#### COPROPHILOUS PYRENOMYCETES

## OF THE ISLAND OF MONTREAL AND VICINITY

by

.

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## TABLE OF CONTENTS

	PAGE
ACKNOWLEDGEMENTS	i
TABLE OF CONTENTS	ii
INTRODUCTION	, 1
REVIEW OF LITERATURE	
Nomenclature	. 2
Distribution	6
MATERIALS AND METHODS	
Collection of materials	12
Culture method	14
The study method	15
OBSERVATIONS AND RESULTS	17
DISCUSSION AND CONCLUSION	109
SUMMARY	114
APPENDICES	115
BIBLIOGRAPHY	117

#### INTRODUCTION

Very little work has been done with regard to the presence and distribution of coprophilous Pyrenomycetes in the Province of Quebec. So far only the Ungava Bay area and the Lake Mistassini area of the province have been surveyed by Cain(1957) concerning the presence of fimicolous Ascomycetes. Barr(1961) in her study of the Pyrenomycetes of Gaspesian Park, Quebec recorded the presence of a few coprophilous species. No survey of the occurrence of coprophilous Pyrenomycetes has been done on the island of Montreal and vicinity. Thus the aim of this study is to make such a survey in this area, which will be helpful in adding to our knowledge of the local flora.

This present work will include an account of the species of coprophilous Pyrenomycetes that have been found and identified during this period of study, and a brief review of the nomenclature of the family <u>Sor-</u><u>dariaceae</u> and the occurrence of coprophilous Pyreno-mycetes in other parts of Canada where such kinds of investigations have been carried out.

#### REVIEW

#### NOMENCLATURE OF THE FAMILY SORDARIACEAE

Since the authors(D.Griffiths,1901; and R.F.Cain,1934) of the two monographs which I have used as my chief guide for the identification of coprophilous Pyrenomycetes do not agree in their treatment of the family <u>Sordariaceae</u>, it is necessary to include here a brief explanatory review of the nomenclature of this family.

In 1863, Cesati and DeNotaris established the genus <u>Sordaria</u> with <u>Sphaeria</u> <u>sordaria</u> Fr. as the type. Owing to the fact that the sixteen species included in <u>Sordaria</u> by Cesati and DeNotaris were not closely related, many attempts had been made to subdivide the genus.

In 1869, Fuckel tried to divide genus <u>Sordaria</u>, but his revision was not well defined. He called species with no stroma and non-appendaged ascospores, <u>Hypocopra</u>, in spite of the fact that this name had been used by Fries(1849) as a subgenus of <u>Massaria</u> for species with stroma. The division of the other three genera: <u>Sordaria</u>, <u>Cerocophora</u> and <u>Malinvernia</u> is not at all clear. Fuckel's attempt in subdividing the genus is not accepted by Griffiths or Cain.

Niessl(1883) treated the genus in a more logical way. He had four genera: Hypocopra Fries ( stromatic, ascospore without apiculum), Coprolepa Fuckel emend (stromatic, ascospore with apiculum), Sordaria Ces.& DeNot. emend (non-stromatic, ascospore without appendages), and <u>Podospora</u> Ces. emend ( non-stromatic, ascospore with appendages). Cain pointed out that most authors do not separate Coprolepa(Fuckel)Niessl from Hypocopra. The remaining three genera as emended by Niessl have come into general use, and were adapted by Winter(1885), Karsten(1885), Ellis and Everhart(1892), Feltgen(1899), Magnus(1905), Traverso(1907), Spegazzini(1921), and with certain changes of names by Griffiths(1901), Griffiths and Seaver(1910), Kirstein(1911), and Migula(1913).

In place of <u>Podospora</u> Griffiths(1901) used <u>Pleurage</u> because in 1898, O.Kuntze had called attention to the fact that Fries (1849) established the genus <u>Pleurage</u> with <u>Schizothecium</u> fimicolum Corda(1835) as a type. Since Corda's generic name is a homonym, Griffiths accepted Kuntze' proposal that the name given by Fries should stand. It is not known now what species Corda described, but it is usually thought to have been <u>Pleurage</u> fimiseda. Rehm, however, quoted it as <u>Pleurage</u> curvula. After studying the description and figures given by Corda, Griffiths concluded that Corda described one of the <u>Pleurage</u> curvula group.

