores simple, heads dry	<i>Monocillium</i>
2. Conidiophores simple, heads slimy	<i>Acremonium</i>

- 2. Conidiophores simple, conidia in branching chains *Monilia*
- 2. Conidiophores synnematous *Stilbella*
- 2. Conidiophores sporodochial *Tubercularia, Coryne*
- 2. Conidiophores sympodially branched *Verticillidiella*
- 2. Conidiophores deep phialides *Chalara*
- 2. Conidiophores lacking, conidia produced on hyphae *Hormonema*
- 1. Conidia nonseptate, colored 3
 - 3. Conidiophores with polyblastic heads *Botrytis*
 - 3. Conidiophores verticillately branched *Paecilomyces, Trichoderma*
 - 3. Conidiophores paniculate *Cladosporium (Hormodendron)*
- 1. Conidia 1-septate, hyaline *Septonema*
- 1. Conidia 1-septate, colored 4
 - 4. Conidia in arthric chains *Scytalidium*
 - 4. Conidia single, chlamydosporic *Trichocladium*
- 1. Conidia multiseptate, hyaline *Fusarium, Cylindrocarpon*
- 1. Conidia multiseptate, colored *Bactrodesmium*
- 1. Conidia muriform, hyaline *Ascoconidium*
- 1. Conidia muriform, colored *Epicoccum*

DESCRIPTION OF SPECIES

(All species arranged alphabetically by genus)

Acremonium tsugae Gams *Cephalosporium*-artige Schimmel. 117 (1971).

Cultural Description: Colonies on malt agar advancing 1.5 cm in 10 days, floccose, white to ochre yellow or orange yellow, reverse similar. Conidiophores abundant, branched, 25-70 um long; phialides slightly tapered, thick-walled with collarlette, 15-30 × 2-3 um. Conidia hyaline, obovate, nonseptate, 3.7-5.6 × 2.3-3.5 um, produced in slimy heads at the tips of the phialides. Culture smells of soap.

HOST: *Tsuga heterophylla*

DISEASE: Causing stem cankers of *Tsuga heterophylla* (Denyer 1953).

NOTES: Closely related to the microconidial state of *Nectria fuckeliana* Booth, differentiated chiefly by the broader conidia.

Acrospermum cuneolum Dearn. & House Bull. N.Y. State Mus. 266: 67 (1925).

Ascocarps wedge-shaped, dark brown, 600 × 300 um, with concentric ridges. Ascii up to 550 um long, 6-7 um wide. Paraphyses filiform. Ascospores filiform (thread-like), smoky-colored *en masse*, approx. 500 um × 1 um.

HOSTS: Hardwoods

Amphisphaerella amphisphaeroides (Sacc. & Speg.) Kirschst. Krypt. Mark Brand. 7: 305 (1911).

Perithecia scattered, half immersed, spheric-conical, dull black, glabrous, ostiole papillate, 400-500 um diameter, peridial wall 80-95 um thick, mycelium around immersed portion dark brown, sinuate, nodulose. Ascii cylindric, without apical ring, 110-120 × 13-15 um. Ascospores ellipsoid, dark brown, ends rounded, with oil droplets, 3 equatorial germ pores, occasionally apiculate or slightly appendaged at one end, nonseptate, 19-25 × 9-12 um. Paraphyses filiform, numerous, entangled.

HOST: *Populus balsamifera*

DISEASE: Secondary invader of rough-bark disease of balsam poplar (Zalasky 1968b).

Apiosporina collinsii (Schw.) Hoehn. Sitzber. K. Akad. Wiss. Wien 119: 439 (1910).

ANAMORPH: *Cladosporium*

Systemic in twigs, where thick, black, mycelial subicula are formed. Ascostromata black, hypophylloous on a subiculum, gregarious, globose, ostiolate,

tapered at the base, 125-250 um diameter, collapsing when dry. Ascii clavate, bitunicate, 40-70 × 9-12 um. Ascospores pale green to yellowish brown, elliptic-fusoid, 1-septate near the base, 12-15 × 4-6 um.

Conidiophores covering subiculum early in the season, erect, single or branched, septate, brown, up to 225 um long and 4 um wide. Conidia ellipsoid, denticulate, brown, nonseptate, 8-18 × 5-8 um.

HOST: *Amelanchier alnifolia*

DISEASE: Causes a mild brooming of Saskatoon berry where it is systemic in the twigs, and a blackening and curling of the leaves.

***Apiosporina morbososa* (Schw.) Arx Acta Bot. Neerl. 3: 86 (1954).**

SYNONYM: *Dibotryon morbosum* (Schw.) Theiss. & Syd.

ANAMORPH: *Hormodendron*

Stromata large, irregular, greenish black, consisting of hyphae on the outside and mixed hyphae and host cells inside. Ascostromata densely crowded over surface of stroma, black, globose, 150-400 um diameter, ostiolate, not papillate. Ascii clavate, bitunicate, 50-75 × 10-15 um. Ascospores clavate, pale green, 1-septate near the base, 13-18 × 4-6 um. Pseudoparaphyses hyaline, septate.

Conidial state preceding the ascigerous, superficial on surface on young stromata. Conidiophores erect, simple or branched, flexuous, brown, up to 70 um long and 7 um wide. Conidia blastic, pale brown, ovate to irregular, 0-1-septate, formed apically and laterally, 4-12 × 3-5 um.

HOSTS: *Prunus*

DISEASE: Causes black-knot disease of wild and domestic plum and cherry. Infections are perennial and may cause severe deformity of branches. (Fig. 2).

***Ascocalyx abietis* Naumov Bolesni Rast. 14: 138 (1925).**

ANAMORPH: *Bothrodiscus berenice* (Berk. & Curt.) Groves

Apothecia black, circular, clustered on a stroma, 0.3-1.0 mm diameter, with a light grey margin; stroma of irregular *textura angularis*, stalk and ectal excipulum of *textura prismatica*; hypothecium of *textura intricata*. Ascii cylindric-clavate, 8-spored, J-, 65-100 × 9-11 um. Ascospores hyaline, cylindric to subclavate, 0-3-septate; irregularly biseriate, 14-22 × 4-5 um. Paraphyses hyaline, filiform, septate, branched, not forming an epithecium.

Conidiomata discoid, black, up to 2 mm diameter and 1 mm high, pseudoparenchymatous. Conidial locules approx. 75 um diameter. Conidiogenous cells hyaline, blastic-sympodial, cylindric, 8-12 um long. Conidia hyaline, lunate, with a basal frill, bluntly pointed, 0-5-septate, 16-44 × 3-5 um, adhering together in glomerules.

HOST: *Abies balsamea*

DISEASE: Associated with shaded-out, lower crown branch mortality in balsam fir.

NOTES: Mature apothecia of *Ascocalyx* are difficult to obtain because the stromata on which they form detach readily and drop off at this stage.



Fig. 2. *Apiosporina morbosae*. Stromata on living stems of wild cherry.

Ascocalyx tenuisporus Groves Can. J. Botany 46: 1275 (1968).

ANAMORPH: *Bothrodiscus*

Apothecia black with grayish margin and hymenium, seated on erumpent stroma, usually in clusters, inrolled when dry, opening when moist, 0.5-1.5 mm in diameter, 0.8-2.0 mm in height. Tissue of stromatic base *textura prismatica*; medullary and ectal excipula of dark brown *textura angularis*; hypothecium of hyaline interwoven hyphae. (Fig. 3).

Asci cylindric-clavate, short-stalked, 8-spored, pore not bluing in iodine, 80-95 × 8-10 um. Ascospores hyaline, acicular to subfiliform, straight or curved, ends pointed, 3-5-septate, 30-50 × 2-3 um. Paraphyses hyaline, filiform, septate, simple or branched, not forming an epithecium. (Fig. 4).

Pycnidia consisting of locules in a stalked, discoid stroma with membranous margins, up to 2 mm in diameter and 1 mm in height, dark brown to black, tissue of *textura globulosa*. Locules immersed in the disc, 30-90 × 50-100 um. Con-



Fig. 3. *Ascocalyx tenuisporus*. Apothecium, vertical section.

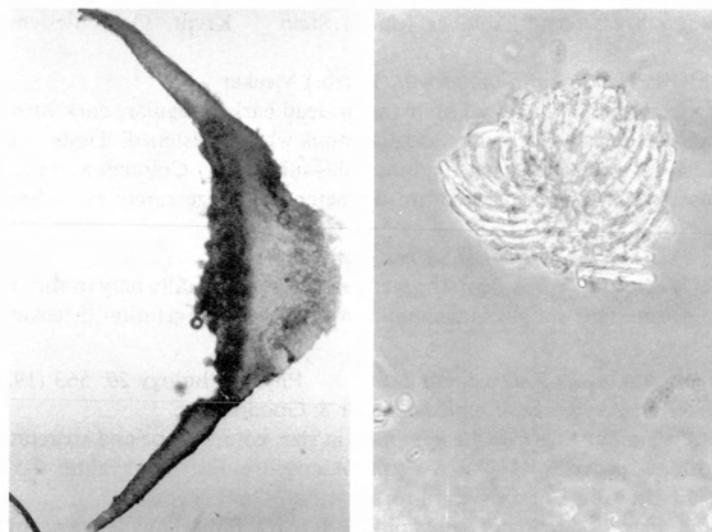


Fig. 4. *Ascocalyx tenuisporus*. *Bothrodiscus* anamorph, vertical section. Glomerule of conidia.

idiogenous cells blastic-sympodial, hyaline, septate, simple, cylindric, 10-25 × 2-3 um. Conidia hyaline, filiform, straight or curved, 1-6-celled, 20-45 × 3-5 um, adhering together in glomerules.

HOST: *Abies lasiocarpa*

DISEASE: On dead branches of *Abies lasiocarpa*; very closely related to *Ascocalyx abietis* Naumov which occurs on *Abies balsamea* in eastern areas, but clearly distinguished by its larger ascospores.

Ascocoryne sarcoides (Jacq. ex Gray) Groves & Wilson Taxon 16: 40 (1967).

ANAMORPH: *Coryne dubia* Pers. ex Gray

Apothecia superficial, clustered, gelatinous, sessile, cupulate, purplish, sometimes irregular and lobed, up to 1 cm diameter, flesh of loosely interwoven hyphae in a gelatinous matrix, ectal excipulum of thin-walled pseudoparenchyma. Ascii cylindric-clavate, 8-spored, apex slightly J +, 160 × 10 um. Ascospores ellipsoid to inequilateral, aseptate to 3-septate, sometimes germinating in the ascus, 10-19 × 3-5 um. Paraphyses filiform, swollen at the tips.

Sporodochia gelatinous, reddish purple, composed of densely aggregated conidiophores. Conidiophores branching verticillately, with two or more metulae giving rise to one or more mono-phialides. Phialoconidia hyaline, slimy, rod-shaped to allantoid.

HOSTS: *Abies*, *Cupressus*, *Larix*, *Picea*, *Pinus*, *Populus*, *Pseudotsuga*, *Tsuga*

NOTES: Commonly isolated from the heartwood of living trees. Some isolates are antagonistic to decay fungi but its role is not yet clarified (Etheridge 1970). Fruiting bodies are generally found on fallen branches or stumps.

Atichia glomerulosa (Ach. ex Mann) Stein Krypt. Fl. Schlesiens 2: 356 (1879).

TELEOMORPH: *Seuratia millardetii* (Racib.) Meeker

Stromatic colonies superficial on living or dead bark, irregular, dark brown, hard when dry, swelling and becoming cartilaginous when moistened. Tissue consists of torulose cells in a gelatinous matrix, inner cells subhyaline. Colonies at maturity with subglobose swellings approx. 100 um diameter, total size rarely exceeding 1 mm. (Fig. 5).

HOSTS: *Pseudotsuga menziesii*, *Abies grandis*

NOTES: A common epiphyte in the wet coastal areas, usually only in the vegetative form. This fungus is common on subtropical vegetation (Meeker 1975).

Atropellis pinicola Zeller & Goodding Phytopathology 20: 563 (1930).

ANAMORPH: *Neofuckelia pinicola* Zeller & Goodding

Apothecia similar to *Atropellis piniphila* in size, color, shape and structure (q.v.). Ascii clavate, 8-spored, 74-178 × 8-13 um. Ascospores filiform, hyaline, 0-5-septate, 32-63 × 1.5-3.5 um. Paraphyses filiform, septate, branched.

Pycnidia black, pulvinate, substipitate, 0.8-1.2 mm diameter, carbonaceous, multiloculate. Conidiophores branched, lining interior of locules. Conidia hyaline, nonseptate, rod-shaped to narrowly ellipsoid, 8-11 × 1.5-3 um.

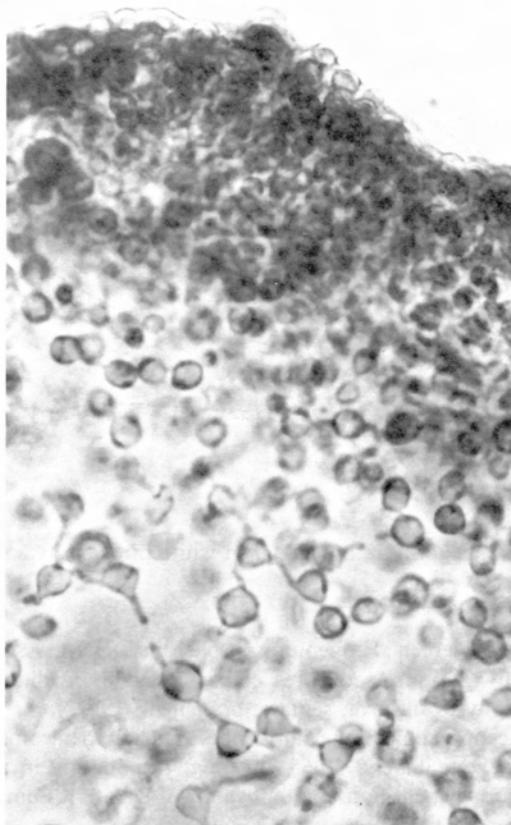


Fig. 5. *Atichia glomerulosa*.
Cells of vegetative
stroma.

HOSTS: *Pinus monticola*, rarely on *P. contorta*

DISEASE: Causes perennial branch and stem cankers of western white pine. (Fig. 6).

NOTES: Differs from *A. piniphila* chiefly in its longer, narrower ascospores and its more frequent occurrence on soft pines.

Atropellis piniphila (Weir) Lohman & Cash J. Wash. Acad. Sci. 30: 260 (1940).

Apothecia erumpent, black, furfuraceous-carbonaceous, stipitate, solitary or gregarious, at first cupulate, expanding to discoid with fimbriate margins, 1-4.5 mm diameter. Ectal excipulum of two distinct tissues, the outer layer of dark, irregular *textura globulosa*, the inner layer of light brown plectenchyma (these tissues extend over the hymenium in the young stage and possess a preformed opening point). Medullary excipulum of loose, hyaline, thin-walled hyphae. Hypothecium of light brown plectenchyma, continuous with inner layer of ectal excipulum. Apothecial

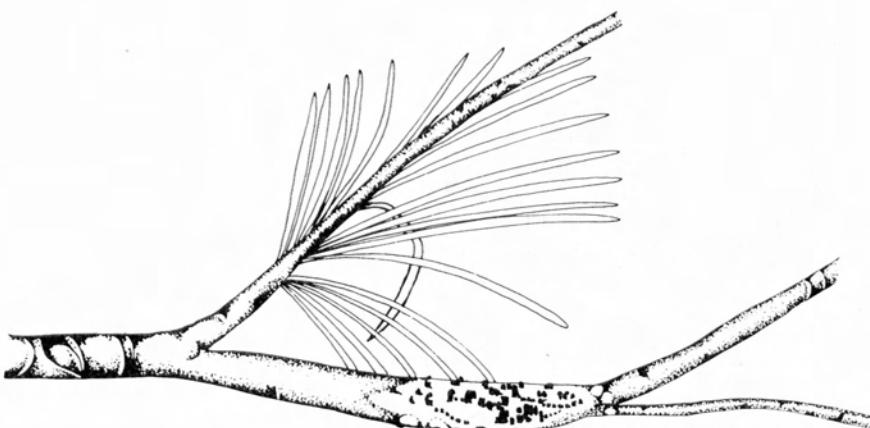


Fig. 6. *Atropellis pinicola*. Apothecia on canker in white pine.

tissue colors 5% KOH solution bluish green. Hymenium purplish in section. Ascii clavate, 8-spored, J-, $90-160 \times 10-15$ um. Ascospores ellipsoid-fusoid, hyaline, 0-1-septate, $16-28 \times 4-7$ um. Paraphyses filiform, septate, branched. (Fig. 7).

Pycnidia globose, black, furfuraceous, substipitate, sometimes splitting to become cupulate. Conidiophores branched verticillately, 30-65 um long, terminating in a phialide, 30-40 um long. Conidia rod-shaped, nonseptate, hyaline, $4-8 \times 1-1.7$ um.
HOSTS: *Pinus contorta*, *P. ponderosa*

DISEASE: Causes perennial stem and branch cankers of hard pines. (Fig. 8). Blues-taining of the wood and copious resin flow are characteristic (Hopkins 1963). Pycnidia usually appear on young cankers, before the apothecia. Conidia do not germinate in culture, but resemble those produced in cultures made from ascospores (Hopkins 1961).

NOTES: Four species of *Atropellis* are recognized (Reid and Funk 1966) but only two occur on western trees; both color 5% KOH solution greenish blue. The ascii are J-.

Aureobasidium pullulans (de Bary) Arn. Ann. Myc. 8: 470 (1910).

Cultural Description: Hyphae hyaline when young, transversely septate, cells may be wider than long, up to 16 um wide; in age dark brown, thick-walled. Conidiogenous cells not differentiated, intercalary or terminal on hyaline hyphae or as short lateral branches. Conidia blastically produced in dense groups from the cell surface. Small scars or denticles remain on cell surface where conidia are detached. Conidia hyaline, ellipsoid, nonseptate, variable, $7-16 \times 4-7$ um; often budding small, secondary conidia. Endoconidia sometimes produced.

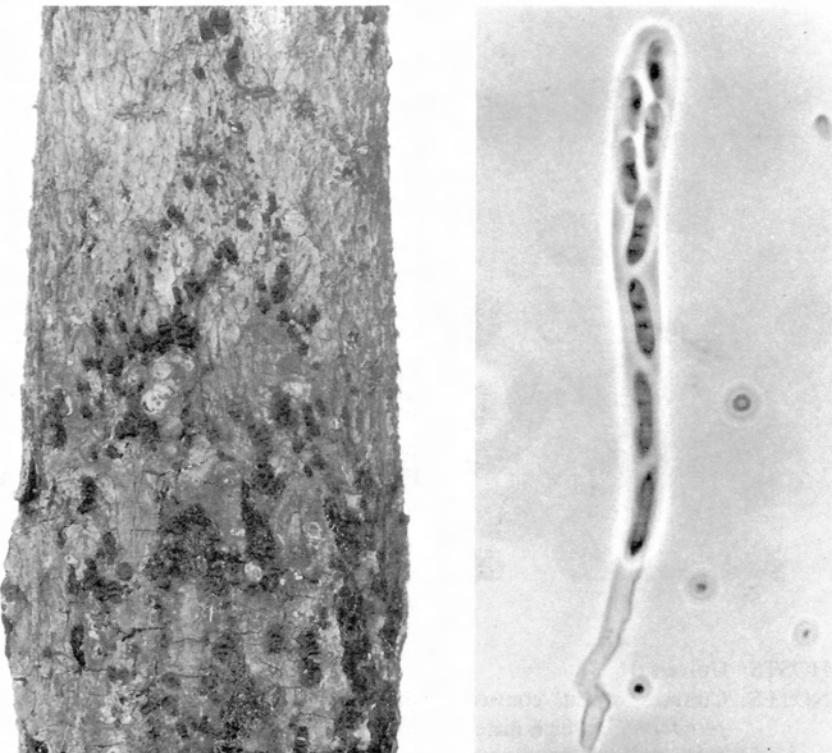


Fig. 7. *Atropellis piniphila*. Apothecia, in canker. Ascus.

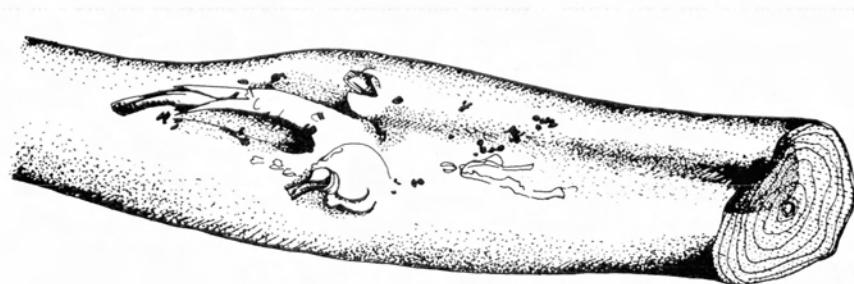


Fig. 8. *Atropellis piniphila*. Canker in lodgepole pine.

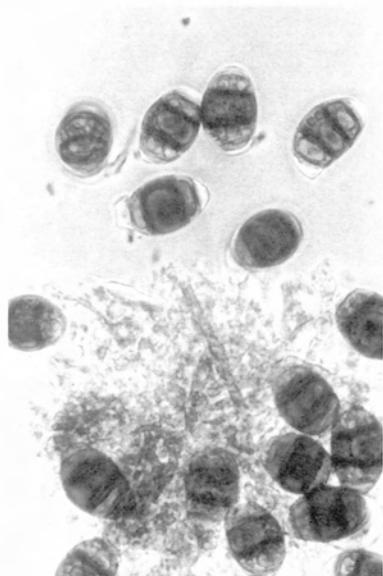


Fig. 9. *Bactrodesmium obliquum*. Conidia.

HOSTS: Universal

NOTES: Cultures often confused with *Hormonema* state of *Sclerophoma pithyophila*, which differs in conidiogenesis, in that conidia are produced from a single locus in the cell.

Bactrodesmium obliquum Sutton Can. J. Botany 45: 1778 (1967).

Sporodochia scattered or gregarious, punctiform, black, shiny, up to 400 um diameter. Mycelium branched, septate, hyaline to brown, smooth-walled. Conidiophores fasciculate, arising from apices of aggregated hyphae, simple or branched, flexuous, subhyaline to brown, 1-5-septate, up to 26 um long and 2.5 um wide, inflated at the apex to 11 um. Conidia blastospores, formed singly at the apex of the conidiophores, frequently at an angle to conidiophore, ovoid, truncate at the base, 4-septate, the two innermost septa thick and black, each end cell pale brown with 0-3 longitudinal oblique septa, middle cell dark brown, intermediate cells medium brown, 23-33 × 16-22 um. (Fig. 9).

HOSTS: *Picea glauca*, *Pseudotsuga menziesii*

NOTES: Epiphytic on bark of white spruce and Douglas-fir. The fungus on Douglas-fir has fewer longitudinal septa and may represent a variety.

Bertia moriformis (Tode) de Not. Giornale Bot. Ital. I: 335 (1846).

Perithecia densely gregarious, superficial, seated on a broad base, subcylindric, outer surface with coarse warts and furrows (mulberry-like), black, without ostiole, 1.5 mm high, 0.75 mm wide. Ascii long-stalked, clavate, thin-walled, up to 105 × 13 um, 8-spored. Ascospores sausage-shaped, hyaline, 1-septate, 30-50 × 4-8 um. (Fig.

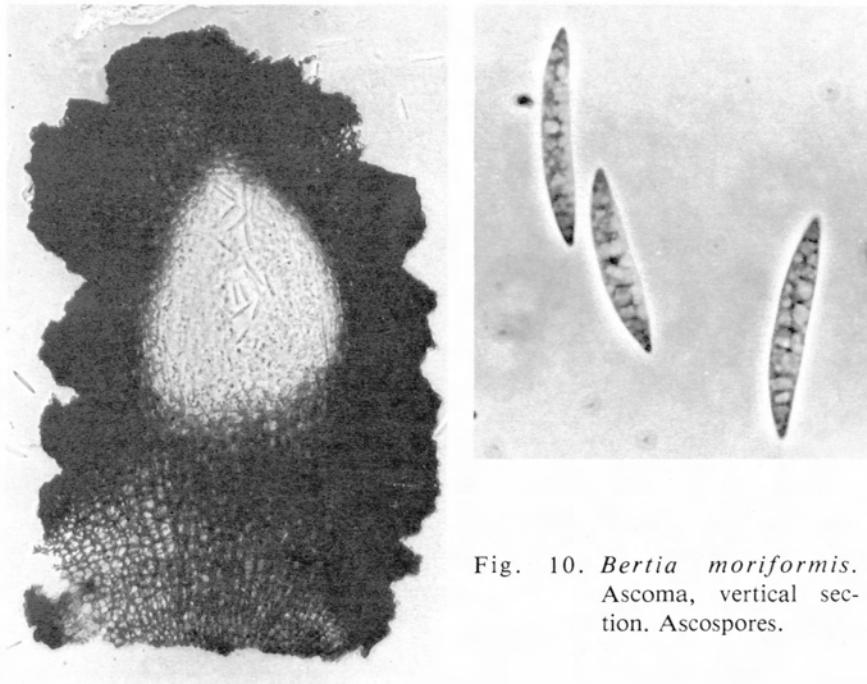


Fig. 10. *Bertia moriformis*.
Ascoma, vertical section. Ascospores.

10).

HOSTS: Common on decorticated wood of conifers and hardwoods.

***Biatorella resinae* (Fr.) Mudd** Manual of British Lichens 191 (1861).

SYNONYM: *Sarea resinae* (Fr. ex Fr.) Kuntze

ANAMORPH: *Zythia resinae* (Ehrenb.) Karst.

Apothecia orange throughout, sessile, disc flat with a low margin, gregarious, up to 1.5 mm in diameter. Asci clavate, multispored, J+, 100 × 20 um. Ascospores globose, hyaline, 2-3 um in diameter, innumerable. Paraphyses slender, simple or branched, swollen at the tips.

Pycnidia orange, densely caespitose, subglobose to compressed, 0.2-0.5 mm in diameter. Conidiophores penicillate, consisting of a short simple stalk bearing 2-5 flask-shaped phialides which are 8-10 × 2 um, sometimes proliferating to twice length, lining inner cavity of pycnidia. Conidia globose, hyaline, acrogenous, 2-2.5 um in diameter.

HOSTS: *Abies*, *Picea*, *Pinus*, *Pseudotsuga*, *Tsuga*

NOTES: On resin exudations of conifers. Also isolated from living sapwood and heartwood (Robinson-Jeffrey and Loman 1963). Pathogenicity was shown by Smerlis (1973).

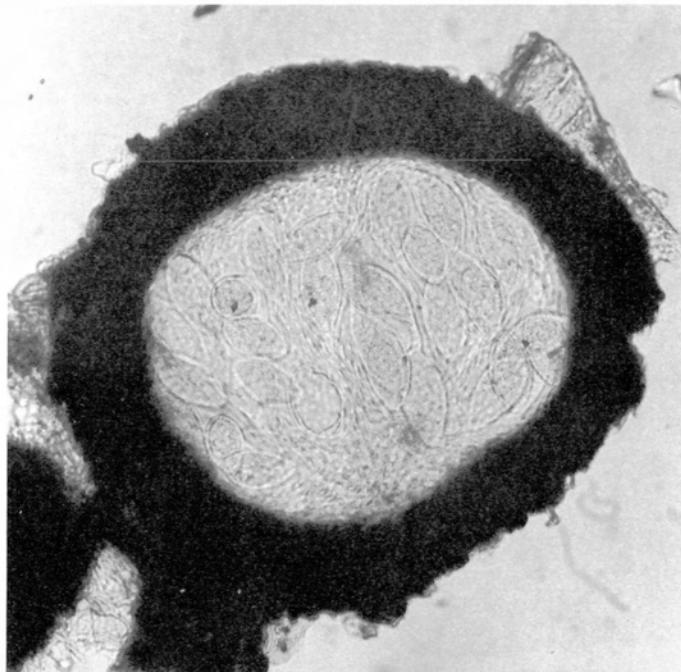


Fig. 11. *Botryosphaeria piceae*. Ascocarp.

Bisporella citrina (Batsch ex Fr.) Korf & Carpenter Mycotaxon 1: 58 (1974).
SYNONYM: *Helotium citrinum* (Hedw. ex Purton) Fr.

Apothecia superficial, gregarious, often running together in confluent masses, stipitate, bright lemon-yellow, 0.3-3.0 mm in diameter, up to 1 mm high. Asci clavate, 75-135 × 10 um, 8-spored, J-. Ascospores ellipsoid, hyaline, biguttulate, 0-1-septate, 9-14 × 3-5 um. Paraphyses filiform, slightly enlarged upwards and containing yellow oil droplets.

HOSTS: Common on dead branches of hardwoods and conifers.

Botryosphaeria piceae Funk Can. J. Botany 43: 45 (1965).

Ascostromata black, globose, densely gregarious, sometimes on a common basal stroma, uniloculate, 0.4-0.8 mm in diameter; walls pseudoparenchymatous, 45-95 um thick. Asci clavate, short-stalked, bitunicate, 240-280(360) × 67-84(100) um, immersed in hyaline pseudoparaphysoids. Ascospores ellipsoid, nonseptate, hyaline when in ascocarp, black when germinating, (44)60-85(93) × (18)26-42(46) um. (Figs. 11, 12).

HOSTS: *Picea* spp.

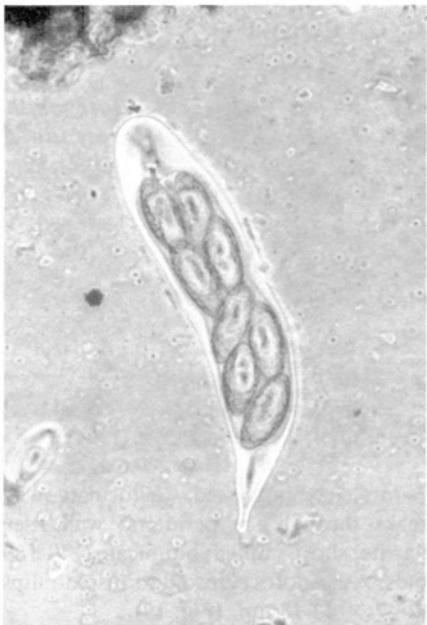


Fig. 12. *Botryosphaeria piceae*. Ascus and spores.



Fig. 13. *Botryosphaeria piceae*. Habit on spruce branch.

DISEASE: Causing large, corky, canker-like swellings on most species of *Picea*. The lesions are perennial on living stems and branches, and may be completely covered with ascostromata. (Fig. 13).

NOTES: The coelomycete *Rileya piceae* Funk (Funk 1979b) is found in these cankers and is either the anamorph of *Botryosphaeria* or a mycoparasite.

***Botryosphaeria pseudotsugae* Funk** Can. J. Botany 53: 2300 (1975).

Ascostromata immersed, black, triangular, uniloculate, ostiolate, 400-450 um high, 625-675 um broad at the base; locules spherical to ovoid, 150-275 um in diameter. Ascii ellipsoid, unstalked, bitunicate, 120-130 × 70-75 um, immersed in filamentous pseudoparaphyses. Ascospores ellipsoid, hyaline, nonseptate, 50-67 × 21-30 um. (Fig. 14).

HOST: *Pseudotsuga menziesii*

NOTES: In living branches of Douglas-fir. Rare. Possibly associated with insect attack.



Fig. 14. *Botryosphaeria pseudotsugae*. Ascostroma, ascus with spores.

Botryosphaeria tsugae Funk Can. J. Botany 42: 770 (1964).

ANAMORPH: *Macrophoma*

Ascostromata black, globose, completely immersed, uniloculate with a short apical beak with ostiole that breaks through the periderm; wall pseudoparenchymatous, 60-70 um thick. Ascii clavate, short-stalked, bitunicate, 140-180 × 30-36 um, immersed in pseudoparaphysoids. Ascospores ellipsoid to fusoid-ellipsoid or in equilateral, nonseptate, hyaline, 42-47 × 13-18 um. (Fig. 15).

Pycnidia black, immersed, globose, uniloculate with short apical beak, 400-540 um in diameter, wall 35-45 um thick. Conidiophores simple, cylindric, 10-15 × 3 um. Conidiogenous cells holoblastic, in apices of conidiophores. Conidia blastospores, oblong to obovoid, hyaline, nonseptate, 36-41 × 18-22 um. (Fig. 16). HOST: *Tsuga heterophylla*

DISEASE: Causing serious dieback of western hemlock predisposed by drought and other factors.

NOTES: *Botryosphaeria ribis* Grossen. & Duggar resembles *B. tsugae* in both teleomorph and anamorph, but has smaller ascospores (17-23 × 7-10 um) and smaller conidia (17-25 × 5-7 um). It can cause a serious dieback of *Sequoiadendron giganteum* and other conifers.

Botrytis cinerea Pers. Syn. Meth. Fung. 690 (1801).

TELEOMORPH: *Sclerotinia fuckeliana* (de Bary) Fckl.

Conidiophores arising within shoots and leaves, forming a grey weft over the host, up to 2 mm long and 15-30 um wide, with a stipe and open head of branches, smooth, clear brown below, paler near the apex, ends of the branches almost hyaline. Conidiogenous cells polyblastic, terminal on the branches or growing out of subterminal cells. Conidia holoblastic, ellipsoid to obovate, colorless to pale brown, with a slight frill or hilum at point of attachment, 6-8 × 4-11 um. Small, black, irregular sclerotia may also be present on the host or in culture. The ascigerous stage is rarely found. (Fig. 17).

HOSTS: Most conifers and many broad-leaved species.

DISEASE: Causes blight or rot ("Gray mould") of nursery seedlings and stored planting stock of conifers. A secondary invader of stem cankers.

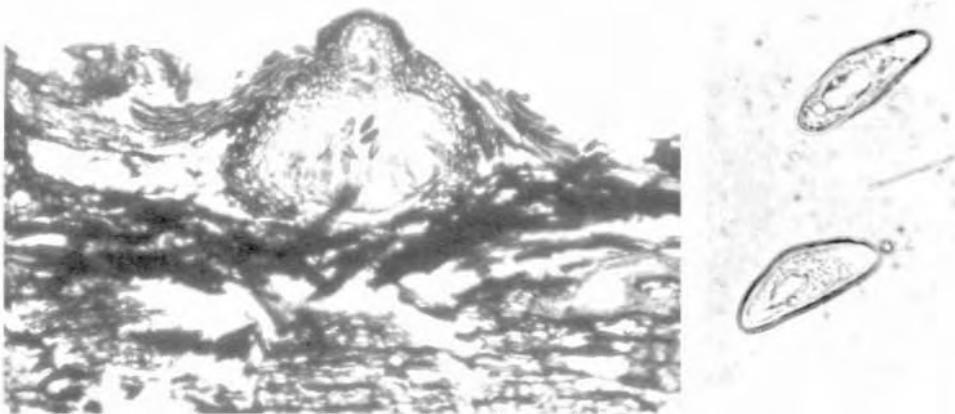


Fig. 15. *Botryosphaeria tsugae*. Ascocarp. Ascospores.

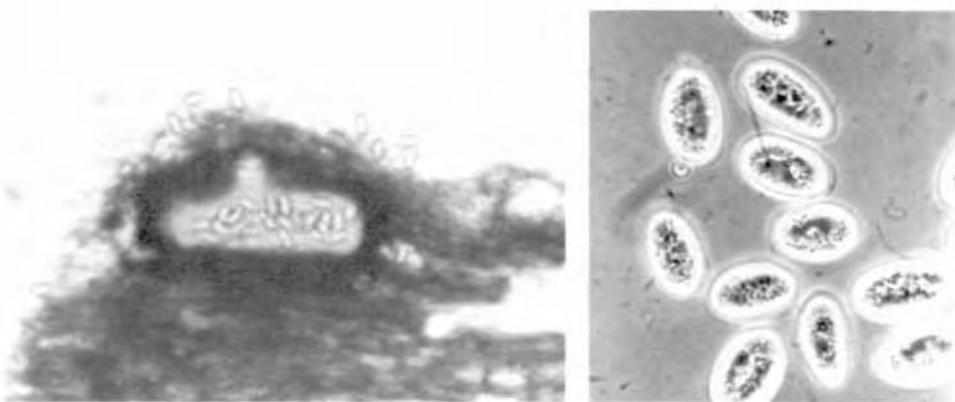


Fig. 16. *Botryosphaeria tsugae*. Pycnidium. Conidia.



Fig. 17. *Botrytis cinerea*. Conidio-phores and conidia.

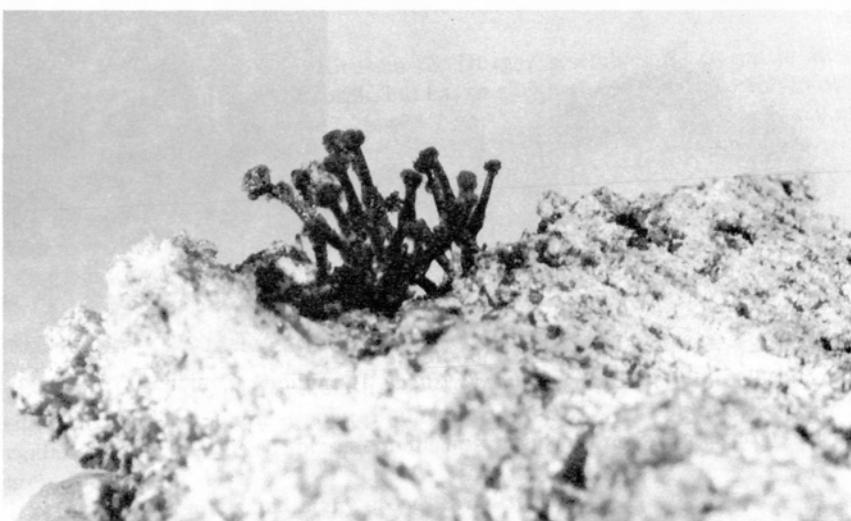


Fig. 18. *Caliciopsis calicioides*. Ascomata on poplar bark.

Caliciopsis calicoides (Ell. & Ev.) Fitzp. Mycologia 12: 220 (1920).

Ascocarps appear as black columns arising from an erumpent stroma, with a submedian ascigerous swelling and a prominent beak, up to 2 mm long, and 350 um wide at the swelling, straight to curved, tapering to the apex. Asci ovate to clavate, 15-20 × 8-10 um, thin-walled, evanescent, 8-spored. Ascospores ellipsoid, light brown, 6-8 × 3-5 um, extruding from the ascocarp in a dry mass (mazaedium). (Fig. 18).

Spermogonia crowded on same stroma, preceding ascocarps, black, conical, 150 um diameter, apically perforated. Spermatia hyaline, nonseptate, irregularly rod-shaped, 3 × 1 um.

HOSTS: *Populus trichocarpa*, *P. balsamifera*

DISEASE: Parasitic on bark of living poplars, especially on rough-bark following *Rhytidella moriformis* (Zalasky 1968b).

Caliciopsis pseudotsugae Fitzp. Mycologia 34: 496 (1942).

Ascocarps appear as slender black columns, tapering from a slightly broadened base and provided with a prominent subapical enlargement, tapering above the enlargement to form a beak, from 1-3 mm in height, and approximately 0.2-0.3 mm broad at the base. Asci are produced in the subapical enlargement, subglobose to ellipsoid, with a very long, narrow stalk, 8-spored, evanescent at maturity, 12-19 × 5-9 um; ascospores golden brown, subglobose to ellipsoid, 3-6 × 2-4 um, extruding in a mass from the beak of the column. (Fig. 19).

Pycnidia (spermogonia?) black, subglobose to pyriform, papillate, superficial, separate, 40-140 um in diameter; conidia (spermatia?) hyaline, allantoid, 1-celled, 3.5-5 × 1-1.5 um.

HOSTS: *Pseudotsuga menziesii*, *Tsuga heterophylla*, *Abies grandis*

DISEASE: Parasitic on living branches, colonizing various lesions without causing necrosis; also colonizing bacterial galls of Douglas-fir (Funk 1963). Invades dwarf mistletoe infections of hemlock (Baranyay 1966).

Camarographium abietis (Wils. & Anders.) Grove Brit. Stem and Leaf Fungi 2: 107 (1937).

SYNONYM: *Myxocyclus cenangiooides* (Ell. & Rothr.) Petr.

Pycnidia erumpent, globose-hemispherical, scattered or aggregated, dark brown, wall parenchymatous, less than 1 mm diameter. Conidiophores short, hyaline, cylindric, lining the single, simple locule. Conidia blastic, broadly fusoid, brown, clathrato-muriform, up to 10 cross septa, with 0-4 longitudinal or oblique septa in each cell, 30-60 × 15-22 um. (Fig. 20).

HOST: *Abies lasiocarpa*

NOTES: Associated with dieback of alpine fir.

Camarosporium quaternatum (Haszl.) Schulz. Myk. Beitr. 649 (1870).

Pycnidia immersed, separate, black, subglobose, unilocular, 450 um diameter or less, wall pseudoparenchymatous and approx. 25 um thick, ostiolate. Conidiogenous cells short-cylindric, holoblastic, annellidic, formed from inner cells of the wall, up to 7 um tall. Conidia dark brown, smooth, ellipsoid, mostly 3-euseptate, sometimes



Fig. 19. *Caliciopsis pseudotsugae*.
Ascomata in canker on
Douglas-fir.

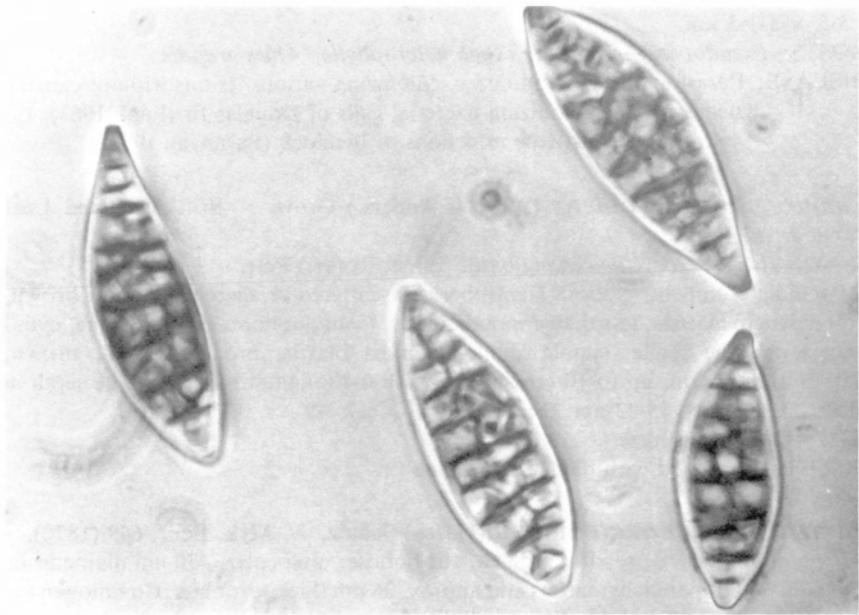


Fig. 20. *Camarographium abietis*. Conidia.

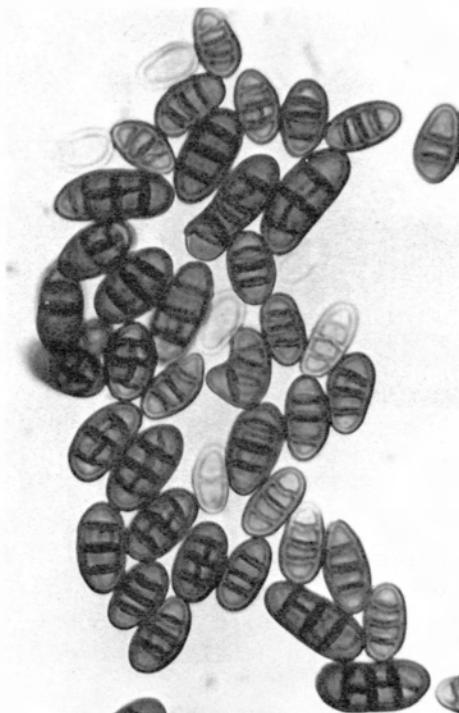


Fig. 21. *Camarosporium quaternatum*. Conidia.

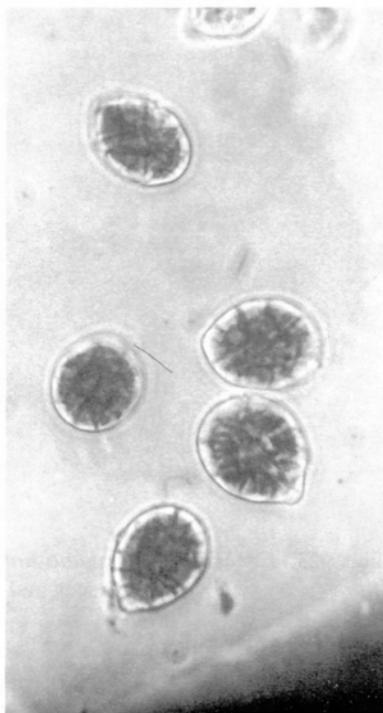


Fig. 22. *Camarosporium strobilinum*. Conidia.

with 1 or 2 longitudinal septa in the median cells, base truncate, $11-17 \times 6-7$ um. (Fig. 21).

HOSTS: *Cornus nuttallii*, *Populus tremuloides*

DISEASE: Associated with stem cankers in young trees.

Camarosporium strobilinum Bomm., Rouss. & Sacc. Syll. Fung. 10: 344 (1892).

Pycnidia dark brown, glabrous, globose, sessile, superficial, 300-500 um diameter; ostiolate, not beaked; walls of brown *textura globulosa*, grading to hyaline, compressed cells toward interior. Conidia at first clavate, becoming globose, brown with lighter colored basal cells when young, muriform, $21-35 \times 17-20$ um exuding in a slime drop. Conidiophores mostly simple annellophores, $15-40 \times 2-4$ um. (Fig. 22). HOSTS: *Abies lasiocarpa*, *Picea glauca*

DISEASE: Parasitic on buds and shoots of subalpine fir and white spruce, causing necrosis and dieback (Shoemaker 1967). Epidemic outbreaks of bud killing sometimes occur.

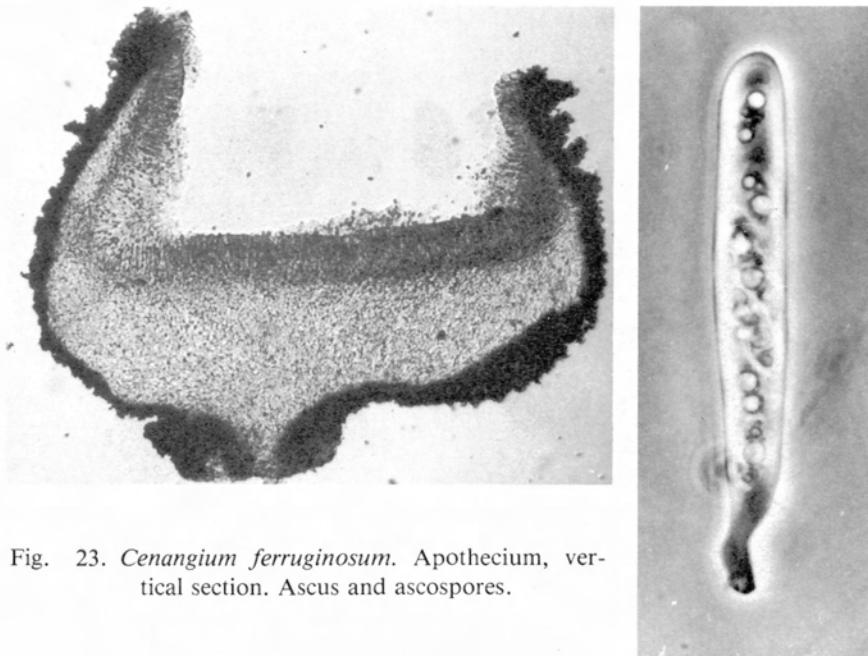


Fig. 23. *Cenangium ferruginosum*. Apothecium, vertical section. Ascus and ascospores.