Griffiths and Seaver(1910) used Fimetaria for the

genus Sordaria as emended by Niessl. According to the American Code of Botanical Nomenclature, "the application to a genus of a former specific name of one of the included species designates the type". Following this rule Sphaeria sordaria Fries becomes the type of the genus Sordaria. This is a doubtful species which many authors include in Coniochaeta or Rosellinia so that Sordaria becomes a synonym of one of these genera. This rule, however, does not apply under the International Rules. S. sordaria is the first species included by Cesati and DeNotaris(1863) in the genus Sordaria. If the International Rules are interpreted as to mean that the first species named becomes the type of a genus when there is none specifically designated by the author, then the name Sordaria becomes invalid, and should be placed on a list of Genera Conservonda. However, Cain has the opinion that the species which should be chosen as the type of Sordaria is Sphaeria fimicola Rob. This is the only species included by Niessl(1883) in his emended genus Sordaria which was among the sixteen species placed in the genus by Cesati and DeNotaris.

According to Cain(1934), the presence of gelatinous appendages and sheaths on the ascospores is to be interpreted as a development correlated with the distinctive habitat and life history of the organism concerned rather

than as characters which have a broad phylogenetic significance. He considered that the type of germ pore or germinal slit in the ascospore and the method of dehiscence of the ascus to be of greater importance in indicating relationships. Therefore, it is his opinion that the name <u>Sordaria</u> should be conserved for a group of species having:l. perithecia devoid of a definite stroma in the form of a clypeus,

- 2. asci without any apical structure other than a simple pore, and
- 3. dark ascospores without an elongated germ slit and with appendages present or lacking. (1)

A group of species generally included in <u>Sordaria</u> differs from the others in having spiny hairs on perithecial wall and discoid ascospores with an elongated germ slit. Cain felt that they show close relationship with certain lignicolous forms commonly included in <u>Coniochaeta( a segregate of Fries)</u>, therefore, he transferred them to this genus. Griffiths retained them in <u>Sordaria</u>.

For convenience, I have adapted Cain's classification (1934) in dealing with the Sphaeriales in this present work.

(1). See Appendix I.

#### DISTRIBUTION

It is beyond the scope of the present work to include in this review the extensive survey of coprophilous members of Sordariaceae carried out by Griffiths in the United States and reports by other workers of coprophilous Pyrenomycetes from other countries of the world. This review of the distribution of species of coprophilous Pyrenomycetes will be restricted to Canada.

Not much has been done with regard to the distribution of coprophilous Ascomycetes as a whole in Canada. Only the province of Ontario so far has received an extensive survey with regard to this particularly adapted group of fungi. However, the extensive survey conducted by Cain in Ontario was confined only to coprophilous Pyrenomycetes. In his publication (1934), "Studies of Coprophilous Sphaeriales in Ontario", Cain reported the presence of the following twelve genera in Ontario: - Sordaria (42 spp.), Coniochaeta(5 species), Bombardia(5 species), Zygospermella(1 species), Delitschia(13 spp.), Sporormia(25 spp.), Pleophragmia(2 spp.), Hypocopra(3 spp.), Chaetomium(13 spp.), Phomatospora(1 sp.), Leptosphaeria(lsp.), and Venturia(1 sp.). Of the 42 species of Sordaria Cain found, nine species were reported for the first time in North America, and ten were identified as new species. Coniochaeta scatigena(Berkely & Broome) comb.nov. and C.Hansenii (Oud.) comb. nov. were reported for the first time in North America by Cain(1934).

Cain added C. multispora to the list of coprophilous Coniochaeta. Of the five species of Bombardia, two are new ones (B. scortea and B. muskokensis ) and one was then reported for the first time in North America. Cain established a new genus called Zygospermum ( this was later changed into Zygospermella) with only one species, Z. setosa. Of the thirteen species of Delitschia, D. Auerswaldii Fuckel, D. leptospora Oud. and Delitschia bisporula(Crouan) Hausen were reported for the first time in North America. D.araneosa, D.timagamensis, Delitschia Griffithsii and D. gigaspora are new species established by Cain. Of the twenty five species of Sporormia, seven were reported for the first time, and eight ( Sp. pilosa, Sp. pilosella, Sp. muskokensis, Sp. lengispora, Sp. bipartis, Sp.ontariensis, Sp.splendens, and Sp.venusta ) were new species. Of the two species of Pleophragmia found, P. leporum Fuckel was reported for the first time on this continent. P. ontariensis was established by Cain as a new species. Chaetomium cuniculorum Fuckel, Leptosphaeria fimiseda Winter, and Venturia fimiseda Mout. were reported for the first time in North America by Cain(1934).