***Cenangium ferruginosum* Fr.** Syst. Myc. 2: 187 (1822).

Apothecia erumpent, single or clustered, dark brown, mealy, margin inrolled when dry, hymenium yellow, 2-3 mm diameter. Ectal excipulum of dark, irregular *textura angularis*; medullary excipulum of hyaline, loose interwoven hyphae (*textura intricata*); hypothecium yellow-brown. Asci cylindric-clavate, tips broadly rounded and asymmetric, J-, 70-80 × 12-15 um, 8-spored. Ascospores hyaline, broadly ellipsoid, nonseptate, 12-14 × 5-6 um. Paraphyses hyaline, filiform, slightly swollen at the tips, agglutinated above to form the yellow hymenium. (Fig. 23).

Spermogonia formed in culture, black, globoid, containing bacilliform spermatia (Van Vloten and Gremmen 1953).

HOSTS: *Pinus* spp.

DISEASE: Weakly parasitic on senescent pine branches, or saprophytic. Pathogenicity confirmed by Smerlis (1973).

***Cenangium singulare* (Rehm) Davidson & Cash** Phytopathology 46: 36 (1956).

SYNONYM: *Phibalis pruinosa* (Ell. & Ev.) Kohn & Korf

Apothecia erumpent under bark, densely gregarious, leathery, outer surface encrusted with crystals, cupulate when moist, rolling up when dry; ectal excipulum of hyaline hyphae which turn outward to form a layer of dark brown, globose cells; medullary excipulum of light brown, roughened hyphae, all tissues gelatinized. Asci

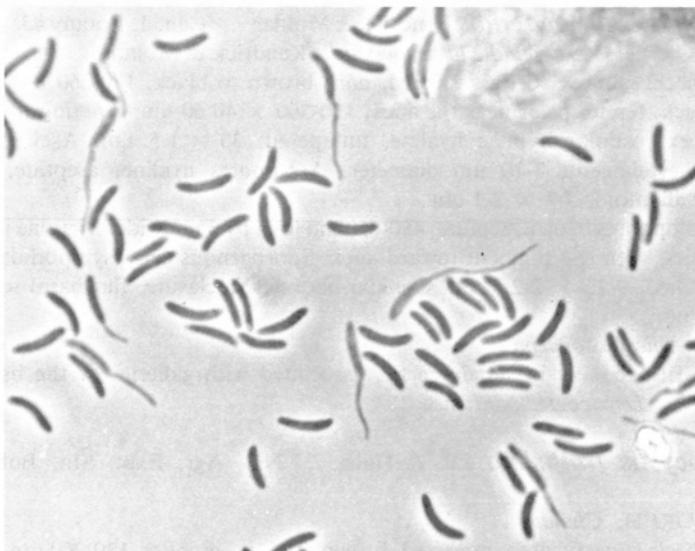
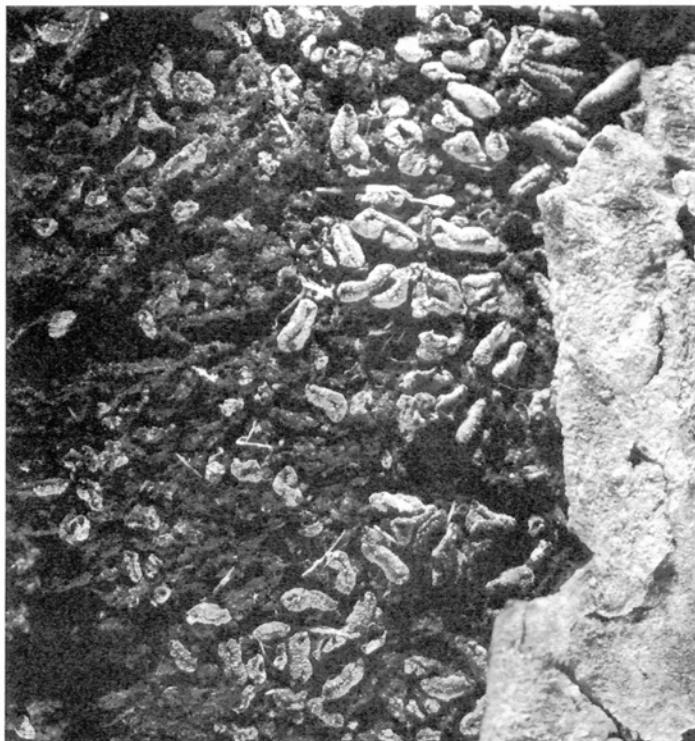


Fig. 24. *Cenangium singulare*. Apothecia in bark. Ascospores.

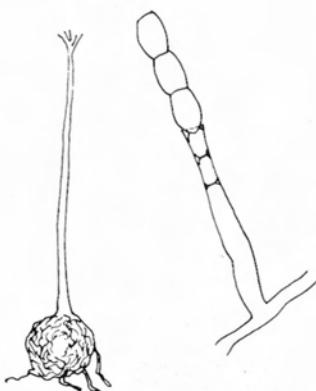


Fig. 24B. *Ceratocystis fimbriata*.
Perithecioid. *Chalara*
anamorph.

clavate, 8-spored, apex J-, $40-55 \times 4-5$ um. Ascospores hyaline, allantoid to ellipsoid, nonseptate or occasionally 1-septate, $8-11 \times 2-3$ um, sometimes elongating and producing polar buds within the ascus. Paraphyses filiform, slender, with brownish tips. (Fig. 24).

HOST: *Populus tremuloides*

DISEASE: Causing sooty canker of aspen.

Ceratocystis dryocoetidis Kendrick & Molnar Can. J. Botany 43: 39 (1965).

ANAMORPH: *Verticicladiella dryocoetidis* Kendrick & Molnar

Perithecia globose to flask-shaped, dark brown to black, 170-260 um diameter, beak black, terete, paler near the apex, $150-560 \times 40-60$ um, tapering to 35-45 um near apex, ostiolar hyphae hyaline, untapered, 30×1.5 um. Ascii globose to clavate, evanescent, 7-10 um diameter. Ascospores hyaline, aseptate, smooth, broadly allantoid, $5-7 \times 2-3$ um.

Conidiophores brown, septate, $450-650$ um long by 6 um wide. Metulae in three or four series, with less pigment toward apex. Sporogenous cells (sympodulae) simple or branched, $9-22 \times 2-2.5$ um. Conidia obovoid to clavate, flat basal scar, up to 23×3 um.

HOST: *Abies lasiocarpa*

DISEASE: Parasitic in subalpine fir, associated with galleries of the bark beetle *Dryocoetes confusus*.

Ceratocystis fimbriata Ell. & Halst. N.J. Agr. Expt. Stn. Bull. 76: 14 (1890).

ANAMORPH: *Chalara*

Perithecia superficial to immersed, brown to black, globose, 130-200 um diameter; necks black, with long, hyaline ostiolar hyphae, up to $800 \times 20-35$ um. Ascospores

Table 1. *CERATOCYSTIS* SPECIES

Species	Anamorph	Perithecia	Ascospores	Hosts
<i>C. alba</i>	Conidia in culture	Hyaline 55-85 um	Fusiform 6-8.5 × 1-1.3 um	<i>Populus tremuloides</i>
<i>C. crassivaginata</i>	<i>Verticillidiella</i> <i>dryocoetidis</i>	Black 40-90 um	Fusiform 5-7 × 1 um	<i>Populus tremuloides</i>
<i>C. dryocoetidis</i>	<i>Verticillidiella</i> <i>dryocoetidis</i>	Black 170-260 um	Allantoid 5-7 × 2-3 um	<i>Abies lasiocarpa</i>
<i>C. fimbriata</i>	<i>Chalara</i>	Black 130-200 um	Hat-shaped 4.5-8 × 2.5-5.5 um	<i>Populus tremuloides, Platanus</i>
<i>C. hunnii</i>	<i>Verticillidiella</i>	Black 280-450 um	Cucullate 3-4 × 1.5-2 um	<i>Pinus contorta</i>
<i>C. montia</i>	Conidia in culture	Black 180-440 um	Rectangular 3-5 × 2-3 um	<i>Pinus</i>
<i>C. tremulo-aurea</i>	Conidia in culture	Black 95-150 um	Crescent-shaped 4.7-5.9 × 1.1-2.4 um	<i>Populus tremuloides</i>

hat-shaped, hyaline, $4.5-8 \times 2.5-5.5$ um. (Fig. 24B).

Endoconidiophores single or clustered, simple, cylindric, blunt or tapered, septate, $25-150 \times 3-8$ um. Phialoconidia cylindric, hyaline to brown, unicellular, $10-27 \times 3-5$ um, or ellipsoid to pyriform, truncate, golden brown, $12-22 \times 6-13$ um.

HOSTS: *Populus tremuloides*, *Platanus* spp.

DISEASE: Causing target canker, twig dieback and leaf blight of aspen (Hinds 1972; Zalasky 1965). Also the cause of "canker stain" of plane tree in which it discolors the wood and produces lesions where it reaches the cambium.

***Ceratocystis huntii* Robinson** Can. J. Botany 42: 528 (1964).

ANAMORPH: *Verticildiella*

Perithecia globose, black, leathery, 280-450 um diameter, beaks 140-720 \times 40-70 um, tapering to 20-40 um at the apex; perithecia ornamented with brown hyphal hairs. Ascii globose, evanescent, up to 7 um diameter. Ascospores hyaline, continuous, cucullate, embedded in gelatinous matrix, $3-4 \times 1.5-2$ um.

Conidiophores brown, septate, up to 170 um long; metulae in two series, sporogenous cells sympodulae up to 30 um long; conidia hyaline, cylindric to clavate, $4-10 \times 2-4.5$ um.

HOST: *Pinus contorta*

DISEASE: Accompanies attack by the mountain pine beetle, *Dendroctonus ponderosae*, and causes bluestain of sapwood in lodgepole pine (Robinson-Jeffrey and Grinchenko 1964).

***Ceratocystis montia* (Rumb.) Hunt** Lloydia 19: 45 (1956).

Perithecia black, globose, 180-440 um diameter, beaks black, hyaline at the apex, often swollen near the base, $1000-2000 \times 40-100$ um, 10-30 um wide at the apex; ostiolar hyphae absent. Ascii evanescent; ascospores rectangular with gelatinous flanges, $3-5 \times 2-3$ um.

HOSTS: *Pinus* spp.

DISEASE: Accompanies attack by various bark beetles.

***Ceratocystis tremulo-aurea* Davidson & Hinds** Mycologia 56: 794 (1964).

Perithecia black, smooth, 95-150 um diameter; necks black, $300-480 \times 13-35$ um; ostiolar hyphae numerous, hyaline, 25-50 um long. Ascospores hyaline, crescent-shaped, $4.7-5.9 \times 1.1-2.4$ um.

HOST: *Populus tremuloides*

DISEASE: Associated with aspen "black canker". (Davidson and Hinds 1964).

NOTES: Two species of *Ceratocystis* sometimes reported in aspen cankers are *C. crassivaginata* Griffin with fusiform ascospores $5-7 \times 1$ um, and *C. alba* Devay, Davidson & Moller with similar ascospores but hyaline perithecia. Both species belong to the "Minuta Group" of the genus characterized by fusoid ascospores with a gelatinous sheath (Olchowecski and Reid 1974).

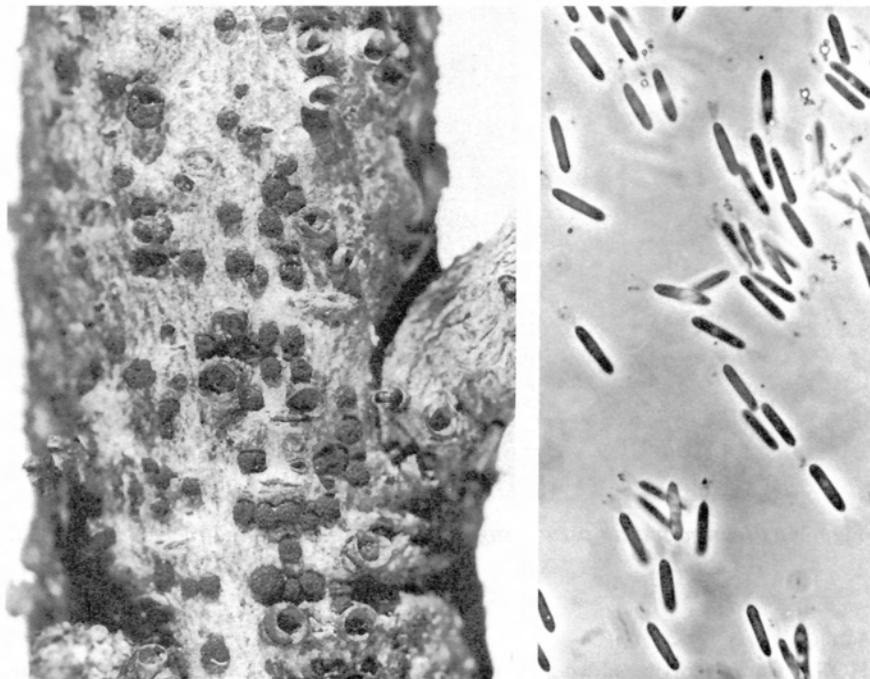


Fig. 25. *Ceuthospora* sp. Pycnidia in bark. Conidia.

***Ceuthospora* spp.**

Pycnidia pseudostromatic, black, immersed, with several separate locules opening by separate or individual furfuraceous ostioles; conidiophores hyaline, branched, septate; conidia hyaline, nonseptate, cylindric with an evanescent apical mucilaginous appendage. (Fig. 25).

HOSTS: Conifers

DISEASE: Associated with cankers and dieback.

NOTES: Several undescribed *Ceuthospora* spp. are found on western conifers which are probably anamorphs of species of Phacidiales.

***Chlorociboria aeruginascens* (Nyl.) Kan. ex Ram., Korf & Bat.** Mycologia 49: 858 (1958).

SYNONYM: *Chlorosplenium aeruginascens* (Nyl.) Karst.

Apothecia superficial, solitary or gregarious, sometimes clustered on a stromatic mass, stipitate, cupulate to infundibuliform, bluish-green, hymenium concolorous or orange-yellow, up to 7 mm in diameter, ectal excipulum of gelatinized *textura intricata*, giving rise to coiled or straight tomentum hyphae. Ascii cylindric-clavate with long, tapering stalk, (40)50-65(75) × 3-4(5) µm, J+, 8-spored. Ascospores elliptic to fusiform, nonseptate, hyaline to light green, bipolar guttules,



Fig. 26. *Claussenomyces pseudotsugae*. Apothecia on cut end of Douglas-fir log.

5-7(10) × 1-1.5(2.4) um.

HOSTS: On decorticated wood of many kinds, characteristically stained deep blue-green.

Cladosporium resinae (Lindau) de Vries Ant. v. Leeuw. 21: 166 (1955).

TELEOMORPH: *Amorphotheca resinae* Parberry

Conidiophores paniculate, erect, several times branched well toward the apex, smooth or verrucose, septate, extremely variable in length (up to 2000 um), 2-4 um wide, thick-walled, brown. Conidia blastospores, catenate, chains of up to 20 conidia sometimes branched, aseptate, ellipsoid, brown to olive, 24 × 3-12 um.

Ascocarps dark brown to black, subglobose, 50-110 × 40-90 um, peridium membrane 5-20 um thick, uneven in thickness, ostiole absent. Asci subglobose to pyriform, up to 8-spored, lysing at maturity, 12-27 × 10-15 um. Ascospores aseptate, ellipsoid to naviculoid, hyaline to light brown, rarely dark, often biguttulate, inner wall constricted, commonly 8 × 4 um.

HOSTS: *Picea*

NOTES: On resin exudates of *Picea sitchensis* and possibly other conifers. This is the notorious "Kerosene fungus" that is able to grow in aircraft jet fuel.

Claussenomyces pseudotsugae (Groves) Ouellette & Pirozynski Can. J. Botany 52: 1909 (1974).

Apothecia black, circular to undulate, erumpent, separate or caespitose, ionomidototic, sometimes greenish pulverulent, 1-4 mm diameter, hard when dry, cartilaginous when moist; hymenium black, plane, marginate. Apothecial tissue of interwoven hyphae (plectenchyma), gelatinized, brownish, walls thicker and darker in

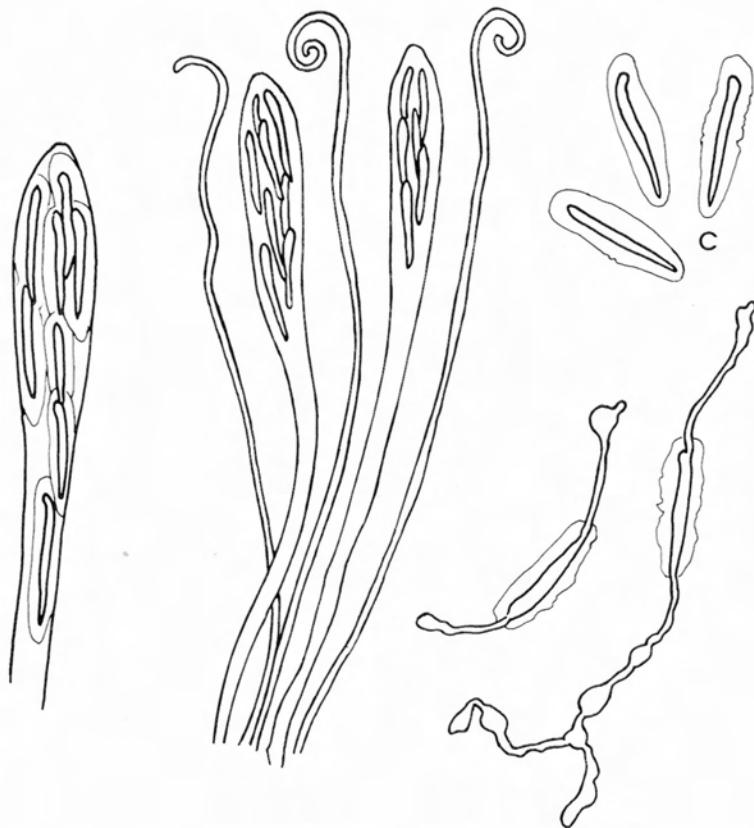


Fig. 27. *Cocomyces heterophyllae*. Ascii, paraphyses and ascospores.

the ectal excipulum. Ascii cylindric, at first 8-spored, becoming multisporous, $175-260 \times 18-25$ um. Primary ascospores hyaline, ellipsoid-fusiform, multiseptate to muriform, $15-25 \times 4-6$ um. Secondary ascospores (ultimate cells) form directly from ascospore on "tiny phialide-like filaments", hyaline, continuous, cylindric to allantoid, $2-4 \times 1-1.5$ um. Paraphyses hyaline, filiform, septate, simple or branched, tips exceeding the ascii and forming a brownish, gelatinous epithecium. (Fig. 26).

HOST: *Pseudotsuga menziesii*

NOTES: Isolated from sapwood of Douglas-fir where it may cause green stain (Funk 1967a); also fruiting on bark and on cut ends of logs.

***Cocomyces heterophyllae* Funk** Can. J. Botany 45: 2263 (1967).

Apothecia erumpent, then epicortical, solitary, gregarious, sessile, circular to polyhedral, black, 0.5-1.1 mm diameter, 0.2 mm high; hymenium pale yellow; ex-

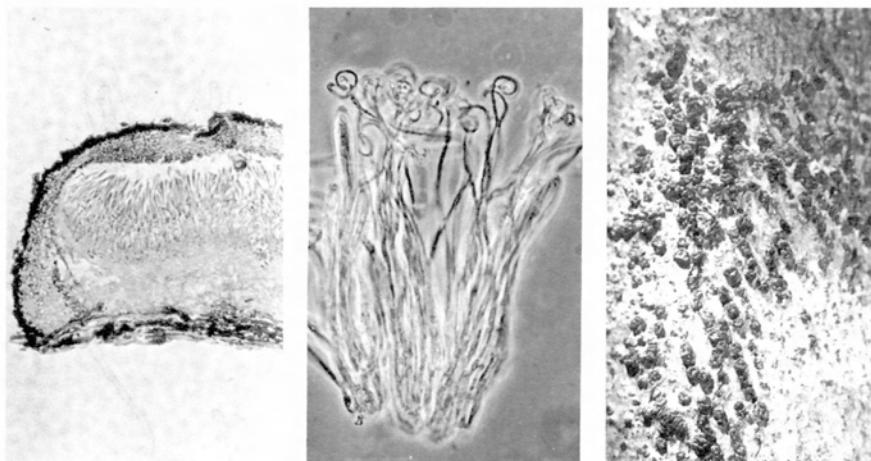


Fig. 28. *Cocomyces heterophyllae*. Apothecium.

cipulum black, crustose, opening by irregular, radiating splits to expose the hymenium. Ascii clavate, 8-spored, long-stalked, acutely rounded at the apex, 75-140 × 8-10 um. Paraphyses hyaline, filiform, recurved or coiled at the tips, not agglutinated above. Ascospores hyaline, nonseptate, filiform-clavate, broadest at the upper end and slightly hooked, with a mucilaginous sheath 3-4 um thick, 19-27 × 1.5-2 um. (Figs. 27, 28).

HOST: *Tsuga heterophylla*

DISEASE: Associated with dieback of suppressed western hemlock seedlings; secondary invader of trees attacked by other fungi.

***Cocomyces pseudotsugae* Funk** Can. J. Botany 53: 2297 (1975).

Apothecia sessile, solitary, gregarious, angular, black, 0.6-1.2 mm diameter; hymenium pale brown; excipulum black, crustose, opening by irregular, radiating splits to expose the hymenium. Ascii clavate, 8-spored, long-stalked, acutely rounded



Fig. 29. *Cocomyces pseudotsugae*. Apothecium, ascus and paraphysis.



Fig. 30. *Colpoma crispum*. Ascocarps on hemlock branch.

at the apex, $125-200 \times 8-10$ um. Ascospores hyaline, filiform-clavate, nonseptate, slightly curved, with a mucilaginous sheath, $35-43 \times 2-3$ um. Paraphyses hyaline, septate, filiform, partly recurved and nodose at the tips. (Fig. 29).

HOST: *Pseudotsuga menziesii*

DISEASE: Associated with leader dieback of young Douglas-fir saplings.

***Colpoma crispum* (Pers. ex Fr.) Sacc.** Syll. Fung. 9: 1127 (1891).

Ascocarps elongated, vermiform, often curved, subperidermal or breaking through, opening by a long slit, covering layer and base well developed, black, subhymenium hyaline, $3-5 \times 0.5-1.0$ mm. Ascii clavate with a narrow basal stalk, 8-spored, $90-110 \times 8-9$ um. Ascospores nonseptate, hyaline, filiform, sheathed in mucous, occupying upper portion of ascus, $30-45 \times 1.5-2$ um. Paraphyses slender, slightly recurved, abundant. (Fig. 30).

HOSTS: *Tsuga heterophylla*, *Pseudotsuga menziesii*, *Pinus monticola*

NOTES: Ascospores in some collections measure only 24-28 um long and possibly represent an undescribed subspecies.

***Cryptodiaporthe salicella* (Fr.) Petr.** Ann. Myc. 19: 180 (1921).ANAMORPH: *Discella salicis* (Westend.) Boerema

Perithecia immersed, single or in small clusters, globose, black, approx. 350 um wide; ostioles erumpent, black. Ascii clavate, 8-spored, 50 × 12 um. Ascospores hyaline, 2-celled, slightly constricted at the septum, 15-22 × 2-3 um. No blackened zone around the perithecia; small grayish stroma present around the ostioles.

Pycnidia black, globose at first, later discoid, 0.5-1 mm diameter. Conidia hyaline, fusoid, 2-celled, 13-18 × 3.5-5 um.

HOSTS: *Alnus*, *Acer*, *Populus*, *Salix*

DISEASE: The cause of branch cankers. Rare.

NOTES: *Cryptodiaporthe salicina* (Curr.) Wehm. is similar to the above but differs in its larger ascii (66-74 × 15-16 um) and ascospores (15-20 × 5-7 um). It is the cause of a canker disease of *Salix* (Bier 1959).

***Cryptomyces maximus* (Fr.) Rehm** Rab. Krypt. F1. I/3: 107 (1888).

Stroma forming beneath the bark of small branches, splitting the bark in blistered patches up to 10 cm long, shiny black outside, white within, hymenium yellowish brown. Ascii cylindric-clavate, 250 × 33 um, 8-spored. Ascospores ovoid to ellipsoid, hyaline or yellowish, with thin gelatinous coating, unicellular, 20-30 × 10-13 um. Paraphyses numerous, tips united in a brown, gelatinous matrix.

HOSTS: *Salix* spp.

DISEASE: Parasitizes willow branches leaving extensive scars, but not always killing the branches. Long black cushions produced in the bark give a blistered appearance to the branches.

***Cryptosphaeria populin*a (Pers.) Sacc.** Syll. Fung. 1: 183 (1882).ANAMORPH: *Libertella* (in culture)

Entostroma effuse, not erumpent through periderm, a faint grayish dorsal zone just beneath the periderm, and a stout black ventral zone deep in the bark, up to several cm broad, sometimes confluent. Perithecia growing densely near the periderm, subspheric, approx. 400 um diameter; ostioles separately erumpent through the periderm, straight, black, rough, 250 um thick; peridium 30-35 um thick, dark brown outside, almost hyaline inside, filled with hyaline to light brown periphyses. Ascii long-stipitate, 35-45 × 5-8 um in the spore bearing section, up to 95 um long including the stalk, with a small apical ring. Ascospores yellowish, allantoid, 8-12 × 2-3 um (Fig. 31).

Conidial state produced in culture; small, dark pycnidia with a wide open cavity bearing large numbers of hyaline, filiform, strongly curved conidia, 15 × 1 um. (Fig. 31).

HOST: *Populus tremuloides*, *Populus* spp.

DISEASE: This fungus has been isolated frequently from red stain of heartwood of aspen and incipient decay of aspen (Basham 1958a; Etheridge 1961). It appears to move out of the wood into the bark, killing large areas and fruiting abundantly beneath the periderm, which becomes loosened. Mortality of trees is attributed to these extensive cankers (Hinds and Laurent 1978).

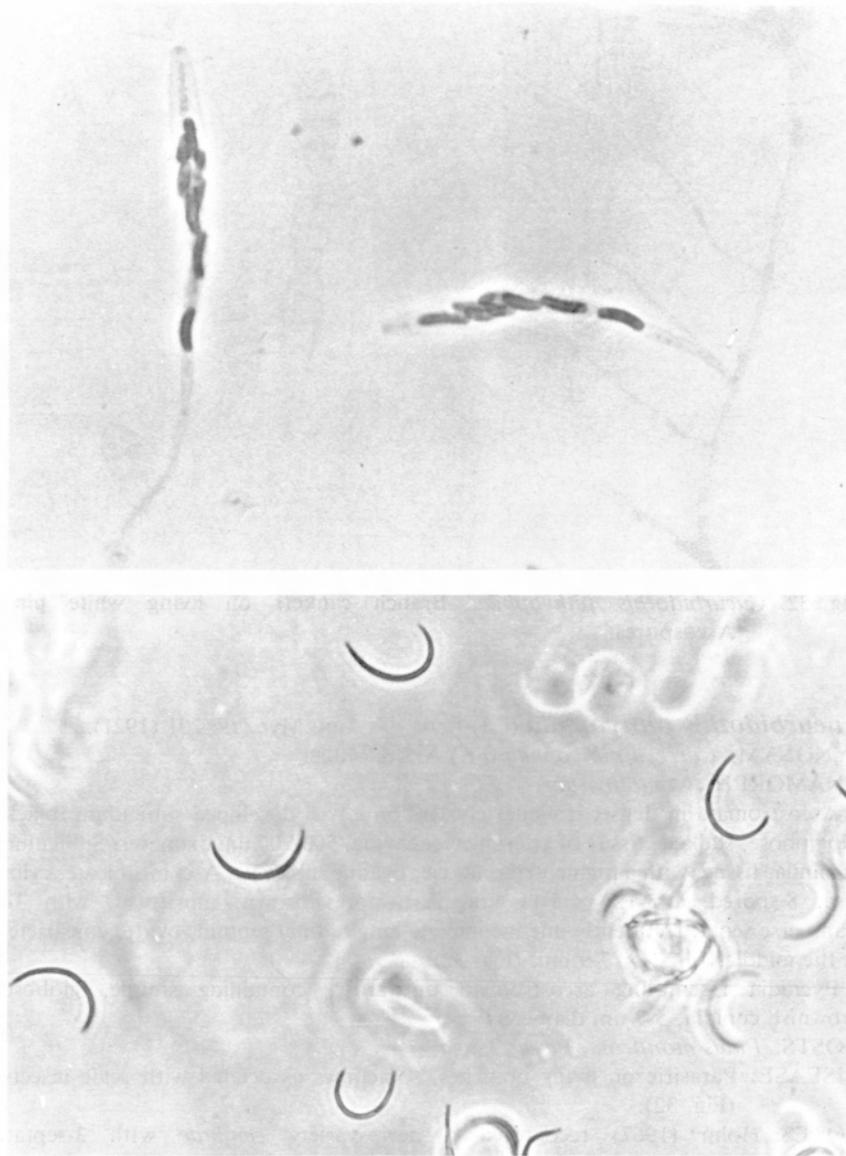


Fig. 31. *Cryptosphaeria populina*. Ascus with ascospores. *Libertella* anamorph, conidia from culture.

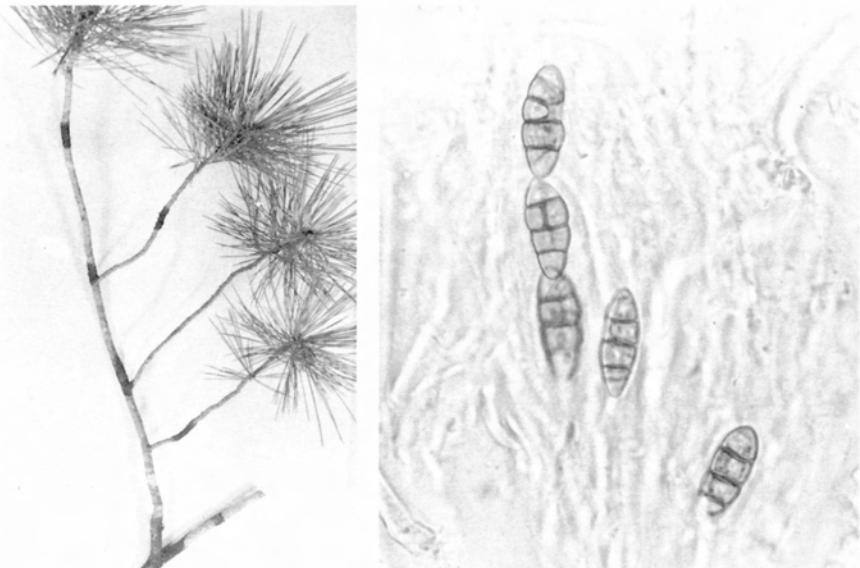


Fig. 32. *Cucurbitothis pithyophila*. Branch cankers on living white pine.
Ascospores.

***Cucurbitothis pithyophila* (Fr.) Petr.** Ann. Myc. 19: 201 (1921).

SYNONYM: *Curreya pithyophila* (Fr.) Arx & Müller

ANAMORPH: *Coniothyrium*

Ascostromata in dense, irregular clusters on a well developed subiculum, black, subglobose, stalked, tissue of scleroplectenchyma, 500-700 um diameter. Subiculum of similar tissue, with a pigmented rind over hyaline subtissue. Asci bitunicate, cylindric, 8-spored, 105-120 × 8-11 um. Ascospores brown, muriform, with 3-5 transverse septa, frequently one incomplete longitudinal septum, ovate, constricted at the middle, 16-22 × 7-9 um. (Fig. 32).

Pycnidia resembling ascostromata outwardly, containing simple, globose, brownish conidia, 5-7 um diameter.

HOSTS: *Pinus monticola*, *Picea*, *Tsuga*

DISEASE: Parasitic on living branches, sometimes associated with scale insects. (Fig. 32).

NOTES: Holm (1967) recognized a new variety *cembrae* with 3-septate phragmospores.

***Cucurbitaria staphula* Dearn. ex Arnold & Russell** Mycologia 52: 501 (1960).

ANAMORPH: *Pseudodichomera*

Stromata turbinata to subglobose, black, roughened, arising from a basal layer closely attached to host, tissue pseudoparenchymatous, darkly pigmented.

Ascigerous locules 335-470 × 165-300 um diameter. Ascii clavate, bitunicate, short-stipitate, 144-240 × 18-25 um. Ascospores brown, muriform, ovate to subclavate, 3-7-septate, constricted strongly at central septum and slightly at others, 27-48 × 12-16 um. Pseudoparaphyses filiform, branching, septate.

Pseudodichomera conidial state also present on host: stromata uni- or multiloculate, single or clustered on basal stroma, frequently erumpent at margin of the host gall. Locules 100-300 × 75-300 um, lined with short hyaline conidiophores. Conidia brown, muriform, subglobose to oblong, 12-16 × 8-10 um.

HOSTS: *Populus* spp.

DISEASE: On galls and rough-bark of aspen, black cottonwood, and balsam poplar produced by *Diplodia tumefaciens* (q.v.).

Cylindrocarpon destructans (Zins.) Scholten Neth. J. Plant Path. 70: 9 (1964).

TELEOMORPH: *Nectria radicicola* Gerl. & Nils.

Sporodochia white, erumpent, variable in size and shape. Conidiophores formed as lateral branches of the mycelium with elongate stem and loosely branched apex, each branch terminating in one or more phialides, 22-35 × 3.5-4.5 um. Conidia cylindric with rounded ends, straight or curved, narrowing slightly toward the base, 1-3-septate, 30-40 × 5-6.5 um, rarely up to 5-septate and then 45-52 × 6.5-7.5 um. Microconidia oval to ellipsoid, 6-10 × 3.5-4 um.

HOST: *Pseudotsuga menziesii*

DISEASE: Causing decay of conifer seedlings.

NOTES: Widespread in forest soils, both pathogenic and saprophytic strains occur.

Delphinella abietis (Rostr.) E. Müller Beitr. Krypt. Schweiz 11: 26 (1962).

Ascostromata subepidermal, becoming erumpent, on shoots and needles, single or rarely aggregated, black, globose, pseudoparenchymatous, 150-200 um diameter. Asci cylindric-clavate, bitunicate, 50-90 × 18-22 um, multisporous (16-24), paraphysate. Ascospores ellipsoid, uniseptate, hyaline, 11-21 × 4-7 um.

Pycnidia resembling ascostromata, conidia fusiform, hyaline, aseptate, 10-16 × 4-7 um, produced from cells of inner wall.

HOST: *Abies lasiocarpa*

DISEASE: Parasitic on shoots and leaves of true firs, causing typical reddening of new growth.

NOTES: A closely related species, *Delphinella balsameae* (Waterm.) E. Müller, has much larger asci (80-140 × 33-41 um), and ascospores (30-50 × 7-12 um), and also occurs on alpine fir. This species was described and studied under the name *Rehmiellopsis* (Waterman 1945).

Delphinella is very similar to the genus *Sydiowia*, differing only in that *Sydiowia* may have muriform ascospores. Conidial states are also similar in the two genera, and referable to the genus *Sclerophoma*.

Dermea balsamea (Peck) Seaver Mycologia 24: 427 (1932).

ANAMORPH: *Foveostroma abietinum* (Peck) DiCosmo

Apothecia erumpent, gregarious, separate or caespitose, sessile, circular or un-



Fig. 33. *Dermea pseudotsugae*. Cankered stems of Douglas-fir with apothecia.

dulate, at first yellowish then black, hard, leathery when moistened, 1-2.5 mm diameter, tissue pseudoparenchymatous in the base, toward the outside becoming parallel-elongate cells. Ascii cylindric-clavate, stalked, 8-spored, 90-150 × 12-16 um. Ascospores ellipsoid-fusiform, hyaline, 1-3-septate, 20-35 × 6-10 um. Paraphyses hyaline, filiform, septate, branched, tips exceeding the asci and forming a yellowish epithecium.

Conidiomata erumpent, pulvinate, greenish yellow to black, 0.5-1.0 mm diameter, up to 0.6 mm high, basal tissue pseudoparenchymatous, becoming plectenchymatous toward the fertile region, irregularly loculate. Conidiophores tapered, lining locules, simple or branched, hyaline, 22-33 × 3-4 um. Conidiogenous cells phialidic, 10-15 × 2-3 um. Conidia blastic-phialidic, falcate to sigmoid or variously curved, hyaline to pale yellow, 0-3-septate, 60-90 × 3-4 um. Microconidia hyaline, filiform, curved, nonseptate, 11-22 × 1.5 um. (Fig. 56B).

HOSTS: *Abies lasiocarpa*, *Tsuga heterophylla*

DISEASE: Weakly parasitic, causing dieback of branches and leaders similar to "red-top" of balsam fir in Ontario (Raymond and Reid 1961), associated with the same fungus.

NOTES: It is chiefly the conidial state that is found in western trees, the *Dermea* state apparently very rare in most areas.

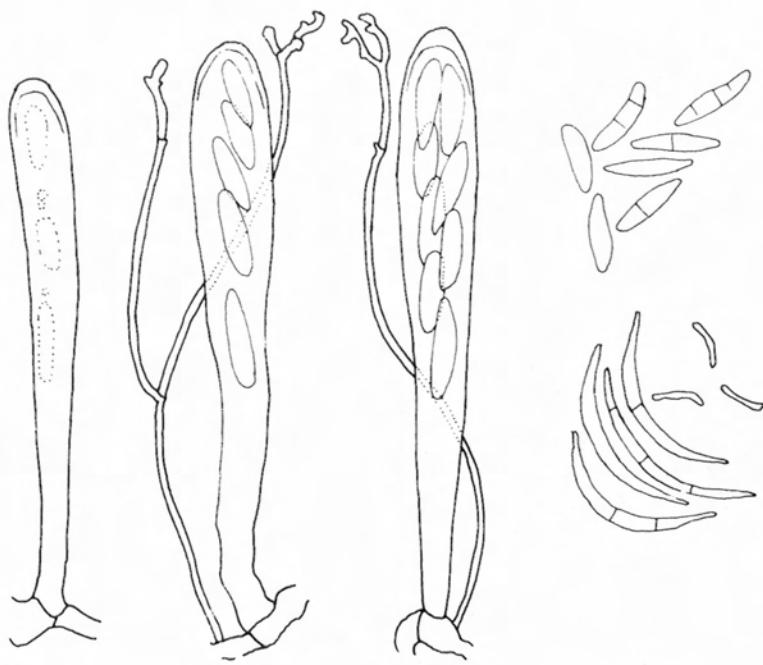


Fig. 34. *Dermea pseudotsugae*. Ascii, ascospores and conidia.

***Dermea pseudotsugae* Funk** Can. J. Botany 45: 1803 (1967).

ANAMORPH: *Foveostroma boycei* (Dearn.) Funk

Apothecia erumpent, separate, gregarious, sessile, circular or slightly undulate, 1.0-1.6 mm diameter, yellowish, blackish when dry; hymenium yellow or black, plane, marginate. Asci cylindric-clavate, 8-spored, 80-150 × 9-14 um. Ascospores ellipsoid, straight or slightly bent, hyaline, 0-3-septate, 16-28 × 4-7 um. Paraphyses hyaline, filiform, septate, simple or branched, slightly swollen at the tips, agglutinated above the asci to form an epithecium. (Figs. 33, 34).

Conidiomata immersed and erumpent, conic, yellowish, 0.3-1 mm diameter, fleshy, tearing open widely. Conidiophores simple or branched, 18-30 um long. Macroconidia sickle-shaped, hyaline to pale yellow, 0-3-septate, 42-56 × 3-4 um. Microconidia hyaline, filiform, variously bent, 8-14 × 1-2 um. (Fig. 56A).

HOSTS: *Pseudotsuga menziesii*, *Abies grandis*

DISEASE: Causes serious bark necrosis, cankering and dieback of immature trees, especially after early frosts (Funk 1967b) and summer drought (McMinn and Funk 1970). Serious damage to plantations and nursery seedlings may also occur (Miller 1972). (Fig. 33).

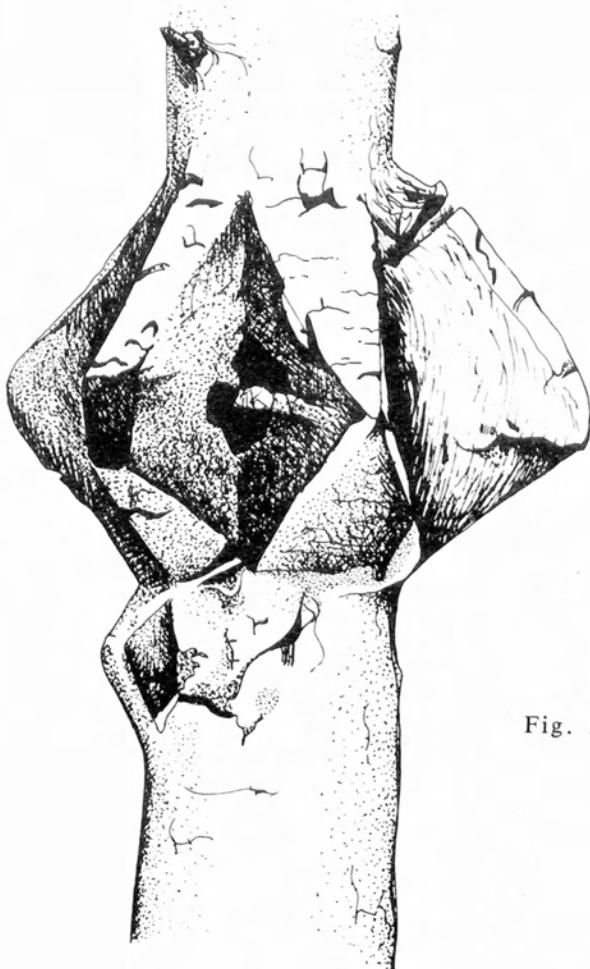


Fig. 35. *Dermea rhytidiformans*. Cork-bark on alpine fir.

Dermea rhytidiformans Funk & Kuijt Can. J. Botany 48: 1481 (1970).

ANAMORPH: *Gelatinosporium*

Apothecia dark brown, furfuraceous, stipitate, aggregated or single, superficial, round or slightly undulate, 0.8-1.0 mm diameter; hymenium dark brown, plane, marginate. Ascii cylindric-clavate, 8-spored, J-, 130-155 × 14-17 um. Ascospores ellipsoid to oval to irregular, light brown, nonseptate, 18-28 × 8-11 um. Paraphyses filiform, branched, agglutinated above the ascci to form a dark epithecium that is heavily encrusted with brown granules.

Conidiomata dark brown, columnar to globoid, single or aggregated, superficial, 0.2-0.6 mm diameter. Macroconidia sickle-shaped to fusoid, hyaline to light brown, 0-3-septate, 26-65 × 3-5 um, frequently with swollen cells. Microconidia hyaline, filiform, strongly curved, nonseptate, 10-22 × 1.5 um. (Fig. 36).

HOST: *Abies lasiocarpa*

DISEASE: Associated with the cork-bark disease of *Abies lasiocarpa* and found only on or near the corky ridges (Kuijt 1969). (Fig. 35).

Dermea tetrasperma Funk Can. J. Botany 54: 2853 (1976).

ANAMORPH: *Gelatinosporium lunasporum* (Linder) Funk

Apothecia erumpent, solitary, gregarious, sessile, black, coriaceous, ellipsoid to suborbicular, 0.5-1.5 mm diameter. Hymenium black, plane, without a margin. Ascii clavate, 4-spored, 78-95 × 8-10 um. Ascospores ellipsoid, biguttulate, hyaline, continuous, 14-17 × 4-6 um. Paraphyses hyaline, filiform, septate, branched, agglutinated above the ascii to form a dark epithecium.

Conidiomata erumpent, black, irregular, becoming shallow cup-shaped, 0.3-1.0 mm diameter. Conidiophores simple, cylindric, phialidic, 10-30 × 2-3 um. Macroconidia hyaline, falcate, continuous, 15-22 × 5-6 um. (Fig. 57B).

HOSTS: *Abies lasiocarpa*, *A. grandis*, *Larix occidentalis*, *Pseudotsuga menziesii*, *Pinus monticola*

DISEASE: Attacks weakened trees or branches, producing cankers or dieback. May also occur as a needle endophyte (Carroll and Carroll 1978).

Diaporthe eres Nitschke Pyren. Germ. 245 (1870).

ANAMORPH: *Phomopsis oblonga* (Desm.) Hoehn.

Perithecia in small clusters immersed in the bark, sometimes beneath old pycnidial stroma, globose, 200-500 um diameter. Necks black, cylindric, up to 800 um long, collectively erumpent through the black dorsal zone. Black ventral zone widespread into the wood, may envelop several perithecial pustules. Ascii cylindric-clavate, with apical ring in the thickened tip, 40-60 × 8 um, 8-spored. Ascospores biseriate, ellipsoid-fusiform, hyaline, 1-septate with slight constriction, 9-15 × 3-4 um.

Pycnidial stroma immersed then erumpent, conical, 1-2 mm diameter, with single lysigenous ostiole. Conidiophores hyaline, subulate, simple, 5-10 um long, phialidic. Conidia of two types: A-conidia elliptic-fusoid, hyaline, nonseptate, 5-11 × 2-4 um; B-conidia filiform, straight or curved, hyaline, nonseptate, 25-33 × 1 um.

HOSTS: *Acer*, *Populus*, *Salix*

NOTES: Chiefly saprobic, sometimes associated with dieback in hardwoods. Requires dead tissues from which to invade living bark.

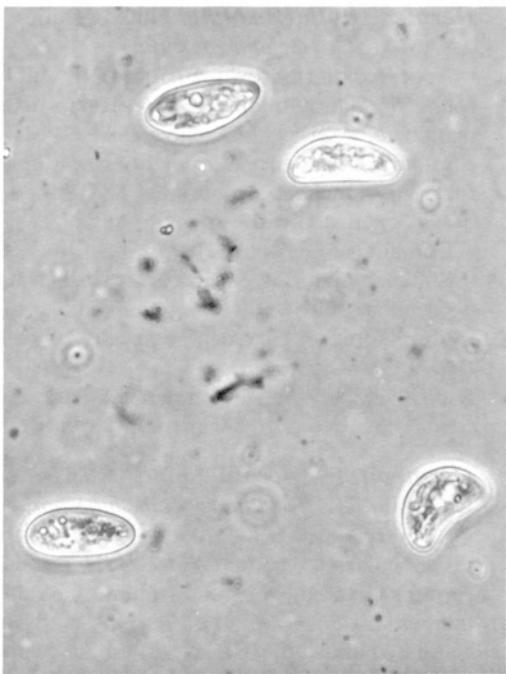
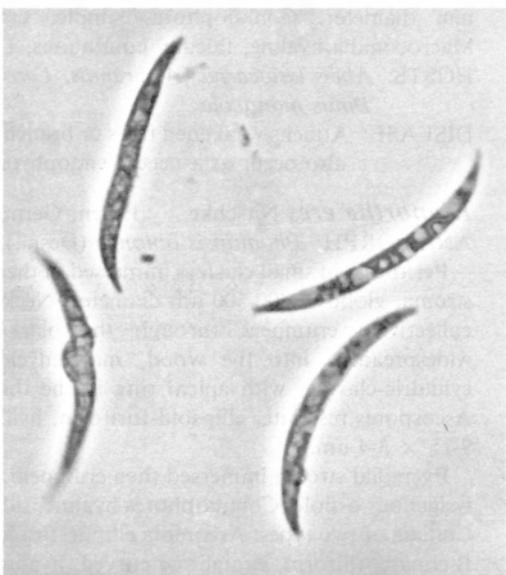


Fig. 36. *Dermea rhytidiformans*.
Ascospores, asci and
conidia.



Diaporthe lokoyae Funk Can. J. Botany 46: 601 (1968).

ANAMORPH: *Phomopsis lokoyae* Hahn

Perithecia gregarious in clusters of 2-4, immersed in entostromatic area of the bark, black, subglobose, 300-400 μm diameter; ostioles cylindric, 100-270 μm long, joined in a small stromatic disc, beaks slightly exserted; ventral surface of entostroma definitely delimited by a black zone in the bark dipping almost to the wood surface. Asci cylindric, 8-spored, 36-68 \times 7-12 μm , with refractive ring in the apex. Ascospores cylindric-ellipsoid, constricted at the single septum, each cell biguttulate and appendaged, hyaline, 10-16 \times 2.5-4.5 μm . Paraphyses broad and tapering, up to 200 μm long, 8-10 μm wide at the base, 3-4 μm wide at the rounded tip, hyaline, simple or branched, septate. (Figs. 37, 38).

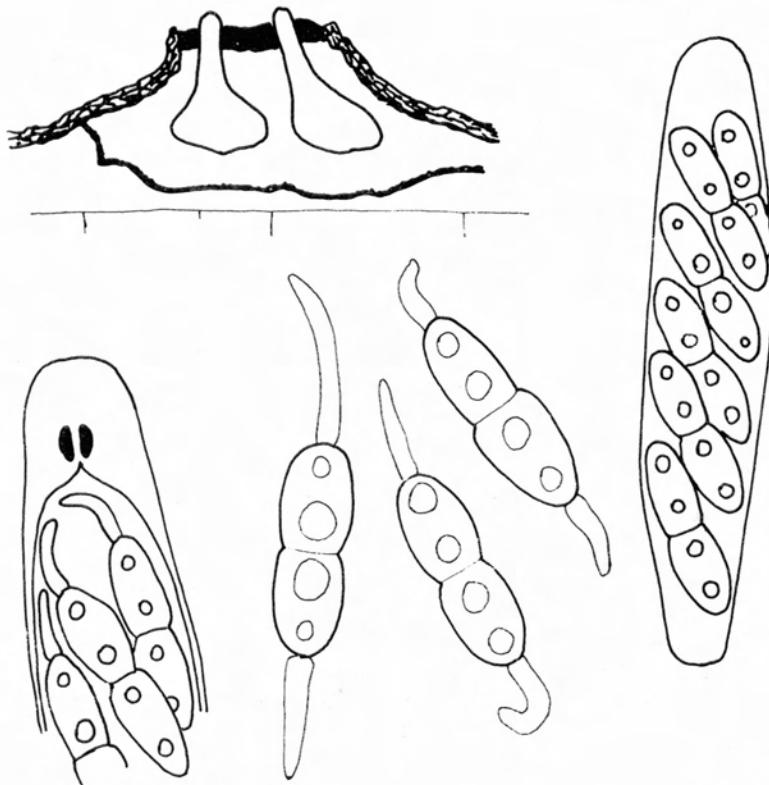


Fig. 37. *Diaporthe lokoyae*. Perithecia, ascospores.

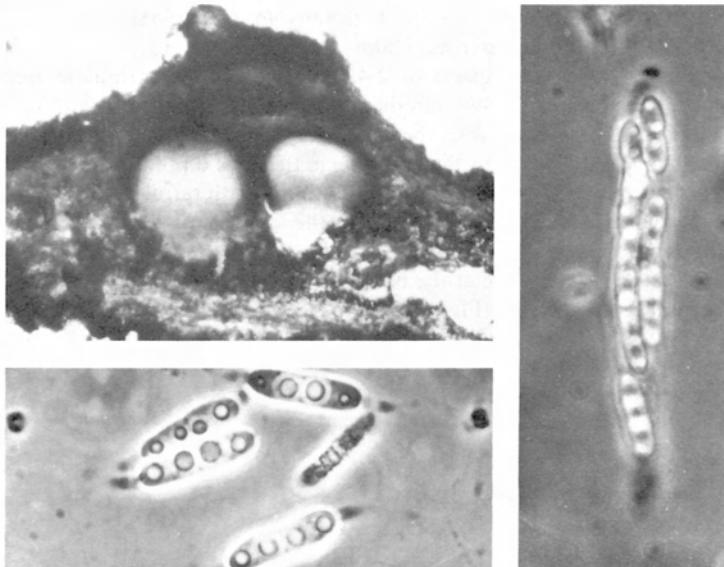


Fig. 38. *Diaporthe lokoyae*. Perithecia. Ascus. Ascospores.

Pycnidia erumpent, black, lenticular to subglobose, 300-600 μm in diameter, 200-300 μm high. Conidiophores lining the single locule, flexuous, subulate, 5-20 μm long; conidiogenous cells phialidic. Conidia of 2 types: A-spores hyaline, elliptic-fusoid (irregular), nonseptate, biguttulate, 6-10 \times 2-4 μm ; B-spores hyaline, elongate-fusiform, nonseptate, minutely guttulate, 10-12 \times 1.5-2.5 μm (Fig. 93). HOSTS: *Pseudotsuga menziesii*, occasionally on *Tsuga heterophylla* and *Thuja plicata*

DISEASE: Causes annual stem cankers and a limited dieback of Douglas-fir, usually after stress by drought or frost (Hahn 1933). Major epidemics in coastal nurseries in California have also been reported (Bega 1978). (Fig. 39).

NOTES: *Phomopsis occulta* Trav. (teleomorph: *Diaporthe conorum* (Desm.) Niessl. synonyms: *D. occulta* (Fckl.) Nits., *D. pitya* Sacc.) is a common saprophyte on many conifers. It has been isolated from Douglas-fir seedlings in British Columbia. The A-conidia are oblong-ellipsoid 6-9 \times 2-3 μm ; B-conidia are curved, filiform, 20-30 \times 1 μm ; and there are conidia intermediate in shape and size.

***Dichomera gemmicola* Funk & Sutton** Can. J. Botany 50: 1514 (1972).

Pycnidia stromatic, unilocular or multilocular, black or dark brown, each locule with a papillate ostiole, outer wall of dark brown to medium brown pseudoparenchyma, inner layer hyaline, thin-walled; unilocular pycnidia 350 μm by 450 μm high,

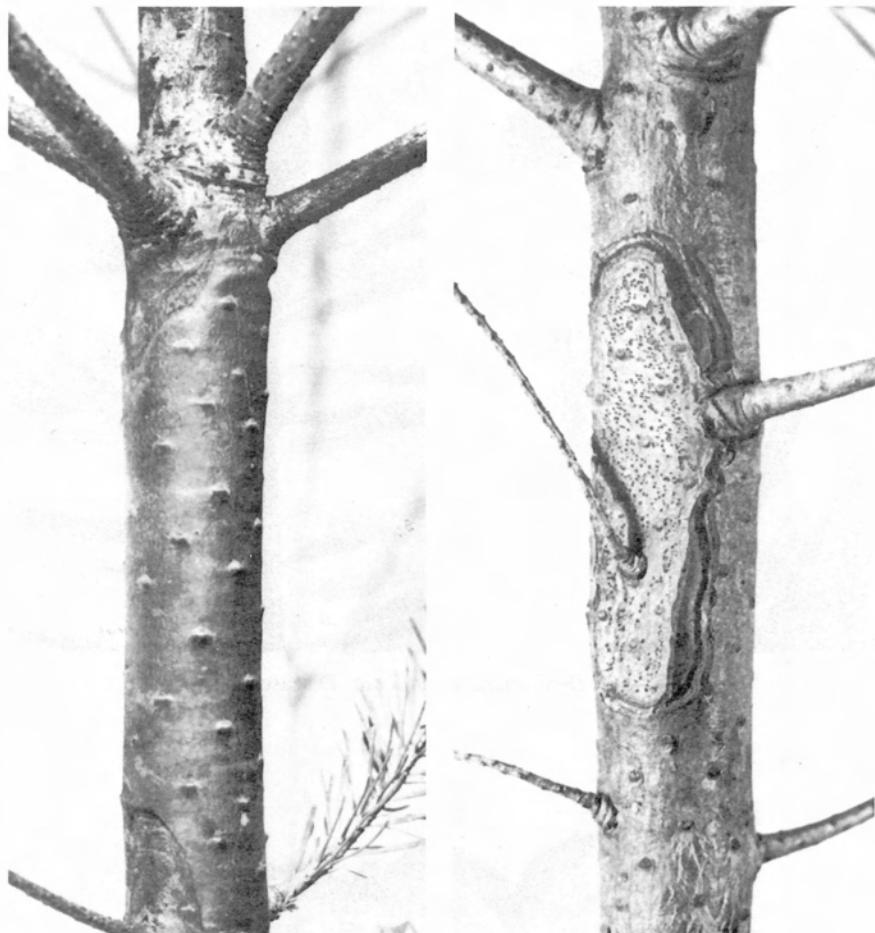


Fig. 39. *Diaporthe lokoyae*. Dieback and cankers on Douglas-fir.

multilocular pycnidia proportionately larger. Conidiogenous cells holoblastic, annellidic, ampulliform to short-cylindric, unbranched, $8-11 \times 5-7$ um, produced all around stromatal cavities. Conidia blastospores, produced singly from apex of conidiophore, pale brown, muriform, with 11-17 transverse septa, most cells with several longitudinal septa, cylindric, curved, $70-85 \times 12-17$ um. (Fig. 41).

HOSTS: *Pseudotsuga menziesii*, *Picea sitchensis*, *P. glauca*, *P. engelmannii*

DISEASE: Causing bud necrosis of *Pseudotsuga* and *Picea*, resulting in deformation, or death of the tree in severe cases. (Fig. 40).



Fig. 40. *Dichomera gemmicola*. Diseased buds.



Fig. 41. *Dichomera gemmicola*. Pycnidia.



Fig. 42. *Didymosphaeria oregonensis*. Canker on alder.

Didymosphaeria oregonensis Gooodding Phytopathology 21: 916 (1931).

Pseudothecia black, globose, ostiolate, pseudoparenchymatous, 1 mm diameter, immersed, single. Ascii bitunicate, cylindric-clavate, 8-spored, 75-90 um long. Ascospores greenish, ellipsoid, 1-septate, 18-21 × 7-9 um. Pseudoparaphyses filiform, branched, septate.

HOSTS: *Alnus* spp.

DISEASE: Parasitic on living stems and branches of young trees. Causing bands of rough bark that encircle the stem, sometimes producing swollen, spindle-shaped cankers. (Fig. 42).



Fig. 43. *Diplodia pinea*. Conidia.

Diplodia pinea (Desm.) Kickx Fl. Flandres I: 397 (1867).

Pycnidia black, ovoid, immersed then erumpent, solitary or gregarious, with apical ostioles; pycnidial wall thickened around the top, 0.5 mm diameter. Conidiophores simple, subulate, about half as long as the conidia. Conidia (blastoconidia) yellow to dark brown, wall roughened, oblong to clavate, apex rounded, base blunt, aseptate to tardily 1-septate, 30-45 × 10-16 um. (Fig. 43).

HOSTS: *Pinus* spp. chiefly, but also many other conifers

DISEASE: On bark, shoots and leaves of *Pinus*. Rare in western Canada, but universal on various conifers, causing moderate to serious dieback and cankering of bark. Crown wilt, shoot blight and bluestain also attributed to this fungus. In nurseries, young seedlings may be killed.

Diplodia tumefaciens (Shear) Zalasky Can. J. Botany 42: 1050 (1964).

SYNONYM: *Macrophoma tumefaciens* Shear

TELEOMORPH: *Keissleriella emergens* (Karst.) Bose

Pycnidia dark violet to black, immersed in hypertrophied tissue, occasionally erumpent, papillate, irregular to subglobose, caespitose or solitary, with distinct inner and outer walls of pseudoparenchyma, 250-450 um in diameter, occasionally confluent, then to 650 um. Conidia oblong, ellipsoid, sometimes irregular or inequilateral, with a basal scar and marginal frill, hyaline to yellowish, (20)28-40(50) × (6)9-15(18) um, usually continuous, rarely 1-2-septate, contents granular. Sporogenous cells annellophores, hyaline, subulate, mostly simple and nonseptate, 10-40 um long. (Fig. 45).

HOSTS: *Populus* spp.



Fig. 44. *Diplodia tumefaciens*. Galls produced on poplar branches.

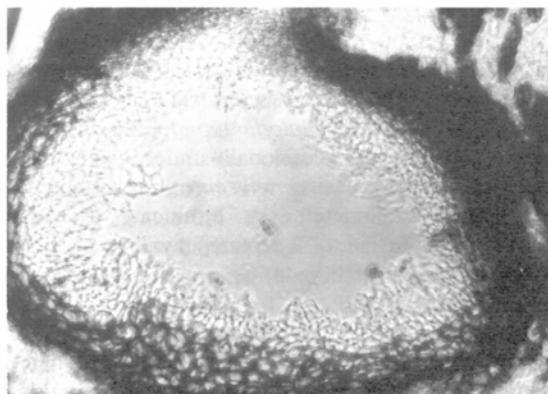


Fig. 45. *Diplodia tumefaciens*. Pycnidium, vertical section.

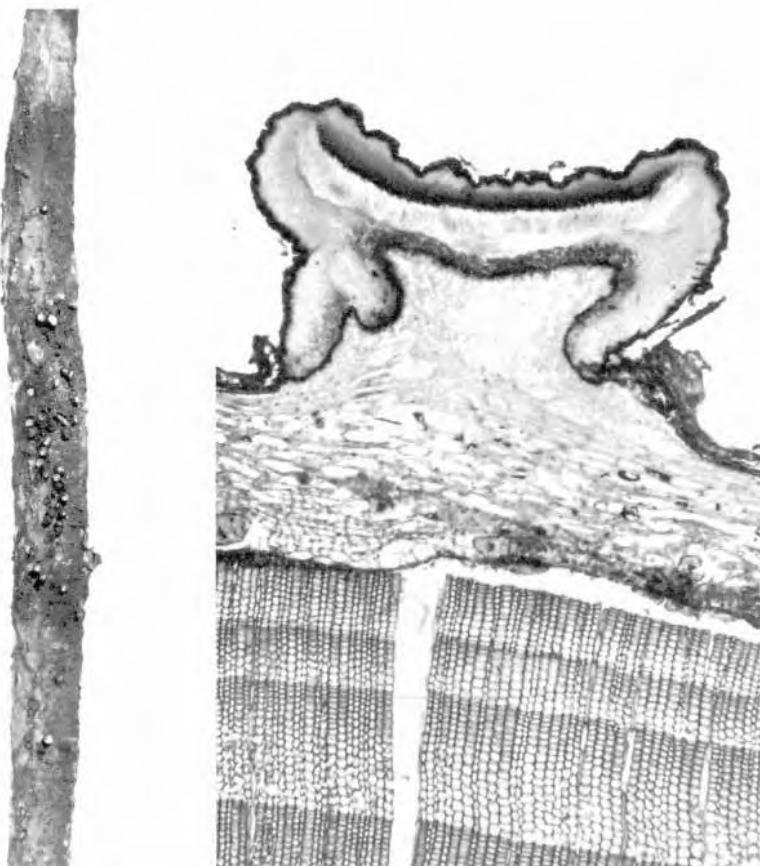


Fig. 46. *Discocainia treleasei*. Apothecia on cankered stem. Apothecium, vertical section.

DISEASE: Causing hypertrophy on branches and stems of poplars. Frequently associated with *Cucurbitaria staphula* and its *Pseudodichomera* conidial state in the galls. The ascigerous state of *Diplodia tumefaciens* rarely, if ever, occurs on above ground galls, but occasionally under moist conditions in diseased roots (Zalasky 1974); *Keissleriella emergens* has conical pseudothecia up to 380 um diameter; the bitunicate asci are 65-85 × 9-12 um; ascospores fusoid, 1-3-septate, hyaline to light brown, 20-27 × 4-5 um (Bose 1961). (Fig. 44).

Discocainia treleasei (Sacc.) J. Reid & Funk Mycologia 58: 432 (1966).

Apothecia erumpent, single or clustered, up to 4 mm diameter and 1.5 mm high, circular, black, narrowed below, opening by irregular tearing of the excipulum

overlying the hymenium. Hymenium light yellow. Medullary excipulum composed of *textura intricata*, the basal portion delimited by a band of dark, thick-walled hyphae. Ectal excipulum of dark, thick-walled *textura globulosa*. Ascii clavate, acutely rounded at the tip, J-, 100-140 × 5-10 um, 8-spored, unitunicate. Ascospores filiform-clavate, broadest near upper end, straight to slightly curved, hyaline, 35-60 × 1.5-2.5 um. Paraphyses filiform, coiled at the tips, simple or branched at the tips, extending above the ascci to form an epithecium. (Fig. 46).

HOSTS: *Picea sitchensis*, *Tsuga heterophylla*

DISEASE: Causes perennial stem and branch cankers that are characterized by a fusiform swelling of the wood. May colonize entire stem after death of the tree. Appears to invade wood and cause limited decay (Reid and Funk 1966). Invades dwarf mistletoe swellings in western hemlock (Funk and Baranyay 1973).

***Dothidea sambuci* Fr.** Syst. Myc. 2: 551 (1823).

Ascostromata gregarious, erumpent, pulvinate, black, approx. 1 mm long, multiloculate. Ascii bitunicate, cylindric-clavate, 8-spored, 95 × 15 um. Ascospores olive-brown, ovate, 1-septate, upper cell larger, biseriate, 19-21 × 8-9 um.

HOST: *Acer negundo*

DISEASE: Associated with branch dieback.

***Dothiora polyspora* Shear & Davidson** Mycologia 32: 105 (1940).

SYNONYM: *Sydotia dothideoides* Dearn. & Barth.

Ascostromata erumpent, depressed-pulvinate, circular to irregular in outline, gregarious, smooth, black, unilocular or occasionally multilocular, astomous. Ascii polysporous, bitunicate, cylindric-clavate, 90-115 × 12-15 um. Paraphyses absent. Ascospores hyaline, muriform (3 transverse septa and 1 or 2 longitudinal septa in upper cells), clavate, constricted, 15-18 × 5-6 um. In culture *Hormonema*.

HOSTS: *Populus tremuloides*, *Salix*

DISEASE: Tip dieback and branch cankers.

NOTES: The genera *Dothiora* and *Sydotia* are distinguished chiefly on the basis of ascospore septation (Arx and Müller 1975) but muriform septation appears in both genera (Smerlis 1970).

***Durandiella pseudotsugae* Funk** Can. J. Botany 40: 332 (1962).

ANAMORPH: *Corniculariella pseudotsugae* (W.L. White) DiCosmo

Apothecia erumpent, gregarious on a common stroma, stalked, circular, 0.3-0.7 mm diameter, tissue plectenchymatous. Ascii cylindric-clavate, short-stipitate, 8-spored, J-, 105-150 × 10-13 um. Ascospores hyaline, fusiform, 0-3-septate, 45-95 × 2.5-3.5 um. Paraphyses hyaline, filiform, branched, agglutinated at the apex to form a dark epithecium. (Fig. 48).

Conidiomata erumpent, solitary or gregarious, sometimes on same stroma as the apothecia, subcylindrical, tapering toward the apex, 1-1.5 mm high, ostiolate, of densely packed plectenchyma. Locule confined to upper half of conidioma, lined with conidiophores. Conidiophores hyaline, simple or branched, septate, 20-30 × 3 um. Conidiogenous cells phialidic, sometimes proliferating percurrently,



Fig. 47. *Durandiella pseudotsugae*.
Circular stem cankers on
Douglas-fir.

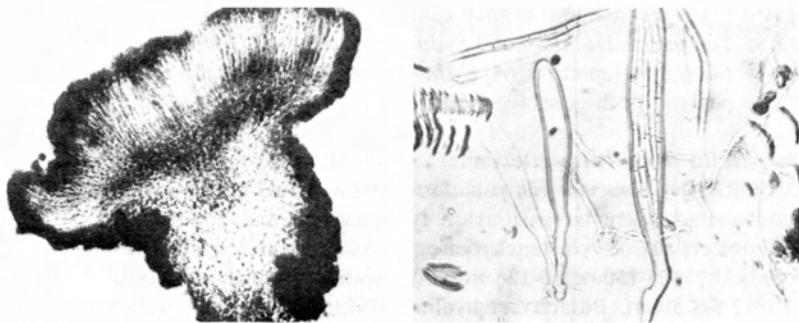


Fig. 48. *Durandiella pseudotsugae*. Apothecium. Ascii.

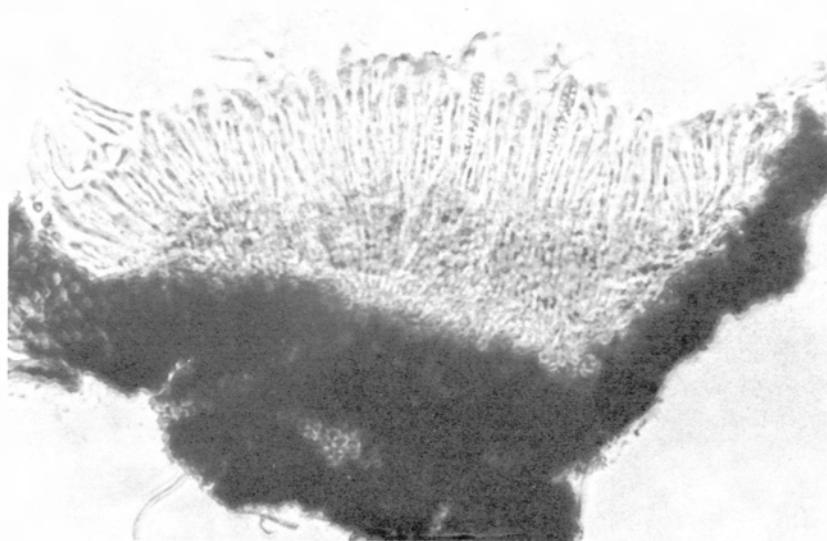


Fig. 49. *Durandiella tsugae*. Apothecium, vertical section.

$10-25 \times 2-3$ um. Conidia blastic-phialidic, falcate to crescentic, 1-3-septate, hyaline, guttulate, $40-60 \times 3.5-4.5$ um.

HOST: *Pseudotsuga menziesii*

DISEASE: Causes small, superficial, perennial cankers on stem and branches. Cork proliferation under the cankers usually causes a circular button of bark to erupt with the fruiting bodies produced in the center (Funk 1962). (Fig. 47).

***Durandiella tsugae* Baranyay Can. J. Botany 44: 599 (1966).**

Apothecia erumpent, usually clustered on a stromatic base with up to 15 in a cluster, a ridge-like collar below the cluster, black, circular to undulate, 0.8-1.0 mm diameter, hymenium black to grayish, marginate. Tissue of stroma and excipulum plectenchymatous, brown to subhyaline, ascending interwoven hyphae, hypothecium yellowish, compact. Ascii cylindric-clavate, short-stalked, J-, 8-spored, $70-100 \times 6-9$ um. Ascospores hyaline, fusiform, pointed or obtuse, straight to slightly curved, 2-8-celled, $16-27 \times 2-3.5$ um. Paraphyses hyaline, filiform, septate, simple, tips slightly swollen and embedded in a gelatinous matrix, forming a dark epithecium. (Figs. 49, 50).

HOST: *Tsuga heterophylla*

DISEASE: Found in cankered dwarf mistletoe swellings of western hemlock (Baranyay 1966) and also on other diseased specimens.



Fig. 50. *Durandiella tsugae*. Cluster of apothecia.



Fig. 51. *Encoelia furfuracea*.
Apothecia on bark.

Encoelia furfuracea (Roth ex Pers.) Karst. Not. Sallsk. Fauna Flora Fenn. 11: 253 (1870).

Apothecia erumpent in caespitose clusters of three to six, or singly, at first entirely closed, then opening irregularly, margin inrolled, covered with a rusty-colored meal, up to 1.5 cm diameter, hymenium drying black. Asci cylindric-clavate, 8-spored, J+, 80-120 × 6-7 um. Ascospores ellipsoid to allantoid, hyaline, biguttulate, 8-10 × 2-4 um. Paraphyses filiform, slightly swollen at the tips. (Fig. 51).

HOST: *Alnus rubra*

DISEASE: Parasitic on living branches.

Encoeliopsis laricina (Ettl.) Groves Can. J. Botany 47: 1324 (1969).

ANAMORPH: *Brunchorstia laricina* Ettl.

Apothecia dark brown to black, erumpent, gregarious to scattered, sessile to substipitate, at first subglobose becoming disc-shaped, inrolled when dry, 0.5-1.0 mm in diameter, 0.3-0.5 mm high, hard and brittle when dry, becoming coriaceous-waxy when moist. Ectal excipulum of dark brown *textura angularis*, medullary excipulum of brownish *textura epidermoidea*, hypothecium of hyaline interwoven hyphae. Asci cylindric-clavate, with a slender stalk, 8-spored, J-, 85-115 × 7-10 um. Ascospores hyaline, ellipsoid to subfusiform, 1-septate, 10-22 × 3-5 um. Paraphyses hyaline, filiform, septate, tips slightly swollen, not forming an epithecium. (Fig. 52).

Pycnidia black, subglobose, slightly flattened above, 0.3-0.8 mm in diameter, tearing open irregularly. Conidiophores phialidic, cylindric-subulate, septate, much

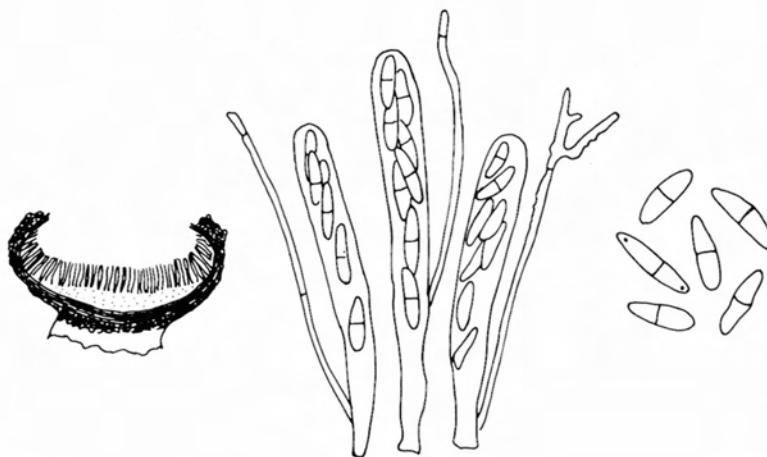


Fig. 52. *Encoeliopsis laricina*. Apothecium, asci, ascospores.



Fig. 53. *Encoeliopsis laricina*. Dieback of larch. Apothecia on stem.

branched, hyaline, up to 50 um in length, 2-4 um in width. Conidia hyaline, fusoid, (0)1-(3)-septate, usually straight, 14-20 × 3-4.5 um, borne at the tips of phialides.

HOST: *Larix occidentalis*

DISEASE: Causing shoot blight and stem canker of western larch (Funk 1969b). (Fig. 53).

NOTES: There is much difference of opinion on the classification of this fungus, being placed originally in *Crumenula*, then transferred to *Scleroderris*; another recent revision has placed it in *Ascocalyx* (Schläpfer-Bernhard 1968).

Epicoccum nigrum Link Mag. Ges. naturf. Fr. Berl. 7: 32 (1815).

Sporodochia black, pulvinate, up to 2 mm diameter. Mycelium mostly immersed, stromata present. Conidiophores densely packed on stromata, mostly simple,

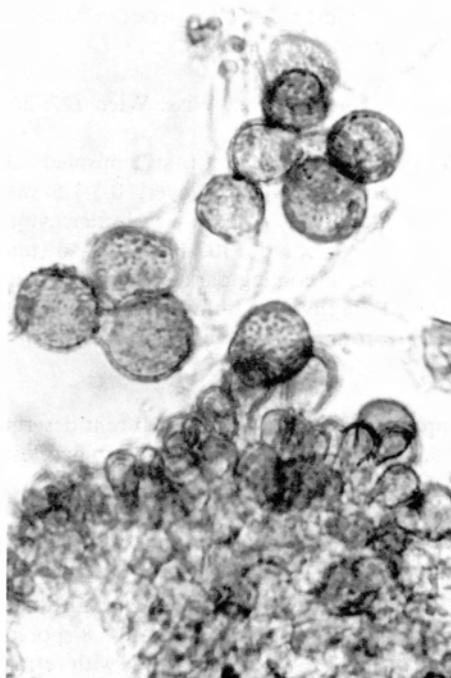


Fig. 54. *Epicoccum nigrum*. Sporo-dochium and conidia.

5.15×3.6 um. Conidiogenous cells monoblastic, terminal, cylindric. Conidia solitary, dry, acrogenous, globose to pyriform, brown, often with a pale basal stalk cell, muriform but septa obscured by rough, opaque wall, 15-25 um diameter, occasionally to 50 um. (Fig. 54).

HOSTS: Conifers and hardwoods

NOTES: Isolated from heartwood and sapwood of various conifers. Invades dwarf mistletoe infections of hemlock (Baranyay 1966). Colonizes diseased conifer seedlings.

Europodium trinacriiforme A.K. Parker Can. J. Botany 35: 175 (1957).

ANAMORPH: *Verticilladiella*

Cleistothecia globose, black, 225-345 um diameter, leathery, breaking open irregularly at maturity. Asci subglobose, evanescent, 8-spored, 5-9 um diameter. Ascospores hyaline, continuous, cucullate, in gelatinous matrix, $4.5.5 \times 2.3$ um.

Conidiophores brown, septate, $70-600 \times 6-10$ um, metulae in two or three series, sporogenous cells sympodulae. Conidia hyaline, truncate, up to 7.5×4 um, mostly smaller.

HOST: *Pinus monticola*

DISEASE: In bark and wood of decadent western white pine (Parker 1957b).

NOTES: Three species of *Europodium*, distinguishable by their conidial states, were

described by Robinson-Jeffrey and Davidson (1968) on western conifers. The genus *Europium* is closely related to *Ceratocystis*.

Eutryblidiella sabina (de Not.) Hoehn. Sitzb. Akad. Wiss. Wien 127: 564 (1918).

Pseudothecia superficial, single or clustered, sessile, black, at first hemispherical, becoming flattened, opening by stellate cracking of upper layer, 0.5-1.5 mm diameter, outer wall dark pseudoparenchyma, inner wall pale brown plectenchyma. Ascii bitunicate, cylindric-clavate, 4-, 6- or 8-spored, 100-175 × 24-46 um. Ascospores irregularly arranged, at first hyaline, becoming dark brown, 1-septate and strongly constricted, 25-40 × 13-20 um. Paraphysoids filiform, branching and anastomosing above the ascci where they are rounded and gelatinized to form a brown layer.

HOST: *Juniperus* spp.

NOTES: On dead wood of *Juniperus*, probably saprophytic. For a recent description see Reid and Pirozynski (1966). One of the "bitunicate discomycetes" belonging in the Dothideales.

Eutypa acharii Tul. Sel. Fung. Carp. 2: 53 (1863).

Perithecia scattered, subglobose, immersed in stroma, ostiolate, 400-500 um diameter; stroma widely effused in the wood, brownish, faintly blackened dorsal zone, no ventral zone. Ascii oblong-clavate, no apical structure, 8-spored, 22-28 × 4-5 um. Ascospores hyaline but brownish *en masse*, allantoid, with refractive body in each end, 5-7 × 1 um.

HOSTS: *Populus* spp.

Eutypella stellulata (Fr.) Sacc. Syll. Fung. I: 149 (1882).

Perithecia densely clustered in a pustulate stroma, ostioles collectively erumpent, diverging, subspheric-elongated, 500-600 um in diameter; stroma sharply delimited by dark dorsal zone, approx. 2 mm diameter, 1 mm high, disc perforated by the ostioles less than 1 mm diameter. Ascii without apical apparatus, truncate above, 32-40 × 6-7 um, 8-spored. Ascospores hyaline, allantoid, biguttulate, 8-12 × 2-3 um. Paraphyses indistinct, agglutinating.

HOSTS: *Alnus*, *Populus*, *Betula*

Fusarium lateritium Nees Syst. Pilze Schwamme 31 (1817).

TELEOMORPH: *Gibberella baccata* (Wallr.) Sacc.

Colonies grow rapidly, producing a dense floccose aerial mycelium. Cultural pigmentation variable, peach to deep orange, vinaceous to reddish brown, greenish yellow to blue-black. Macroconidia produced generally in sporodochia, 3-7-septate, beaked at the apex, 22-50 × 3.5-5.5 um, formed on simple phialides. Chlamydospores sparse, globose, 7-8 um. (Fig. 55).

HOSTS: *Populus trichocarpa*, *P. tremuloides*, *Salix* sp.

DISEASE: Causes stem and branch cankers (Bier 1961).

NOTES: The forma specialis *pini* of this fungus is the cause of pitch canker of pines in southeastern U.S.A. This form may have a sporodochial state and is

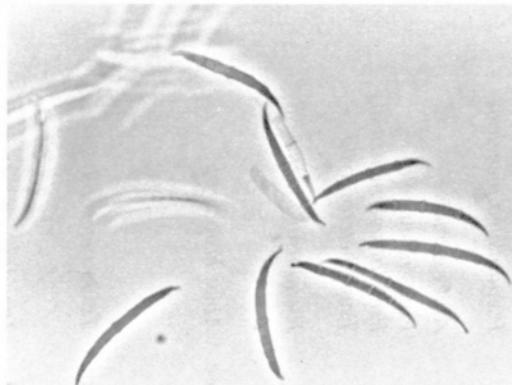


Fig. 55. *Fusarium* sp. Conidia.

considered by some to be *F. moniliforme* Sheldon var. **subglutinans** Wr. & Reinke (Blakeslee *et al.* 1978). There is one tentative record on western red cedar from British Columbia.

Gelatinosporium Peck char. emend. DiCosmo 25th Rep. State Mus. N.Y. 84 (1873).

Conidiomata dark colored, pulvinate, unilocular or irregularly plurilocular, lacking an ostiole but opening irregularly by splits in upper wall; composed of *textura oblita* with inner layers gelatinized. Conidiophores lining inner wall, cylindric, simple or branched. Conidiogenous cells phialidic, cylindric. Conidia blastic-phialidic, lunate to falcate, septate or nonseptate, hyaline. (Figs. 56,57).

The following eight species occur on western conifers. All are associated with cankering or dieback of branches, except for one that causes bark proliferation (anamorph of *Dermea rhytidiformans*). Shape and size of the macroconidia are diagnostic in this genus and are presented in the accompanying table and in the illustrations (Table 2).

NOTES: Many species of *Gelatinosporium* and *Foveostroma* were previously classified in *Micropera* and *Cryptosporium*, two names now discredited (DiCosmo 1978; Funk 1976b, 1979c).

Geniculodendron pyriforme Salt Trans. Brit. Mycol. Soc. 63: 340 (1974).

TELEOMORPH: *Caloscypha fulgens* (Pers.) Boudier

Cultural Description: Colony texture loose to cottony, varying from beige to pale yellowish brown; reverse side yellowish with blue patches to yellowish orange. Conidiophores 150-450 um high, sometimes verrucose below, hyaline to yellowish brown below, 4-5 um broad at the tips, 8-12 um broad at the base, dichotomously branched above 250 um. Conidiogenous cells sympodulae, in verticils of 2-4, 34-48 × 3-4.5 um. Conidia hyaline, obovate, holoblastic, dry, 4.5-6.5 × 3-4 um. (Fig. 58).

HOSTS: *Picea glauca*, *P. sitchensis*

Table 2. *GELATINOSPORIUM* SPECIES ON CONIFERS (Ref. Funk 1976b, 1979c)

Species	Conidia	Conidiomata	Hosts
<i>G. fosteri</i> (Funk) Funk	falcate, 3-septate 42-48 × 4 um	greenish, pulvinate up to 1.5 mm diameter	<i>Pseudotsuga menziesii</i>
<i>G. griseo-lanatum</i> Funk	banana-shaped nonseptate 30-32 × 4 um	black, discoid up to 0.5 mm diameter	<i>Abies grandis</i> <i>Tsuga heterophylla</i>
<i>G. lunasporum</i> (Linder) Funk	broadly falcate nonseptate 15-22 × 5-6 um	black, irregular discoid up to 1 mm diameter	<i>Abies grandis</i> <i>Abies lasiocarpa</i> <i>Pinus monilicola</i> <i>Pseudotsuga menziesii</i>
<i>G. pinicola</i> (Linder) Funk	falcate, nonseptate 33-36 × 3-4 um	black, disc-like up to 0.5 mm diameter	<i>Abies grandis</i> <i>Pinus monilicola</i> <i>Pseudotsuga menziesii</i> <i>Tsuga heterophylla</i>
<i>G. sinuatum</i> Funk	sinuate, 7-10-septate 55-66 × 6 um	black, irregular in shape up to 0.4 mm diameter	<i>Pseudotsuga menziesii</i>
<i>Gelatinosporium</i> state of <i>Dermea</i> <i>rhytidiformans</i>	fusoid to sickle-shaped 0-3-septate 26-65 × 3.5-5.5 um	brown, conical to subglobose up to 0.6 mm diameter	<i>Abies lasiocarpa</i>
<i>G. stillwellii</i> Funk	straight or curved, 8-10-septate 85-110 × 4 um	black, globose to substipitate up to 0.8 mm diameter	<i>Tsuga heterophylla</i>
<i>G. uncinatum</i> Funk	uncinate to sickle-shaped 30-38 × 2.5 um	black, discoid up to 0.8 mm diameter	<i>Pseudotsuga menziesii</i>

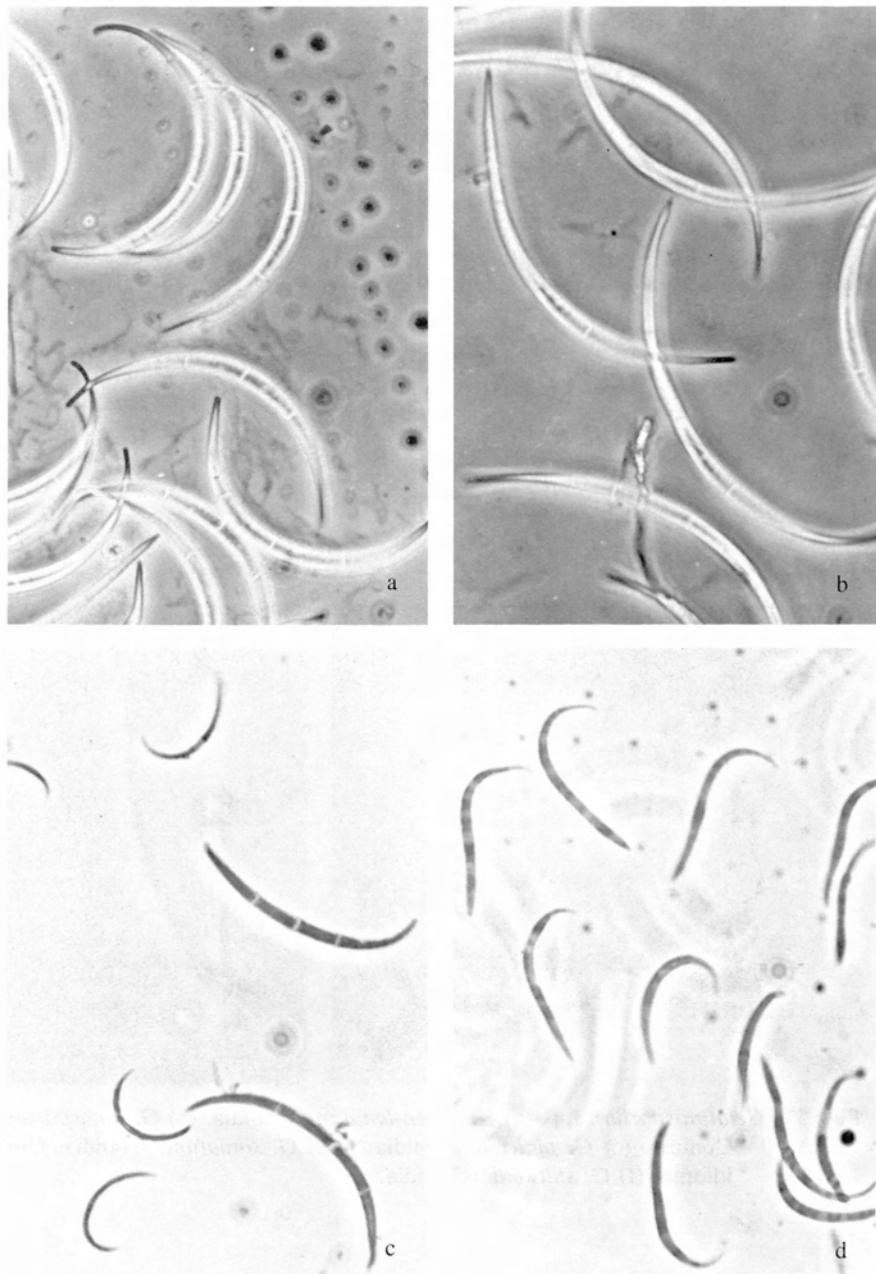


Fig. 56. *Gelatinosporium* and *Foveostroma* spp. Conidia. (a) *F. boycei* (b) *F. abietinum* (c) *G. fosteri* (d) *G. uncinatum*.

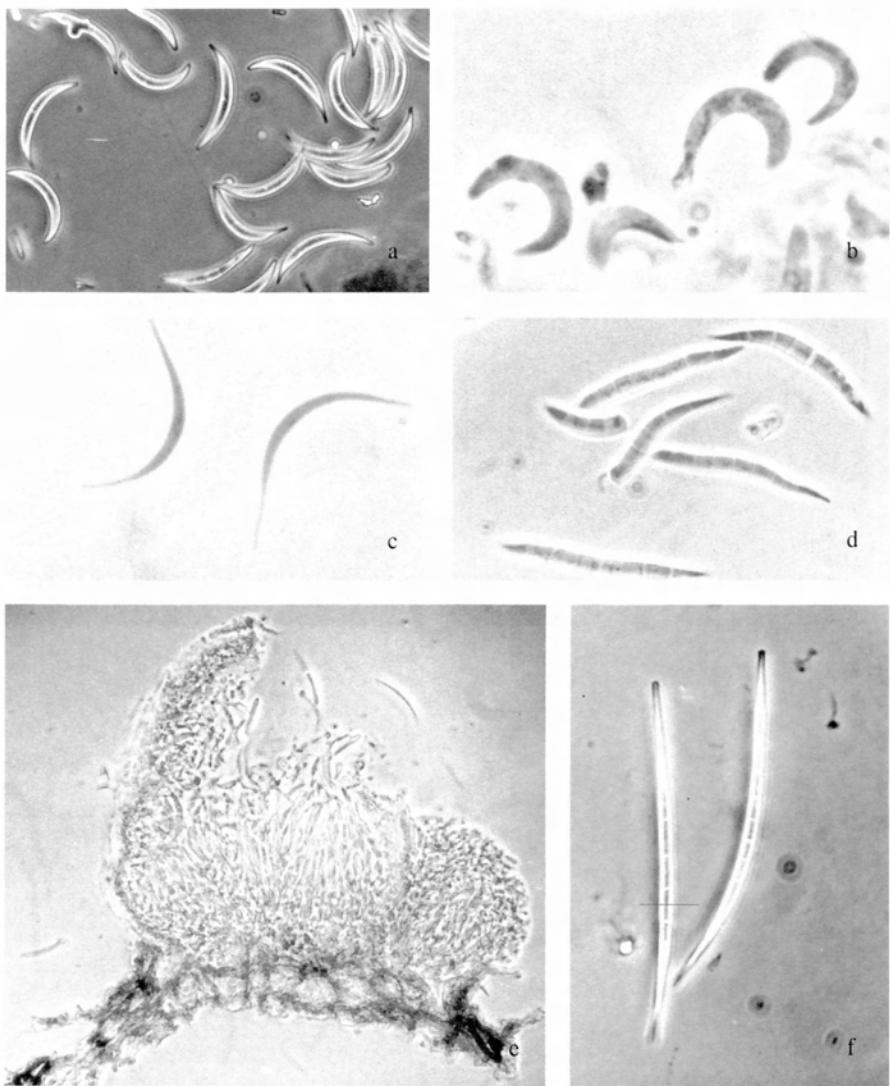


Fig. 57. *Gelatinosporium* spp. (a) *G. griseo-lanatum*. Conidia. (b) *G. lunasporum*. Conidia. (c) *G. pinicola*. Conidia. (d-e) *G. sinuatum*. Conidia. Conidioma. (f) *G. stillwellii*. Conidia.

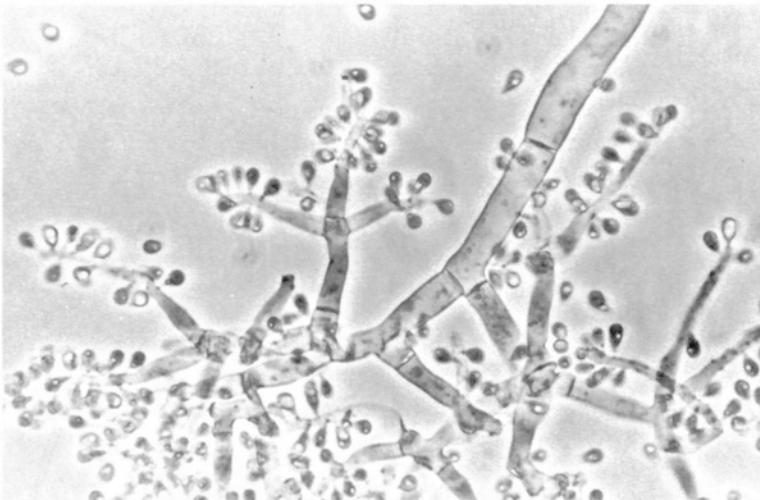


Fig. 58. *Geniculodendron pyriforme*. Conidia from culture.

DISEASE: A pathogen of conifer seeds. The teleomorph is a large fairy cup (Paden, Sutherland and Woods 1978).

Glomerella cingulata (Stonem.) Spauld. & Schrenk U.S.D.A. Bull. 44: 751 (1903).

SYNONYM: *Physalospora miyabeana* Fukushi

ANAMORPH: *Colletotrichum gloeosporioides* Penz.

Perithecia single or clustered, immersed, subhyaline to brown, subglobose, 100-350 um diameter; ostioles papillate or beaked, with external hairs. Ascii cylindric to ellipsoid, 4-8-spored, 35-80 × 8-14 um. Ascospores ellipsoid, hyaline, unicellular, with densely granular cytoplasm at the poles, 12-28 × 4-7 um. Paraphyses filiform, soon disappearing.

Acervuli pink, setose, slimy, bearing ellipsoidal, unicellular conidia, 12-20 × 4-6 um, on cylindrical, phialidic conidiophores.

HOSTS: *Salix* spp.

DISEASE: Associated with *Venturia saliciperda* in blight of willows (q.v.). Also parasitic on a wide variety of host plants.

Godronia fuliginosa (Fr.) Seaver Mycologia 37: 344 (1945).

ANAMORPH: *Topospora proboscidea* (Fr.) Fr.

Apothecia erumpent, densely gregarious in cankered areas, at first subglobose, becoming urceolate, margin fimbriate, sessile to substipitate, reddish brown to black, slightly striated and furfuraceous, coriaceous-waxy, 0.5-1.2 mm diameter; hymenium grayish. Tissue of basal stroma brown *textura epidermoidea*; medullary excipulum of brownish black *textura angularis*; ectal excipulum of yellowish *textura*

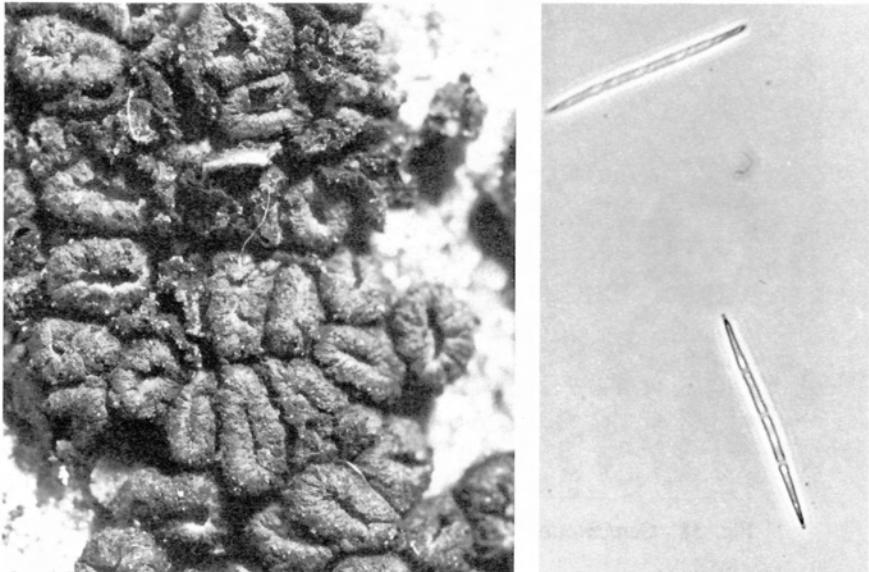


Fig. 59. *Godronia fuliginosa*. Apothecia, densely crowded on willow bark.
Ascospores.

oblita; hypothecium of hyaline interwoven hyphae. Asci cylindric-clavate with slender stalk, 8-spored, pore staining blue with iodine (J+), $100-140 \times 9-12$ um. Ascospores hyaline, filiform, straight or curved, pointed at the ends, 5-7-septate, $55-85 \times 2-4$ um. Paraphyses hyaline, filiform, septate, branching, not forming an epithecium. (Fig. 59).