However, one must also mention that Griffiths had in 1901 included in his study species from samples of cow, horse and rabbit dung obtained from London, Ontario.

The presence of the following species were reported:-<u>Sordaria fimicola (from horse, cow, and rabbit dung),</u> <u>Pleurage anserina (from cow dung), P.amphicornis (from</u> horse dung), <u>P.zygospora(from horse dung), P.decipiens</u> (from cow and horse dung), <u>Delitschia Marchalii</u> (from rabbit dung), <u>Sporormia minima</u> (from cow dung), <u>Sp.leporina</u> (from rabbit dung) and <u>Sp.intermedia</u> (from cow dung).

Very little was known about the fimicolous Ascomycetes of the Canadian Arctic before Cain made a survey of the Hudson Bay area in 1957. The area covered in the study comprised Ungava Bay area and Lake Mistassini area of Quebec; Corwallis Island, N.W.T.; and Churchill, Manitoba. The survey was carried out by culturing( in the laboratory, University of Toronto) dung of the following animals dwelling in the Hudson Bay area: fox, Canada goose, ptarmigan, caribou, white partridge, rock partridge. Arctic hare, birch partridge, spruce partridge, lemming, hare, wolf, muskox, and deer. None of these various kinds of dung was obtainable for use by the writer in her study. In this survey, Cain reported the presence of twenty six species in the following genera:-Gymnoascus(l species), Aniciopsis(lsp.), Ascobolus( l species), Coniochaeta(2 species), Delitschia(2species), Gelasinospora(l species), Melanospora(l species), Phaeotrichum(l sp.), Sordaria(5 spp.), Sporormia (9 spp.), Sphaeronaemella(1 sp.)

and <u>Trichodelitschia</u> (1 species). Only the last nine genera are members of the Pyrenomycete series. <u>Sordaria</u> <u>arctica</u> and <u>Sporormia</u> polymera were reported to be new species.

In studying the Pyrenomycetes of British Columbia, Barr(1953) reported the presence of Sordaria fimicola from seeds of Cucurbita maxima and Dauca carota, and on horse dung culture in damp chamber. She also reported that in 1897, Ellis and Everhart had found Hypocopra gigaspora ( described as Coprolepa gigaspora by them ) on cow dung collected in the Rocky Mountains. In 1957, Barr turned to study the Northern Pyrenomycetes of eastern The area she surveyed was the Gaspesian Park in Canada. Quebec.Even though she was not particularly concerned with coprophilous Pyrenomycetes in her investigation , she reported in 1961 finding of five species of coprophilous Pyrenomycetes. Sporormia leporing from horse dung, Sp.minima from moose dung, Coniochaeta scatigena from horse dung, Sordaria pilosa from horse dung, and S. pleiospora from horse dung.

Bisby et al carried out an extensive survey of the fungi of Manitoba. In their book "The Fungi Of Manitoba" (1929), they reported the following genera of fimicolous Pyrenomycetes: <u>Sordaria</u> ( 2 spp.), Delitschia ( 2 spp.),

Pleurage (12 species), Sporormia (11 species) and Chaetomium (2 species). This list of coprophilous Pyrenomycetes was lengthened by them in 1938 by the addition of 27 species belonging to 9 genera. Genera Bombardia, Coniochaeta, Gelasinospora, Hypocopra and Zygospermella were new additions to the 1929 11st. In this later publication (1938) Bisby et al followed Cain's classification and included species of Pleurage in genus Sordaria. They also listed the fimicolous Ascomycetes found in Saskatchewan. Altogether thirty-eight species belonging to eleven genera were reported. Of these only thirty-five species belong to the following genera of Pyrenomycetes :- Sphaeroderma(l species), Chaetomium (2 spp.), Bombardia(l species), Coniochaeta(3 species), Delitschia (3 species), Hypocopra(1 species), Sordaria(14 species) and Sporormia (10 species). Almost all of them were from cultures of rabbit dung obtained from Saskatchewan.