Pycnidia erumpent, gregarious, globose to ovoid, black, glabrous, 0.1-0.5 mm diameter; tissue a mixture of *textura epidermoidea* and *angularis*, dark brown to yellowish. Locule globose to lobed, tearing open at the top. Conidiophores cylindric-subulate, septate, simple or branched, $5-25 \times 2$ um. Conidia hyaline, fusiform, straight or curved, 3-septate, $20-30 \times 2-4$ um; microconidia hyaline, aseptate, ellipsoid, $3-4 \times 2-3$ um.

HOSTS: *Salix* spp., *Populus tremuloides*

DISEASE: In cankers of willow, sometimes following disease produced by *Cryptomyces maximus*. Smerlis (1968) proved pathogenicity in aspen by inoculation.

Gremmeniella abietina (Lagerberg) Morelet Bull. Soc. Sci. Nat. Arch. Toulon 183: 9 (1969).

SYNONYM: *Scleroderris lagerbergii* Gremmen

ANAMORPH: *Brunchorstia pinea* (Karst.) Hoehn.

Apothecia dark brown, short-stalked, erumpent, cup-shaped, folded when dry,

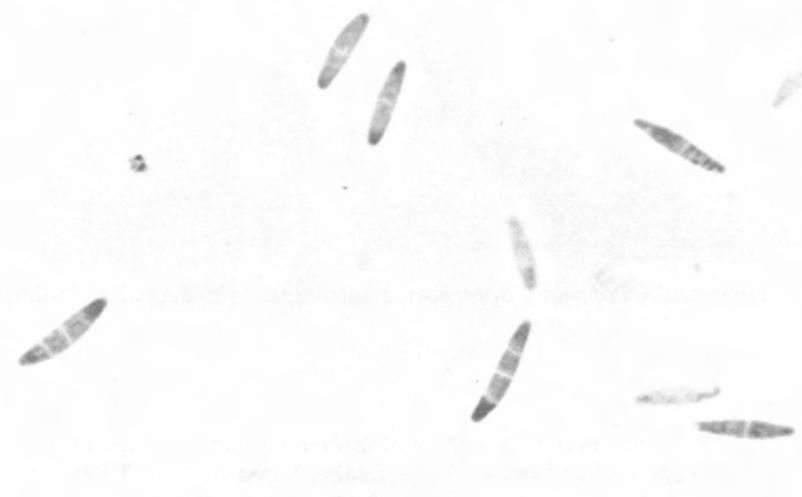


Fig. 60. *Gremmeniella abietina*. Habit on pine stem. Apothecia, vertical section.
Ascospores.

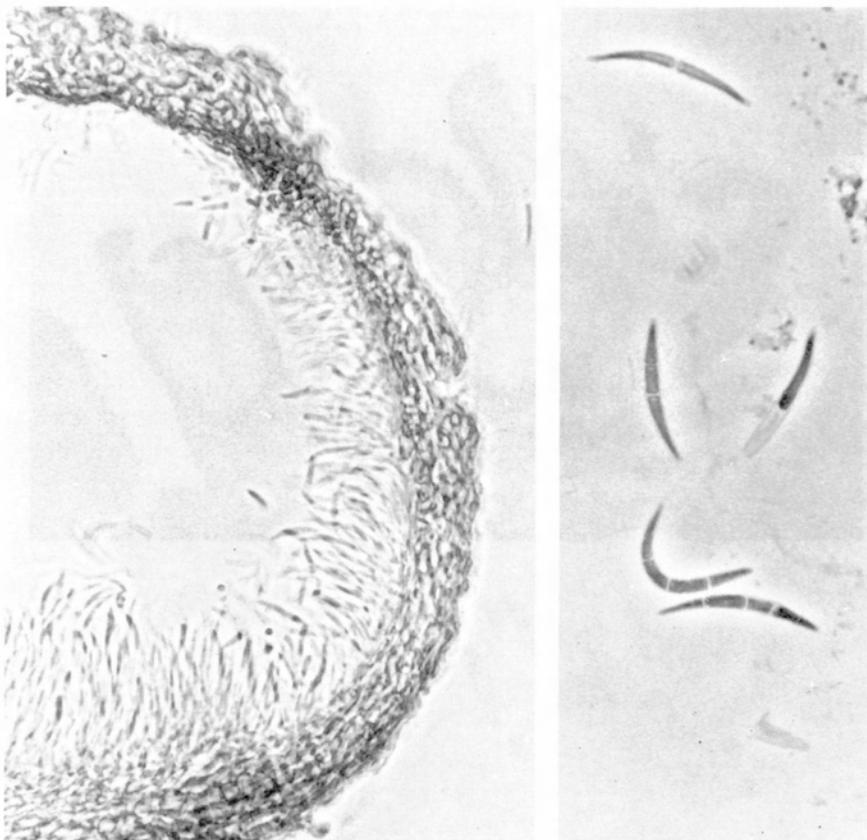


Fig. 61. *Gremmeniella abietina*. *Brunchorstia* anamorph. Pycnidial wall. Conidia.

inrolled margin 1 mm diameter; excipulum of *textura angularis*; hymenium pale to cream-colored; hypothecium hyaline. Asci cylindric, 8-spored, J-, 110-120 × 8-10 um. Ascospores hyaline, 4-celled, ellipsoid, 15-22 × 3-5 um. Paraphyses hyaline, filiform, forming an epithecium. (Fig. 60).

Pycnidia dark brown, erumpent, irregular to subglobose, thick-walled, 0.4-0.5 mm diameter, conidiophores simple, short, probably phialidic, lining inner wall; conidia curved to sickle-shaped, fusoid, hyaline, 25-50 × 3-4 um, up to 4-celled. (Fig. 61).

HOSTS: *Pinus* spp.

DISEASE: Causing "Scleroterris Canker" of pines, death of shoots and needles. An important pathogen, found only rarely in western Canada on *Pinus contorta*, *P. ponderosa* and *P. albicaulis*.

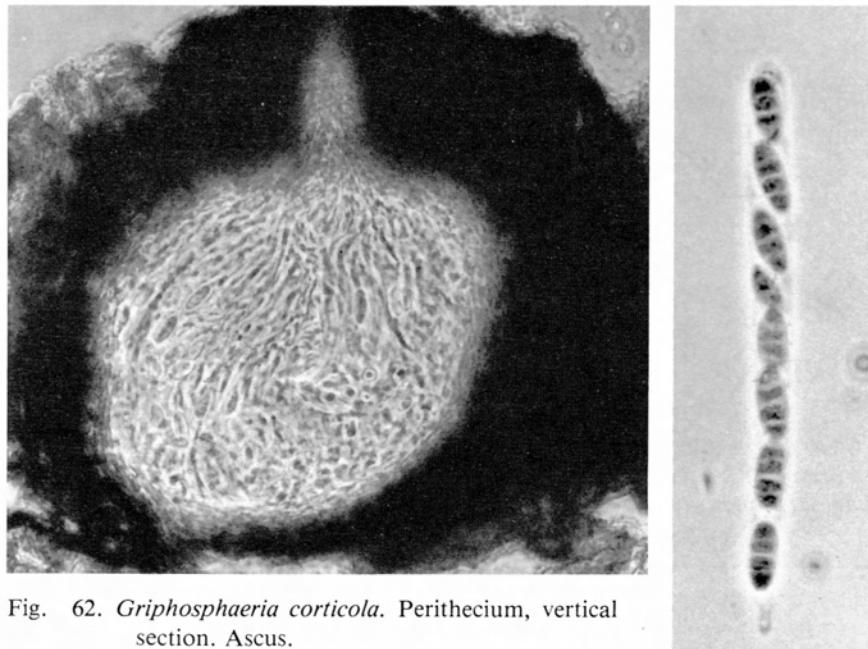


Fig. 62. *Griphosphaeria corticola*. Perithecium, vertical section. Ascus.

Griphosphaeria corticola (Fckl.) Hoehn. Ann. Myc. 16: 87 (1918).

SYNONYMS: *Clathridium corticola* (Fckl.) Shoem. & Müller, *Phragmoporthe pseudotsugae* Funk

ANAMORPH: *Seimatosporium lichenicola* (Corda) Shoem. & Müller

Perithecia solitary, immersed, globose, black, 250-375 × 200-300 um; ostioles 80-90 um long, piercing an ectostromatic disc but not exceeding it; ectostromatic disc approx. 400 um diameter, 80-90 um thick, erumpent and exposed, covering upper surface of perithecia. Ascii cylindric with refractive apical apparatus, 8-spored, 95-110 × 8-9 um. Paraphyses hyaline, septate, simple, tapered. Ascospores hyaline, ellipsoid, 3-septate, 14-17 × 5-7 um. (Fig. 62).

Acervuli formed in malt agar culture. Conidia clavate, reddish brown, thick-walled, 3-septate, with a hyaline, short, thin-walled basal cell narrowed to a truncate base, 18-20 × 5-7 um. Conidiophores hyaline, septate, annellate, 10-50 × 2 um. (Fig. 63).

HOST: *Pseudotsuga menziesii*

DISEASE: Associated with leader and branch tip dieback in young Douglas-fir.

Grovesiella abieticola (Zeller & Goedding) Morelet & Gremmen Bull. Soc. Sci. Nat. Arch. Toulon 185: 8 (1969).

Apothecia produced on a stroma, black, single or clustered, short-stipitate, at first globose becoming cupulate, hymenium grayish, 0.5-1.4 mm in diameter. Stroma



Fig. 63. *Griphosphaeria corticola*. *Seimatosporium* anamorph from culture.

composed of *textura epidermoidea*, medullary excipulum of *textura intricata* and ectal excipulum of *textura angularis*, darkening to *textura prismatica* on the outside scales. Ascii cylindric-clavate, short-stipitate, J+, 8-spored, 90-135 × 9-16 um. Ascospores hyaline, filiform, 3-12-septate, 40-70 × 2.5-4 um. Paraphyses hyaline, simple or branched, lanceolate, not forming an epithecium.

HOSTS: *Abies lasiocarpa*, *A. grandis*

DISEASE: Associated with annual cankers of *Abies* spp. (Zeller and Goodding 1930) but most common on dying and dead branches of *A. lasiocarpa*.

***Grovesiella grantii* Funk** Can. J. Botany 56: 245 (1978).

Apothecia produced on an erumpent, black stroma, black, urceolate, single or caespitose, short-stalked, 0.2-0.5 mm diameter; ectal excipulum of dark brown *textura prismatica*, forming scales on the exterior; medullary excipulum of brown *textura angularis*; stromata are of dark brown *textura epidermoidea*. Ascii cylindric-clavate, short-stalked, tips flattened, inoperculate, 8-spored, pore staining blue in iodine (J+), (57)60-80(85) × 6-8 um. Ascospores filiform, hyaline, 3-septate, 18-24(34) × 2-3 um. Paraphyses hyaline, simple or branched, slightly longer than the ascii but not forming an epithecium. (Fig. 64).

HOST: *Abies grandis*

DISEASE: A secondary invader of cankers of *Abies grandis* and colonizer of shaded branches.

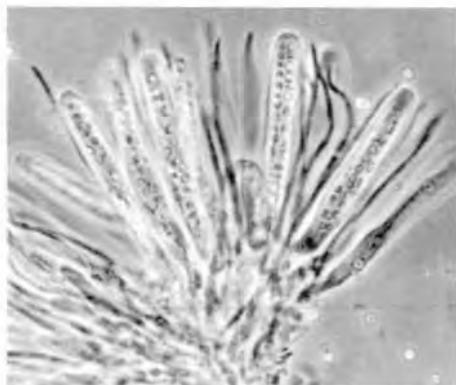
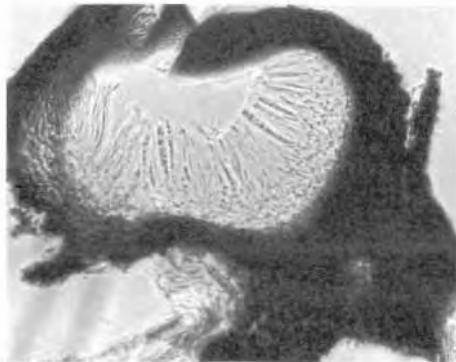


Fig. 64. *Grovesiella grantii*. Apothecium, vertical section. Hymenium with asci and paraphyses.

Helotium resinicola Baranyay & Funk

ANAMORPH: *Stilbella*

Apothecia usually on a white, cottony subiculum, pale orange, caespitose, with up to 10 in a cluster, rarely single, circular, short-stalked, 0.2-0.6 mm in diameter; hymenium orange, plane, marginate when young; tissue composed of interwoven hyphae (plectenchyma) throughout. Height of caespitose clusters less than 1 mm. Ascii cylindric-clavate, 8-spored, I-, 45-67 × 5.8 µm. Ascospores hyaline, ellipsoid to oval, aseptate, 5.8-5.5 × 1.5-2.5 µm. Paraphyses hyaline, filiform, simple or once branched. (Fig. 65).

Synnemata erect, straight, or slightly flexuous, simple or rarely branched, white to pale yellow with pale orange heads, slightly broader at the base, brittle when dry, 0.5-2.0 mm high, up to 0.5 mm broad at the base, composed of parallel interwoven hyphae which diverge and branch profusely at the apex, the final branches becoming conidiophores. Conidiophores hyaline, tapering, blunt tipped, approx. 60-70 µm in length. Conidia in a mucoid mass, brittle when dry, up to 0.5 mm in diameter; conidia hyaline, orange, globose, with a small denticle, 2.0-2.5 µm in diameter.

HOSTS: Occurring on resin of most conifers except *Pinus*.

Can. J. Botany 47: 1011 (1969).

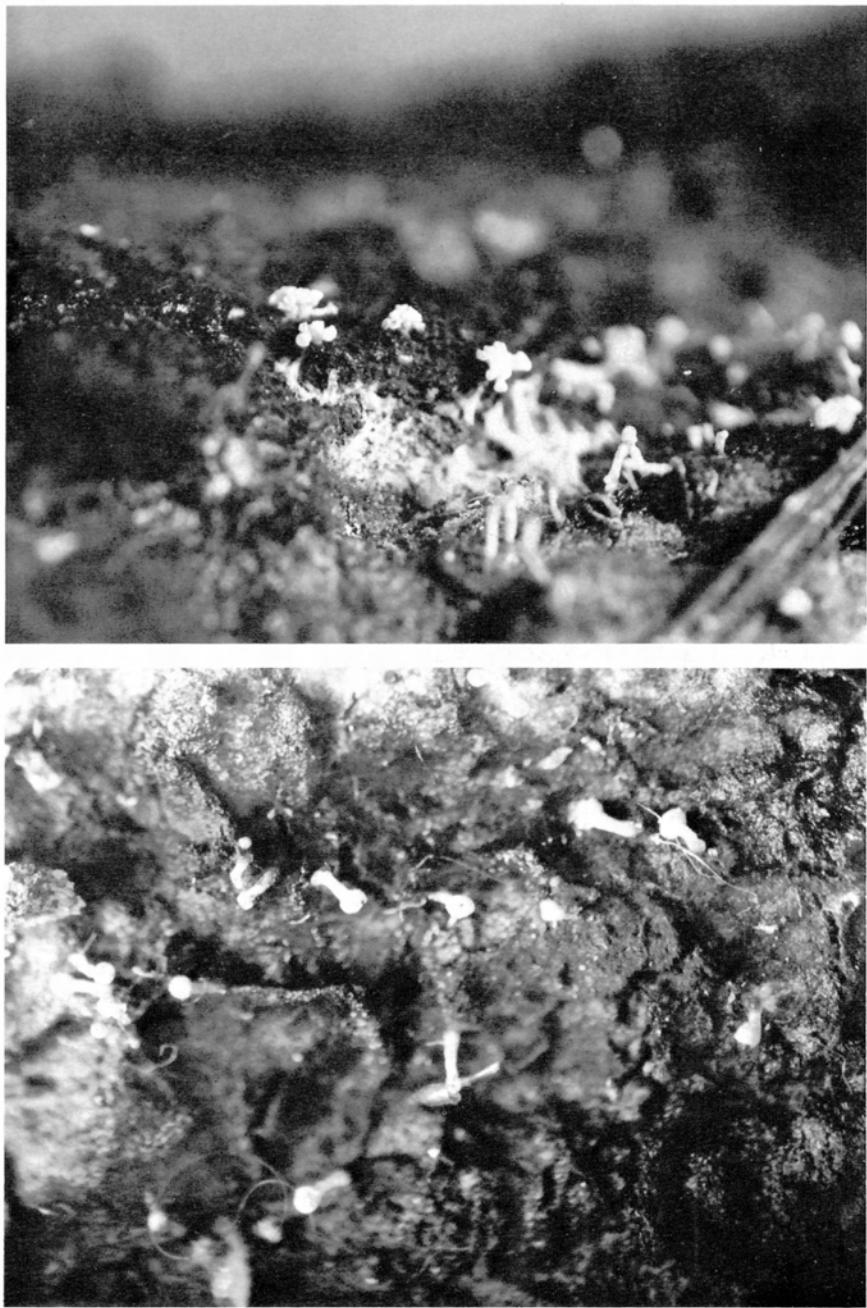


Fig. 65. *Helotium resinicola*. Apothecia. Synnemata.

Hemimyriangium betulae J. Reid & Pirozynski Can. J. Botany 44: 651
(1966).

Ascomata forming on drops of resinous excretion of the host, black, hemispherical, superficial, 0.2-0.8 mm in diameter; outer layer of black pseudoparenchyma in which asci are embedded; inner layer embedded in the resin, composed of loose, branched, septate, yellowish brown hyphae. Asci globose, bitunicate, 8-spored, 15-25 µm in diameter, arranged in two or more concentric rings in the ascoma. Ascospores hyaline, oval to broadly ellipsoid, 3-5-septate, sometimes muriform, 13-20 × 5-8 µm.

HOSTS: *Betula* spp.

NOTES: On living twigs of birch, inhabiting resinous droplets.

Hendersonula toruloidea Nattrass Trans. Brit. Mycol. Soc. 18: 197 (1933).

CULTURE: *Scytalidium*

Pycnidial stroma black, solitary, immersed then erumpent, uni- or multilocular,



Fig. 66. *Hendersonula toruloidea*. Canker produced on arbutus.

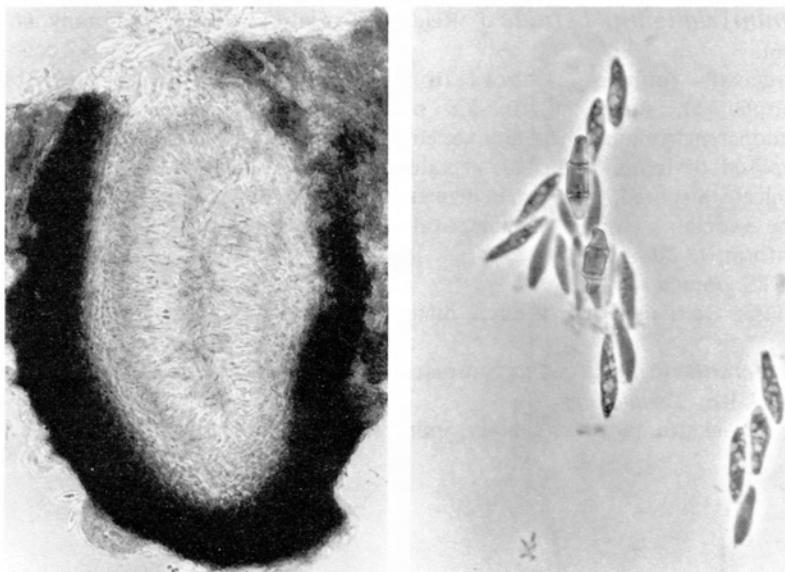


Fig. 67. *Hendersonula toruloidea*. Pycnidium. Conidia.

up to 1.5 mm in diameter. Conidiophores (phialides) simple, subulate, lining locular walls. Conidia ellipsoid, hyaline and nonseptate at first, becoming brown and 2-septate, with middle cell darker. Toruloid state formed from hyphae which break up into 1- or 2-celled, brown, arthroconidia, approx. $4-10 \times 4$ um. (Fig. 67).

HOST: *Arbutus menziesii*

DISEASE: Causes cankers and branch dieback of *Arbutus* in British Columbia. (Fig. 66). Cultural description given by Sigler and Carmichael (1976).

***Herpotrichia coulteri* (Peck) Bose** Phytopath. Z. 41: 195 (1961).

SYNONYM: *Neopeckia coulteri* (Peck) Sacc.

Pseudothecia globose, dark brown, single or in small groups, formed on a subiculum of felty brown hyphae, 250-500 um diameter, with a distinctly papillate pore, wall of thick-walled pseudoparenchyma, covered by brown hyphae. Ascii cylindrical, short-stalked, bitunicate, 8-spored, $140-210 \times 14-20$ um. Ascospores monostichous, elliptical, dark brown, 1-septate, constricted, with a dark episore, $10-28 \times 7-10$ um. Pseudoparaphyses hyaline, septate, filiform, sparsely branched.

HOSTS: Chiefly on *Pinus*, rarely on *Picea*

DISEASE: Causes snow mould, invading foliage when it is covered by snow, therefore affecting lower branches or very young trees, especially in nurseries. A brown, felt-like mycelium covers the branches, penetrating the cuticle, and producing microsclerotia. Branch dieback or death of seedlings may result.

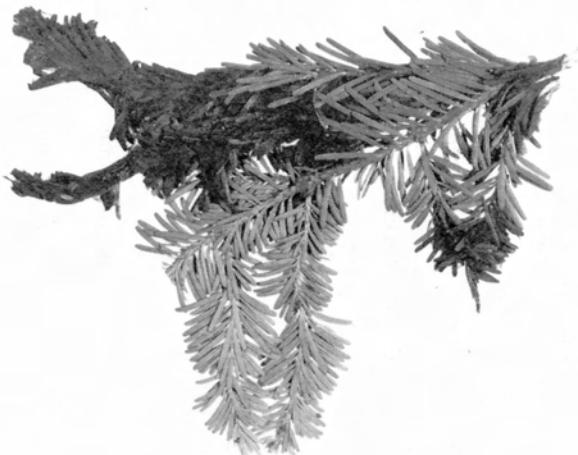


Fig. 68. *Herpotrichia juniperi*. Snow blight on alpine fir.

Herpotrichia juniperi (Duby) Petr. Ann. Myc. 23: 43 (1925).

SYNONYM: *Herpotrichia nigra* Hartig

Pseudothecia dark brown, globose, sparsely gregarious, partly hidden in a felt-like subiculum of dark brown hyphae, 200-450 um diameter, with a definite apical pore, wall of polygonal cells 20-40 um thick, covered with brown, septate hyphae. Ascii cylindric to subclavate, 8-spored, bitunicate, 115-190 × 12-18 um. Ascospores monostichous or obliquely distichous, hyaline and 1-septate at first, becoming brown and 3-4-septate, elliptical, constricted at median septum, with a mucous sheath, 25-34 × 8-12 um. Pseudoparaphyses filiform, hyaline.

HOSTS: *Abies*, *Chamaecyparis*, *Juniperus*, *Picea*, *Pinus*, *Tsuga*

DISEASE: Similar to *H. coulteri*. (Fig. 68).

NOTES: Another snow mould occurring on true firs and Douglas-fir is *Phacidium abietis* (Dearn.) Reid & Cain, but it does not invade branches or cause dieback.

Hypoxyylon deustum (Hoffm. ex Fr.) Grev. Scot. Crypt. Fl. 6: 324 (1828).

Stromata orbicular to effused irregularly, 1.5-3 mm thick, grayish white at first, almost black with age. Perithecia very large, ostioles papillate. Ascii cylindric, 190-260 × 10-15 um, stipe 50-60 um long. Ascospores elliptic to inequilateral, ends acute, opaque, 28-40 × 8-12 um.

HOST: *Acer macrophyllum*

Table 3. *HYPPOXYLON* SPECIES

Species	Perithecia	Asci	Ascospores	Hosts
<i>H. deustum</i>	larger than 1 mm	240-320 × 10-15 um	28-40 × 8-12 um	<i>Acer macrophyllum</i>
<i>H. diathrauston</i>	up to 1 mm	200-250 × 18 um	20-36 × 12-18 um	Conifers
<i>H. fuscum</i>	up to 300 um	150 × 8 um	12-15 × 5-8 um	<i>Alnus, Populus</i>
<i>H. howeianum</i>	200-300 um	90-110 × 5-6 um	6-9 × 3-3.5 um	<i>Alnus</i>
<i>H. mammatum</i>	up to 1 mm	170-240 × 12-16 um	20-33 × 9-12 um	<i>Populus, Alnus, Salix</i>
<i>H. multiforme</i>	up to 1 mm	150 × 6 um	8-12 × 3.5-5 um	<i>Betula, Alnus</i>
<i>H. rubiginosum</i>	200-500 um	150 × 8 um	9-13 × 4-6 um	<i>Alnus, Populus</i>
<i>H. serpens</i>	500-1000 um	150 × 8 um	10-15 × 5-7 um	<i>Populus tremuloides</i>

Hypoxylon diathrauston Rehm — Hedwigia 21: 48 (1882).

Stromata erumpent, composed of single perithecia or 3-12 coalesced, gray-brown surface and white inside, 2-10 × 2-5 mm, ostioles papillate. Perithecia 0.7-1 mm diameter, semiglobose. Ascii cylindric, 200-250 × 18 um. Ascospores uniseriate, variable in shape, broadly ellipsoid to fusoid to oblong, inequilateral, dark brown to opaque, at first with hyaline sheath, 20-36 × 12-18 um. Paraphyses present.

HOSTS: On branches of several genera of conifers.

Hypoxylon fuscum Pers. ex Fr. — Sum. Veg. Scand. 384 (1849).

Stromata hemispheric, 2-4 mm diameter, erumpent, purplish brown, soft. Perithecia 150-300 um diameter, ostioles umbilicate. Ascii cylindric, 70-96 × 8-10 um, stipe 60-70 um long. Ascospores inequilateral, elliptic, nearly opaque, 12-15 × 5-8 um.

HOSTS: *Alnus*, *Populus*

Hypoxylon howeianum Peck — N.Y. State Mus. 24: 98 (1871).

Stromata globose to hemispheric, 3-12 mm diameter, erumpent, brick-red to brown, black in age. Perithecia 200-300 um diameter, ostioles umbilicate. Ascii cylindric, 50-60 × 5-6 um, stipe 40-50 um long. Ascospores inequilateral, elliptic, almost opaque, 6-9 × 3-3.5 um.

HOST: *Alnus*

Hypoxylon mammatum (Wahl.) J.H. Miller — A monograph of the World species of *Hypoxylon* 64 (1961).

Ascostromata immersed or erumpent, discrete, whitish pruinose at first, becoming black, 2-5 mm in diameter and 1-2 mm thick, usually coalescing to form an effused stroma up to 25 mm in length, smooth except for the papillate ostioles, carbonaceous, sometimes tuberculate; perithecia globose, single or up to 30 in a stroma, 0.7-1 mm in diameter; ascii cylindric, 140-200 × 12-16 um with stipe 30-40 um long;



Fig. 69. *Hypoxylon mammatum*. Ascospores.



Fig. 70. *Hypoxylon mammatum*. Stem canker on aspen.

ascospores uniseriate, ellipsoid, dark brown, $20-30 \times 9-12$ um. Paraphyses present but indistinct and gelatinizing. (Fig. 69).

Conidial state: Gray, pillar-like coremia arising from a brownish subiculum below the periderm. Conidiophores branched, with 2-3 terminal conidiogenous branches, 75-150 um high. Conidia blastic from geniculations on conidiogenous branches, hyaline to fuscous, ellipsoid, $6-9 \times 2-4$ um.

HOSTS: *Populus*, *Alnus*, *Salix*

DISEASE: Causes perennial stem cankers that usually kill the tree. (Fig. 70).

NOTE: Many aspects of the biology of Hypoxylon have been treated by Rogers (1979).

Hypoxylon multiforme Fr. Sum. Veg. Scand. 384 (1849).

Stromata hemispheric, 1-3 × 0.5-1 mm, 2-5 mm high, rusty red, erumpent at lenticels. Perithecia elevated, with prominent, conic ostiola, 800-1000 um diameter. Ascii cylindric, 60-80 × 5-6 um, stipe 60-80 um long. Ascospores inequilateral, elliptic, light to dark brown, 8-12 × 3.5-5 um.

HOSTS: *Betula*, *Alnus*

Hypoxylon rubiginosum (Pers. ex Fr.) Fr. Sum. Veg. Scand. 384 (1849).

Stromata variable in shape, 1-20 × 0.5-10 cm, rusty red. Perithecia 200-500 um diameter, ostioles umbilicate. Ascii cylindric, 60-80 × 8-9 um, stipe 40-50 um long. Ascospores inequilateral, elliptic, light to dark brown, 9-13 × 4-6 um.

HOSTS: *Alnus*, *Populus*

Hypoxylon serpens (Pers. ex Fr.) Kickx Flor. Crypt. Env. Louvain 115 (1835).

Stromata orbicular to elliptic, 2-40 × 2-20 mm, superficial, at first white then gray to dark purple in age. Perithecia 500-1000 um diameter, ostioles conic, papillate. Ascii cylindric, 75-100 × 6-9 um, stipe 40-60 um long. Ascospores oblong to inequilateral-elliptic, brown, 10-15 × 5-7 um.

HOST: *Populus tremuloides*

Kabatina thujae Schneider & Arx Phytopath. Z. 57: 180 (1966).

Acervuli erumpent, brown, up to 150 um diameter, separate or confluent, pulvinate, formed of brown, thick-walled pseudoparenchyma, often vertically elongated and cylindrical toward top. Conidiophores pale brown or hyaline, branched at the base. Conidiogenous cells enteroblastic, phialidic, dolioform or ampulliform, terminal or lateral, 6-8 × 4-5 um. Conidia hyaline, nonseptate, ellipsoid, 5-8 × 2-3 um. (Fig. 71).

In agar culture almost black; hyaline conidia less than 8 um long produced directly from the dark, septate hyphae (*Hormonema*-like).

HOST: *Chamaecyparis nootkatensis*

DISEASE: Causes shoot blight and canker of yellow cedar. An epidemic on ornamental varieties was reported in Fraser Valley nurseries by Funk and Molnar (1972). (Fig. 72). Cultural characteristics were described by Hermanides-Nijhof (1977).

Kirschsteiniella thujina (Peck) Pomerleau & Etheridge Mycologia 53: 160 (1961).

SYNONYM: *Amphisphaeria thujina* (Peck) Sacc.

Perithecia slightly immersed in wood, single or gregarious, black, carbonaceous, subglobose with a flattened base, papillate, 450-600 um in diameter, 375-500 um high; peridial wall 50-75 um thick, of dark isodiametric cells. Ascii cylindric or enlarged below, short-stalked, bitunicate, 8-spored, 100-140 × 17-22 um. Ascospores fusoid-oblong, 2-celled, slightly constricted at the septum, upper cell often larger, thick-walled, dark brown, smooth, each cell with a large guttule,

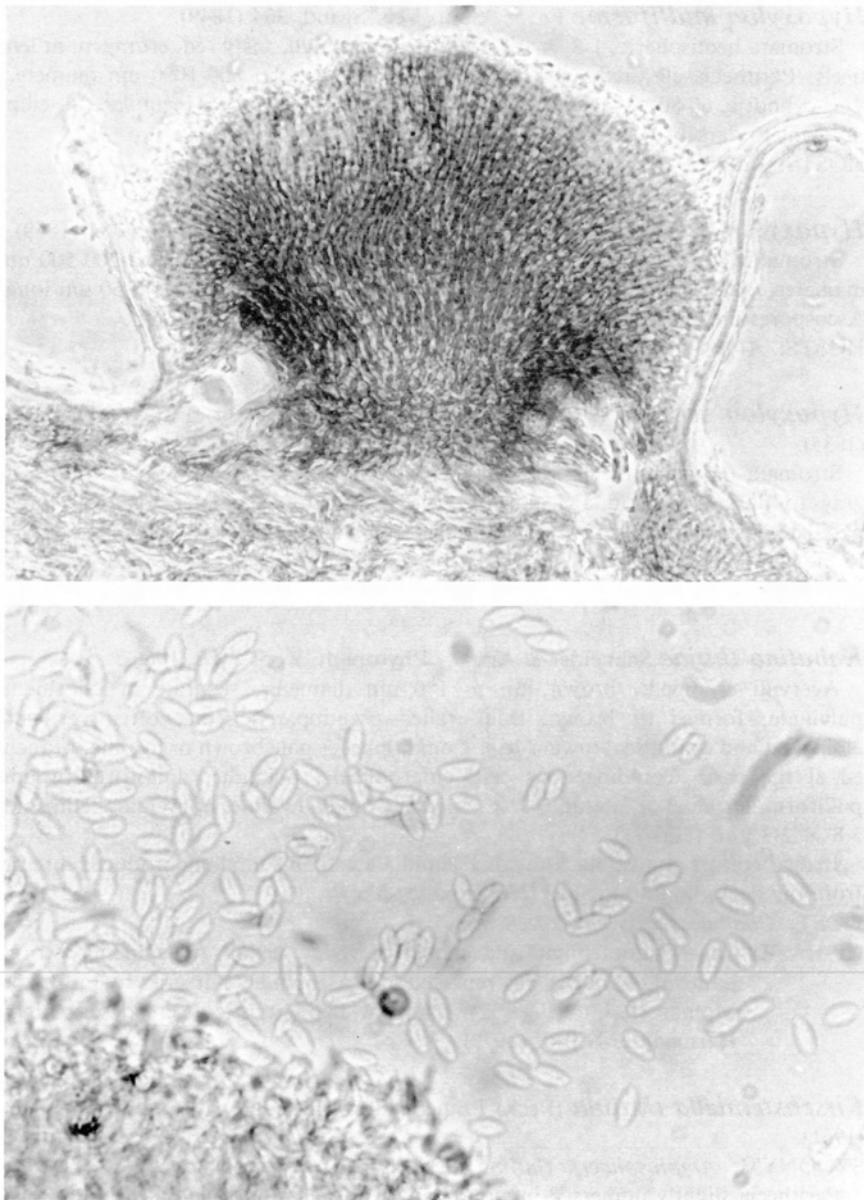


Fig. 71. *Kabatina thujae*. Conidioma in bark of yellow cedar. Conidia.



Fig. 72. *Kabatina thujae*. Dieback produced in yellow cedar.

(29)36-48(55) × 12-16(19) um. Paraphysoids filiform, septate, branched, hyaline.
HOSTS: *Abies* spp.

NOTES: The cause of blue stain in heartwood of *Abies* spp. Frequently isolated from pith region; mycelium typically dark, septate and encrusted. Perithecia produced on the surface of decorticated wood.

***Lachnellula agassizii* (Berk. & Curt.) Dennis** Persoonia 2: 183 (1962).

ANAMORPH: *Naemospora*

Apothecia large, white, up to 5.5 mm diameter, hymenium yellow to bright orange. Ascii cylindric-clavate, 47-60 × 4-5 um. Ascospores hyaline, ellipsoid, 5-9 × 3-4 um.

Conidial stage of light-colored, erumpent stromata with irregular locules lined with simple or branched conidiophores bearing subulate phialides. Conidia hyaline, ellipsoid, 1.5-4.5 × 0.5-1.0 um.

HOSTS: *Pinus* spp., *Abies* spp., *Picea sitchensis*, *Tsuga heterophylla*

NOTES: Pathogenicity on pine and balsam fir confirmed by Smerlis (1973).

***Lachnellula calyciformis* (Willd. ex Fr.) Dharne** Phytopath. Z. 53: 124 (1965).

Apothecia small, white, up to 2.5 mm diameter, hymenium orange to orange-yellow; ectal excipulum of *textura epidermoidea* with excipular hairs; medullary ex-

Table 4. *LACHINELLULA* SPECIES ON CONIFERS

Species	Apothecia	Asci	Ascospores	Hosts
<i>WHITE EXCIPPLE</i>				
<i>L. agassizii</i>	up to 5.5 mm	47-60 × 4-5 um	5.9 × 3-4 um	<i>Pinus, Abies, Picea, Tsuga</i>
<i>L. calyciformis</i>	up to 2.5 mm	45-65 × 4-6 um	4.7.5 × 2.5-3.5 um	<i>Abies, Pinus monticola</i>
<i>L. ciliata</i>	1-2 mm	60-90 × 6-12 um	8-12 × 4-6 um	<i>Pseudotsuga</i>
<i>L. occidentalis</i>	1-3 mm	120-150 × 10-12 um	15-23 × 4-8 um	<i>Larix, Abies grandis</i>
<i>L. pseudotsugae</i>	up to 3.5 mm	50-60 × 5 um	4.7.5 × 2-4 um	<i>Pseudotsuga</i>
<i>L. suecica</i>	up to 6 mm	60-70 × 6-7 um	globose 4-6 um	<i>Larix, Pinus, Picea</i>
<i>BROWN EXCIPPLE</i>				
<i>L. arida</i>	approx. 3 mm	65-75 × 6 um	6-9 × 5 um	<i>Pinus, Abies lasiocarpa</i>
<i>L. flavovirens</i>	approx. 3 mm	65-75 × 5-7 um	7-12 × 4-5 um	<i>Pinus, Larix</i>
<i>L. fuscosanguinea</i>	2-6 mm	70-105 × 7-12 um	10-17 × 4-6 um	<i>Pinus contorta</i>
<i>L. pini</i>	2-4 mm	88-123 × 7-12 um	13-22 × 4-7 um	<i>Pinus monticola</i>

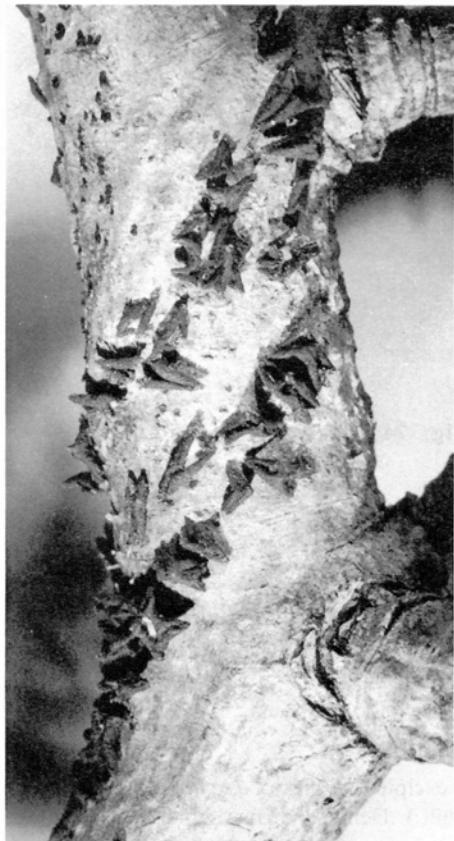


Fig. 73. *Lachnellula arida*. Apothecia on whitebark pine.

cipulum of *textura intricata* loosely interwoven. Asci cylindric-clavate, 8-spored, rounded apices, $45-65 \times 4-6$ um. Ascospores obliquely uniseriate, hyaline, ellipsoid, $4-7.5 \times 2.5-3.5$ um. Paraphyses filiform, exceeding the asci.

Conidial stage similar to that of *L. agassizii* occasionally present.
HOSTS: *Abies* spp., *Pinus monticola*

***Lachnellula flavovirens* (Bres.) Dennis Persoonia 2: 184 (1962).**

Apothecia scattered, short-stipitate, brown, saucer-shaped, approx. 3 mm diameter, hymenium bright yellow to orange-yellow; ectal excipulum of two layers; outer layer of compact yellow-brown hyphal cells which extend to form long cylindrical hairs; inner layer of *textura oblita*. The medullary excipulum is of *textura intricata*, hyaline and loosely interwoven. Asci clavate, short-stalked, 8-spored, pore not staining blue in iodine (J-), $65-75 \times 5-7$ um. Ascospores obliquely uniseriate, oblong-ellipsoid, with fusiform ends, hyaline, $7-12 \times 4-5$ um. Paraphyses longer

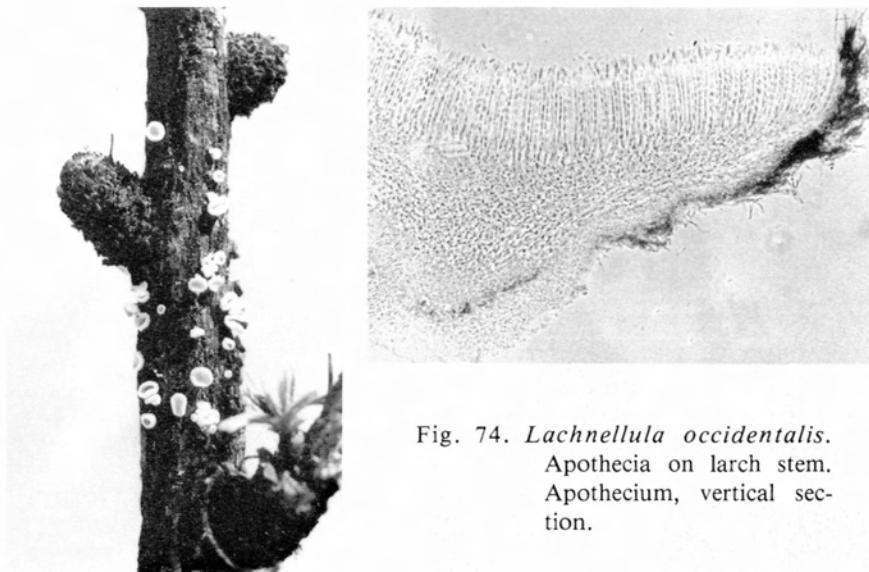


Fig. 74. *Lachnellula occidentalis*.
Apothecia on larch stem.
Apothecium, vertical sec-
tion.

than the ascii and containing orange oil globules.

HOSTS: *Pinus*, *Larix*

DISEASE: A facultative parasite of pine and larch, associated with cankers and dieback (Frajo-Apor 1976).

NOTES: There are several other brown-excippled species of *Lachnellula*: A closely related species, *L. arida* (Phill.) Dennis, differs chiefly in size of ascospores which are only $6-9 \times 5$ um, and the ectal excipulum is formed of *textura globulosa* (Dharne 1965). (Fig. 73). This is a parasite of pine and balsam fir (Smerlis 1973).

Lachnellula pini (Brunch.) Dennis has brown apothecia from 2-4 mm diameter, ascii from $88-123 \times 7-12$ um and ascospores $13-22 \times 4-7$ um. This species is parasitic on soft pines (5-needle pines) causing stem cankers (Hahn and Ayers 1934b).

Lachnellula fuscosanguinea (Rehm) Dennis has a red hymenium and olive-brown apothecia 2-6 mm diameter. Ascii measure $70-105 \times 7-12$ um, ascospores ellipsoid, $10-17 \times 4-6$ um. Saprophytic on hard pines (*Pinus contorta*) (Hahn and Ayers 1934b).

Lachnellula occidentalis (Hahn & Ayers) Dharne Phytopath. Z. 53: 129 (1965).

SYNONYM: *Lachnellula hahniana* (Seaver) Dennis

Apothecia single or caespitose, 1-3 mm diameter, short-stipitate, white, urn-shaped at first, becoming saucer-shaped, hymenium orange-buff to salmon-orange; ectal excipulum of *textura globulosa* with flexuous, minutely roughened hairs that

are easily broken off; medullary excipulum of loosely interwoven, hyaline *textura intricata*. Ascii clavate, obtusely rounded apex, $120-150 \times 10-12$ um, ascus pore stained blue in iodine. Ascospores eight, uniseriate, hyaline, continuous, ellipsoid, $15-23 \times 4-8$ um. Paraphyses filiform, exceeding the asci, with moniliform filaments interspersed sometimes. (Fig. 74).

HOSTS: *Larix* spp., *Abies grandis*

NOTES: Pathogenicity on larch confirmed by Smerlis (1973).

***Lachnellula pseudotsugae* (Hahn) Dennis** Persoonia 2: 184 (1962).

ANAMORPH: *Naemospora*

Apothecia white, short-stipitate, with persistent hairs, hymenium orange-yellow to orange, 1-3.5 mm diameter. Ascii clavate, $50-60 \times 3-5.5$ um. Ascospores hyaline, continuous, ellipsoid, $4-7.5 \times 2-4$ um. Paraphyses filiform, longer than the asci.

Conidial stage of light buff stromata with irregular labyrinthiform cavities. Conidiophores subulate, phialidic, conidia hyaline, continuous, ellipsoid, $3.5-4 \times 2.5$ um.

HOST: *Pseudotsuga menziesii*

DISEASE: Causes perennial target cankers of young Douglas-firs, especially on dry sites.

NOTES: Another white species, occurring on small dead twigs of Douglas-fir, is *Lachnellula ciliata* (Hahn) Dennis, with apothecia 1-2 mm diameter, very conspicuous hairs, larger ascii ($60-90 \times 6-12$ um) and ascospores $8-12 \times 4-6$ um.

***Lachnellula suecica* (de Bary ex Fckl.) Nannf.** Fungi exs. Suec. Praes. Upps. Fasc. 41-42: 48 (1953).

Apothecia large, white, up to 6 mm diameter, hymenium orange-red, with persistent white hairs. Ectal excipulum of *textura globulosa*. Ascii cylindric, apex stained blue by iodine, $60-70 \times 6-7$ um. Ascospores hyaline, continuous, globose, 4-6 um diameter. Paraphyses cylindric, slightly swollen above, with colored oil globules.

Typical *Naemospora* sometimes present, with conidia measuring $3-5 \times 1-1.5$ um.

HOSTS: *Larix*, *Pinus*, *Picea*

***Leciographa gallicola* Funk** Can. J. Botany 57: 4 (1979).

ANAMORPH: *Seimatosporium etheridgei* Funk

Apothecia black, sessile, carbonaceous, solitary or caespitose, gregarious, 0.5-0.9 mm diameter, composed of *textura globulosa*; hymenium black, plane, without margin. Ascii clavate, bitunicate, 8-spored, bluing entirely in iodine, $85-100 \times 10-18$ um. Ascospores ellipsoid to oblong, dark brown with end cells light brown to hyaline, 3-7-euseptate, $27-50 \times 8-12$ um. Paraphyses hyaline, branched, greatly swollen at the apex with brown, globose cells, exceeding the asci and forming a thick, dark epithecium. (Fig. 75).

Acervuli depressed or invaginated in proliferated bark, black, irregular to round-ed, more or less in concentric rings, subiculum composed of brown, isodiametric cells, 0.1-0.4 mm diameter. Conidiophores arising from the upper cells of the

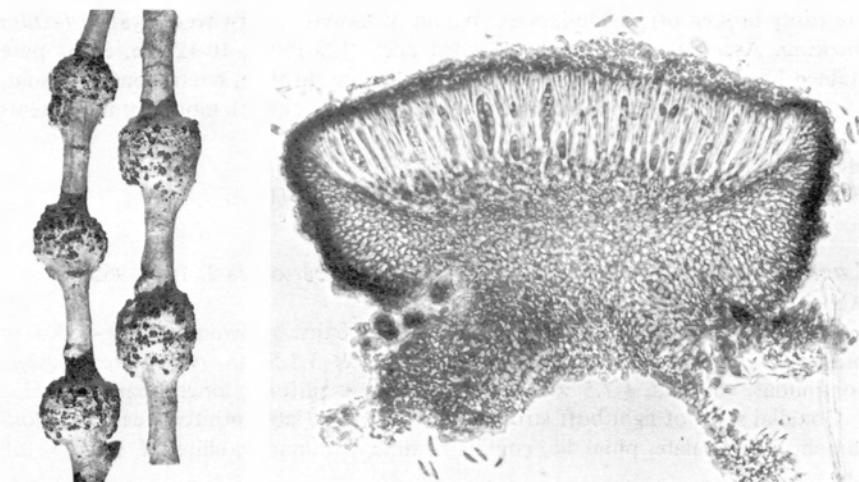


Fig. 75. *Leciographa gallicola*. Apothecia on aspen galls. Apothecium.

subiculum, hyaline, septate, cylindric, $10-12 \times 4$ um. Conidiogenous cells anellophores, borne terminally. Conidia solitary in the apices, oval to oblong, occasionally broadly fusiform, straight or slightly curved, median cells dark brown, apical and basal cells hyaline to light brown, 3-6-euseptate, $30-40 \times 13-15$ um, basal cell sometimes truncate with a marginal frill. (Fig. 76).

HOSTS: *Populus* spp.

DISEASE: Associated with gall diseases of poplars.

NOTES: The causal relations have not been established, but it may produce bark swellings (Funk 1978b) or be a parasite of the poplar galls (Funk 1979a).

Although described separately, the two states of this fungus have been linked culturally, identical conidia forming in colonies grown from ascospores or conidia.

Leucostoma kunzei (Fr.) Munk Dansk. Bot. Ark. 15: 80 (1953).

SYNONYM: *Valsa kunzei* Fr.

ANAMORPH: *Leucocytospora kunzei* (Sacc.) Urban

SYNONYM: *Cytospora kunzei* Sacc.

Stromata conic, erumpent through the bark to expose a gray to blackish disc (ectostroma), sometimes marginate, delimited by a black conceptacle, entostroma pale brown. Perithecia embedded in entostroma, globose to irregularly flattened, 200-600 um diameter. Ostiolar necks collectively erumpent through ectostromatic disc, 300-350 um long. Asci clavate, with apical ring, 8-spored, $20-30 \times 4-6$ um. Ascospores hyaline, allantoid, unicellular, rounded at both ends, $6-9 \times 1-2$ um. (Fig. 77).

Pycnidial stroma immersed in the bark, similar to perithecial stroma, multilocular,

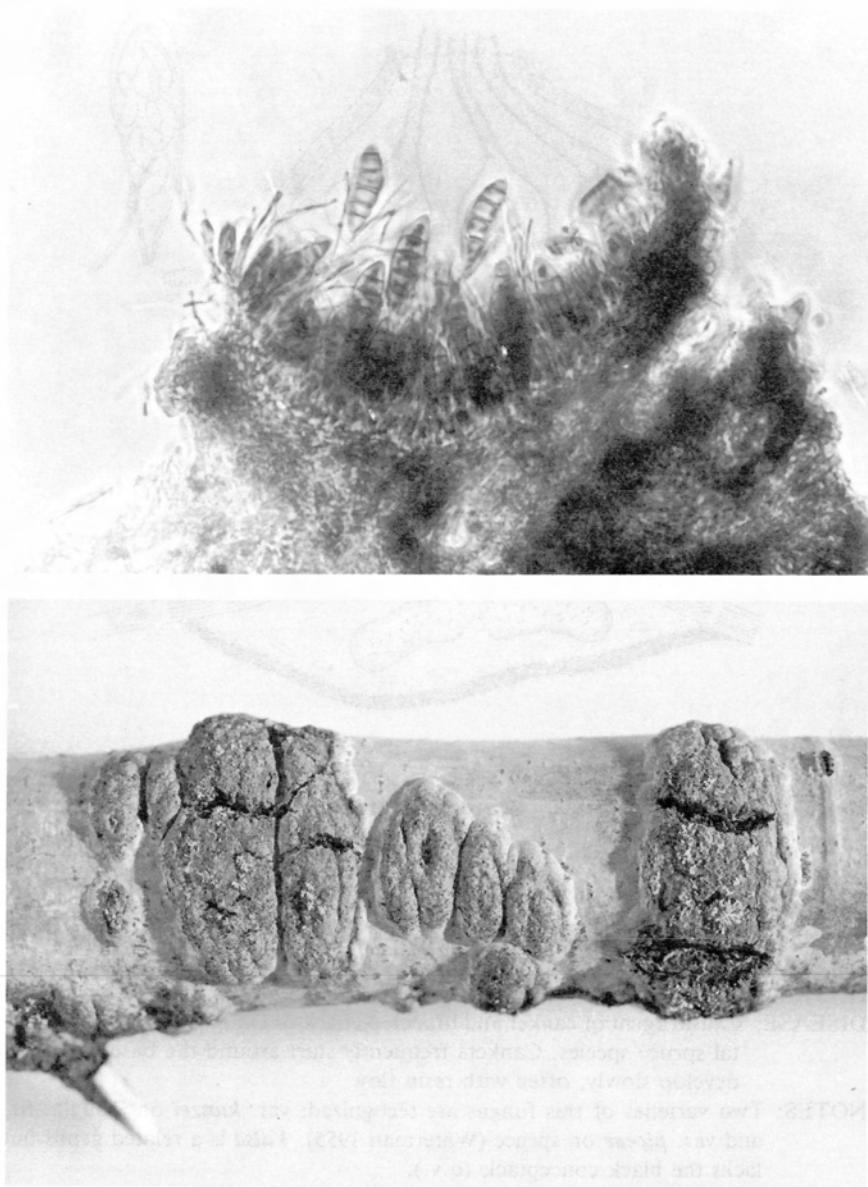


Fig. 76. *Lecio grapha gallicola*. *Seimatosporium* anamorph, acervulus with conidia.
Bark swellings on aspen associated with this fungus, but probably produced by *Diplodia tumefaciens*.

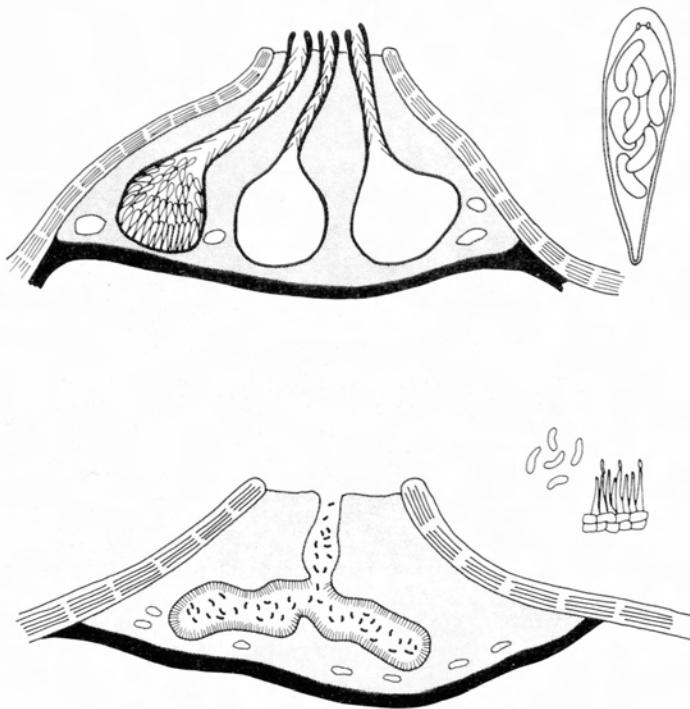


Fig. 77. *Leucostoma kunzei*. Perithecia (semidiagrammatic). *Leucocytospora* anamorph.

with a single pore at the center of the stroma. Conidiophores simple, hyaline, conglutinated in later stages. Conidia hyaline, allantoid, unicellular, $4-6 \times 0.5-1$ um.

HOSTS: *Pseudotsuga menziesii*, *Picea* spp.

DISEASE: Causal agent of canker and branch dieback of Douglas-fir and ornamental spruce species. Cankers frequently start around the base of a twig, develop slowly, often with resin flow.

NOTES: Two varieties of this fungus are recognized: var. *kunzei* on Douglas-fir, and var. *piceae* on spruce (Waterman 1955). *Valsa* is a related genus but lacks the black conceptacle (q.v.).

***Lophium mytilinum* (Pers.) Fr.** Syst. Myc. 2: 533 (1823).

Hysterothecia mussel-shaped, erect, black, shiny, often with a foot-like stalk, brittle, 1-2 mm long, 0.2-0.6 mm wide, 0.3-0.8 mm high. Wall composed of dark, isodiametric pseudoparenchyma. Ascii cylindric with a short foot, bitunicate, 8-spored, $180-260 \times 10$ um. Ascospores filiform, pale olivaceous, parallel in the

ascus, many-septate, 170-250 × 1-2 um.

HOSTS: Numerous conifer genera

NOTES: Secondary invader of a variety of bark diseases of conifers.

***Melanconis thelebola* (Fr.) Sacc.** Syll. Fung. I: 605 (1882).

Perithecia valloid, in groups of 6-10, immersed, spheric, 800-1100 um diameter; ostioles collectively erumpent through a stromatic disc, up to 250 um thick at the tip, lined with periphyses. Ascii oblong-cylindric, sessile, mixed with paraphyses, 140-150 × 16-20 um. Ascospores 2-3-seriate, sausage-shaped, curved, 2-celled, hyaline, 24-42 × 8-10 um, with a long slender appendage at each end.

HOSTS: *Alnus* spp.

NOTES: Saprophytic.

***Melanconium bicolor* Nees** Syst. Pilze 32 (1817).

Acervuli immersed, producing a flat-conical pustule in the bark, at first white inside; black spore mass spreading on the bark. Conidiophores hyaline, subulate, approx. 25 × 2 um; conidiogenous cells annellidic. Conidia brown, not opaque, ovoid, usually 1-guttulate, 10-16 × 6-8 um. Hyaline, cylindric beta-conidia have been reported in culture (*Libertella*).

HOSTS: *Betula* spp.

DISEASE: Associated with branch dieback.

***Melanconium sphaeroideum* Link ex Fr.** Linn. Spec. Pl. Ed. Willd. 6: 92 (1825).

TELEOMORPH: *Melanconis alni* Tul.

Acervuli immersed, producing a flat-conical pustule in the bark, black spore mass spreading over the pustule. Conidiophores narrow, subulate, approx. twice the length of the conidia. Conidia ovoid to rounded-ellipsoid, hyaline at first but becoming deep black, 10-13 × 6.5-7.5 um.

HOST: *Alnus rubra*

DISEASE: Associated with branch dieback.

NOTES: A large-spored species on *Acer macrophyllum* is very close to *M. ovatum*

Link, but the conidia are slightly broader (26 × 15 um). (Fig. 78). The teleomorphs of these *Melanconium* species are all in the genus *Melanconis*, but are rarely found in western trees.

***Monocillium nordinii* (Bourchier) Gams** *Cephalosporium-artige* Schimmel. 162 (1971).

Cultural Description: Colonies on malt agar expanding 1 cm in 10 days, light orange-yellow, reverse darker yellow, finely floccose or farinaceous with interwoven synnemata. Phialides straight or slightly curved, subulate, thick-walled below, mostly simple, 23-45 × 3 um. Conidia obovate, hyaline, unicellular, 3-6 × 2 um, produced in dry heads or short chains.

HOST: *Pinus contorta*

NOTES: Isolated from the healthy heartwood of lodgepole pine (Bourchier 1961).

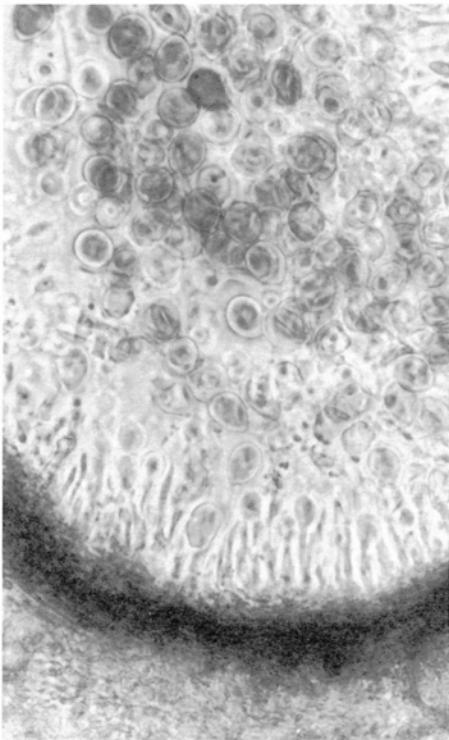


Fig. 78. *Melanconium* sp. from maple. Pycnidium and conidia.

Mycosphaerella populinum G.E. Thompson Phytopathology 31: 246 (1941).

ANAMORPH: *Septoria musiva* Peck

Pseudopothecia scattered or aggregated, partly erumpent, black, globose, wall pseudoparenchymatous, papillate, 64-106 um diameter. Asci bitunicate, cylindric-clavate, fasciculate, 8-spored, 54-70 × 13-16 um. Ascospores hyaline, ellipsoid, 1-septate, slightly constricted at the septum, 16-28 × 4-6 um. Paraphyses absent.

Pycnidia immersed, globose to subglobose, ostiolate, 48-128 um diameter. Conidia cylindric, straight or curved, hyaline, 1-4-septate, 28-54 × 4 um. In humid conditions, conidia ooze out in a pink tendril.

HOSTS: *Populus* spp.

DISEASE: Causes cankers and leaf spot of native, exotic and hybrid poplars.

NOTES: Another related species, *M. populincola* G.E. Thompson (ANAMORPH: *Septoria populincola* Peck), produces similar diseases in poplars, but is somewhat larger in all respects: pseudopothecia 96-160 um diameter; asci 64-90 × 13-16 um; ascospores 22-32 × 6 um; conidia 45-80 × 3.5-4.5 um (Bier 1939; Thompson 1941; Zalasky 1978).

Mytilidion gemmigenum Fckl. Symb. Myc. II: 299 (1871).

Hysterothecia mussel-shaped, erect, black, shiny, striated, brittle, 0.4-1 mm long, 0.2-0.5 mm wide, 0.3-0.6 mm high. Wall composed of dark, isodiametric pseudoparenchyma. Ascii cylindric with a short foot, bitunicate, 8-spored, 100-150 × 10-14 um, surrounded by paraphysoids. Ascospores yellow to brown, cylindric-fusoid, 8-10 celled, (27)32-38(48) × (4)5-6(8) um.

Conidial state is probably a *Septonema* species (Bisby and Hughes 1952).

HOSTS: *Larix occidentalis*, *Pinus contorta*

NOTES: Saprophytic on killed branches of larch (Funk 1969b). The closely related species, *M. tortile* (Schw.) Ell. & Ev., was found on dwarf mistletoe swellings of *Tsuga* (Baranyay 1966) and differs in its slightly longer hysterothecia and in its 3-septate ascospores that measure 14-17 × 5-7 um.

Nectria cinnabarina (Tode ex Fr.) Fr. Sum. Veg. Scand. 388 (1849).

ANAMORPH: *Tuberularia vulgaris* Tode ex Fr.

Perithecia red, clustered on an erumpent stroma or on the edge of a conidial stroma, globose, slightly collapsed at the ostiole, rough outer wall, approx. 400 um in diameter. Ascii cylindric-clavate, 8-spored, 60-90 × 9-14 um. Ascospores elliptic-cylindric, hyaline, slightly constricted at the single, central septum, 12-20 × 4-9 um.

Sporodochia pink to light red, erumpent through the bark, cushion-shaped, up to 500 um in diameter. Phialides subulate, 20-30 × 2-4 um, arise from the pseudoparenchymatic stroma, densely packed. Conidia oval to cylindric, 5-7 × 2-3 um, produced in large masses and supported in a mucous.

HOSTS: Hardwoods

DISEASE: Associated with canker and dieback of hardwoods, weakly parasitic.

Nectria ditissima Tul. Sel. Fung. Carp. 3: 73 (1865).

ANAMORPH: *Cylindrocarpon willkommii* (Lindau) Wr.

Perithecia deep red, clustered on a poorly developed stroma, 3-50 in a cluster, smooth, 250-300 um diameter. Ascii clavate, short-stalked, apex thin-walled, rounded, 8-spored, 85-95 × 15-18 um. Ascospores variable in shape and size, oval to ellipsoid, slightly constricted at the central septum, 14-21 × 5-8 um.

Macroconidia formed on branched conidiophores, each terminating in 1-3 phialides, cylindric, straight or slightly bent, narrowing slightly toward the apex, 4-7-septate, 50-90 × 3-6 um.

HOST: *Alnus rubra*

DISEASE: Causing large, perennial stem cankers of red alder. First reported by Zeller (1935) and confirmed by cultural isolation from cankered trees in British Columbia. (Fig. 79).

NOTES: A closely related species, *N. galligena* Bres., causes cankers of western flowering dogwood (Shaw and Harris 1967) and aspen (Zalasky 1968a); it is distinguished by its rough-walled perithecia and shorter, stouter macroconidia.

Table 5. *NECTRIA* SPECIES

Species	Anamorph	Perithecia	Asci	Ascospores	Hosts
<i>N. cinnabrina</i>	<i>Tubercularia vulgaris</i>	approx. 400 um	60-90 × 9-14 um	12-20 × 4-9 um	Hardwoods
<i>N. coccinea</i>	<i>Cylindrocarpon</i>	approx. 300 um	75-100 × 7-10 um	12-15 × 5-6 um	<i>Acer</i> , <i>Salix</i>
<i>N. ditissima</i>	<i>Cylindrocarpon willkommii</i>	approx. 300 um	85-95 × 15-18 um	14-21 × 5-8 um	<i>Alnus rubra</i>
<i>N. episphaeria</i>	<i>Fusarium</i>	approx. 140 um	56-70 × 5-6 um	7-11 × 4-5 um	Pyrenomyces
<i>N. fuckeliana</i>	<i>Cylindrocarpon cylindroides</i> var. <i>tenuie</i> Basham's Fungus F	approx. 400 um	86-120 × 7-9 um	13-16 × 5-6 um	<i>Abies lasiocarpa</i>
<i>N. galligena</i>	<i>Cylindrocarpon heteronema</i>	250-350 um	75-95 × 12-15 um	14-22 × 6-9 um	<i>Populus tremuloides</i> , <i>Cornus nuttallii</i>
<i>N. macrospora</i>	<i>Cylindrocarpon cylindroides</i>	400-600 um	85-130 × 8-12 um	16-22 × 5-7 um	<i>Tsuga</i> , <i>Pinus</i> , <i>Abies</i>

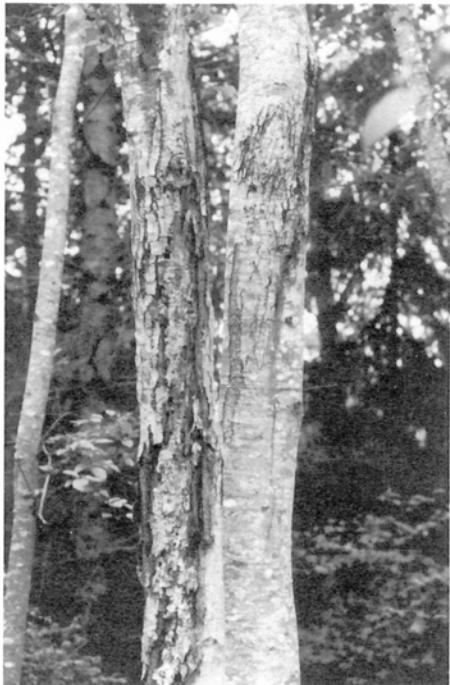


Fig. 79. *Nectria ditissima*. Canker on red alder.

Nectria episphaeria (Tode ex Fr.) Fr. Sum. Veg. Scand. 388 (1849).

ANAMORPH: *Fusarium*

Perithecia bright red, ampulliform with short papilla, smooth, single or gregarious on a thin byssus, 125-140 μ m diameter. Ascii cylindric-clavate, with apical ring, 8-spored, 56-70 \times 5-6 μ m. Ascospores hyaline, ellipsoid, slightly constricted at the single central septum, 7-11 \times 4-5 μ m.

Macroconidia produced in culture, falcate, 2-5-septate, with *Fusarium*-type foot cell, 35-50 \times 3 μ m.

HOSTS: Sphaeriaceous pyrenomycetes

NOTES: Because this fungus is a mycoparasite, it can be confused with the tree parasite.

Nectria fuckeliana Booth C.M.I. Mycol. Paper 73: 56 (1959).

ANAMORPH: *Cylindrocarpon cylindroides* Wr. var. *tenue* Wr.

Perithecia red to maroon, broadly ovate, with a short papilla, 300-400 μ m in diameter. Ascii cylindric, with thickened apex, possessing an apical ring, 8-spored, 86-120 \times 7-9 μ m. Ascospores broadly fusiform to ellipsoid, hyaline to light brown at maturity with slight roughening, 13-16 \times 5-6 μ m.

Cultures are white and floccose, assuming a powdery appearance due to formation

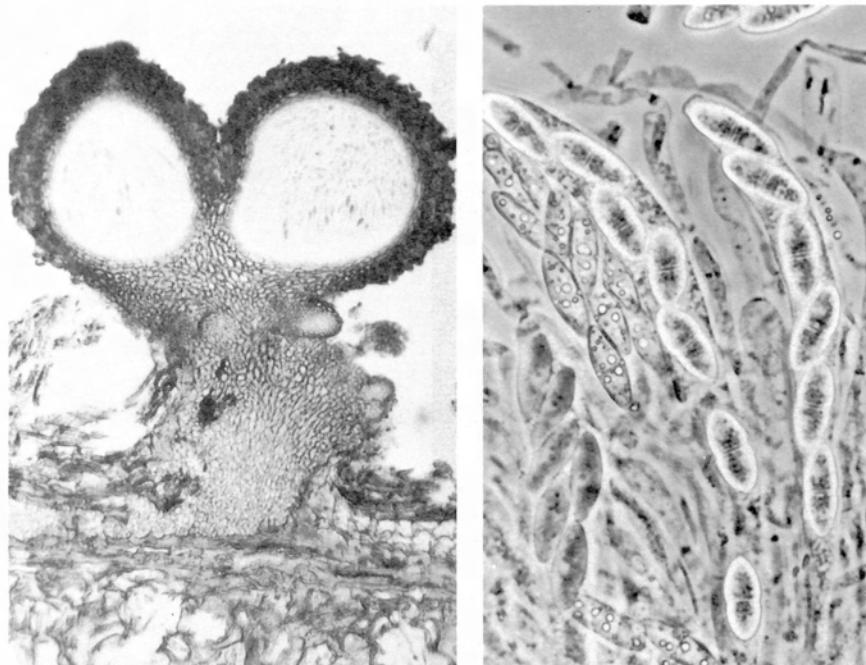


Fig. 80. *Nectria macrospora*. Perithecia on stroma, vertical section. Ascii and ascospores.

of masses of microconidia. Phialides simple or branched, 15-25 × 1-1.5 um. Microconidia cylindric to oval, hyaline, 4-8 × 2-4 um. Macroconidia sparse or absent, hyaline, cylindric, 3-7-septate, 33-85 × 4-7 um.

HOST: *Abies lasiocarpa*

DISEASE: Isolated from stems of alpine fir. Associated with logging damage and incipient decay; a wound parasite, sometimes also associated with dieback.

NOTES: This species in culture was referred to as Fungus F before its identification (Basham 1958b). The microconidial state was also described by Gams (1971).

A similar species, *N. coccinea* (Pers. ex Fr.) Fr., occurs on *Acer* and *Salix*; it is distinguished by its smaller perithecia and yellow-brown cultures.

***Nectria macrospora* (Wr.) Ouellette** Eur. J. For. Path. 2: 178 (1972).

SYNONYM: *Nectria fuckeliana* Booth var. *macrospora* (Wr.) Booth

ANAMORPH: *Cylindrocarpon cylindroides* Wr.

Perithecia bright red, densely clustered on an erumpent stroma, ovoid, papillate,

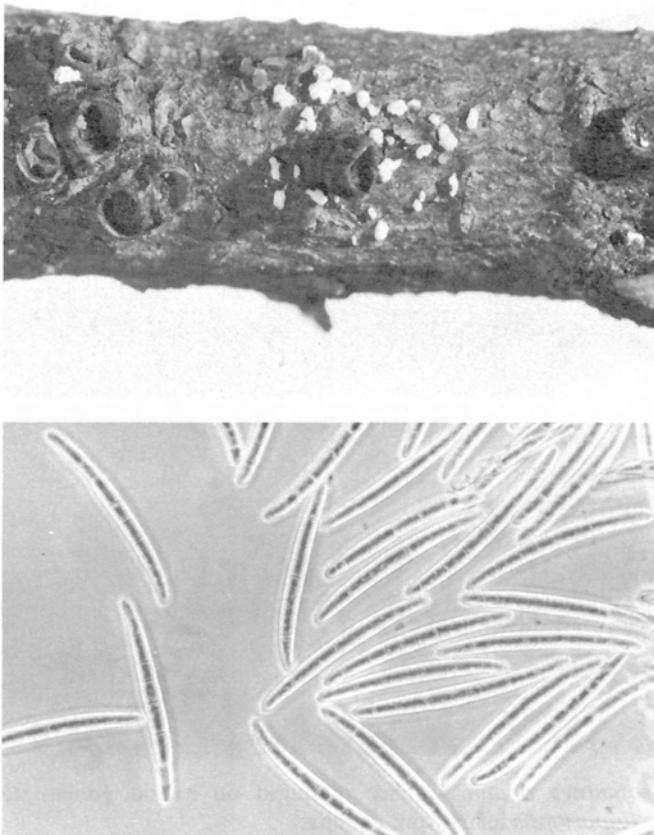


Fig. 81. *Nectria macrospora*. *Cylindrocarpon* anamorph, sporodochia produced on hemlock branch attacked by dwarf mistletoe. Conidia.

400-600 μm in diameter. Ascii cylindric, apex rounded with a well-marked ring, 85-130 \times 8-12 μm . Ascospores ellipsoid, slightly constricted at the single central septum, hyaline and smooth, becoming light brown and slightly verrucose, 16-22 \times 5-7 μm . (Fig. 80).

Sporodochia pure white, erumpent, dry, 1-2 mm in diameter. Conidiophores phialidic, branching, up to 80 μm in length, 2-3 μm wide. Conidia cylindric, curved, hyaline, 5-10-septate, 80-105 \times 5-7 μm . (Fig. 81).

HOSTS: *Tsuga heterophylla*, *Pinus* spp., *Abies* spp.

DISEASE: Causes cankering and death of dwarf mistletoe swellings in western hemlock (Funk, Smith and Baranyay 1973). Also attacks the galls pro-

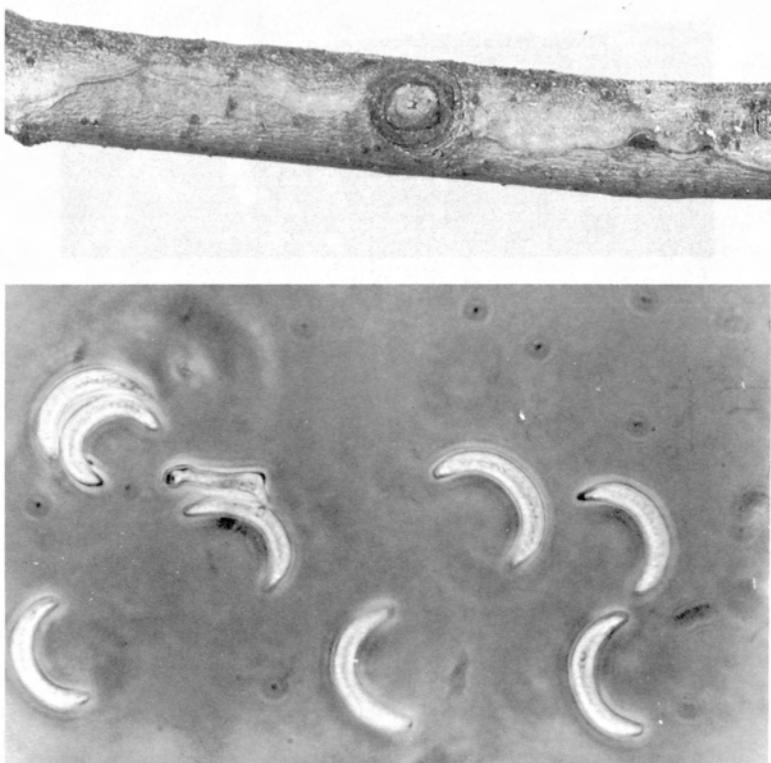


Fig. 82. *Neofabraea populi*. Canker produced on hybrid poplar stem. *Cryptosporiopsis* anamorph, conidia.

duced by the rust fungus *Endocronartium harknessii* (J.P. Moore) Y. Hirat. on shore pine (Byler, Cobb and Parmeter 1972).

Neofabraea populi G.E. Thompson Mycologia 31: 458 (1939).
ANAMORPH: *Cryptosporiopsis*

Apothecia erumpent, densely aggregated, single or rarely confluent, fleshy, brown, circular, umbilicate, short-stalked, 0.5-1.5 mm diameter, tissue plectenchymatous. Ascii cylindric-clavate, short-stalked, 8-spored, 80-112 × 9-12 um. Ascospores oblong-ellipsoid, straight or slightly curved or flattened unilaterally, hyaline, 0-3-septate, 16-22 × 5-6 um. Paraphyses filiform, septate, simple or branched, slightly swollen at the tips.

Acervuli exposed by rupturing of periderm, densely aggregated, white or pale yellowish, 0.5-1.5 mm diameter. Stroma plectenchymatous, up to 50 um thick. Con-

idiophores hyaline, septate, simple or branched, 25-35 × 4 um; conidiogenous cells phialidic, ampulliform. Conidia borne singly at tips of phialides, cylindric-fusiform, curved, hyaline, nonseptate, contents granular, 25-45 × 4-5 um, sometimes oozing out in pinkish masses. (Fig. 82).

HOSTS: *Populus* spp.

DISEASE: The cause of serious cankering in native and exotic poplars, especially hybrids, encountered in young nursery stock. (Fig. 82).

NOTES: The genus *Neofabrea* is sometimes considered synonymous with *Pezicula*.

***Nipterella tsugae* Funk Can. J. Botany 56: 1578 (1978).**

Apothecia superficial, gregarious, subsessile, at first subglobose, expanding to circular discs, regular to broadly undulate, occasionally proliferating smaller apothecia

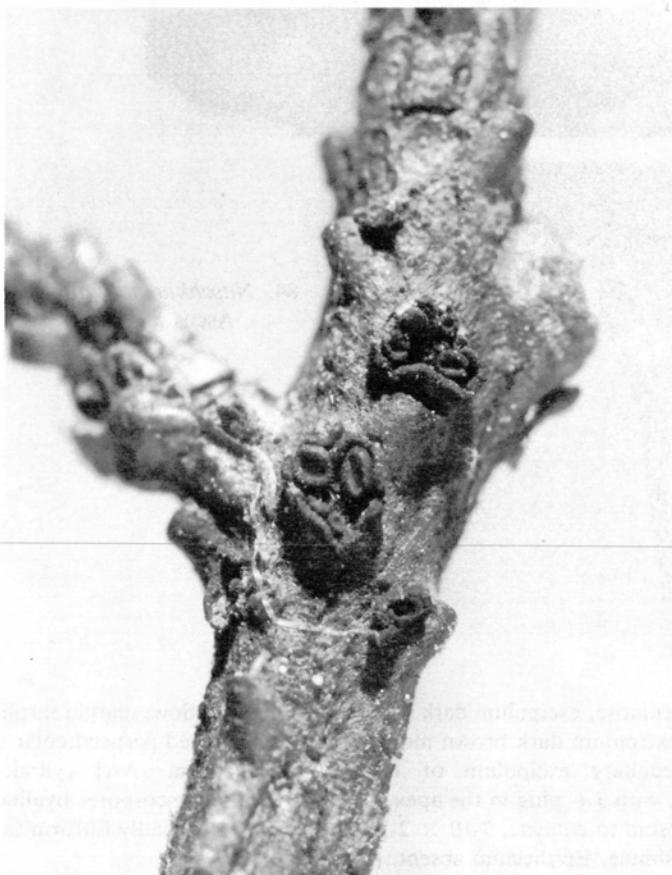


Fig. 83. *Nipterella tsugae*. Apothecia on hemlock twig.

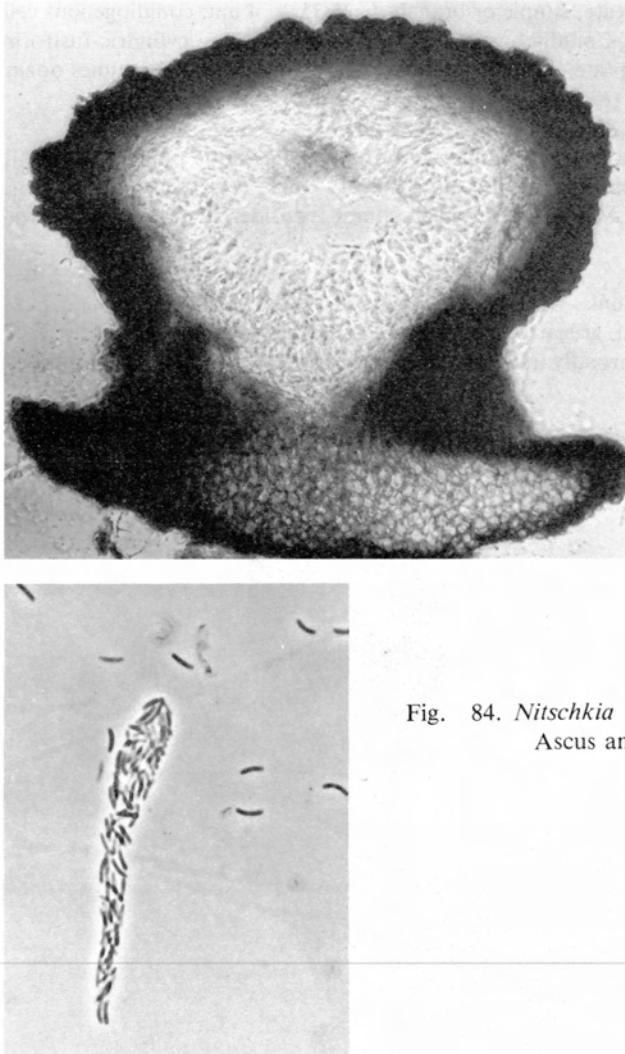


Fig. 84. *Nitschkia molnarii*. Ascocarp.
Ascus and ascospores.

within, pruinose, excipulum dark brown, hymenium yellow, margin inrolled. Tissue of ectal excipulum dark brown moniliform cells arranged perpendicular to the surface; medullary excipulum of hyaline plectenchyma. Asci cylindric-clavate, 8-spored, with J+ plug in the apex, $45-55 \times 6-8$ um. Ascospores hyaline, nonseptate, ellipsoid to cuneate, $7-10 \times 2-3$ um. Paraphyses broadly filiform to cylindric, hyaline, simple. Epithecum absent. (Fig. 83).

HOST: *Tsuga heterophylla*

DISEASE: On shaded branches of young saplings.

Nitschzia molnarii Funk Can. J. Botany 57: 2113 (1979).

Ascocarps black, erumpent, solitary or in small clusters, collapsing cupulate, apical papilla inconspicuous or absent, tuberculate, composed of brown pseudoparenchyma with "Munk pores", $0.5-0.7 \times 0.5$ mm. Subiculum pseudoparenchymatous. "Quellkörper" present. Ascii clavate, short-stalked, apical wall thickened, 64-spored, $90-110 \times 12-15$ um. Ascospores hyaline, allantoid, nonseptate or indistinctly 1-septate, $6-8 \times 1.5-2$ um. (Fig. 84).

HOSTS: *Pseudotsuga menziesii*, *Tsuga heterophylla*

DISEASE: Associated with terminal dieback.

NOTES: A microconidial state associated with this fungus is probably related to it, but this has not been proven.

Paecilomyces varioti Bainier Bull. Soc. Myc. France 23: 26 (1907).

Cultural Description: Colonies growing rapidly on most media, yellowish brown, loosely floccose and ropy. Phialides simple or verticillate, flask-shaped, 15-20 um long. Conidia borne in long chains, elliptical, yellow-brown, $5-7 \times 3$ um. Chlamydospores present or absent.

HOST: *Pinus contorta*

NOTES: Isolated from living heartwood of pine (Bourchier 1961). This species resembles the anamorph of *Byssochlamys fulva* Olliver & Smith whose spores can withstand the commercial sterilizing process. Cosmopolitan on a wide variety of substrates.

Parkerella populi Funk Can. J. Botany 54: 868 (1976).

Ascomata black, erumpent, stipitate, turbinate, 125-200 um in diameter, 240-250 um high; excipulum composed of dark brown *textura epidermoidea*, dehiscing over the hymenium in irregular radiating fissures, 10-25 um thick; hymenium with ascii at several levels; subhymenium hyaline, composed of thin-walled *textura angularis*. Ascii clavate, long-stalked, unitunicate, J-, $85-110 \times 10-14$ um. Paraphyses filiform, anastomosing frequently, not swollen at the tips. Ascospores hyaline, crescent-shaped, 1-or 3-septate, $18-33 \times 4$ um. (Figs. 85, 86).

HOST: *Populus tremuloides*

DISEASE: On cork-bark of aspen, often associated with *Rhytidella baranyayi*. Causal relationships not known.

Pestalopezia tsugae Funk Can. J. Botany 56: 1575 (1978).

Apothecia erumpent, single or in small groups, subsessile to short-stalked, at first globose, then expanding to circular discs; excipulum grayish brown, pruinose with a dark brown hymenium. Tissue of ectal excipulum of light brown *textura globulosa*; medullary excipulum of white *textura globulosa*; a narrow hypothecium of yellowish *textura intricata*. Ascii cylindric, 4-spored, J-, 110×15 um. Ascospores ellipsoid, dark brown with a brittle episore, one or two guttulate, nonseptate, $20-24 \times 10-14$ um. Paraphyses hyaline, filiform, simple, greatly inflated at the tip with brown, globose cells 6-10 um diameter, forming a dark brown epithecium. (Fig. 87).

HOST: *Tsuga heterophylla*

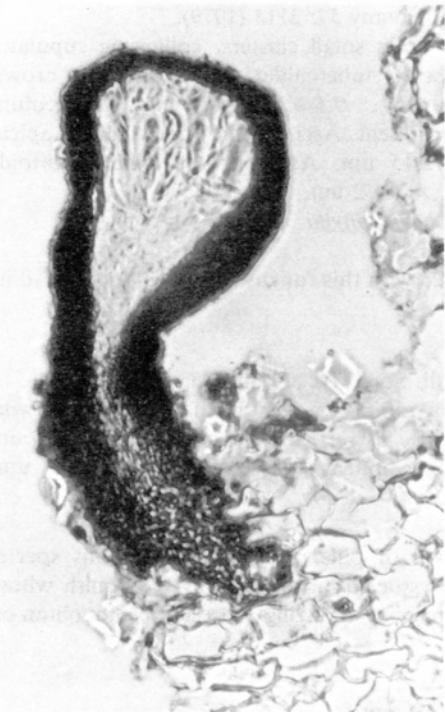


Fig. 85. *Parkerella populi*. Ascoma.

DISEASE: Associated with dieback of branches.

NOTES: Associated with *Seiridium abietinum* but no relationship proven.

Pestalotiopsis funerea (Desm.) Steyaert Bull. Jard. Bot. Brux. 19: 340 (1949).

Acervuli lenticular to globose, rupturing the epidermis, 1-2 mm diameter. Conidiogenous cells annellidic, formed from upper cells of acervular stroma, cylindric to obovoid, 5-15 × 2-4 um. Conidia fusiform, straight or curved, 4-euseptate, slightly constricted at the septa, 3 median cells olive-brown, apical and basal cells hyaline, 22-32 × 7-13 um; with 2-6 apical appendages hyaline, 5-28 um long; basal appendage single, endogenous, hyaline, straight, 2-11 um long. (Fig. 88).

HOSTS: Cupressaceae

DISEASE: Causes stem and leaf blight of conifers, especially Cupressaceae. Also saprophytic on dead material. Often in association with other fungi in diseased trees. Not considered a serious pathogen in good growing conditions.

NOTES: The genus *Pestalotiopsis* has 4-euseptate conidia, separating it from *Pestalotia* which has 5-distoseptate conidia (Sutton 1969). See note under *Truncatella truncata*.

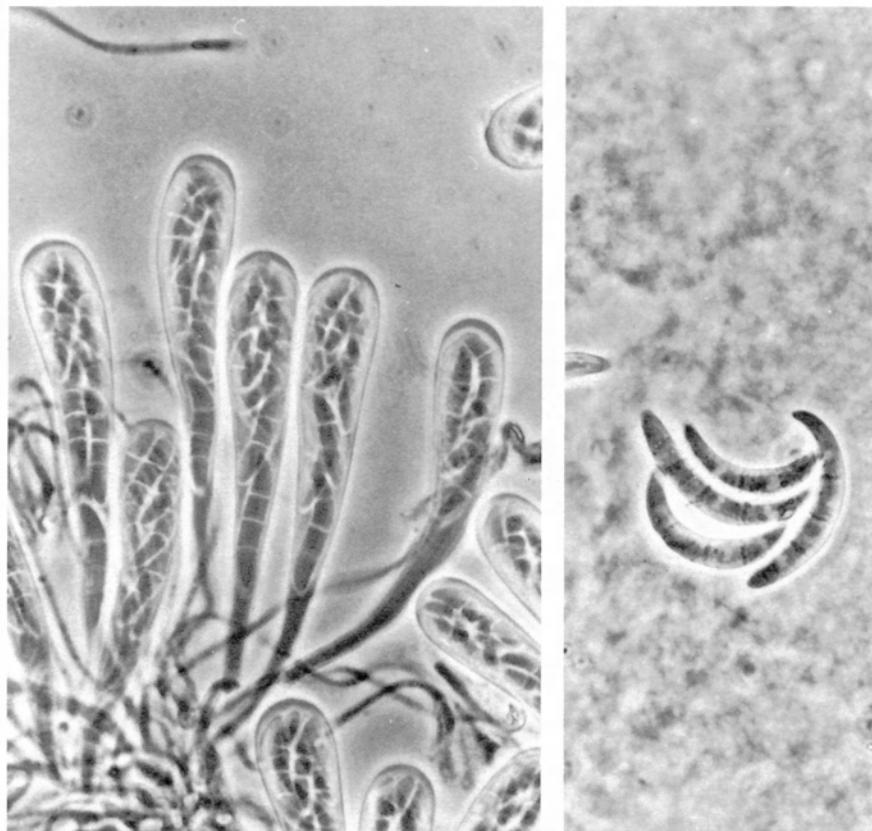


Fig. 86. *Parkerella populi*. Asci. Ascospores.

Pezicula livida (Berk. & Br.) Rehm Ber. Nat. Ver. Augsberg 26: 112 (1881).
ANAMORPH: *Cryptosporiopsis*

Apothecia erumpent, single or in small clusters, orange-yellow or brownish, subsessile, up to 2 mm diameter; excipulum of pale *textura globulosa*. Asci clavate, 4-8-spored, up to 120×20 um, pore staining blue in iodine after treatment with dilute KOH. Ascospores ellipsoid, hyaline, partially biseriate when 8-spored, often 3- or more-septate at maturity, $20-30 \times 6-8$ um. Paraphyses filiform, swollen at the apex. (Fig. 89).

Conidial stromata (acervuli) immersed, irregular, splitting overlying bark, pseudoparenchymatous, colorless, $0.5-0.7$ um diameter; conidiophores (annellides) simple, cylindric, $8-10 \times 2-3$ um. Conidia hyaline, oblong, aseptate, $20-32 \times 10-12$ um. (Fig. 90).

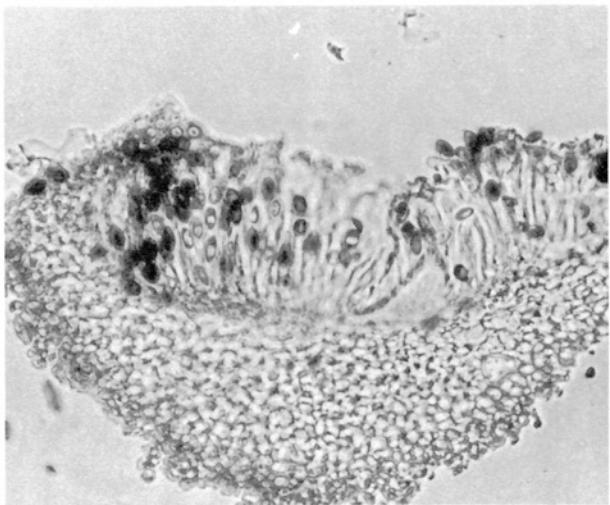


Fig. 87. *Pestalopezia tsugae*. Apothecium.

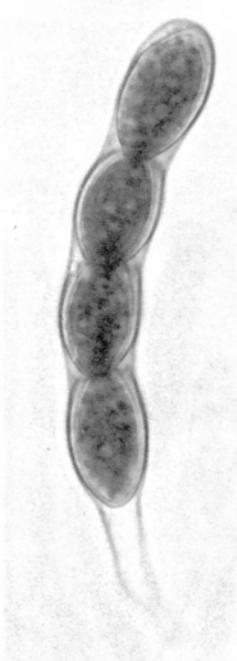


Fig. 88. *Pestalotiopsis funerea*.
Conidia.



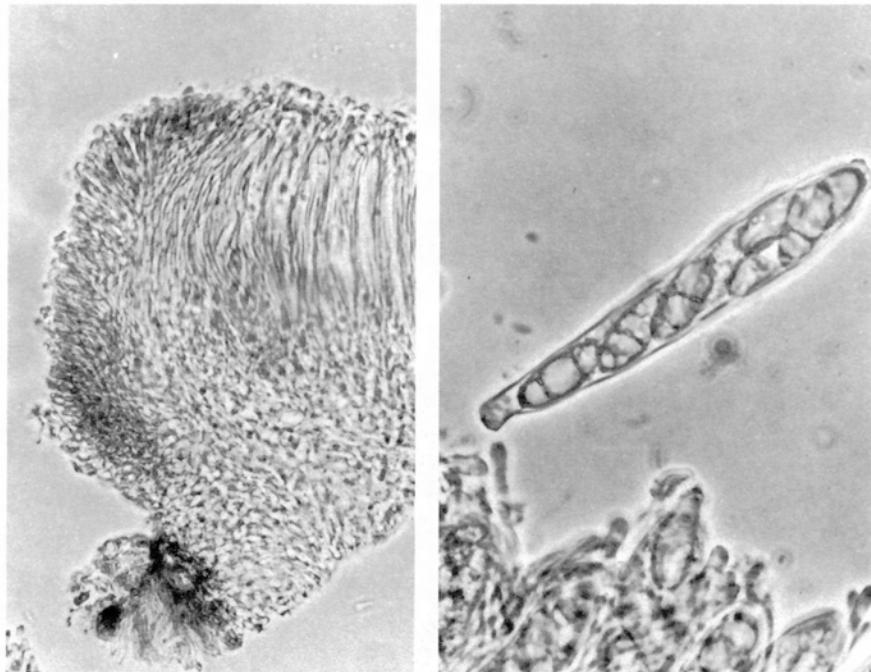


Fig. 89. *Pezicula livida*. Portion of an apothecium, vertical section. Ascus with ascospores.

HOSTS: *Pseudotsuga menziesii*, *Tsuga heterophylla*

DISEASE: A secondary invader of cankers and diebacks in Douglas-fir and western hemlock.

***Pezicula ocellata* (Pers.) Seaver** N. Am. Cup Fungi (Inoperculates) 345 (1951).

Apothecia erumpent, single, yellowish with an irregular whitish margin, 1-2 mm diameter. Ascii clavate, non-stipitate, 8-spored, 120×24 um. Ascospores hyaline, ellipsoid, 0-3-septate, $25-30 \times 10-12$ um. Paraphyses filiform, enlarged above.