In 1950, Wehmeyer in his book, "The Fungi Of New Brunswick, Nova Scotia and Prince Edward Island", reported the presence of twenty species of coprophilous Ascomycetes belonging to eleven genera in Nova Scotia. Most of the species reported were from cow dung collected by Wehmeyer in Colchester Co., N.S. in 1940. The species reported are:-DISCOMYCETES : Ascobolus stercorarius(from cow dung, by

Harrison, 1927), Ascophanus carneus (from bear dung, Wehmeyer, 1940; moose dung, Harrison, 1927), A. granulatus var. cervorum(from cow dung, Wehmeyer, 1940), A. lacteus (from cow dung, Wehmeyer, 1940), A. ochraceus (from Cape Breton, Harrison, 1927), Lachnea alpina (from moose and porcupine dung, Wehmeyer, 1940), L. coprinaria (from cow and bear dung, Wehmeyer, 1940), L. fimetaria (from cow dung, Harrison, 1927), L. stercorea(from cow dung, Wehmeyer, 1940), L. thelebeloides(from moose dung, Hants Co.), Lasiobolus equinus(from rabbit dung, Wehmeyer, 1940), Peziza fimeti(from cow dung, Wehmeyer, 1940), Saccobolus Kerverni(from bear(?) dung, Wehmeyer, 1940); and PYRENOMYCETES: Chaetomium globosum(from grouse(?) dung, Wehmeyer, 1942), C. indicum (from deer dung, Wehmeyer, 1942), Bombardia coprophila (from cow and porcupine dung, Wehmeyer, 1942), Sordaria appendiculata (from rabbit and porcupine dung, Wehmeyer, 1942), S. fimicola(moose dung, Wehmeyer, 1942), Sporormia ambigua(from horse dung, Wehmeyer, 1942) and Xylaria coprophila(from porcupine dung, Wehmeyer, 1942). Ascophanus granulatus(a Discomycetes from cow dung) was reported by Macoun(1888) to be present in Prince Edward No coprophilous Ascomycetes was reported in that Island. book for the province of New Brunswick, this most likely is due to the lack of such an investigation in that province.

#### MATERIALS AND METHODS

#### COLLECTION OF MATERIALS.

Dung of herbivorous animals was used in this study. Only horse, cow and sheep dungs were collected between April and November of 1961 from the following localities:-1. The Island of Montreal:-

- a. Mount Royal Park, including Fletcher's Field on the eastern slope of the mountain. Only horse dung has been collected in the months of April, June and October of 1961.
- b. MacDonald College in St.Anne de Bellevue.
  Cow and sheep dungs were collected from the pastures in June and November, 1961.
- c. An afternoon's trip to the eastern end of the island proved rather fruitless; only some horse dropping was available on Sherbrooke Street E. in the Town of Point Aux Tremble, in October, 1961.
- 2. To the south of the Island of Montreal:-
  - a. The Gault Estate on Mount St. Hilaire.
     Only horse dung was obtained from the stable ground, June, 1961.
  - b. St.Bruno. Samples of horse dung were collected from the fields, September, 1961.

- c. St. Basile le Grand. Samples of horse and cow dungs were collected from fields and pastures, September, 1961.
- 3. To the north and northwest of the Island of Montreal:a. St. Elzéar de Laval on Ile Jésus. Samples of
  of horse and cow dung were collected in July,1961.
  b. Bas St. Martin on Ile Jésus. Only horse dung
  - was obtainable, July, 1961.
  - c. Village Cap St. Martin on Ile Jésus. Only cow dung was obtainable, July,1961.
  - d. Oka. Samples of horse, cow and sheep dungs were collected from roadsides and pastures, Oct., 1961.

The above mentioned localities, with the exception of Mount Royal Park, Town of Point Aux Tremble, and the Gault Estate on Mount St.Hilaire, are farming areas. In all cases, only dried or almost dried samples of dung lying on the ground or in the fields were collected. Samples thus collected were put separately into paper bags, duly labelled, air dried and kept until use.

# 6 1 + SU 4 ۹ MONTREAL 1 8 (5) 2 ST. LOUI RIVE RICHELIEU $\bigcirc$ Oka 6 Pointe Aux Trembles

THE ISLAND OF MONTREAL AND VICINITY

- 2 St.Anne de Bellevue
- 3 St. Martin
- 4 St. Elzear
- 5 Mt. Royal Park
- $\overline{\mathbf{1}}$ St. Bruno 8 St. Basile le Grand ۲
  - St. Hilaire

#### CULTURE METHOD.

The culturing method employed in this study is the method used by Cain (1934). A sample of dung was wetted with tap water and then put into glass moist chambers. Moist chambers were prepared by putting several layers of wet filter paper or paper towels in the bottom of the glass vessels. Each vessel had a glass cover to allow light in but to prevent excessive evaporation and contamination. In the case of sheep dung ( having smaller dung pellets), Petri dishes were used for the convenience of handling.