Acervuli submerged and erupting the bark, fleshy. Conidiophores phialidic, up to 35 um long, subulate. Conidia ellipsoid, hyaline, with granular contents, $30-35 \times 10-12$ um.

HOSTS: *Salix*, *Populus*

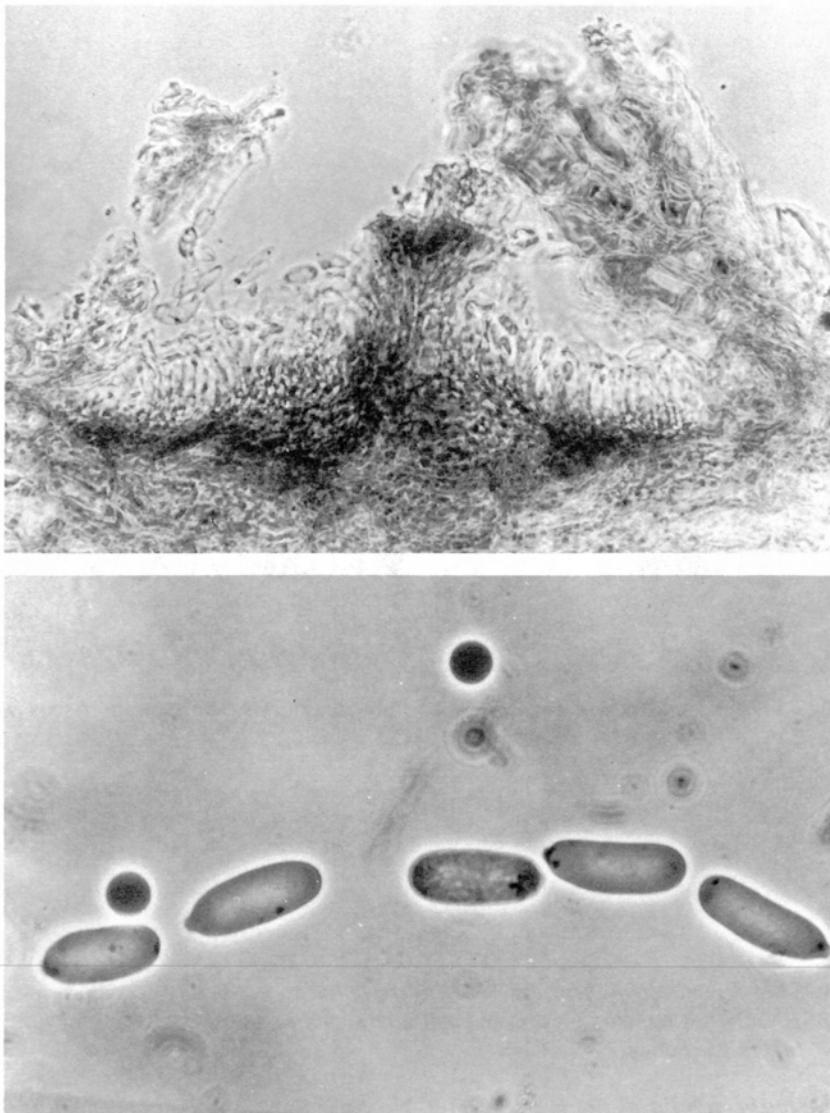
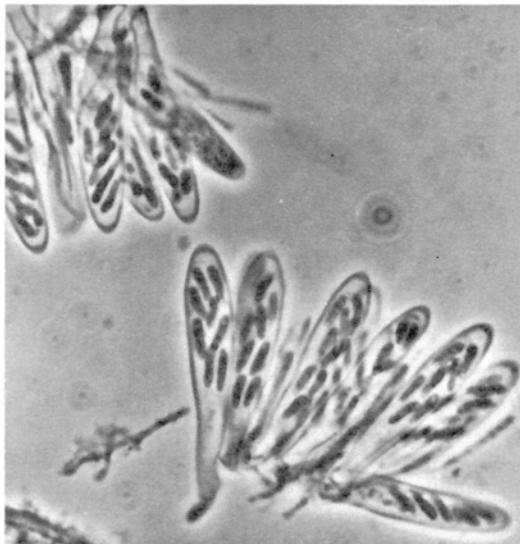


Fig. 90. *Pezicula livida*. *Cryptosporiopsis* anamorph, subperidermal acervulus.
Conidia, produced in culture.



Fig. 91. *Pezizella chapmani*.
Apothecium. Asci.



Pezizella chapmani Whitney & Funk Can. J. Botany 55: 888 (1977).

ANAMORPH: *Monilia*

Apothecia in the bark, minute, white, circular, stalked, slightly pruinose, single, 100-400 μm diameter; excipulum composed of prismatic cells, hairs acute, recurved, 6-8 μm long. Asci clavate or subcylindric, 8-spored, not bluing in iodine (J-), 27-47 \times 4-8 μm . Ascospores monostichous or distichous, allantoid or oval, nonseptate or rarely uniseptate, hyaline, 5-9 \times 2-2.5 μm . Paraphyses sparse, filiform and branched, slightly swollen at the tips, not exceeding the asci in length. (Fig. 91).

Monilia state produced in culture. Conidia catenate, hyaline, subglobose or rectangular, 3-6 \times 1.5-3.5 μm . (Fig. 92).

HOSTS: *Picea*, *Pinus*, *Pseudotsuga menziesii*

NOTES: Grows inside bark beetle galleries.

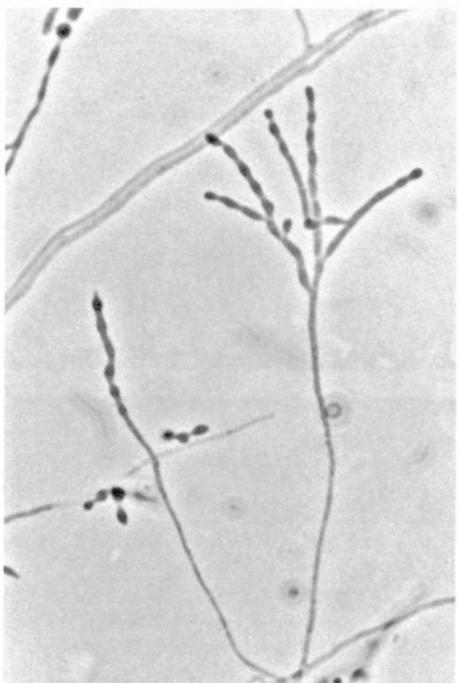


Fig. 92. *Pezizella chapmanii*.
Monilia state in culture.

Phoma glomerata (Corda) Wr. & Hochapf. Z. Parasit Kde. 8: 592 (1936).

Pycnidia globose to pyriform or elongated, with long necks and often with more than one ostiole, dark brown, 50-300 um in diameter; wall of dark pseudoparenchyma outside, of subhyaline, thin-walled cells inside, bearing conidio-phores. Conidia unicellular, rarely 1-septate, ellipsoid to oblong or obovate, guttulate, subhyaline, smooth, pale olive-brown with minutely roughened wall, 5-10 × 2.5-4 um. Dictyochlamydospores brown, in chains sometimes branched, irregularly ovate, up to 9 transverse septa and 3-6 longitudinal septa (produced in culture).

HOSTS: Conifers

DISEASE: Causes damping-off of conifer seedlings.

NOTES: Similar to *P. pomorum* Thuem. (= *P. prunicola* (Opiz.) Wr. & Hochapf.) also found on conifer seedlings, but this species produces chlamydospores terminally and singly, not in chains.

Macrophomina phaseolina (Tassi) Gord. causes seedling blight in southern nurseries. Black sclerotia are produced in stems and roots and pycnidia contain hyaline, ellipsoid conidia, 14-30 × 5-10 um.

Phomopsis juniperovora Hahn Phytopathology 10: 248 (1920).

Pycnidia erumpent on stems and leaves, solitary, lenticular to subglobose, dark brown, ostiolate, up to 400 um diameter, unilocular or rarely plurilocular,

Table 6. *PHOMOPSIS* SPECIES

Species	Teleomorph	Pycnidia	A-conidia	B-conidia	Hosts
<i>P. juniperovora</i>	unknown	400 um 6-12 × 2-3 um	Fusiform 6-10 × 2-4 um	Filiform, curved 20-30 × 1 um	<i>Juniperus</i> , Cupressaceae
<i>P. lokoyae</i>	<i>Diaporthe lokoyae</i>	300-600 um	Ellipsoid-fusoid 6-10 × 2-4 um	Fusiform 10-12 × 1.5-2 um	<i>Pseudotsuga</i> , <i>Tsuga</i> , <i>Thuja</i>
<i>P. oblonga</i>	<i>Diaporthe eres</i>	1-2 mm	Fusiform 5-11 × 2-4 um	Filiform 25-33 × 1 um	<i>Acer</i> , <i>Populus</i> , <i>Salix</i>
<i>P. occulta</i>	<i>Diaporthe conorum</i>		Ellipsoid 6.9 × 2-3 um	Filiform, curved 20-30 × 1 um	Conifers
<i>P. porteri</i>	unknown	250-400 um	Ellipsoid 6.5-8 × 2.5-3.5 um	Falcate 10-12 × 1.5 um	<i>Pseudotsuga</i>

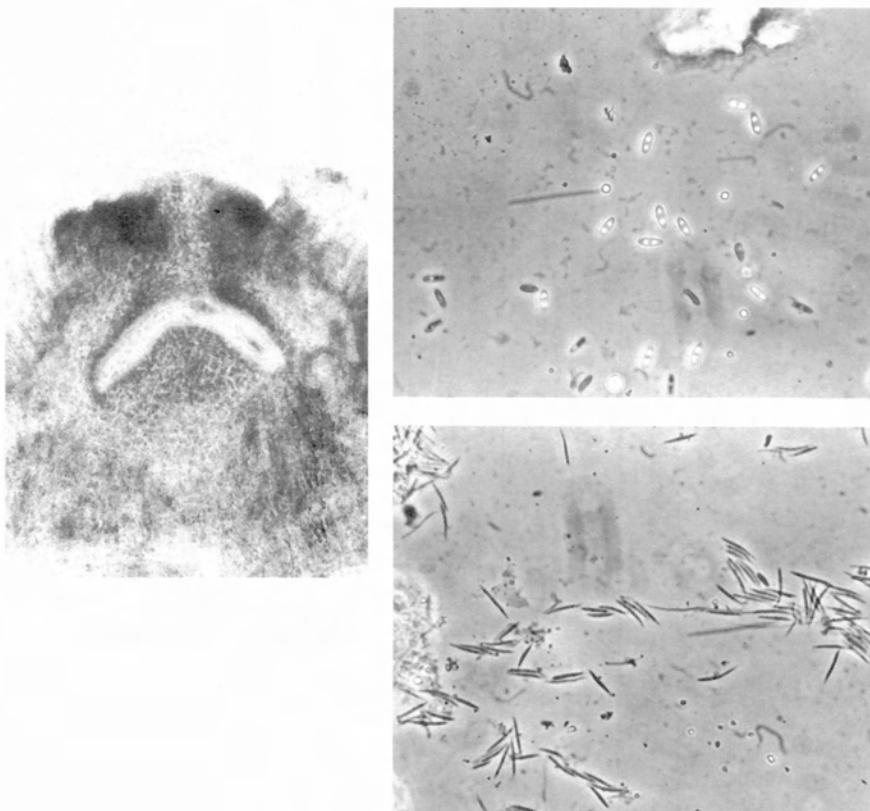


Fig. 93. *Phomopsis lokoyae*. Pycnidium. Conidia.
(See description under *Diaporthe lokoyae*).

pseudoparenchymatous. Conidiophores subulate, lining interior of locules, simple or branched, 5-15 × 1-2 um. Conidiogenous cells enteroblastic, mono-phialidic, cylindric to obclavate. A-conidia (phialospores) hyaline, unicellular, fusiform to ellipsoid, biguttulate, 6-12 × 2-3 um; B-conidia (phialospores) hyaline, filiform, curved or hooked, 20-30 × 1 um.

HOSTS: *Juniperus* spp., Cupressaceae, Pinaceae

DISEASE: Causes blight of new shoots and death of seedlings. Dieback may result from spread to older tissues. Occasionally found in forest nurseries.

***Phomopsis porteri* Funk Can. J. Botany 53: 2300 (1975).**

Pycnidia erumpent, solitary, black, irregularly shaped, multiloculate or uniloculate, composed of *textura angularis*, 250-400 × 325-400 um. Conidiogenous cells phialidic, enteroblastic, subulate, simple, 10-12 × 2 um. Phialoconidia of 2

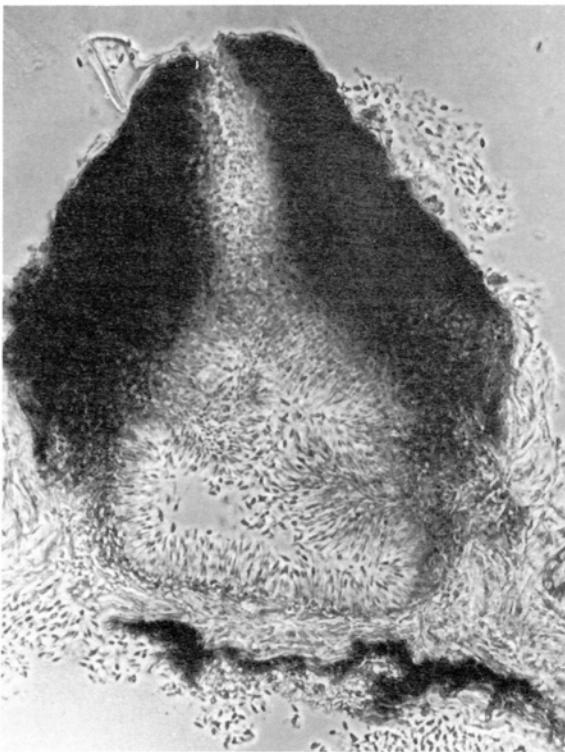


Fig. 94. *Phomopsis porteri*. Pycnidium, vertical section. Conidia.

kinds: A-conidia ellipsoid, hyaline, biguttulate, $6.5-8 \times 2.5-3.5$ um; B-conidia falcate, hyaline, $10-12 \times 1.5$ um. (Fig. 94).

HOST: *Pseudotsuga menziesii*

DISEASE: Associated with branch tip dieback in young Douglas-fir. Rare.

Phyllostictina hysterella (Sacc.) Petr. Trans. Brit. Mycol. Soc. 22: 102 (1938-39).

TELEOMORPH: *Physalospora gregaria* Sacc.

Pycnidia immersed, subgregarious, dark brown, subglobose to ovoid, $185-210 \times 140-180$ um, ostiole indistinct, wall of dark brown elongated cells, young pycnidia filled with parenchymatous cells. Conidiophores straight, cylindric, tapered at the tip, $5-11 \times 2-3$ um. Conidia in mucilage, oval to elliptical, unicellular, hyaline, filled with granular cytoplasm, $10-16 \times 8-10$ um.

HOST: *Taxus brevifolia*

DISEASE: Causes shoot and leaf blight of western yew.

NOTES: The teleomorph has not been found in the range of western yew.



Fig. 95. *Pleospora laricina*. Ascus and ascospores.

Pithya vulgaris Fckl. Jahrb. Nass. Naturk. 23-24: 317 (1870).

Apothecia gregarious, sessile to short-stipitate, at first subglobose becoming discoid, regular to undulate in age, pale orange to yellowish white, with white mycelium at the base, reaching a diameter of 12 mm; hymenium bright orange, plane to convex; asci cylindric, operculate, 8-spored, $300-325 \times 15$ μm ; ascospores uniseriate, at first granular, later with one large oil droplet, globose, smooth, hyaline, 12-14 μm diameter; paraphyses filiform, slightly enlarged above.

HOSTS: *Pseudotsuga menziesii*, *Abies* spp.

NOTES: Saprophytic on branches of balsam and Douglas-fir. A closely related species on *Juniperus* and *Thuja* is *P. cupressina* (Fr.) Fckl. with smaller apothecia, asci (up to 250 μm long) and ascospores (10-12 μm diameter).

Pleospora laricina Rehm Hedwigia 21: 121 (1882).

Ascostromata immersed or erumpent, single or clustered, globose, black, 200-900 μm diameter, ostiole short and stout; wall thick, parenchymatous with an inner hyaline layer. Asci long-cylindric, bitunicate, base claw-like, $90-170 \times 10-20$ μm .



Fig. 96. *Potebniamyces balsamicola* var. *balsamicola*. Apothecium, ascospores, ascii, pycnidium and conidia.

Ascospores ellipsoid to fusoid, yellow-brown, muriform, 5-7 cross septa, constricted at center septum, $18-28 \times 8-12$ um. Pseudoparaphyses filiform, numerous. (Fig. 95).

HOSTS: Conifers and hardwoods

NOTES: Saprophytic on wood and bark of conifers and hardwoods.

Potebniamyces balsamicola Smerlis var. *balsamicola* Can. J. Botany 40: 352 (1962).

ANAMORPH: *Phaciidiopycnis balsamicola* Funk

Apothecia stromatic, intraperidermal, erumpent, sessile, circular to ellipsoid, black, 0.3-1.0 mm diameter, covered by a black excipulum that splits irregularly to expose the pale hymenium. Ascii clavate-cylindric, 8-spored, J+, unitunicate, $60-90 \times 6-8$ um, apex subacute. Ascospores uniseriate or irregularly biseriate, hyaline, nonseptate, biguttulate or triguttulate, ellipsoid-fusoid, $8-15 \times 4-6$ um. Paraphyses filiform, septate, simple or branched, tips slightly swollen, forming an epithecium. (Fig. 96).

Pycnidia stromatic, intraperidermal, partially erumpent, single or gregarious, multiloculate, 0.2-0.6 mm diameter, subglobose, usually with a heavy dark wall above. Conidiophores phialidic, tapered, $6-10 \times 2-4$ um, lining inner cavities of pycnidium. Conidia hyaline, nonseptate, irregularly rhomboid, guttulate, $6-12 \times 3-5$ um.

HOSTS: *Abies lasiocarpa*, *A. balsamea*

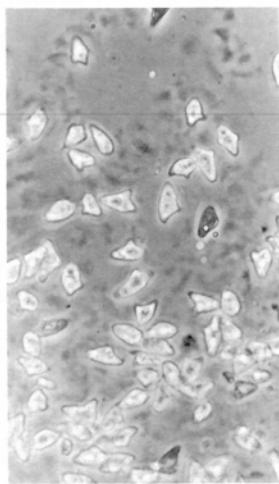


Fig. 97. *Potebniamyces balsamicola* var. *boycei*. Canker on grand fir. Conidia.

DISEASE: Causing cankers, dieback and tip-blight of balsam and alpine firs (Smerlis 1973).

Potebniamyces balsamicola var. *boycei* Funk Can. J. Botany 48: 1023 (1970).

ANAMORPH: *Phaciidiopycnis boycei* (Hahn) Funk

Morphologically similar to var. *balsamicola* except that the conidia are markedly angular, trapeziform and irregular. (Fig. 97).

HOSTS: *Abies grandis*, *A. amabilis*

DISEASE: Causing canker and dieback of grand fir and amabilis fir.

NOTES: This fungus produces the antibiotic phacidin in culture (Funk and McMullan 1974).

In a revision of the family Phaciidiaceae, these species of *Potebniamyces* on conifers are all considered to belong to the genus *Phacidium* (F. diCosmo, personal communication).

Potebniamyces coniferarum (Hahn) Smerlis Can. J. Botany 40: 352 (1962).

SYNONYM: *Phaciidiella coniferarum* Hahn

ANAMORPH: *Phaciidiopycnis pseudotsugae* (M. Wils.) Hahn

SYNONYM: *Phomopsis pseudotsugae* M. Wils.

Apothecia discoid, black, sessile, 0.3-1.0 mm in diameter, covered by a dark olivaceous excipulum that splits irregularly to expose the dark hymenium. Ascii clavate-cylindric, stalked, 80-140 × 8-12 um, usually 8-spored but not less than 4-spored, sometimes with secondary 'bud' spores. Ascospores hyaline, guttulate, irregularly elliptic-fusiform, aseptate or occasionally 1-2-septate, 10-20 × 3-6 um. 'Bud' spores rod-shaped, aseptate, hyaline, 3-5 × 1-1.5 um. Paraphyses numerous, filiform, simple or branched near the tip, tips slightly swollen, greenish, forming an epitheciun above the ascii.

Pycnidia black, stromatic, embedded in the bark, partially erumpent, lenticular to subglobose, usually without a definite ostiole, uni- or plurilocular, 0.1-1 mm in diameter. Conidiophores phialidic, lining inner walls, subulate, simple, 5-10 um in length. Conidia hyaline, aseptate, elliptic-fusoid or irregularly rhombic, guttulate, 5-12 × 2-4 um.

HOSTS: *Pseudotsuga menziesii*, *Larix occidentalis*, *Tsuga*

DISEASE: Causes stem and branch cankers of young Douglas-fir, and top dieback of western larch (Wicker 1965). Rare in western Canada (Hahn 1957a, b). A virulent pathogen on eastern conifers (Smerlis 1973).

Pragmopora pini Groves Can. J. Botany 45: 173 (1967).

Apothecia erumpent, scattered or gregarious, separate or clustered, sessile, narrowed below, circular or undulate, 0.3-0.5 mm diameter, black, glabrous, hard; hymenium black, plane, slightly marginate; excipulum of interwoven hyphae (*textura epidermoidea*), brownish in the medulla, very dark and thick-walled in the outer rind; hypothecium lacking. Ascii cylindric-clavate, tapered below to a slender stalk, 8-spored, slightly J+, 80-120 × 10-13 um. Ascospores hyaline, elongate-fusiform

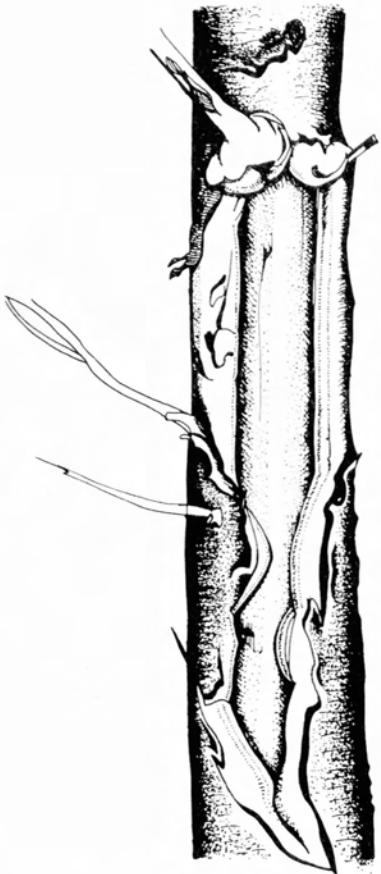


Fig. 98. *Pragmopora pithya*. Canker produced along bark-miner gallery.

to subfiliform, pointed at the ends, straight or curved, 11-15-septate, 30-60 \times 3-4 μm . Paraphyses hyaline, filiform, septate, simple or branched, 1-1.5 μm diameter, tips slightly swollen and embedded in a gelatinous matrix to form an epithecium.
HOST: *Pinus monticola*

***Pragmopora pithya* (Fr.) Groves** Can. J. Botany 45: 176 (1967).
ANAMORPH: *Pragmopycnis pithya* Sutton & Funk

Apothecia erumpent, scattered or gregarious, separate or clustered, at first globose, becoming circular to undulate, sessile, narrowed below, 0.2-0.8 mm diameter, black, glabrous, hard; hymenium black, olivaceous when moist, plane with slightly raised margin; medullary excipulum of interwoven hyphae (*textura epidermoidea*), brownish, rind-like outer zone of more parallel hyphae with very dark thick walls (*textura oblita*). Ascii cylindric-clavate tapering to a stalk, 8-spored, sometimes filled with minute bud spores, J+, 100-400 \times 10-15 μm . Ascospores hyaline, filiform, pointed at the ends, nearly straight or flexuous, up to 35-septate,

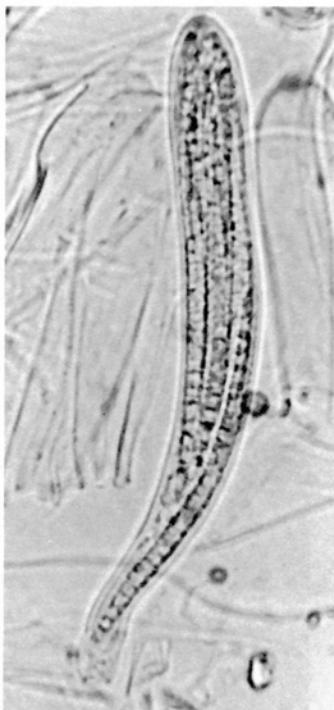


Fig. 99. *Pragmopora pithya*.
Apothecium, vertical
section. Ascus.
Ascospore with secon-
dary spores.

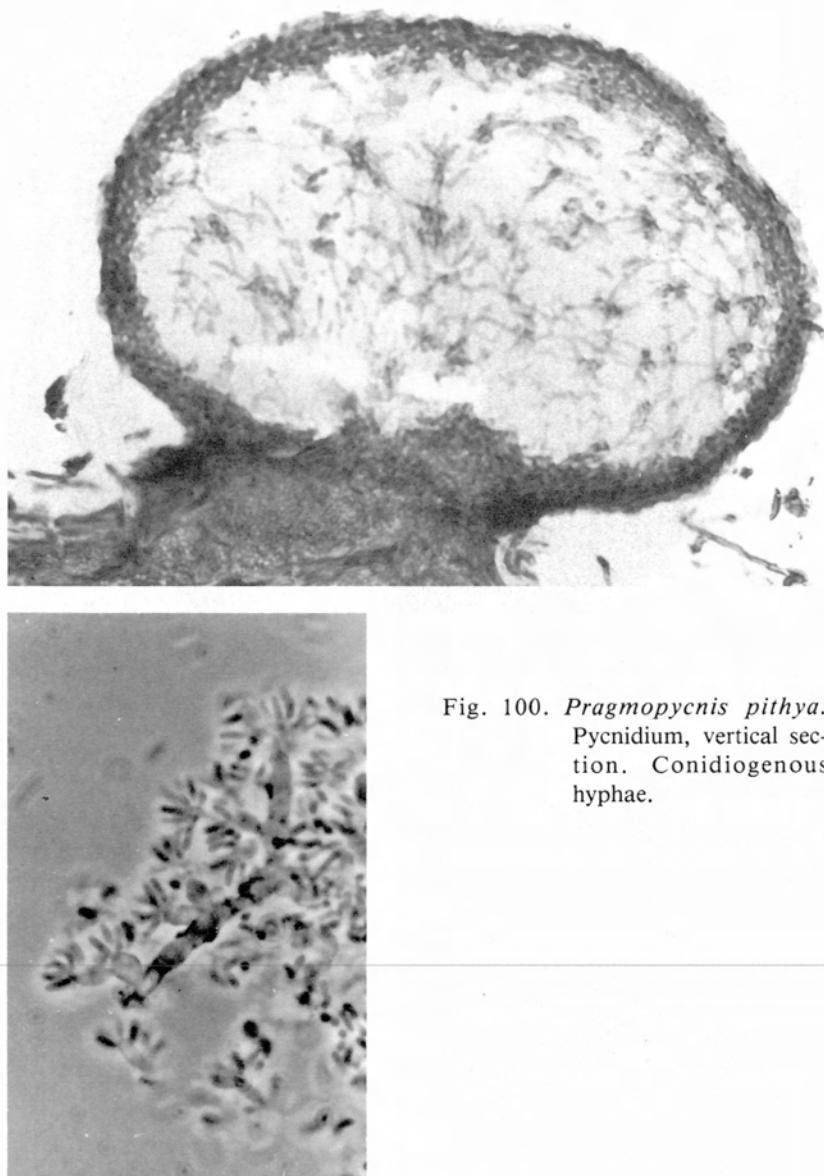


Fig. 100. *Pragmopycnis pithya*.
Pycnidium, vertical sec-
tion. Conidiogenous
hyphae.

$45-75 \times 3-4$ um. Paraphyses hyaline, filiform, septate, simple or branched, 1-1.5 um diameter, tips slightly swollen and embedded in a brownish matrix to form an epithecium. (Fig. 99).

Pycnidia separate, sparse, appearing superficial but often seated on a short, thick base, subglobose to flattened, dull black, unilocular, 200-500 um diameter, base composed of brown parenchyma, lateral and upper walls of dark brown, thick-walled cells on the outside, becoming paler toward the inside; ostiole absent, dehiscence by irregular breakdown of the upper wall. Conidiophores originate from base of pycnidium or from lateral walls, ramifying throughout locule, oriented \pm vertically, septate, hyaline, branched, 2 um wide. Conidiogenous cells enteroblastic, polyphialidic, up to 15 apertures per cell, terminal or intercalary, hyaline, up to 6 um long \times 1.5-2 um. Conidia hyaline, aseptate, guttulate, fusiform-allantoid, 3-4 \times 1 um. (Fig. 100).

HOST: *Pseudotsuga menziesii*

DISEASE: Causes stem cankers of Douglas-fir. Sometimes associated with bark mining insects and then causing bark necrosis around the galleries (Funk 1975b). (Fig. 98). Attacks many different conifers in eastern Canada (Smerlis 1973).

NOTES: In culture, colonies are dark, *Aureobasidium*-like (Hermanides-Nijhof 1977).

Pseudopachacidium garmani Funk Can. J. Botany 58: 2447 (1980).

ANAMORPH: *Myxofusicoccum*

Apothecia dark brown, round, stipitate, single or aggregated in small clusters, originating in subcortical stroma, 0.5-1.2 mm diameter, 0.5-0.6 mm high; hymenium pale brown, plane; excipulum covering hymenium dark brown, crustose, splitting diametrically with irregular cracks which open when moistened. Ascii clavate, 8-spored, J-, 80-105 \times 10-12 um. Ascospores pyriform or ovate, hyaline, nonseptate, 10-12 \times 4-4.5 um, sometimes dimorphic and 17 \times 8.5 um. Paraphyses straight, simple, septate, 3 um diameter, shorter than the ascii. (Fig. 101).

Conidiomata dark brown, subglobose or irregular, multiloculate, non-ostiolate, 0.4-1.2 mm diameter. Conidiophores simple, subulate, arising from cells of inner lining, 10-12 um tall. Conidia hyaline, pyriform, nonseptate, 8-12 \times 4-6 um. Sometimes conidial locules are formed in the medulla of the apothecia, or a part or whole of the hymenium of an apothecium is filled with conidia. The top surfaces of both pycnidia and apothecia are often encrusted with white crystals. (Fig. 102).

HOSTS: *Picea glauca*, *P. engelmannii*

DISEASE: Associated with death of young spruce regeneration in open areas.

Retinocyclus abietis (Crouan) Groves & Wells Mycologia 48: 869 (1956).

SYNONYM: *Sarea difformis* (Fr.) Fr.

ANAMORPH: *Epithyrium resinae* (Sacc. & Berl.) Sacc.

Apothecia black, glabrous, circular to undulate, separate or subcaespitose, superficial, sessile, 0.5-1 mm in diameter; hymenium black, plane, with a raised margin at first. Tissue structure of apothecia composed of interwoven hyphae (plectenchyma) throughout, the outer wall (ectal excipulum) of dark brown, thick-walled hyphae.

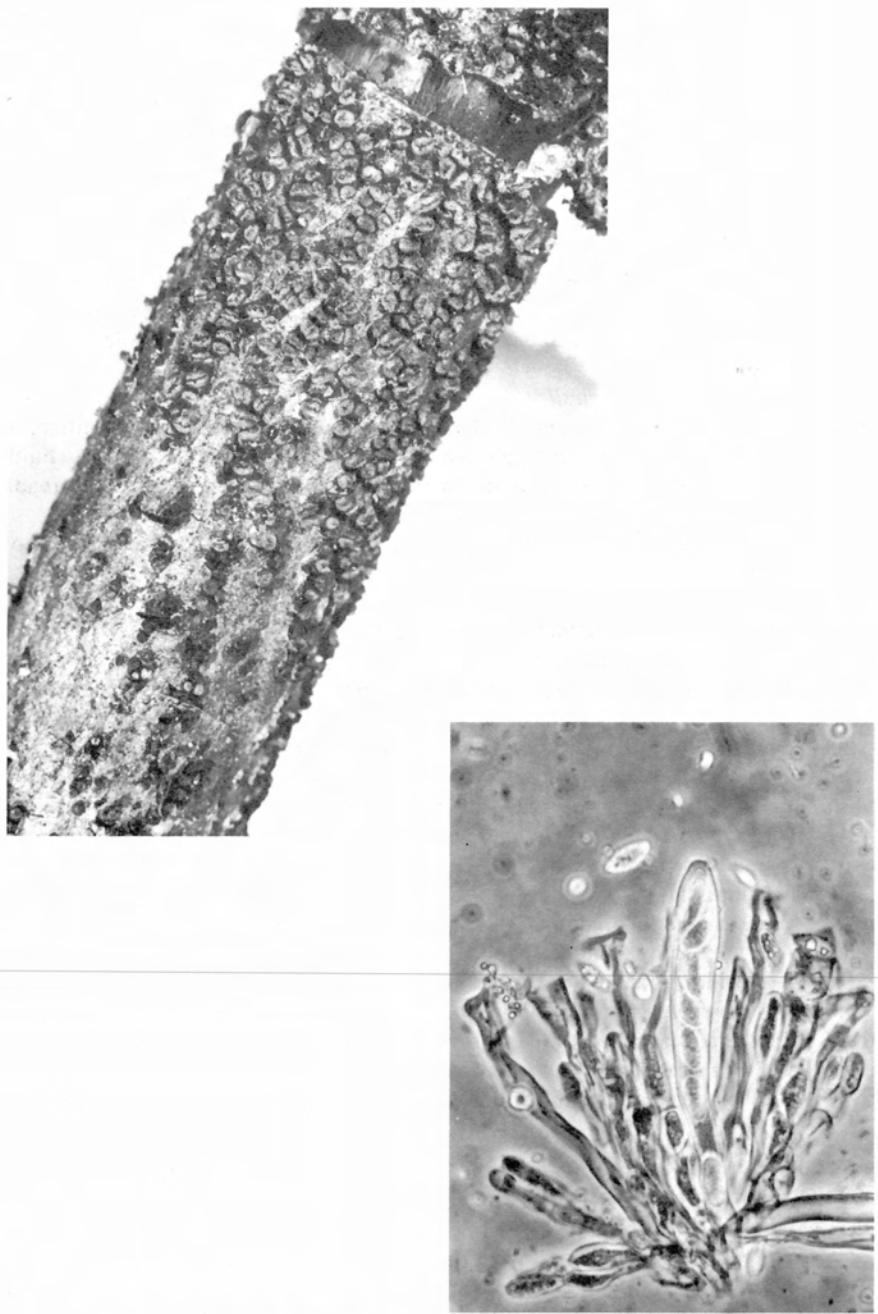


Fig. 101. *Pseudophaeacidium garmani*. Apothecia on spruce. Ascii.

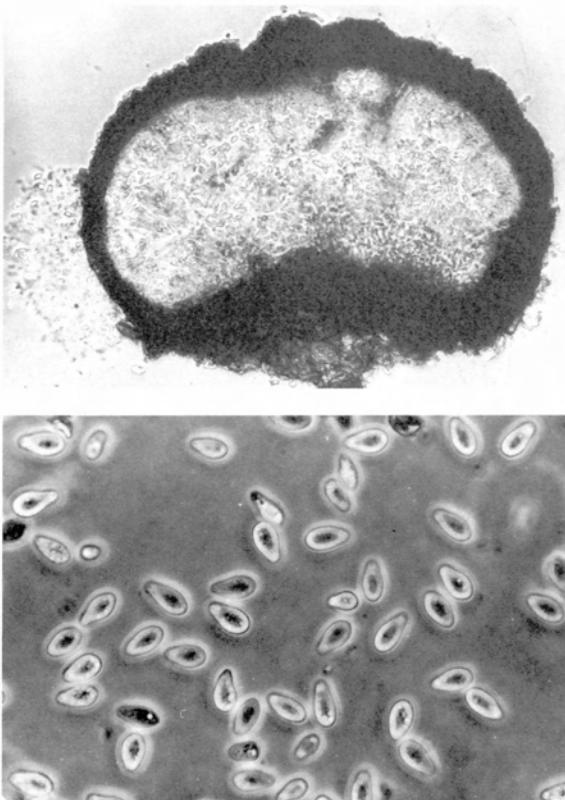


Fig. 102. *Pseudopachacidium garmanii*. Pycnidium. Conidia.

Asci clavate to oval, short-stalked, thick-walled, multisporous, $45-60 \times 12-15$ um. Ascospores hyaline, globose, 2-3 um. Paraphyses hyaline, septate, simple, tips embedded in a brownish matrix to form an epithecium. (Fig. 103).

A conidial state is produced in culture. The fungus growing on malt agar produces an appressed, sodden, whitish colony in which the pycnidia appear in concentric zones. Pycnidia are black, globose to conic, 0.1-0.4 mm in diameter. The single cavity is lined with simple, flask-shaped conidiophores (phialides) which produce at their flaring tips brown, globose conidia 2-4 um in diameter. Pycnidia not found on natural material, but are also produced on sterilized twigs in culture.

HOSTS: *Abies*, *Larix*, *Picea*, *Pinus*, *Pseudotsuga*, *Tsuga*

NOTES: On resin of various conifers. Also isolated from pith region of healthy, suppressed grand fir; and from heartwood and sapwood of balsam fir (Etheridge and Morin 1967).

Hawksworth and Sherwood (1981) have shown that *Retinocyclus abietis* and *Biatorella resinae* are related and belong in the genus *Sarea*.

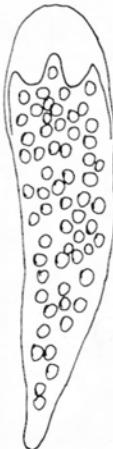


Fig. 103. *Retinocyclus abietis*. Ascus.

Retinocyclus olivaceus Fckl. Jahrb. Nass. Naturk. 25-26: 332 (1871).

SYNONYM: *Claussenomyces olivaceus* (Fckl.) Sherw.

Apothecia dull black, glabrous, circular to undulate, separate, superficial, sessile, 0.5-1 mm in diameter; hymenium dull black to olivaceous. Tissue structure of apothecia plectenchymatous throughout, hyphae of ectal excipulum dark and thick-walled. Asci cylindric-clavate, with a tapering stalk, at first 2-8-spored, finally multisporous, 150-190 × 16-19 µm. Primary ascospores ellipsoid to fusiform, irregular, up to 7-septate and occasionally muriform, 11-28 × 4-7 µm; secondary ascospores globose, 1-celled, hyaline, 1.5-2.5 µm. Paraphyses hyaline, filiform, septate, branching, tips slightly swollen and embedded in a brownish matrix to form an epithecum.

HOSTS: *Picea sitchensis*, *Tsuga heterophylla*

NOTES: On resin of various conifers.

Hawksworth and Sherwood (1981) showed that *Retinocyclus olivaceus* produces muriform primary ascospores and transferred it to *Claussenomyces*.

Rhinocladiella elatior Mangenot Rev. Gén. Bot. 59: 477-519 (1952).

Cultural Description: Colonies on malt agar grow approx. 5 cm in 3 weeks at 25 °C, surface is woolly with smoky gray mycelium. Conidiophores hyaline at first, darkening with age, mostly simple, up to 100 µm long, terminating in a single sporogenous cell that is a cylindric sympodula with small scars where conidia are borne. Conidia produced terminally and in acropetal succession during sympodial extension of the sporogenous cell of the conidiophore, nonseptate, hyaline, variable in shape from ovoid with a truncate to pointed base, to allantoid, 5-6 × 1-1.5 µm.

HOSTS: *Pseudotsuga menziesii*, *Abies lasiocarpa*

NOTES: Isolated from sapwood of conifers, often in old cankers or wounds. Recent descriptions of *Rhinocladiella* given by de Hoog (1977). *Rhinocladiella atrovirens* Nannf. (Fig. 104) has a velvety colony and is found in similar habitats.



Fig. 104. *Rhinocladiella atrovirens*.
Conidiophores and conidia.

Rhytididiella baranyayi Funk & Zalasky Can. J. Botany 53: 752 (1975).

Ascomata immersed, then erumpent, globose, smooth, black, with apical pore, 175-250 μm diameter. Ascii cylindric, bitunicate, 8-spored, parallel, 35-65 \times 8-15 μm . Paraphyses filiform. Ascospores broadly fusiform, curved, tips rounded, 3-septate, 15-25 \times 2-4 μm . (Fig. 105).

HOST: *Populus tremuloides*

DISEASE: Associated with cork-bark of aspen over much of western North America and believed to be the cause of the disease. (Fig. 106).

Rhytididiella moriformis Zalasky Can. J. Botany 46: 1383 (1968).

ANAMORPH: *Phaeoseptoria*

Ascomata immersed, then erumpent, globose to turbinate, black, rugose, with apical pore, 300-580 \times 100-350 μm . Ascii cylindric, bitunicate, 8-spored, 80-120 \times 12-18 μm . Paraphyses abundant, brown, branching, with thick gelatinous wall. Centrum staining bright red with iodine. Ascospores scutelloform, tips tapered, up to 15-septate, cells guttulate when young, hyaline to olivaceous, 60-100 \times 3-6 μm .

Pycnidia immersed, then erumpent, conical to pulvinate, slightly papillate pore, black, 100-250 \times 75-150 μm . Conidiophores phialidic, subulate, branched, 6-18 \times 2-4 μm . Conidia olivaceous, resembling ascospores in shape and size.

HOST: *Populus balsamifera*

DISEASE: Causing rough-bark of balsam poplar.



Fig. 105. *RhytidIELLA baranyayi*.
Ascocarp. AscI.
Ascospores.

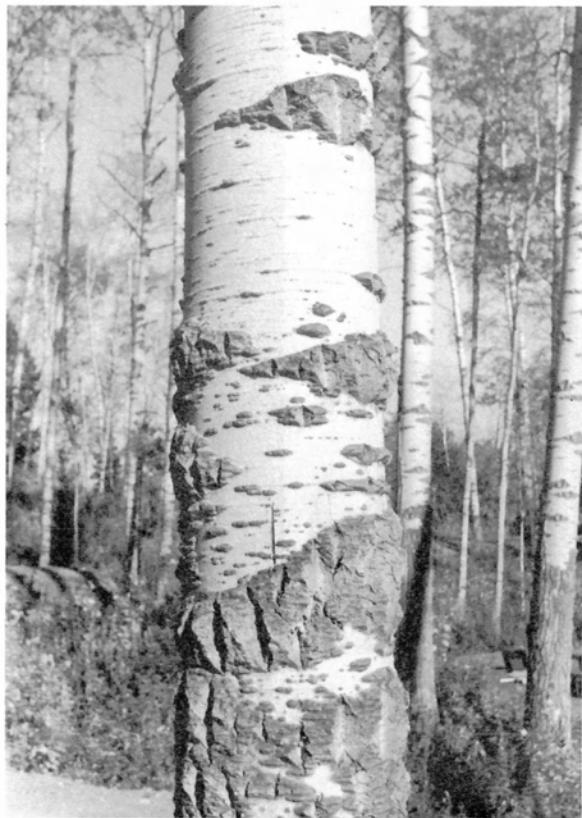


Fig. 106. *Rhytidella baranyayi*. Cork-bark of aspen.

Rosellinia herpotrichioides Hept. & Davidson Phytopathology 27: 307 (1937).

Subiculum a light gray mycelial mat, forming under leaves and branches. Perithecia embedded in subiculum, black, carbonaceous, wrinkled, papillate, gregarious, globose, 500-900 um diameter. Ascii cylindric, with gelatinous pore at the apex, 8-spored, 185-210 × 11-14 um. Ascospores uniseriate, dark brown, unicellular, inequilaterally ovate, with longitudinal germ slit, 23-26 × 9-10 um. (Fig. 107).

"Botrytis"-like conidial state produced in subiculum, conidia hyaline, ovoid, 5-8 × 3-5 um.

HOST: *Pseudotsuga menziesii*

DISEASE: Causing twig and leaf blight, "smothering-disease", of young Douglas-fir seedlings in nurseries.

NOTES: This species on seedlings in B.C. has smaller spores than the type, and is considered a new species by S.M. Francis (private communication).

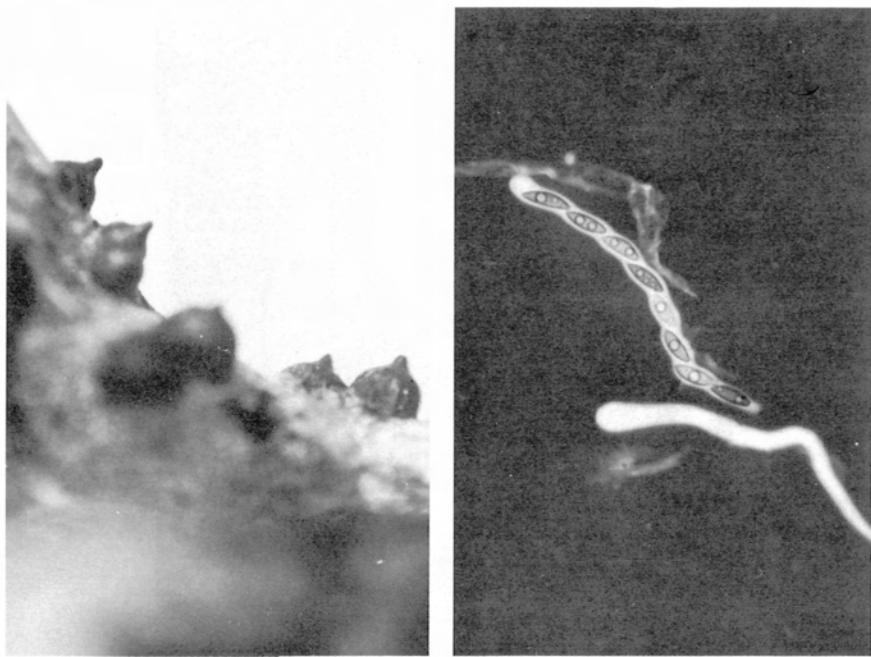


Fig. 107. *Rosellinia herpotrichioides*. Perithecia on Douglas-fir seedling. Ascus and ascospores.

***Rosellinia thelena* (Fr.) Rab.** Fung. Eur. No. 575 (1865).

Perithecia superficial, densely gregarious on a blackish subcicum, subglobose, smooth, ostiolate, dark brown to blackish, approx. 1 mm diameter. Asci cylindric, with apical ring, 8-spored, 100-160 × 9 um. Ascospores uniseriate, ellipsoid with one side flattened, with slender hyaline appendages, dark brown, unicellular, 18-24 × 6-7 um. Paraphyses agglutinated.

HOSTS: *Pinus* spp.

NOTES: On bark of dead branches of pines. Some authors now include the species of *Rosellinia* in *Hypoxyylon* (Martin 1968).