The cultures were then put on a bench near the window where they received both indirect light and the florescent lamp light used in the room. It has been found that certain species of <u>Pleurage</u> require light to form the perfect stage( C.M.Wilson, unpublished work, 1948 ). In 1954, Miss C.C-C.Yu also reported that cultures of <u>Ascobolus</u> magnificus kept in the dark never formed apothecia.

Cultures were kept for four to eight weeks, after which they become too old and too crowded over with discharged spores. Dung samples drying out during the culturing period were watered.

#### THE STUDY METHOD.

Samples of dung were examined with the aid of a wide field binocular dissecting microscope at intervals of one to several days. Ascocarps were removed from the cultures by means of dissecting needles and mounted in water on glass slides. The general morphology of the ascocarps was studied with the aid of a Spencer Compound Microscope. Measurements of the ascocarps were recorded. The ascocarps were then crushed by the putting on of cover slips. Asci, ascospores and whatever characters that could be determined from the crushed mounts were studied and measurements of the various structures were recorded.

Photomicrographs of the structures of the specimens were taken by means of a 35mm. Nikon F. single lens reflex camera attached to the eyepiece of the microscope by means of a Nikon Microscope Adapter Tube. Kodak Plus X Pan, 35mm. bulk film was used in taking the photographs.

After the specimens were studied, measurements recorded, and photomicrographs taken; 15% glycerine solution was applied to the slide to replace the water. Thus the specimens could be maintained for a period of several months to a year or more. However, in many cases, the hyaline gelatinous sheath and the gelatinous appendages ( especially the secondary ones ) of the ascospores were not well preserved or not being preserved at all in the 15% glycerine mount.

Identification of the Pyrenomycetes was chiefly based on the monograph, "North American Sordariaceae", written by D.Griffiths(1901); and R.F.Cain's "Studies of Coprophilous Sphaeriales in Ontario", published in 1934. Chivers' work(1915)-"A Monograph of the Genera <u>Chaetomium</u> and <u>Ascotricha</u>"forms the chief source for the identification of species of Chaetomium.

#### OBSERVATIONS AND RESULTS

The description of the species that have been found and identified will be given. For convenience, the species are arranged in alphabetical order, and no attempt has been made to group them according to their natural relationship since this is still unsettled.

The coprophilous Pyrenomycetes that have been found and identified in this study are as follow:-

Bombardia	arachnoidea
Chaetomiu	m murorum
Coniochaeta discospora	
11	leucoplaca
Sordaria	anserina
11	coronifera
89	curvula
**	decipiens
` <b>11</b>	fimicola
**	fimiseda
11	humana
98	minuta
18	pleiospora
**	vestita
F#	zygospora

#### Sporormia minima

<b>91</b>	obliquisepta
Ħ	octomera
11	vexans

and a few specimens whose identity is undetermined.

In this study I have noted the frequent presence of a few Discomycetes :- <u>Ascobolus</u> immersus, <u>Lasiobolus</u> equinus and a few others such as <u>Saccobolus</u> and <u>Ascophanus</u>.

As noted in the surveys of others mentioned above, a work of this type invariably turns up new species or varieties. The undetermined species noted here are probably of this nature.

# Bombardia arachnoidea (Niessl) comb.nov. Cain. (Griffiths,1901: Pleurage arachnoidea )

Perithecia are pyriform, dark brownish, semi-immersed to becoming superficial, covered with long septate brown hairs or occasionally bare due to age or moisture.(Fig. 1). Their measurement is 700-770 x 406-420 micra.

Asci are cylindrical, 8-spored, having a bright refractive greenish body near the apex, and are about 225 x 13 micra in size.

Ascospores are uniseriately arranged with the primary appendage overlapping the one behind, ellipsoid to ovate or slightly "stalked" depending on the way the septum has been laid down to separate the primary appendage from the fertile cell(towards the apex of the ascus, and generally referred to as the ascospore). The ascospores (meaning the fertile cells) are 16-20.8 x 7-9.6 micra. Both the ascospore and the long primary appendage are tipped by fine lash-like secondary appendages. Only a few ascospores were seen to be brown, most of them were greenish to light olivaceous (Fig. 2). When young the ascospore is cylindrical, hyaline, with the terminal end(the end that will later be separated as the primary appendage) curved to one side. The apical end swells up with age, protoplasm concentrates in the swollen end, a septum is then laid down separating the apical swollen ellipsoid head from the rest ( what is then regarded as the hyaline primary appendage ). The primary appendage measured about  $32-38.5 \times 3.2-4$  micra.