***Sageria tsugae* Funk** Can. J. Botany 53: 1196 (1975).

ANAMORPH: *Ascoconidium tsugae* Funk

Apothecia solitary or caespitose in clusters of two or three, soft, sessile or short-stalked, circular, dark brown, pruinose, originating from a pseudoparenchymatous hypostroma, 0.4-0.7 mm diameter; hymenium plane, light brown, with a whitish margin; ectal excipulum of parallel, intertwined hyphae (*textura porrecta*); medullary excipulum of hyaline, isodiametric cells (*textura angularis*). Asci clavate, 8-spored or irregular, inoperculate, J+, 132-165 × 18-22 um. Ascospores hyaline, ellipsoid-fusiform, 3- or 7-septate, occasionally muriform, 36-45 × 8-11 um (if

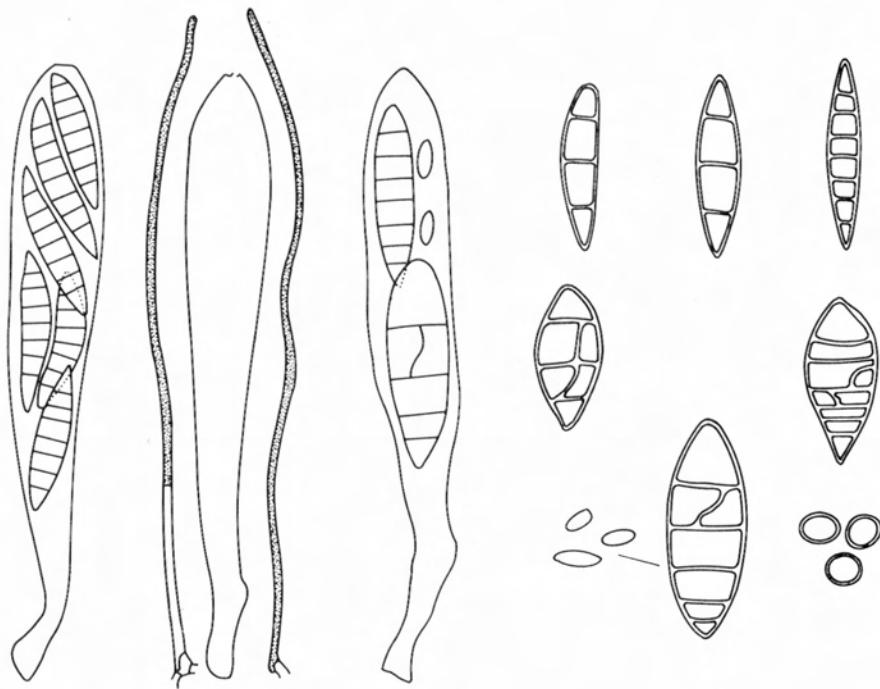


Fig. 108. *Sageria tsugae*. Asci and ascospores.

ascospore number is irregular, very large spores up to 56×14 um, and tiny globose spores may be produced). Paraphyses usually brown, filiform, simple, forming a loose epithecium. (Fig. 108).

Phialides cylindric to clavate, simple, dark brown, aggregated in dense palisade on parenchymatous stroma, $110-135 \times 17-21$ um, apex with rounded tip that splits when conidia are discharged. Conidia rectangular, hyaline, 3- or 7-septate, frequently muriform, produced singly within apical cell of phialide, $45-60 \times 14-15$ um, with a prominent basal fringe. (Fig. 109).

HOSTS: *Tsuga* spp.

DISEASE: On diseased and dying bark of western hemlock and mountain hemlock; often associated with pathogenic fungi or alone on shaded branches.

Sclerophoma ambigua Funk & Parker Can. J. Botany 50: 1623 (1972).

Pycnidia erumpent, subglobose to discoid, dark brown, $150-700 \times 100-200$ um, uniloculate or labyrinthiform, ostiole absent but upper wall disintegrating for con-

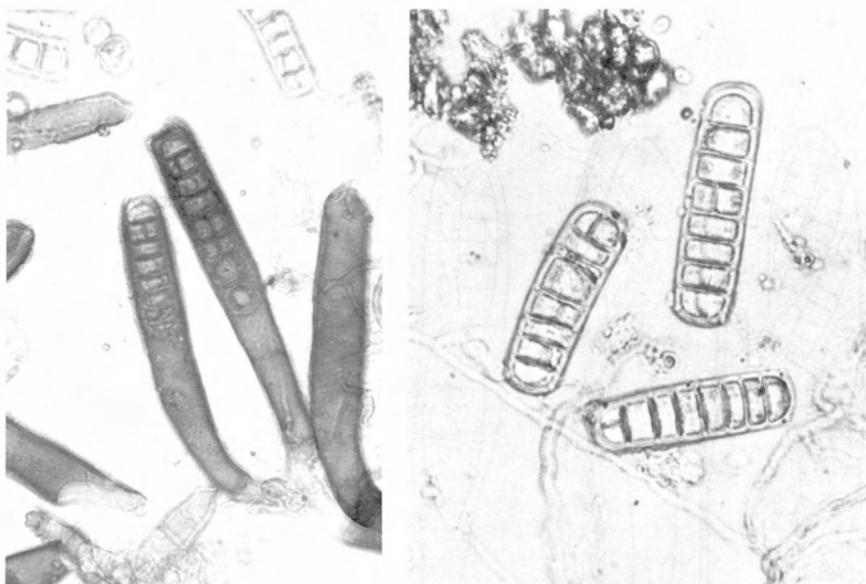


Fig. 109. *Sageria tsugae*. Ascocaridium anamorph, phialides and conidia.

idium discharge. Conidiogenous cells phialidic, formed from globose, hyaline cells lining inner wall of pycnidium. Conidia hyaline, nonseptate or occasionally 1-septate, oblong or irregular, $4-10 \times 2.5-4$ um. (Fig. 110).

HOST: *Cornus nuttallii*

DISEASE: Causes stem cankers of mature trees and also dieback of twigs and branches. The disease is associated usually with stressed trees, as in residuals left after land clearing or drainage changes. (Fig. 110).

Sclerophoma pithyophila (Corda) Hoehn. — *Fragmente z. Mykol.* 402: 1234 (1909).

TELEOMORPH: *Sydowia polyspora* (Bref. & Tav.) E. Müller

CULTURE: *Hormonema dematioides* Lagerb. & Melin

Pycnidia immersed, then erumpent, black, globose to irregular, separate or gregarious, unilocular or imperfectly divided, walls of dark brown parenchyma, rather thick, without ostiole, upper wall disintegrating, 150-300 um diameter. Inner hyaline cells becoming dolioform and producing a single phialidic aperture. Conidia hyaline, ovate to obovate, with central guttule, $4-8 \times 2-3$ um. A bright red pigment is often produced in the locule. (Figs. 111, 113).

Pseudothecia immersed, then partially erumpent, black, glabrous, frequently grooved on the top, subglobose, up to 150 um diameter of dark parenchyma. Asci cylindric, thickest below, bitunicate, $70-100 \times 22-26$ um, 16-spored. Ascospores hyaline, oval with 1-6 transverse septa, constricted at the center septum, sometimes

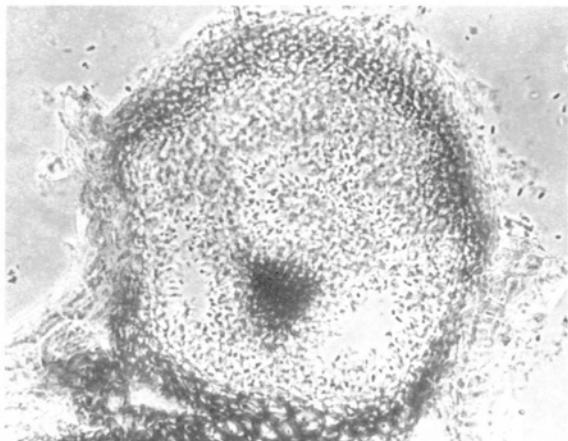
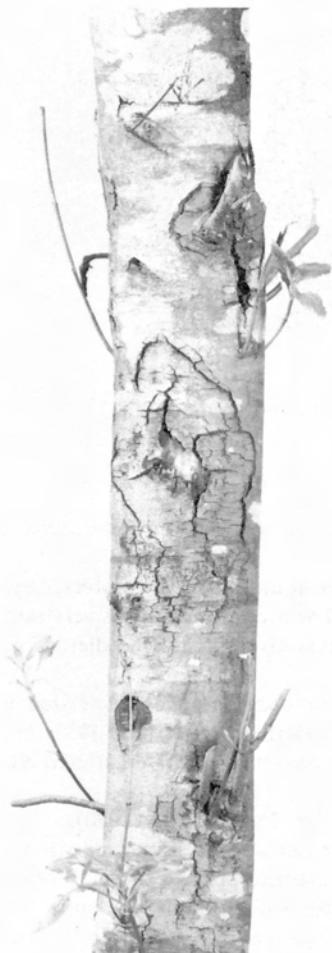


Fig. 110. *Sclerophoma ambigua*. Canker on dogwood. Pycnidium. Conidia.

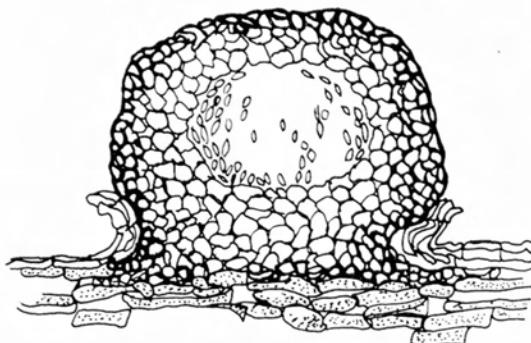


Fig. 111. *Sclerophoma pithyophila*. Pycnidium and conidia.

muriform with 1-3 longitudinal septa, 10-25 × 3-8 um.

HOSTS: *Pinus* spp., *Pseudotsuga*, *Abies* spp., *Picea* spp., *Tsuga heterophylla*, *Larix*, *Thuja*

DISEASE: Follows drought, frost damage and other injuries in most conifers, causing canker, dieback and needle blight. The ascigerous stage is very rare, but the pycnidial stage is produced abundantly in bark or needles. (Figs. 112, 113).

NOTES: In culture, this fungus produces a dark *Hormonema* state characterized by an appressed colony with metallic sheen (Hermanides-Nijhof 1977) and conidia produced basipetally from a single locus in an undifferentiated cell.

***Sclerophoma semenospora* Funk Eur. J. For. Path. 10: 54 (1980).**

Pycnidia erumpent, disciform or irregular, sessile but with an immersed stipe of variable length, black, carbonaceous, up to 500 um diameter, tissues of dark brown, isodiametric cells (pseudoparenchyma), becoming subhyaline toward the inner conidiogenous layer, without definite ostiole. Conidiogenous cells phialidic, formed from cells lining the inner wall, subglobose or short-cylindrical, sometimes at the apex of a vertical row of cells. Conidia ovoid, more or less acute at the base, nonseptate, hyaline, 5-7 × 2.5-3 um, in a waxy matrix. (Fig. 113).

In agar culture, at first unicellular and hyaline (yeast-like), then becoming a dark *Hormonema* state.

HOSTS: *Pseudotsuga menziesii*, *Abies amabilis*, *A. lasiocarpa*

DISEASE: Associated with dieback of droughted, young Douglas-firs, usually with other microfungi present also. Small, discrete stem cankers are produced on amabilis fir, and leader dieback in alpine fir.

***Scoleconectria cucurbitula* (Tode ex Fr.) Booth C.M.I. Mycol. Paper 73: 15 (1959).**

ANAMORPH: *Zythiostroma pinastri* (Karst.) Hoehn.

Perithecia clustered on an erumpent stroma, globose to pomiform with a cupulate



Fig. 112. *Sclerophoma pithyophila*.
Canker on hemlock.

collapse, dull orange red with rough wall that may be covered with a green scurf, 250-400 μm diameter, wall 70-80 μm thick. Ascii cylindric-clavate, up to 4-spored, then filled with ascocnidia, 75-95 \times 8-10 μm . Ascospores hyaline, narrowly clavate, tapering toward the base, 14-18-septate, 36-55 \times 2.5-3.5 μm , producing large numbers of ascocnidia from pores at the septa. Ascocnidia hyaline, allantoid, 3-4.5 \times 1 μm .

Pycnidia irregularly globose, reddish orange, ostiolate, 250-400 μm diameter. Phialides lining inner convoluted wall, subulate, 6-8 \times 2 μm . Conidia hyaline, allantoid, 4-6 \times 1 μm .

HOST: *Abies lasiocarpa*

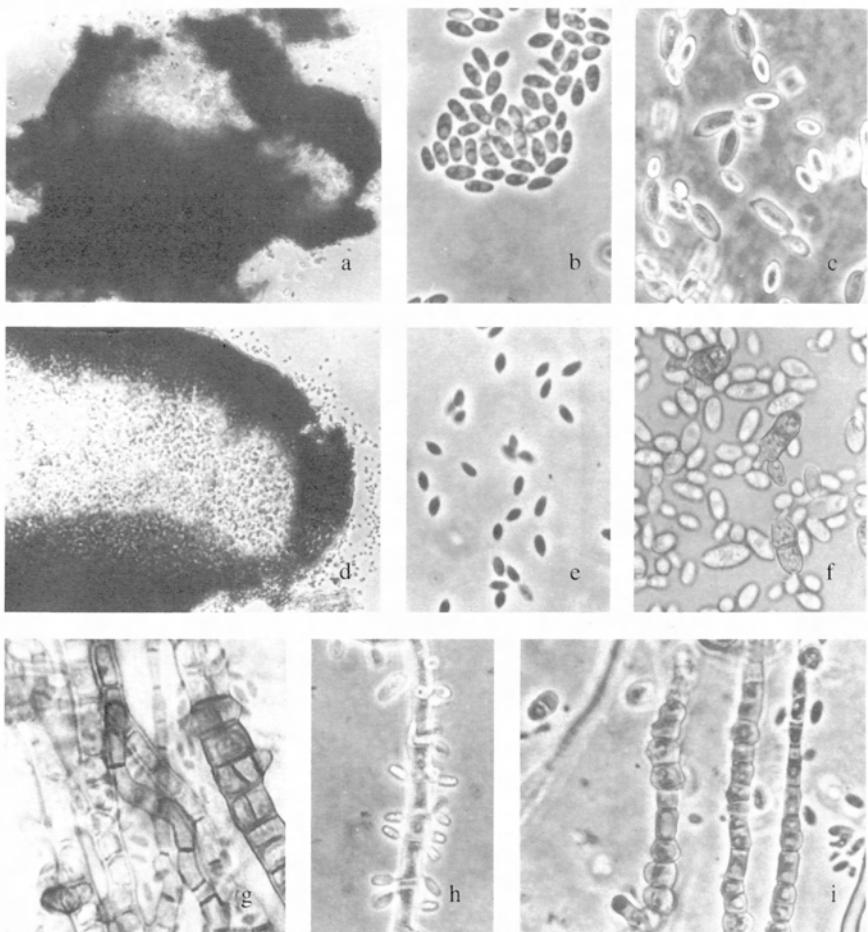


Fig. 113. *Sclerophoma* spp. on conifers. (a-c) *S. xenomeria*. Pycnidium. Conidia. Conidia from culture. (d-f) *S. semenospora*. Pycnidium. Conidia. Conidia from culture. (g-i) Hyphae from culture. (g) *S. pithyophila* (h) *S. xenomeria* (i) *S. semenospora*.

Table 7. COMPARATIVE CHARACTERISTICS OF *SCLEROPHOMA* spp. ON CONIFERS

	<i>S. pithyophila</i>	<i>S. xenomeria</i> (<i>Xenomeris abietis</i>)	<i>S. semenospora</i>
Pycnidia	globose, dome-like, dull black often with red pigment in locule	flat, disc-like or multi-lobed shiny black lacking pigment	flat, disc-like, dull black lacking pigments
Conidia from fruit bodies	ovate, obovate 4.8×2.3 μm easily dispersed in H_2O	ellipsoid 8×4 μm easily dispersed in H_2O	ovate, acute base 5.7×2.5 μm in waxy matrix, not easily dispersed
Colony characteristics in culture	growth rate** 8.5 cm black, metallic sheen agar blued	growth rate 7.0 cm black, glabrous with liquid exudate early agar slightly yellowed	growth rate 8.0 cm yeast-like early, then black agar not stained
Conidia in culture	hyaline, nonseptate, ellipsoid to variable shaped, 4.12×3.5 μm dark, 0-1-septate, rectangular 16.18×5.8 μm	hyaline, nonseptate, ellipsoid, 12×6 μm dark, 0-1-septate, rectangular thick-walled, up to 18×10 μm	hyaline, nonseptate, oval, 6.12×4.6 μm dark, 0-1-septate rectangular, 12.16×6.9 μm
Hyphae in culture	cells rectangular, often wider than long, up to 13 μm diameter, often with longitudinal septa	cells subglobose in chains, 8-9 μm diameter	cells rectangular, longer than wide, frequently slime-coated

**Growth measured at 15°C at 3 wks.
(See Fig. 113)

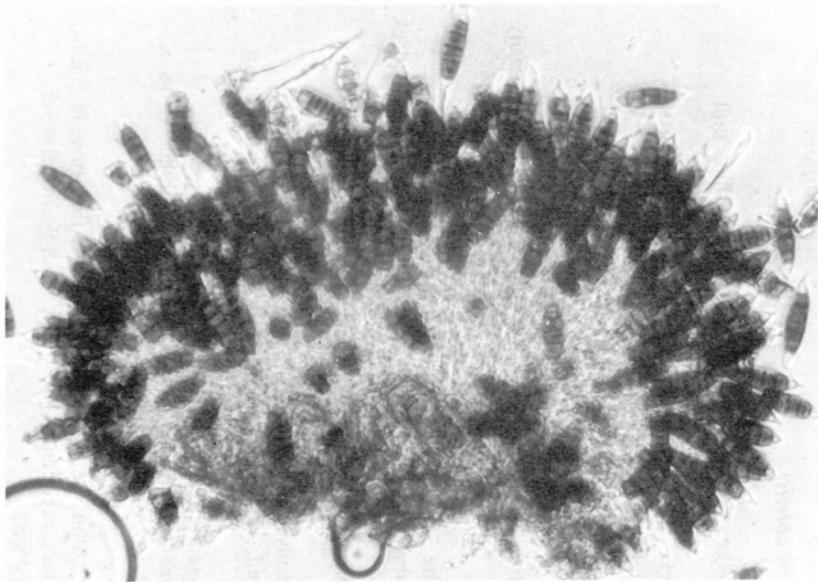


Fig. 114. *Seiridium abietinum*. Sporodochium and conidia.

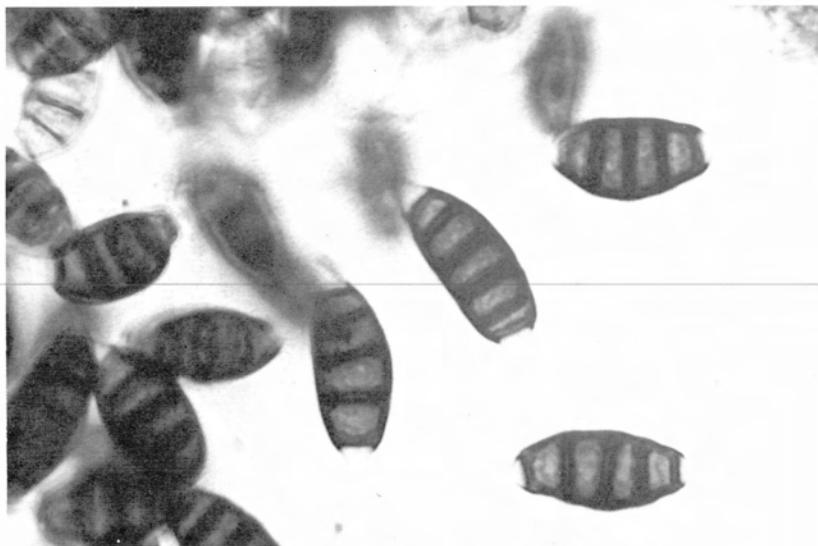


Fig. 115. *Seiridium cardinalis*. Conidia.

Seiridium abietinum (Ell. & Ev.) Sutton C.M.I. Mycol. Paper 138: 53 (1975).

Acervuli black, subperidermal, circular to irregular, composed of pale brown to hyaline pseudoparenchyma, 200-400 um diameter. Conidiophores cylindric, branched, septate, hyaline, up to 60 um long and 2-2.5 um wide. Conidiogenous cells holoblastic, annellidic, with 0-1 annellations, up to 25 um long. Conidia formed at the apex of the conidiogenous cells, straight or slightly curved, 5-euseptate, fusiform, slightly constricted at the equidistant septa, smooth; four median cells equally dark brown, 25-30 um long; apical cell hyaline, conic, projecting into a short appendage 1-3 um long; basal cell hyaline, truncate with marginal frill, usually with an endogenous appendage 2-3 um long, entire conidia 36-42 × 11-13 um. (Fig. 114).

HOST: *Tsuga heterophylla*

NOTES: Rare; associated with canker of *Tsuga heterophylla*, but status as pathogen not known on western conifers. Associated with *Pestalopezia tsugae* but no relationship proven.

Seiridium spp. are characterized by 5-euseptate conidia (Sutton 1969).

Seiridium cardinale (Wagener) Sutton & Gibson C.M.I. Descriptions of Pathogenic Fungi and Bacteria 326 (1972).

SYNONYM: *Coryneum cardinale* Wagener

Acervuli black, peridermal to subperidermal, of pale brown irregular pseudoparenchyma, more hyaline in the conidiogenous region, 200-300 um diameter. Conidiophores cylindric, branched, septate, hyaline, up to 25 um long, 2 um wide, frequently intermingled with hyphae up to 50 um long that may be paraphyses. Conidiogenous cells holoblastic, annellidic, determinate, hyaline, 8-17 × 2 um. Conidia formed at the tips, 5-euseptate, broadly fusiform, constricted slightly at the equidistant septa, smooth, 21-30 × 8-9 um. Median cells equally dark brown; apical cell hyaline, conic with a short appendage 1 um long; basal cell hyaline, truncate with marginal frill, with or without an endogenous appendage 1 um long. (Fig. 115).

HOST: *Thuja plicata*

DISEASE: The cause of a serious shoot and leaf blight of native *Thuja* and ornamental Cupressaceae. May also cause resinous cankers.

NOTES: Swart (1973) considers this fungus to be a variant of *Monochaetia unicornis* (Cooke & Ell.) Sacc., having the perfect state *Lepteutypa cupressi* (Natrass, Booth & Sutton) Swart, but this has not been confirmed in Canada. Sutton (1975) transferred *M. unicornis* to *Seiridium unicornis* (Cooke & Ell.) Sutton because the genus *Monochaetia* is characterized by 4-euseptate conidia (Sutton 1969).

Septonema chaetospira (Grove) Hughes var. ***pini*** Bourchier Can. J. Botany 39: 1782 (1961).

Cultural Description: Colonies on malt agar expand 2.5 cm in 4 weeks, gray, plush-like; margin black, shiny, even. Conidiophores simple, light brown, hyphalike. Blastoconidia light brown, unicellular or 1-septate, dolioform to cylindric, 7-18 × 3-5 um, produced in chains.

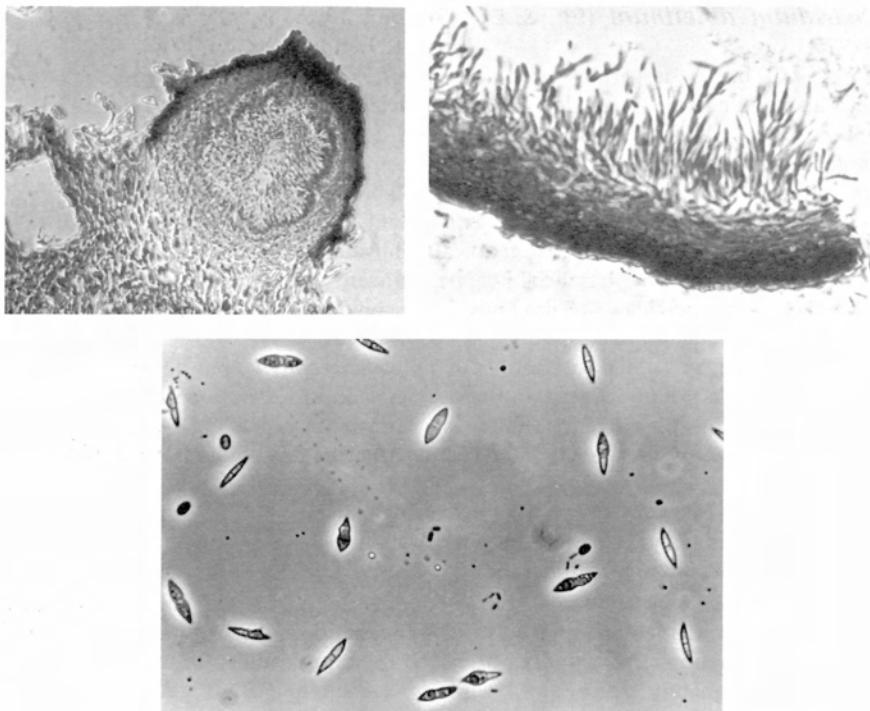


Fig. 116. *Sirococcus strobilinus*. Pycnidium. Conidiophores. Conidia.

HOST: *Pinus contorta*

NOTES: Isolated from the heartwood of healthy lodgepole pine (Bourchier 1961).

Sirococcus strobilinus Preuss Linnaea 26: 716 (1854).

SYNONYM: *Ascochyta piniperda* Lindau

Pycnidia erumpent on shoots and needles, grayish green to black, subconical to spherical, ostiolate, 0.3-1.0 mm diameter; peridium of dark prosenchyma, lined with hyaline interwoven hyphae, 30-50 μm thick, cavity simple. Conidiophores simple or branched, septate, each cell with a single phialide at the tip or just below the septum, 10-45 μm long; phialides tapering, sharply pointed, 6-12 \times 2 μm . Conidia hyaline, medianly 1-septate, tips acute, slightly constricted at the septum, acerose to fusiform, 13-15 \times 2-2.5 μm . (Fig. 116).

HOSTS: *Tsuga heterophylla*, *Pinus* spp., *Picea* spp., *Pseudotsuga menziesii*

DISEASE: Causes shoot blight of various conifers, but is most serious on western hemlock regeneration (Funk 1972) and in pine nursery stock (Smith 1973) and spruce germinants in B.C. (Fig. 117).

NOTES: This fungus often fruits on cones and spores may become seedborne. Killing of spruce germinants has been shown by the seedborne spores from



Fig. 117. *Sirococcus strobilinus*. Blighted tip of hemlock.

natural sources (J.R. Sutherland, personal communication).

Stigmina negundinis (Berk. & Curt.) M.B. Ellis C.M.I. Mycol. Paper 72: 44 (1959).

Sporodochia black, punctiform, at first scattered, later sometimes confluent. Stromata mostly immersed, 200-400 um wide. Conidiophores cylindrical, dolioform or lageniform, 12-26 × 5-9 um, annellated. Conidia ellipsoid, smooth, 2-septate, brown, 25-38 × 12-18 um, base often truncate and slightly protuberant.

HOST: *Acer negundo*

DISEASE: Twig blight and canker.

Therrya piceae Funk Can. J. Botany 58: 1292 (1980).

Ascostromata black, sessile, round or discoid, 600-1100 um diameter, approx. 600 um high; excipulum black, rugose, dehiscing by irregular radiating fissures; hypothecium granular; subhymenium hyaline, plectenchymatous, well developed. Asci clavate, 8-spored, apex rounded and thickened, unitunicate, J-, 80-150 × 10-12 um. Ascospores hyaline, broadly fusiform to clavate, straight, 3-septate and

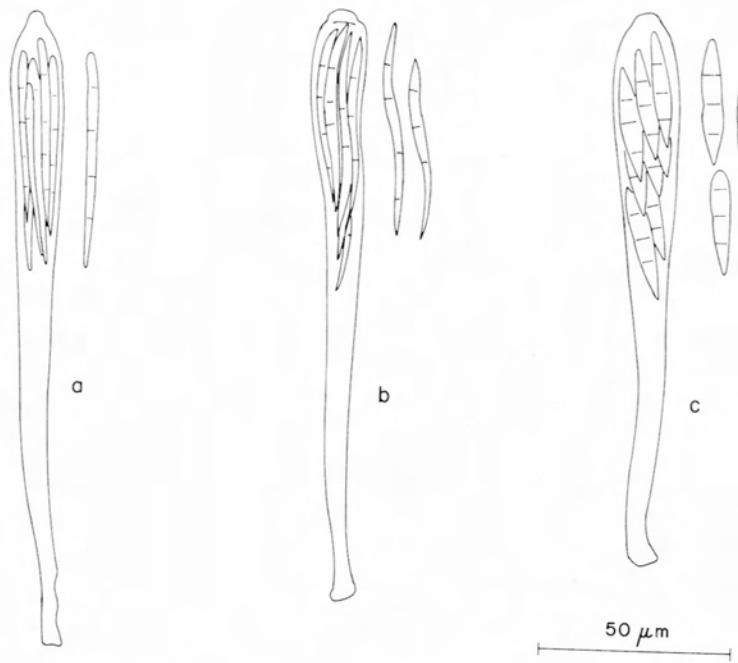


Fig. 118. *Therrya* spp. Ascospores. (a) *T. pseudotsugae* (b) *T. tsugae* (c) *T. piceae*.

sometimes slightly constricted at the middle septum, $30-38 \times 4-4.5$ um, clustered in the upper ascus. Paraphyses filiform, broadened at the apex, agglutinated above the asci to form a brown epithecum. (Fig. 118).

HOST: *Picea glauca*

DISEASE: Associated with a perennial, flaking canker of mainstems that may result in bark eruptions and resinosis. (Fig. 119).

***Therrya pseudotsugae* Funk** Can. J. Botany 58: 1291 (1980).

Ascomata black, sessile, solitary, round to undulating, 500-700 um diameter, approx. 400 um high; excipulum black, crustose, splitting into unequal radiating fissures (usually 3) to expose the pale yellow hymenium, remaining open at maturity; subhymenium hyaline, plectenchymatous. Asci clavate, long-stalked, 8-spored, unitunicate, J-, acutely rounded at the apex and thickened, $165-185 \times 8-10$ um. Ascospores hyaline, straight, fusiform, upper cell rounded at the apex, 3-6-septate, $48-72 \times 2$ um, in a fascicle in the upper ascus. Paraphyses filiform, slightly swollen at the apex and sometimes with short branches near the apex, agglutinated above the asci to form a brown epithecum. (Fig. 118).

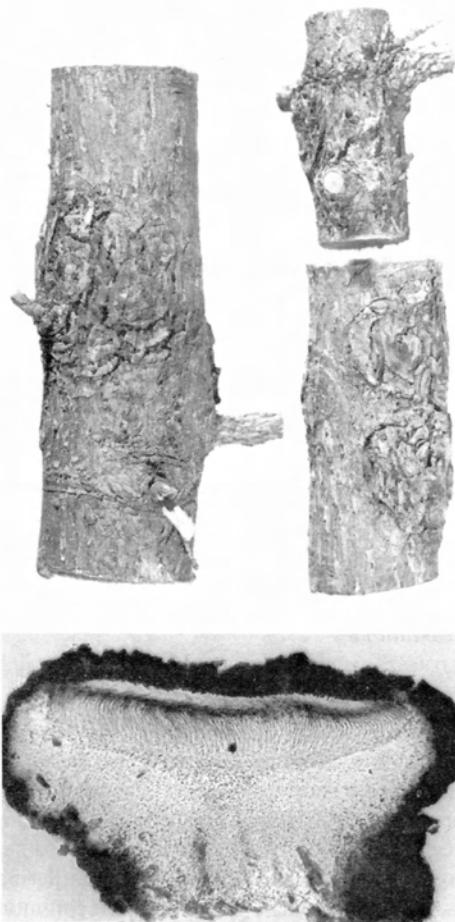


Fig. 119. *Therrya piceae*.
Perennial cankers
on spruce.
Apothecium.

HOST: *Pseudotsuga menziesii*

DISEASE: Associated with excessive callus growth around proliferated branch bases in young trees.

Therrya tsugae Funk Can. J. Botany 58: 1291 (1980).

Ascostromata black, sessile, solitary, hysteriform to irregular, 600×300 um, approx. 300 um high; excipulum black, dehiscing by a single longitudinal split; subhymenium hyaline, plectenchymatous, thin. Asci clavate, long-stalked, thickened at the apex and flattened, unitunicate, J-, 150×12 um. Ascospores hyaline, fusiform, curved, pointed at both ends, 2-4-septate, $45-85 \times 2$ um, coiled together in the upper ascus. Paraphyses filiform. (Fig. 118).

HOST: *Tsuga heterophylla*

DISEASE: Associated with small, annual cankers of hemlock stems and branches, usually on suppressed trees.

Thyronectria balsamea (Cooke & Peck) Seeler J. Arnold Arb. 21: 442 (1940).

Perithecia developing on an erumpent stroma, orange-red, wall rough, globose, 250-400 um diameter, collapsing cupulate. Ascii cylindric-clavate, 4-spored, 70-130 × 8-10 um. Ascospores hyaline, fusiform, muriform, 17-26 × 4-6 um, producing minute allantoid ascocnidia, 3-4 × 1 um, that eventually fill the ascus.

Pycnidia on same stroma as perithecia, deep red, globose, ostiolate, 350-600 um diameter, inner convoluted-wall covered with cylindric phialides 10-16 × 2 um. Conidia hyaline, allantoid, 3-4 × 1-1.5 um.

HOST: *Abies lasiocarpa*

Trichocladium canadense Hughes Can. J. Botany 37: 858 (1959).

Cultural Description: Colonies on malt agar grow rapidly, dark, effuse, some yellow diffusion zone may appear. Chlamydospores produced in great abundance, sessile on hyphae or on stalks up to 40 um long, 1- or 2-celled, pale brown to black, oval to clavate, smooth, thick-walled, 9-18 × 8-12 um, sometimes monilioid. Scattered phialides may occur, single or branched, hyaline, subulate, 25-65 × 3 um. Phialospores oval, hyaline, nonseptate, 4-7 × 2-3 um, produced in slimy heads.

HOSTS: *Tsuga heterophylla*, *Populus tremuloides*

NOTES: Isolated from trunk and butt rots.

Trichoderma viride Pers. Rom. Neu. Mag. Bot. I: 92 (1794).

Cultural Description: Colonies spread rapidly, forming an appressed, colorless mycelium, with irregular patches of verdigris green sporulating areas. Conidiophores erect, aggregated, hyaline, septate, branching verticillately at right angles to main axis, up to 75 um long; sporogenous cells phialidic, single or clustered, hyaline, flask-shaped. Phialoconidia green, globose, finely roughened, nonseptate, gathering in balls at the mouth of the phialide, 2.5-3.5 um diameter. Odor of coconut common in older cultures.

HOSTS: *Pseudotsuga*, *Tsuga*

NOTES: On wood and soil. Frequently isolated from bark wounds and old cankers.

Trichoderma is the conidial state of *Hypocrea rufa* (Pers. ex Fr.) Fr., a large, stromatic ascomycete which is rare and found only on old, dead material.

Truncatella truncata (Lév.) Steyaert Bull. Jard. Bot. Brux. 25: 191 (1955).

Acervuli black, erumpent, pseudoparenchymatous, up to 350 um diameter. Conidiophores simple or branched at the base, cylindric, 24 × 2 um. Conidiogenous cells holoblastic, annellidic, 11-21 × 2 um. Conidia holoblastic, acrogenous, 3-euseptate, broadly fusiform or slightly bent, constricted at the septa, 18 × 8 um; median cells thick-walled, brown; end cells thin-walled, hyaline, the apical cell with a single irregularly branched appendage up to 13 um long.

HOST: *Tsuga heterophylla*

DISEASE: Infects dwarf mistletoe swellings on western hemlock (Baranyay 1966).

NOTES: The segregates of the genus *Pestalotia* display constancy in conidial septation: *Truncatella* is 3-septate, *Pestalotiopsis* and *Monochaetia* are 4-septate, *Pestalotia* and *Seiridium* are 5-septate (Sutton 1969).

***Tryblidiopsis pinastri* (Pers.) Karst.** Myc. Fenn. 1: 262 (1871).

ANAMORPH: *Tryblidiopycnis pinastri* Hoehn.

Apothecia black, circular to undulate, short-stipitate, marginate, gregarious, erumpent, approx. 1-2 mm in diameter. The black, covering excipulum ruptures stellately to expose the white to yellowish hymenium. The medullary excipulum is composed entirely of loosely interwoven, narrow hyphae. Ascii clavate, 8-spored, pseudobitunicate, J-, $90-150 \times 10-15$ um. Ascospores clavate-fusoid, hyaline, 0-1-septate, with gelatinous sheath, $15-35 \times 4-8$ um. Paraphyses filiform, simple, exceeding length of ascii. (Fig. 120).

Pycnidia black, subglobose, sessile, 0.2-0.6 mm in diameter. Conidia filiform, curved, hyaline, $18-30 \times 1$ um, oozing out in a yellowish green spore tendril.

HOSTS: *Picea* spp.

DISEASE: Universally present on dead branches of all species of spruce. Saprophytic or mildly parasitic (Takahashi and Saho 1973).

***Tympanis alnea* (Pers.) Fr.** Syst. Myc. 2: 174 (1823).

ANAMORPH: *Sirodothis inversa* (Fr.) Sutton & Funk

Apothecia erumpent, caespitose, circular or undulate, pruinose to glabrous, black, 0.3-1 mm diameter. Ascii cylindric, with eight primary ascospores, $110-215 \times 14-25$ um. Primary ascospores globose, 1-celled, budding simple or branched chains of cylindric to clavate cells singly or in groups from each end, these in turn budding secondary subglobose to ovoid cells which yield allantoid ultimate cells (secondary ascospores). Primary ascospores $5-6 \times 4-5$ um, secondary ascospores $3-4 \times 1-1.5$ um. (Figs. 121, 122).

HOSTS: *Alnus rubra*, *Populus tremuloides*

***Tympanis hypopodia* Nyl.** Obs. Pez. Fenn. 72 (1868).

Apothecia erumpent, separate to caespitose, circular to undulate, glabrous, black, epithecum greenish black, 0.5-1 mm diameter. Ascii cylindric-clavate, $60-110 \times 8-14$ um, with eight or less primary ascospores. Primary ascospores ellipsoid-fusoid or subclavate and curved, narrow or wide, budding off ovoid cells from each tip, $6-12 \times 2-4$ um. Secondary ascospores (ultimate cells) allantoid, very numerous, continuous, $2-3 \times 1-1.5$ um. Paraphyses hyaline, filiform, tips swollen and embedded in a gelatinous matrix, forming a brown epithecum. (Fig. 122).

HOSTS: Conifers

DISEASE: Often isolated from living stems of *Pinus contorta* (Bourchier 1961).

Pathogenicity on a wide variety of conifers was shown by Smerlis (1970b).

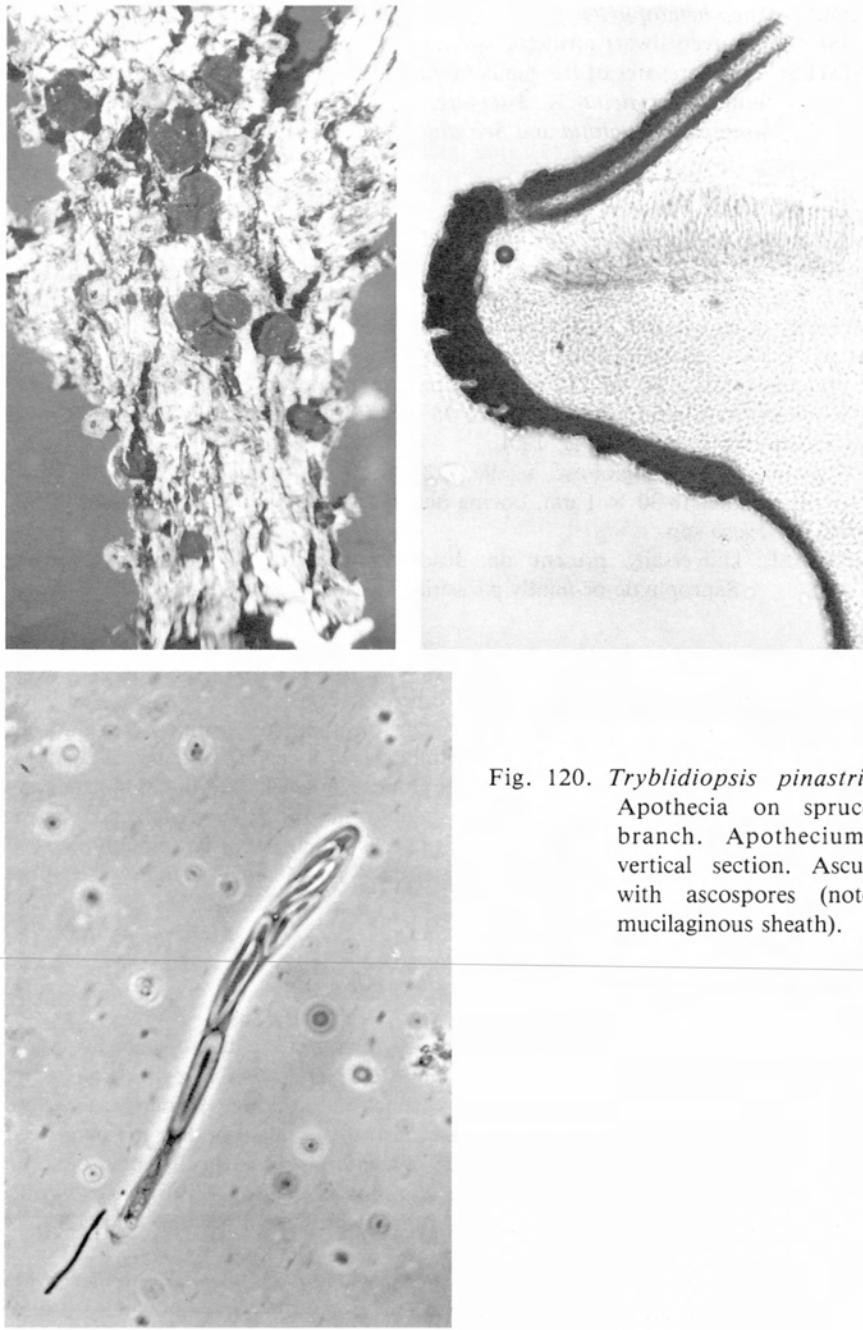


Fig. 120. *Tryblidiopsis pinastri*.
Apothecia on spruce
branch. Apothecium,
vertical section. Ascus
with ascospores (note
mucilaginous sheath).



Fig. 121. *Tymanis alnea*. Conidia produced on hyphae in culture.

***Tymanis hysteroides* Rehm** Rab. Krypt. Fl. I (3): 268 (1889).

Apothecia erumpent, single or caespitose, circular or undulate, hysteriform, glabrous, light brown, 0.8-2 mm diameter. Ascii cylindric, 110-215 × 14-25 um, with eight primary ascospores. Primary ascospores globose, 1-septate, germinating from each end in simple chain of cylindric cells, which bud off ovoid to ellipsoid secondary (or tertiary) cells that give rise to allantoid ultimate cells (secondary ascospores). Primary ascospores 5-6 × 4.5 um, secondary 2-3 × 1-1.5 um. (Fig. 122).
HOSTS: *Alnus* spp.

***Tymanis laricina* (Fckl.) Sacc.** Syll. Fung. 8: 583 (1889).

Apothecia erumpent, single or caespitose, circular or undulate, glabrous, black, 0.5-1 mm diameter, epithecium blackish green. Ascii cylindric, 60-120 × 8-17 um, with eight or less primary ascospores. Primary ascospores clavate, straight or curved, 1-septate, germinating at each end with tufts of subglobose, ovoid or pyriform cells. Primary ascospores 5-10 × 2-4 um; secondary ascospores (ultimate cells) allantoid to rod-shaped, continuous, 2-3 × 1-1.5 um. (Figs. 122, 123).

HOSTS: *Pseudotsuga menziesii*, *Picea glauca*, *Abies lasiocarpa*, *Larix* spp.

DISEASE: Associated with dieback and cankers (Smerlis 1970b).

Table 8. *TYMPANIS* SPECIES

Species	Asci	Ascospores	Hosts
<i>T. alnea</i>	110-215 × 14-25 um	Primary subglobose 5-6 × 4-5 um	<i>Alnus rubra,</i> <i>Populus tremuloides</i>
<i>T. hypopodia</i>	60-110 × 8-14 um	Primary subclavate or ellipsoid-fusoid 6-12 × 2-4 um	Conifers
<i>T. hysterioides</i>	110-215 × 14-25 um	Primary globe 1-septate 5-6 × 4-5 um	<i>Alnus</i>
<i>T. laricina</i>	60-120 × 8-17 um	Primary clavate 1-septate 5-10 × 2-4 um	Conifers
<i>T. spermatoiospora</i>	55-100 × 9-15 um	Primary subglobose to ellipsoid-fusoid 1-septate, 5-8 × 3-4 um	<i>Populus</i>
<i>T. truncatula</i>	80-130 × 10-19 um	Primary globe 1-septate 4-7 × 2-4 um	Conifers and hardwoods

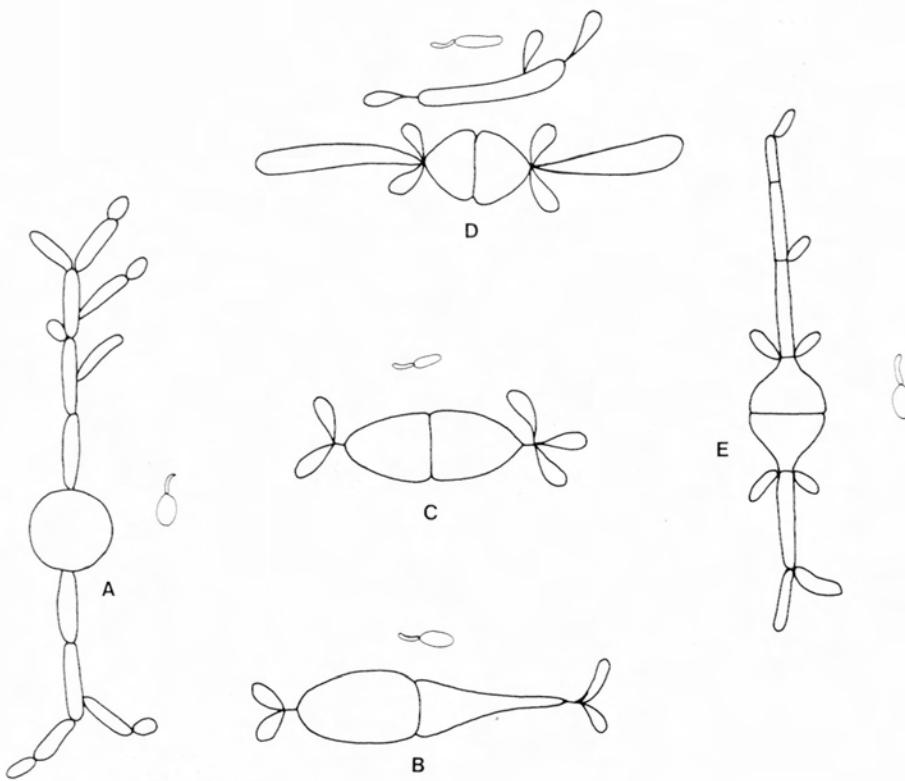


Fig. 122. *Tympanis* spp. Primary ascospores. (a) *T. alnea* (b) *T. laricina* (c) *T. hypopodia*, *T. spermiospora* (d) *T. truncatula* (e) *T. hysteroides*.

***Tympanis spermiospora* (Nyl.) Nyl.** Not. Sallsk. Fauna Flora Fenn. 10: 70 (1868).

Apothecia erumpent, single or caespitose, circular or undulate, glabrous, black, 0.5-1 mm diameter. Ascii cylindric, 55-100 × 9-15 um, with eight primary ascospores. Primary ascospores broadly ellipsoid-fusoid to subglobose, 1-septate, producing at each end a group of pyriform to subglobose cells, which in turn produce allantoid ultimate cells (secondary ascospores). Primary ascospores 5-8 × 3-4 um, secondary 2-4 × 1-1.5 um. (Fig. 122).

HOSTS: *Populus* spp.

***Tympanis truncatula* (Pers. ex Fr.) Rehm** Rab. Krypt Fl. I(3): 277 (1889). Apothecia erumpent, caespitose or single, circular or undulate, glabrous, light

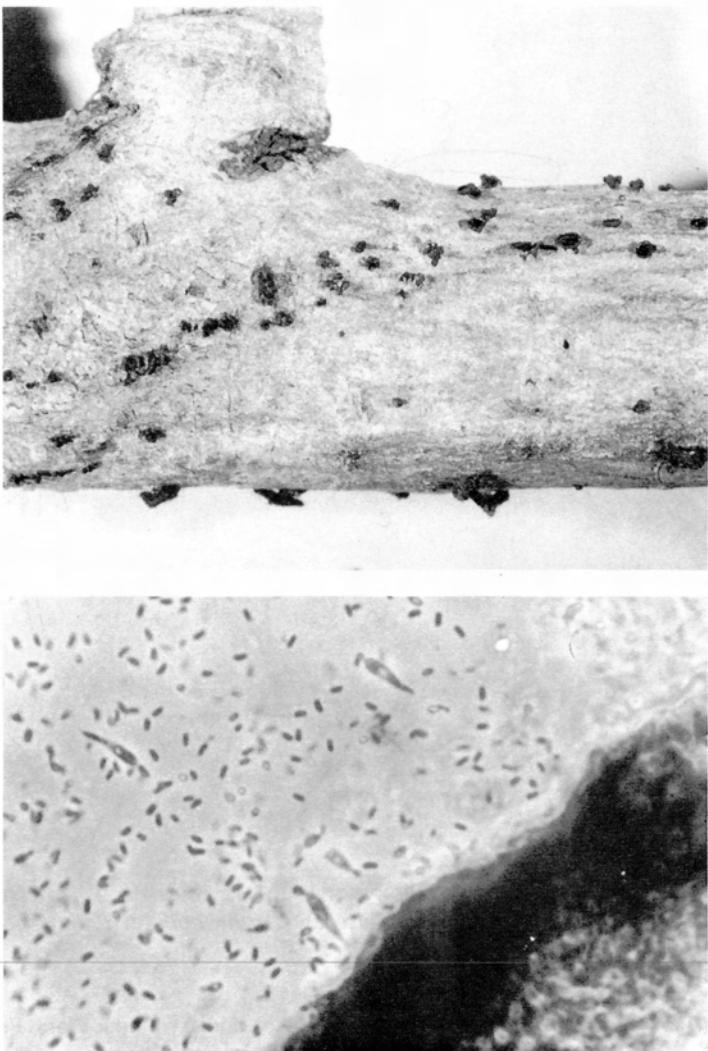


Fig. 123. *Tympanis laricina*. Apothecia. Ascospores, primary and secondary.

brown, 0.4-1.2 mm diameter, epithecum grayish pruinose or black. Ascii cylindric, 80-130 × 10-19 um. Primary ascospores globose, becoming 1-septate, budding a fascicle of pyriform cells at each end, of which the central cell is much longer and clavate-cylindric, these in turn yielding ovoid to pyriform secondary cells (mostly at the base) and allantoid ultimate cells (secondary ascospores). Primary ascospores 4-7 × 2-4 um, secondary 2-3 × 1-1.5 um. Paraphyses hyaline, filiform, tips slightly swollen and embedded in gelatinous matrix to form a brownish epithecum. (Fig. 122).

HOSTS: Conifers and hardwoods

DISEASE: Artificial inoculations showed pathogenicity in certain eastern conifers (Smerlis 1970b).

***Valsa abietis* Fr.** Sum. Veg. Scand. 412 (1849).

ANAMORPH: *Cytospora abietis* Sacc.

Stromata conoid to rounded, 0.5-1 mm diameter, scattered to gregarious, covered by host epidermis, ectostroma scanty. Perithecia embedded in bark tissue, 5-15 in a group, globose or angular from pressure, 150-400 um diameter, black; ostiolar necks collectively erumpent through ectostroma, 350-650 um long. Ascii tapered at the base with apical ring at the rounded tip, 8-spored, 25-50 × 4-6 um.

Ascospores hyaline, allantoid, both ends rounded, unicellular, 6-10 × 1-2.5 um. (Fig. 124).

Pycnidial stroma immersed in bark, erumpent by a single ostiole, multilocular, 0.5-1.5 mm diameter. Conidiophores hyaline, branched, phialidic, 10-35 um long. Conidia hyaline, allantoid, unicellular, 3-5 × 1-1.5 um, borne at the tip of each branch of the conidiophore.

HOSTS: *Pseudotsuga menziesii* and other conifers

DISEASE: Colonizes senescent branches of Douglas-fir and other conifers. Some evidence of pathogenicity is reported for this species (Wright 1942).

NOTES: A closely related species on conifers is *Valsa pini* (Alb. & Schw. ex Fr.) Fr. which has asci and spores of similar sizes, but the perithecia are embedded circinately in the bark and the necks are erumpent around the ectostromatic disc. *Valsa pini* is reported to cause cankers in grand fir and white pine.

Leucostoma is a related genus but the stromata are delimited by a black conceptacle (q.v.).

***Valsa friesii* (Duby) Fckl.** Symb. Myc. 198 (1869).

SYNONYM: *V. juniperina* Cooke

ANAMORPH: *Cytospora pinastri* Fr.

SYNONYM: *C. dubyi* Sacc.

Perithecia embedded in bark or needle tissue, clustered, subglobular, black, 255-275 um diameter, with long neck at the top, necks 430 × 55 um, surrounded by brown stromatic tissue. Ascii ovo-clavate, with short stalk, 28-33 × 5-7 um, 8-spored. Ascospores biseriate, allantoid, hyaline, unicellular, 9-12 × 2 um.

HOSTS: *Juniperus*, *Pseudotsuga menziesii*

DISEASE: Associated with dieback of branches. Rare.



Fig. 124. *Valsa abietis*. Stem canker on Douglas-fir. Ascus.

Valsa sordida Nitschke Pyren. Germ. 203 (1867).

ANAMORPH: *Cytospora chrysosperma* Pers. ex Fr.

Stromata conic to truncate-conic, 0.5-2 mm diameter, breaking through the bark to expose a prominent dark gray disc (ectostroma). Perithecia embedded in the bark, 6-12 in a cluster, globose to compressed, 300-500 μm diameter, dark brown; ostiolar necks collectively erumpent through ectostroma, 500-700 μm long. Ascii clavate, with apical ring, 8-spored, 30-45 \times 5-7 μm ; ascospores hyaline, allantoid, unicellular, both ends rounded, 7-12 \times 1.5-2.5 μm .

Pycnidial stroma immersed in the bark, 0.5-1.5 mm diameter, multilocular, ostiole erumpent, wall indistinct. Conidiophores usually branched, hyaline, phialidic, 10-40 μm long. Conidia hyaline, allantoid, unicellular, 3-5 \times 1-1.5 μm , often emerging in long orange tendrils.

HOSTS: *Populus* spp., rarely on other deciduous trees

DISEASE: Causal agent of poplar canker. Conidial state commonly occurring abundantly, ascigerous state rare.

Valsaria allantospora Ell. & Ev. Proc. Acad. Nat. Sci. Phila. 343 (1894).

Stroma cortical, elliptical, 4-7 \times 3 mm, or subseriate-elongated for 10-20 mm, formed from the substance of the bark which becomes a lighter color than the surrounding parts, and is delimited by a black line which penetrates the wood to a depth of approx. 1 mm. Perithecia 6-12 in a stroma, globose, black, thick-walled, not sunk in the wood, 750-1000 μm diameter. Ostioles erumpent, slightly projecting, conical, black, not crowded, connected by a thin, black crust. Ascii clavate, short-stipitate, 55-62 \times 8-10 μm . Ascospores biseriate, cylindrical, slightly curved, yellowish at first, becoming brown and 1-septate, but not constricted, 12-15 \times 3-3.5 μm . (Fig. 125).

HOST: *Acer negundo*

NOTES: Common on dead branches of boxelder throughout the prairies. Possibly should be transferred to the genus *Endoxylina*.



Fig. 125. *Valsaria allantospora*. Ascospores.

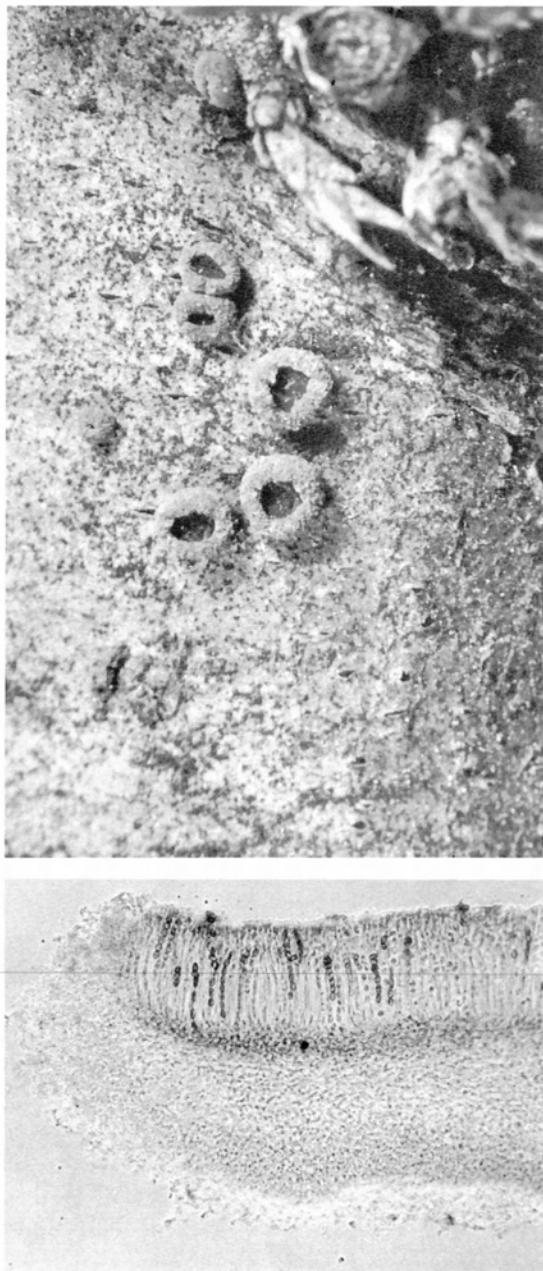


Fig. 126. *Velutarina rufo-olivacea*. Apothecia on western red cedar. Apothecium, vertical section.

***Velutarina rufo-olivacea* (Alb. & Schw.) Korf** Phytologia 21: 207 (1971).

Apothecia single or clustered, erumpent, subsessile, thick margin inrolled; outer surface powdery, tan-gray; hymenium dark brown to black; 2-3 mm diameter. The excipular powder formed of loose, thick-walled irregularly lobed cells. Medullary excipulum whitish loose *textura intricata*, containing numerous round vesicular cells (approx. 30 um diameter) with greenish contents. Ascii cylindric, 8-spored, pore blued by iodine (J+), 130-160 × 12 um. Ascospores broadly ellipsoid, hyaline at first but becoming brown, nonseptate, uniseriate, containing one or two large oil droplets, 10-14 × 6-7 um. Paraphyses filiform, hyaline, 2-3 um diameter, swelling to 5 um at the tip. (Fig. 126).

HOST: *Thuja plicata*

NOTES: Found occasionally as a saprophyte on dieback branches of western red cedar. A polyphagous fungus in other parts of the world. The J+ reaction of the ascus pore may require pretreatment with dilute KOH.

***Venturia macularis* (Fr.) E. Müller & Arx** Ber. Schw. Bot. Gesell. 60: 366 (1950).

ANAMORPHS: *Pollaccia americana* Ondrej

Pollaccia radiosa (Lib.) Bald. & Cif.

Ascomata immersed, globose to conical, erumpent, glabrous or setose, wall of brown polygonal cells, 80-140 um diameter, setae 30-50 um long, apical pore 25-30 um wide. Ascii oblong to saccate, bitunicate, 2-4-8-spored, 42-63 × 10-12 um. Ascospores greenish to brown, elliptical to clavate, straight or inequilateral, 1-septate in the middle or below, slightly constricted, sometimes finely roughened, sometimes with a gelatinous coating, 8-14 × 4.5-6 um.

Acervuli irregular, olive-green. Conidiophores brown, nonseptate, 8-12 × 4-6 um. Conidia brown, ellipsoid to cylindrical, straight or bent, 0-2-septate, 12-22 × 6-7 um.

HOST: *Populus tremuloides*

DISEASE: Causes leaf and shoot blight of poplars. (Fig. 127).

NOTES: A closely related species attacks black and balsam poplars, viz., *V. populina* (Vuill.) Fabric. (ANAMORPH: *P. elegans* Serv.) which has larger ascospores (20-23 × 11-13 um) and conidia (25-36 × 8-14 um). Considerable variation has been noted in some *Venturia* species and it is possible that races exist. Pollaccias are also difficult to distinguish and the work of Ondrej (1972) has facilitated identification.

***Venturia saliciperda* Nüesch** Phytopath. Z. 39: 350 (1960).

ANAMORPH: *Pollaccia saliciperda* (Allesch. & Tub.) Arx

Ascomata immersed, globose to conical, papillate, setose, 80-120 um diameter, wall of 2 layers of brown cells. Ascii oblong to saccate, bitunicate, 35-55 × 8-12 um. Ascospores narrowly ellipsoid, 1-septate slightly above the middle, slightly greenish, 11-14 × 3-5 um.

Conidial state developing on shoots and leaves, in brown irregular spots; conidiophores annellate, cylindric to conic, 8-15 × 5-8 um. Conidia ellipsoid to cylin-



Fig. 127. *Venturia macularis*. Shoot blight on aspen.

dric, 1-2-septate, greenish brown to olivaceous, 16-23 × 6-9 um, base truncate.

HOSTS: *Salix* spp.

DISEASE: Cause of willow blight, often associated with *Glomerella cingulata* in this disease.

Verrucaria plumbaria Stizenb. Erythea 3: 94 (1895).

Pseudothecia immersed or superficial, subglobose to compressed, black, parenchymatous, 135-230 um in diameter; clypeus superficial, plectenchymatous, black. Ascii cylindric, 8-spored, bitunicate, 45-73 × 7-10 um. Paraphyses filiform. Ascospores hyaline, 1-septate, ovate (the upper cell being slightly wider than the lower), with a mucilaginous sheath, 11-16 × 4-6 um. (Fig. 128).

HOST: *Pseudotsuga menziesii*

NOTES: A common bark epiphyte that may become lichenized. It is widespread both on coastal and interior Douglas-fir; and, in some areas, it is found on almost every tree. Sherwood and Carroll (1974) encountered this fungus in their study of fungal succession on Douglas-fir twigs in Oregon.

Verticildiella wagenerii Kendrick Can. J. Botany 40: 793 (1962).

TELEOMORPH: *Ceratocystis wageneri* Goheen & Cobb

Conidiophore stipes up to 775 um long, up to 12-septate, 4-12 um wide, brown. Metulae in 3-5 series; primary series number from 2-10, measuring from 20-50 × 4-8 um, concolorous with stipe; secondary metulae hyaline. Sympodulae very numerous, 10-28 × 2 um. Conidia obovoid, elliptic, or clavate, base usually truncate, continuous, 2-8 × 1.7-3.8 um, accumulate in a mucilaginous mass which eventually becomes brown. (Fig. 129).

Perithecia black, globose, 75-340 um diameter; necks black to light brown at the apex, 350-800 um long, 20-40 um wide at the base, tips may be slightly flared, ostiolar hyphae absent. Ascii evanescent. Ascospores hyaline, curved or kidney-shaped, 7 × 2 um, exuding in a sticky droplet.

HOSTS: *Pinus contorta*, *Pseudotsuga menziesii*

DISEASE: Causes a serious root disease of conifers characterized by a dark brown to black stain in the sapwood of roots and lower stem.

NOTES: The *Verticildiella* state is usually obtained in culture from root and stem isolations. The *Ceratocystis* state was found in galleries of several different insects believed to be the vectors (Goheen & Cobb 1978).

Xenomeris abietis Barr Can. J. Botany 46: 842 (1968).

ANAMORPHS: *Sclerophoma xenomeria* Funk

Hormonema (in culture)

Ascostromata (perithecia) densely clustered on a basal stroma, dark brown to black, spherical to cupulate, uniloculate, 150-200 um diameter, with apical pore. Basal stroma 0.8-1.9 mm in diameter, 0.3-0.5 mm high, erumpent, on hypostroma in host tissues. Ascii bitunicate, 35-55 × 11-13 um, oblong to saccate, 8-spored. Ascospores pale green to olivaceous, oval to ellipsoid, 1-septate, upper cell broader, thick-walled, 11-16 × 4-6 um, one guttule per cell. (Fig. 130).

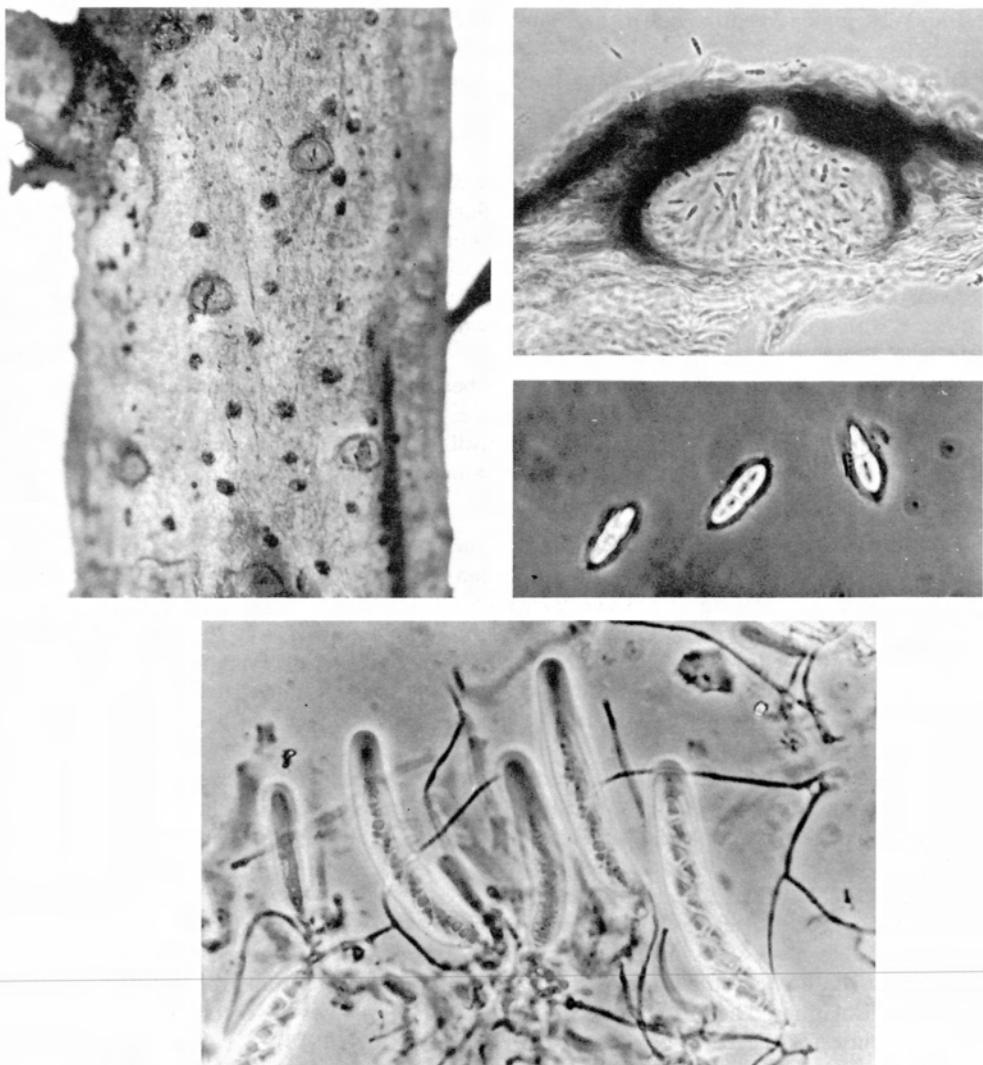


Fig. 128. *Verrucaria plumbaria*. Habit on bark. Perithecium. Ascospores. Ascus.

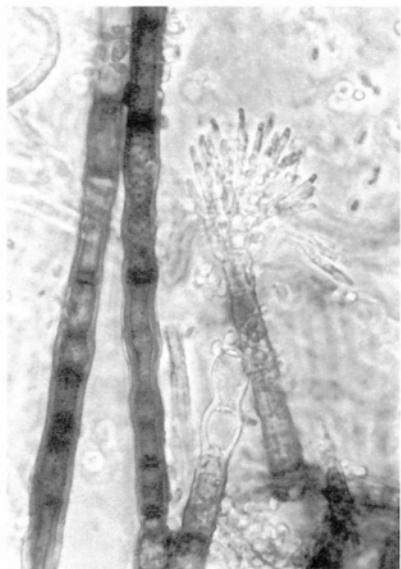


Fig. 129. *Verticiladiella wagenerii*. Conidiphore and hypha from culture.

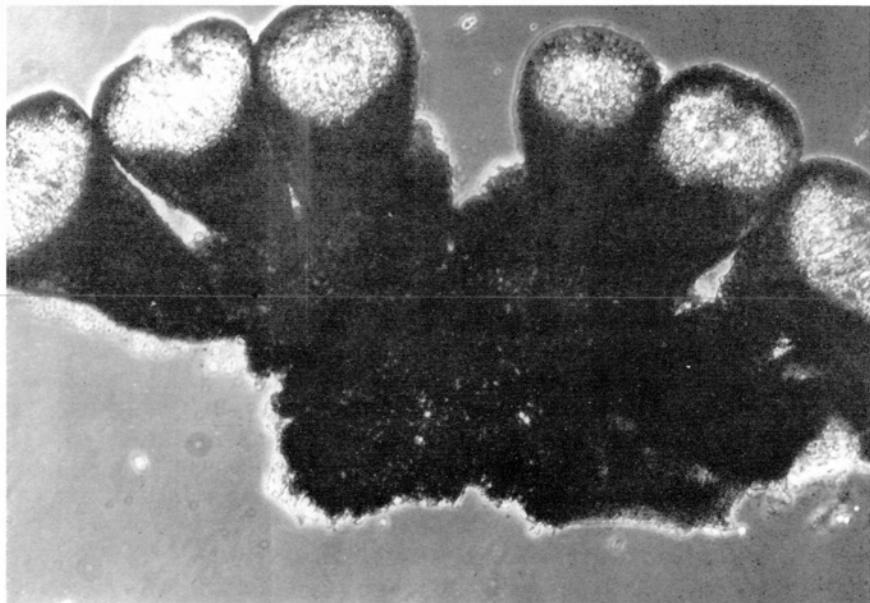


Fig. 130. *Xenomeris abietis*. Ascostromata on bark. Ascostromata.

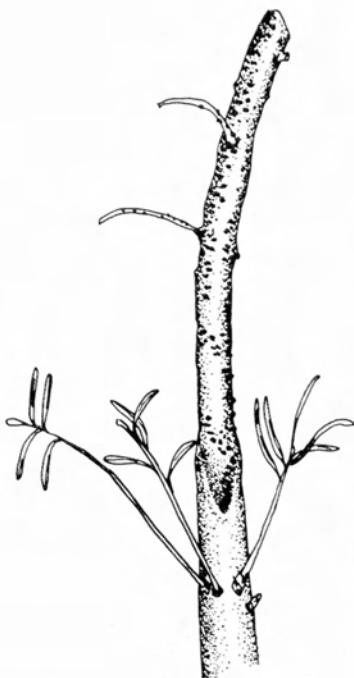


Fig. 131. *Xenomeris abietis*. Dieback of Douglas-fir.

Pycnidia erumpent, sessile, shiny black, disciform to subglobose or multilobed, 200-500 μm diameter, walls composed of dark brown isodiametric cells (pseudoparenchyma), becoming subhyaline toward the inner conidiogenous layer. Conidiogenous cells phialidic, formed from the cell lining the inner wall, globose to ampulliform. Conidia ellipsoid, nonseptate, 1-2-guttulate, hyaline, $8-10 \times 4-5 \mu\text{m}$. (Fig. 113).

HOSTS: *Pseudotsuga menziesii*, *Tsuga heterophylla*

DISEASE: Associated with dieback following drought in young Douglas-fir (McMinn and Funk 1970; Funk and Shoemaker 1971). (Fig. 131).

NOTES: There are three *Sclerophoma* species, all producing *Hormonema* states in culture, associated with dieback of Douglas-fir (Funk 1979e) (See Table under *Sclerophoma*).

***Xylaria hypoxylon* (L. ex Fr.) Grev.** Fl. Edin. 355 (1824).

Stroma slender, subcylindric to strap-shaped, usually forked, stalk black and hairy, upper fertile portion at first white with powdery conidia, darkening as perithecia develop and then papillate, up to 8 cm tall, of isodiametric cells. Perithecia globose, immersed in the stroma, with coarse ostioles, 600-700 μm

diameter, wall of elongate, indistinct cells. Ascii cylindric, 8-spored, with high, slightly refractive apical ring, $80-100 \times 8$ um. Ascospores ellipsoid to bean-shaped, black, with germ slit, $11-14 \times 5-6$ um.

HOSTS: *Alnus*, *Acer*

NOTES: Common on dead hardwoods throughout the year.

GLOSSARY

- acervulus:** fruiting structure of certain Deuteromycotina, consisting of a shallow aggregation of hyphae and bearing conidiophores on the upper surface.
- acicular:** slender and pointed, needle-shaped.
- acrogenous:** at the tip, apical.
- acropleurogenous:** at the tip and sides.
- acuminate:** narrowing to a point.
- acute:** pointed, less than a right angle.
- allantoid:** sausage-shaped, slightly curved with rounded ends.
- ampulliform:** flask-shaped.
- amyloid:** stained blue-black by Melzer's Iodine; symbol J + . (cf. dextrinoid).
- anamorph:** the imperfect state of a fungus; asexual, mitotic diasporic expression of a fungus.
- annellophore:** a conidiogenous cell with a series of ring-like scars left by succeeding blastic conidia (annellospores).
- apical:** at the tip.
- apothecium:** the cup- or saucer-shaped fruit body of the Discomycetes, containing ascii.
- appendage:** a process or outgrowth.
- arthrospore:** spore produced from breaking up a hypha into separate cells.
- ascigerous:** having ascii.
- ascocarp:** the ascus bearing fruit body of an Ascomycete.
- ascomycetes:** the Ascomycotina, or Sac fungi; typified by the ascus, within which are produced ascospores usually 8 in number, but in some species more or less than 8.
- ascospore:** a spore produced within an ascus by free cell formation.
- ascostroma:** a stroma containing ascii.
- ascus:** a sac-like cell of an Ascomycete within which ascospores are produced.
- aseptate:** without crosswalls.
- asexual:** vegetative, without sex organs, imperfect, not involving nuclear fusion.
- basidiomycetes:** the Basidiomycotina, a large subdivision of the fungi characterized by presence of the basidium bearing basidiospores; includes the mushrooms, polypores, etc.
- basipetal:** development in direction of the base, making the apical part the oldest.
- biseriate:** in two series or rows.
- bitunicate:** having two walls, as in the ascii of Loculoascomycetes.
- blastospore:** a spore produced by blowing-out of the cell wall and enlarging before being delimited by a septum. (cf. holoblastic, enteroblastic).
- bluestain:** bluish black discoloration in wood caused by fungi, especially *Ceratocystis* spp.
- botryose:** grouped like grapes.
- budding:** development of a spore from a small outgrowth.
- caespitose:** in groups or clusters, frequently arising from a common stroma.

canker: a localized lesion or area of necrosis in the bark of stems or branches. Three types of cankers are recognized: 1) *Perennial* or *Target* cankers are roughly circular and contain much callus at the face and margins. The fungus is slow growing, roughly equalling radial growth of the tree. 2) *Annual* or *Canker Blight* are cankers that develop rapidly for one season only and contain little or no callus. They frequently occur on stressed trees and disappear in the absence of the stress factors. 3) *Diffuse Cankers* grow more rapidly than the radial growth of the tree and so contain little or no callus. They usually girdle the tree after several years. If the canker fungus also invades the underlying wood, *canker rot* is produced.

catenulate: in chains, chain-like.

cirrhus: a tendril-like mass of forced-out spores.

clavate: club-like, narrowed at the base.

cleistothecium: an ascocarp having no special opening.

clypeus: a shield-like growth over a perithecium.

coelomycete: a division of the Deuteromycotina (Fungi Imperfecti) consisting of Sphaeropsidales and Melanconiales, q.v.

conidiogenous cell: a cell from which a conidium is directly produced.

conidioma: general term for an asexual fruit body, i.e., the anamorphic phase.

conidiophore: a hypha bearing conidiogenous cells from which conidia are produced.

conidium: an asexual spore.

continuous: having no septa.

cuneate: wedge-like.

dehiscent: opening when mature by pores or by breaking up.

deliquescent: becoming liquid after maturing.

dematiaceous: more or less darkly pigmented.

deuteromycetes: Fungi Imperfecti; characterized by the absence of a sexual state.

dextrinoid: stained reddish brown by Melzer's Iodine.

dictyospore: a spore having longitudinal and transverse septa; muriform.

dieback: death of the outermost twigs or extremities of the branches or leaders.

Dieback can be caused by stress complexes or by invasion and girdling of stems by canker fungi.

discomycetes: the cup-fungi, with asci produced in an apothecium.

distoseptate: having each cell surrounded by a wall distinct from the common outer wall.

ecto-: outside.

endo-: inside.

enteroblastic: where only the inner wall, or no wall, contributes to the formation of conidia.

epitheciun: the surface of the disc in certain Discomycetes.

erumpent: bursting through the bark.

euseptate: septa in which the diaphragm merges with the outside wall.

evanescent: soon disappearing, ephemeral.

excipulum: tissues of the apothecium; ectal-, forms outermost layers, including the

- margin, and medullary-, the zone enclosed by the ectal excipulum and the hypothecium.
- falcate*: curved like the blade of a sickle.
- filiform*: thread-like.
- floccose*: cottony.
- fruit body*: a general term for spore-bearing organs.
- gall*: a swelling or outgrowth produced by a plant as the result of fungus attack.
- glabrous*: smooth, not hairy.
- globose*: spherical or almost so.
- guttulate*: having one or more oil drops inside.
- holoblastic*: where both outer and inner walls contribute to the formation of a conidium.
- host*: a living organism harboring a parasite.
- hyaline*: transparent, colorless.
- hymenium*: the spore bearing layer of a fruit body.
- hyphae*: the vegetative, microscopic filaments of a mycelium (or spawn), forming the thallus (body) of a fungus.
- hyphomycetes*: the division of the Deuteromycotina in which conidia are borne on conidiophores not organized into a fruit body.
- hypothecium*: the hyphal layer under the hymenium of an apothecium.
- immersed*: embedded in the bark and covered by it.
- imperfect state*: the asexual spore state, the anamorph.
- inoperculate*: without an apical lid, hence opening through a pore or a split at the tip of the ascus.
- intercalary*: between apex and base.
- interthelial*: between asci.
- ionomidotic*: releasing purple-brown dye when immersed in dilute KOH.
- locule*: a cavity in a stroma.
- lucloascomycetes*: a class of the Ascomycotina characterized by bitunicate asci in an ascostroma.
- lunate*: like a new moon, crescentic.
- macroconidium*: the larger, diagnostic conidium of a fungus which also has microconidia.
- mazaedium*: a loose, powdery mass of ascospores free from asci.
- microconidium*: see macroconidium, sometimes functioning as a male sex cell.
- microfungi*: fungi having small fruit bodies, requiring magnification for observation.
- micron*: one-thousandth of a millimetre; approx. one 25,000ths of an inch; symbol um.
- moniliform*: having swellings at regular intervals, like a string of beads (= monilioid).
- muriform*: see dictyospore.
- myc-*, *mycet-*, *myco-*: prefix meaning fungus.
- mycelium*: a mass of hyphae, the vegetative thallus of a fungus.
- mycology*: the study of the fungi.
- mycoparasite*: the parasitism of one fungus by another.

- operculate:** opening by an apical lid.
- ostiole:** a pore through which spores are freed from a perithecium or pycnidium.
- ovate:** like a hen's egg.
- papilla:** a small rounded process.
- paraphysis:** upward growing hyphal element interspersed with the asci in the hymenium.
- parasite:** an organism living on and obtaining its nutrient from another living organism, frequently causing disease in the host.
- perfect state:** see teleomorph.
- periderm:** the outermost, corky layer of bark of a tree.
- perithecium:** the subglobose or flask-shaped ascocarp of the Pyrenomycetes.
- phialide:** an enteroblastic conidiogenous cell that produces conidia through a special opening where neither wall contributes toward formation of the conidium, often with a collarette surrounding the opening.
- phloem:** inner bark which functions in transport of elaborated foods from the leaves.
- phragmospore:** a spore having 2 or more transverse septa.
- plectenchyma:** tissue formed by hyphae becoming twisted and fixed together.
- pruinose:** having a frost-like covering.
- pseudoparenchyma:** tissue composed of more or less isodiametric cells.
- pycnidium:** the globose or flask-shaped fruit body of the Sphaeropsidales containing conidia (pycnidiospores).
- pyrenomycetes:** the fungi producing unitunicate asci in perithecia.
- sclerotium:** a sterile mass of hyphae, usually rounded and firm.
- septum:** a cross wall forming a division, as in a spore or hypha.
- sessile:** having no stem.
- seta:** a stiff hair or bristle.
- sinuate:** waved, curved.
- species:** in taxonomy, a division of a genus, usually based on morphological characters.
- spermium:** a male sex cell, usually a microconidium in the Ascomycetes.
- spore:** the reproductive propagule in the fungi.
- sporodochium:** a conidial fruit body in which the spore mass is supported by a pulvinate body covered with short conidiophores.
- state:** a phase of the fungus life cycle; Ascomycetes generally have 2 states: 1) Perfect state - the sexual or ascigerous state, also known as the *teleomorph*. 2) Imperfect state - the asexual or conidial state, also known as the *anamorph*. Sometimes a second asexual state is produced in culture.
- sterile:** 1) not producing spores, 2) free from living organisms.
- stipitate:** with a stalk.
- stroma:** a mass of fungus tissue on which perithecia or apothecia are produced, or in the Loculoascomycetes, in which ascigerous locules are formed.
- subiculum:** a net-like, or crust-like growth of mycelium under fruit bodies.
- subulate:** tapering to a point; awl-shaped.
- sympodium:** a conidiogenous cell characterized by continued growth of a succession

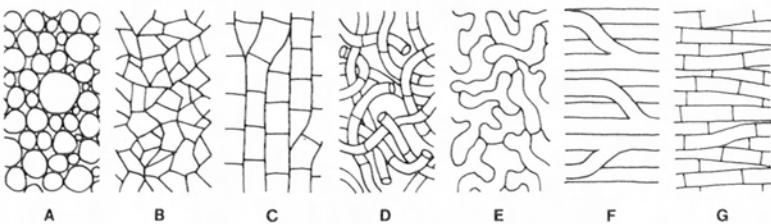
of apices each of which originates below and to one side of the previous apex.

syndrome: a complex of symptoms constituting the picture of a disease.

synnema: a group of erect, fused conidiophores bearing conidia at the apex.

synonym: another name for a fungus, esp. a later or illegitimate name.

teleomorph: the perfect or sexual state of a fungus, i.e., the form involved in producing meiotic spores.



textura: tissue of the Ascomycetes.

Short-celled tissue.

A) cells round: *textura globulosa*.

B) cells polyhedral: *textura angularis*.

C) cells rectangular: *textura prismaatica*.

Long-celled tissue.

D) hyphae loose, not parallel: *textura intricata*.

E) hyphae united, not parallel: *textura epidermoidea*.

F) hyphae thick-walled, parallel: *textura oblita*.

G) hyphae thin-walled, parallel: *textura porrecta*.

tomentose: having a covering of soft, matted hairs.

uncinate: hooked.

unitunicate: of asci, having only one wall.

valloid: groups of perithecia with convergent beaks.

verrucose: warty.

verticillate: whorled.

viscid: sticky.

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HOST INDEX

ABIES AMABILIS (Dougl.)

Forbes - Amabilis fir
 Biatorella resinae
 Grovesiella abieticola
 Helotium resinicola
 Herpotrichia juniperi
 Lachnellula agassizii
 Lachnellula calyciformis
 Nectria macrospora
 Pithya vulgaris
 Potebniamyces balsamicola
 var. boycei
 Sclerophoma pithyophila
 Sclerophoma semenospora
 Sydowia polyspora

Sclerophoma pithyophila
 Sydowia polyspora
 Valsa abietis
 Xenomeris abietis

ABIES BALSAMEA (L.)

Mill. - Balsam fir
 Ascocalyx abietis
 Kirschsteiniella thujina
 Potebniamyces balsamicola
 var. balsamicola

ABIES LASIOCARPA (Hook.)

Nutt. - Alpine fir
 Ascocalyx tenuisporus
 Ascocoryne sarcoïdes
 Camarographium abietis
 Camarosporium strobilinum
 Ceratocystis dryocoetidis
 Delphinella abietis
 Dermea balsamea
 Dermea rhytidiformans
 Dermea tetrasperma
 Grovesiella abieticola
 Herpotrichia juniperi
 Hypoxylon diathrauston
 Lachnellula agassizii
 Lachnellula arida
 Nectria fuckeliana
 Pithya vulgaris
 Potebniamyces balsamicola
 var. balsamicola
 Retinocyclus abietis
 Rhinocladiella elatior
 Sclerophoma pithyophila
 Sclerophoma semenospora
 Scoleconectria cucurbitula
 Sydowia polyspora
 Thyronectria balsamea
 Tympanis larinina
 Tympanis truncatula

ABIES GRANDIS (Dougl.)

Lindl. - Grand fir
 Ascocoryne sarcoïdes
 Atchia glomerulosa
 Caliciopsis pseudotsugae
 Dermea pseudotsugae
 Dermea tetrasperma
 Gelatinosporium griseo-lanatum
 Gelatinosporium pinicola
 Grovesiella abieticola
 Grovesiella grantii
 Lachnellula agassizii
 Lachnellula ciliata
 Lachnellula occidentalis
 Pithya vulgaris
 Potebniamyces balsamicola
 var. boycei

ACER MACROPHYLLUM

Pursh - Bigleaf maple
Hypoxylon deustum
Nectria cinnabarina
Nectria coccinea
Xylaria hypoxylon

ACER NEGUNDO L. -

Manitoba maple, box-elder
Dothidea sambuci
Stigmella negundinis
Valsaria allantospora

ALNUS RUBRA Bong. -

Red alder
Didymosphaeria oregonensis
Encoelia furfuracea
Eutypella stellulata
Hypoxylon fuscum
Hypoxylon multiforme
Hypoxylon rubiginosum
Melanconis thelebola
Melanconium sphaeroideum
Nectria cinnabarina
Nectria ditissima
Tympanis alnea
Xylaria hypoxylon

AMELANCHIER ALNIFOLIA

(Nutt.) Nutt. - Saskatoon
 berry
Aiosporina collinsii

ARBUTUS MENZIESII

Pursh - Arbutus
Hendersonula toruloides

BETULA PAPYRIFERA

Marsh. - White birch
Eutypella stellulata

BETULA

Encoelia furfuracea
Hemimyriangium betulae
Hypoxylon multiforme
Melanconium bicolor

CHAMAECYPARIS

NOOTKATENSIS (D. Don)
 Spach - Yellow cedar
Herpotrichia juniperi
Kabatina thujae
Pestalotiopsis funerea
Pleospora laricina

CORNUS NUTTALLII

Audubon - Western
 flowering dogwood
Camarosporium quaternatum
Nectria galligena
Sclerophoma ambigua

JUNIPERUS COMMUNIS L. -

Common juniper
Herpotrichia juniperi

JUNIPERUS SCOPULORUM

Sarg. - Rocky Mountain
 juniper
Eutryblidiella sabina

LARIX LARICINA

(Du Roi) K. Koch -
 Tamarack
Lachnellula occidentalis
Tympanis larinina
Valsa abietis

LARIX LYALLII Parl. -

Alpine larch

Lachnellula occidentalis
Lachnellula suecica

LARIX OCCIDENTALIS

Nutt. - Western larch

Dermea tetrasperma
Encoeliopsis laricina
Lachnellula flavovirens
Lachnellula occidentalis
Lachnellula suecica
Mytilidion gemmigenum
Potebniamyces coniferarum
Tympanis laricina

PICEA ENGELMANNII

Parry - Engelmann spruce
Biatorella resinae
Botryosphaeria piceae
Botrytis cinerea
Dichomera gemmicola
Herpotrichia coulteri
Herpotrichia juniperi
Lachnellula suecica
Leucostoma kunzei
Pseudophacidium garmanii
Retinocyclus abietis
Sirococcus strobilinus
Sydiowia polyspora
Therrya piceae
Tryblidiopsis pinastri

PICEA GLAUCA (Moench)

Voss - White spruce
Bactrodesmium obliquum
Biatorella resinae
Botryosphaeria piceae
Camarosporium strobilinum
Dichomera gemmicola
Geniculodendron pyriforme
Helotium resinicola

Herpotrichia juniperi
Lachnellula suecica
Pseudophacidium garmanii
Retinocyclus abietis
Sirococcus strobilinus
Sydiowia polyspora
Therrya piceae
Tryblidiopsis pinastri
Tympanis laricina
Valsa abietis

PICEA MARIANA (Mill.)

B.S.P. - Black spruce
Tryblidiopsis pinastri

PICEA SITCHENSIS (Bong.)

Carr. - Sitka spruce
Amorphotheca resinae
Botryosphaeria piceae
Cucurbitothis pithyophila
Dichomera gemmicola
Discocainia treleasei
Geniculodendron pyriforme
Helotium resinicola
Herpotrichia juniperi
Lachnellula agassizii
Retinocyclus abietis
Retinocyclus olivaceus
Rileya piceae
Sirococcus strobilinus
Sydiowia polyspora
Tryblidiopsis pinastri

PINUS ALBICAULIS Engelm. -

Whitebark pine
Biatorella resinae
Gremmeniella abietina
Herpotrichia coulteri
Lachnellula agassizii
Lachnellula arida
Lachnellula flavovirens
Lachnellula pini

Sirococcus strobilinus	Lachnellula fuscosanguinea
Sydomia polyspora	Lachnellula pini
PINUS CONTORTA Dougl. -	Lachnellula suecica
Lodgepole pine	Lophium mytilinum
Atropellis pinicola	Nectria macrospora
Atropellis piniphila	Pragmopora pini
Biatorella resinae	Sydomia polyspora
Cenangium ferruginosum	Tympanis hypopodia
Ceratocystis huntii	
Ceratocystis montia	
Diplodia pinea	
Gremmeniella abietina	
Herpotrichia coulteri	
Herpotrichia juniperi	
Lachnellula agassizii	
Lachnellula arida	
Lachnellula flavovirens	
Lachnellula fuscosanguinea	
Lachnellula suecica	
Lophium mytilinum	
Monocillium nordinii	
Mytilidion gemmigenum	
Paecilomyces varioti	
Retinocyclus abietis	
Rosellinia thelena	
Septonema chaetospira var. pini	
Sirococcus strobilinus	
Sydomia polyspora	
Tympanis hypopodia	
Verticildiella wagenerii	
PINUS MONTICOLA Dougl. -	
Western white pine	
Atropellis pinicola	
Biatorella resinae	
Cenangium ferruginosum	
Colpoma crispum	
Cucurbitoditis pithyophila	
Dermea tetrasperma	
Europhium trinaciforme	
Gelatinosporium pinicola	
Lachnellula agassizii	
Lachnellula calyciformis	
PINUS PONDEROSA Laws. -	
Ponderosa pine	
Atropellis piniphila	
Biatorella resinae	
Cenangium ferruginosum	
Gremmeniella abietina	
Sirococcus strobilinus	
POPULUS BALSAMIFERA L. -	
Balsam poplar	
Amphisphaerella amphisphaeroides	
Caliciopsis calicioides	
Parkerella populi	
Rhytidella moriformis	
POPULUS TREMULOIDES	
Michx. - Trembling aspen	
Camarosporium quaternatum	
Cenangium singulare	
Ceratocystis alba	
Ceratocystis crassivaginata	
Ceratocystis fimbriata	
Ceratocystis tremulo-aurea	
Cryptodiaporthe salicella	
Cryptosphaeria populina	
Diplodia tumefaciens	
Dothiora polyspora	
Fusarium lateritium	
Godronia fuliginosa	
Hypoxylon fuscum	
Hypoxylon mammatum	
Hypoxylon serpens	
Leciographa gallicola	

Neofabrea populi
Parkerella populi
RhytidIELLA baranyayi
Trichocladium canadense
Tympanis alnea
Tympanis spermatiospora
Valsa sordida
Venturia macularis

POPULUS TRICHOCARPA
Torr. and Gray - Black
cottonwood

Ascocoryne sarcoides
Caliciopsis caliciooides
Cryptodiaporthe salicella
Cucurbitaria staphula
Diplodia tumefaciens
Eutypa acharii
Fusarium lateritium
Leciographa gallicola
Mycosphaerella populincola
Mycosphaerella populorum
Neofabrea populi
Tympanis spermatiospora
Valsa sordida

PRUNUS
Apiosporina morbosa

PSEUDOTSUGA MENZIESII

(Mirb.) Franco - Douglas-fir
Ascocoryne sarcoides
Atchia glomerulosa
BactrodDesmium obliquum
Biatorella resinae
Botryosphaeria pseudotsugae
Botrytis cinerea
Caliciopsis pseudotsugae
Claussenomyces pseudotsugae
Coccomyces pseudotsugae
Colpoma crispum
Cylindrocarpon destructans

Dermea pseudotsugae
Dermea tetrasperma
Diaporthe lokoyae
Dichomera gemmicola
Durandiella pseudotsugae
Gelatinosporium fosteri
Gelatinosporium pinicola
Gelatinosporium sinuatum
Gelatinosporium uncinatum
Grifosphearia corticola
Helotium resinicola
Lachnellula ciliata
Lachnellula pseudotsugae
Leucostoma kunzei
Lophium mytilinum
Nitschkia molnarii
Pezicula livida
Pezizella chapmanii
Phoma glomerata
Phomopsis porteri
Phragmoporthe pseudotsugae
Pithya vulgaris
PotebniAmyces coniferarum
Pragmopora pithya
Retinocyclus abietis
Rhinocladiella elatior
Rosellinia herpotrichioides
Sclerophoma pithyophila
Sclerophoma semenospora
Sclerophoma xenomeria
Sirococcus strobilinus
Sydowia polyspora
Therrya pseudotsugae
Tympanis laricina
Valsa abietis
Valsa friesii
Verrucaria plumbaria
Verticildiella wagenerii
Xenomeris abietis

SALIX

Cryptodiaporthe salicella
Cryptomyces maximus
Diaporthe eres
Dothiora polyspora

Fusarium lateritium
Glomerella cingulata
Godronia fuliginosa
Hypoxyton mammatum
Nectria cinnabrina
Nectria coccinea
Pezicula ocellata
Venturia saliciperda

Lophium mytilinum
Nectria macrospora
Nipterella tsugae
Nitschzia molnarii
Pestalopezia tsugae
Pezicula livida
Potebniamyces coniferarum
Retinocyclus abietis
Retinocyclus olivaceus
Sageria tsugae

TAXUS BREVIFOLIA Nutt. -
 Western yew
Phyllostictina hysterella

THUJA PLICATA Donn -
 Western red cedar
Diaporthe lokoyae
Fusarium moniliforme
 var. *subglutinans*
Pithya cupressina
Seiridium cardinale
Valsa abietis
Velutarina rufo-olivacea

TSUGA MERTENSIANA
 (Bong.) Carr. - Mountain
 hemlock
Herpotrichia juniperi
Sageria tsugae

TSUGA HETEROPHYLLA
 (Raf.) Sarg. - Western hemlock

Acremonium tsugae
Ascocoryne sarcoïdes
Biatorella resinae
Botryosphaeria tsugae
Caliciopsis pseudotsugae
Coccozymes heterophyllae
Colpoma crispum
Cucurbitodothis pithyophila
Dermea balsamea
Diaporthe lokoyae
Discocainia treleasei
Durandiella tsugae
Gelatinosporium griseo-lanatum
Gelatinosporium pinicola
Gelatinosporium stillwellii
Helotium resinicola
Herpotrichia juniperi
Lachnellula agassizii

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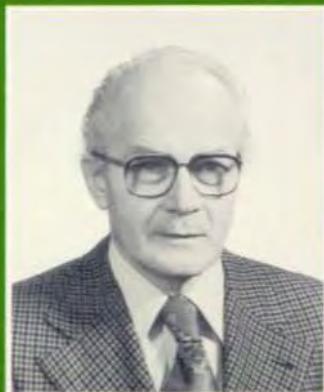
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Biographical Note

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