In this present survey, this species has been met with only once from horse dung collected at the stable ground on Mt. St. Hilaire, June 10, 1961. According to Cain(1934), this species occurs on various kinds of dung, is common and widely distributed in Ontario.



Fig. 1. Bombardia arachnoidea: crushed perithecium with the ostiole pointing towards the upper right hand corner of the photograph. 78 X.



Fig. 2. <u>Bombardia</u> <u>arachnoidea</u>: mature (dark coloured <u>ones</u>) and <u>immature</u> ascospores. 680 X.

#### Chaetomium murorum Corda 1837.

Perithecia are bluish-gray when seen under the dissecting microscope; globose (126-140 x 126 micra); covered with long flexuous, septate lateral hairs. Terminal hairs which occur around the apex of the perithecium are unbranched, septate , long, and gracefully flexed ending in an arch with circinate tip (Fig.4). Hair is smooth to minutely roughened. It has a width of 4 to 5 micra.

Asci are very evanescent. Only immature asci have been seen. They are 8-spored, club shaped and comparatively small.

Ascospores are narrowly elliptical with both ends acutely pointed (Fig. 5). Mature ascospores are hyaline with greenish refractive globules in them. They are about  $12.8-13.5 \ge 8$  micra. These ascospores are released into the perithecial cavity first and are then oozed out through the ostiole at the apex of the perithecium, and are held together in a gelatinous matrix. Once outside, they appeared to the eyes through the dissecting microscope as a bluish green coloured mass amidst the terminal hairs.

This species was found on sheep dung collected from pastures near Morgan's Wood in St.Anne de Bellevue, June 24,1961. The size of the perithecia is smaller than the measurement( 243-337 x 206-337 micra ) given by Chivers in 1915 for this species, but the measurement of the ascospores is very close to that given by him. This species has also been reported by Cain(1934) to be common in Ontario, growing on dung of various kinds, especially dog dung.



Fig. 3 <u>Chaetomium murorum</u>: Perithecium showing both lateral and terminal hairs. 157 X.



Fig. 4. Chaetomium murorum : gracefully arched circinate tip of a terminal hair; septa of hair can also be seen. 680 X.



Fig. 5. Chaetomium murorum : narrow ellipsoid ascospores with the ends acutely pointed. 680 X . Chaetomium sp. (sample SA95).

Perithecia are grayish in colour, many, scattered, superficial, sort of barrel-shaped or subglobose, about 210 x 161-196 micra. (Figs.6-8). Lateral hairs are septated, 4.8 micra near the base, tapering to the tip; basal part has a tinge of brown, colour fading away towards the tip. Terminal hairs are septated, straight below but having spirals(about 6, not tight or regular) near the tip, brown, fading at the tip, encrusted, might have branches. The entire tuft extends to about 245 micra long.

Asci are small, clavate, broad and rounded above, 8-spored, evanescent. Young ones are about 32 x 17.6(apex) x 2.5(base) micra.

As cospores are small, lemon shaped, apiculated at both ends, greenish hyaline in colour, measuring about  $6.4-7 \ge 4.8-6.4$  micra. (Fig.9).

This may possibly be <u>Chaetomium</u> bo<u>strychodes</u> in the lower range of measurements given by Chivers. The specimens studied were found on sheep dung collected in pastures near Morgan's Wood, St. Anne de Bellevue, June 24, 1961.



<u>Chaetomium</u> sp.(SA95): Perithecium with terminal hairs in focus. 78 X.

Fig. 6.

## Fig. 7.

Chaetomium sp.(SA95): Perithecium with lateral hairs in focus. 78 X.





Fig. 8.

Chaetomium sp. (SA95): Perithecium with terminal hairs removed to show mass of ascospores. 157 X.



Fig. 9.

Chaetomium sp.(SA95): lemon-shaped ascospores. 680 X. Chaetomium sp.

(sample SA101)

Specimens from this sample have urn-shaped perithecia (Fig. 10), about 245 micra in height, 154 micra in diameter at the middle, 84 micra near the ostiolar region, and 105 micra wide near the base. The terminal hairs around the ostiolar region of the perithecium are long and spread out extensively beyond the body. Each hair ends in a loose coil of about five turns with no particular pattern of coiling, is septate, brownish and about 4 to 4.8 micra in diameter. The lateral hairs are not very long, straight but may flex back a little, septate, and each tapers towards the tip.

Asci are very evanescent. I have not been able to obtain any asci in good condition.

Ascospores are lemon-shaped, ends apiculate, small, greenish hyaline, and are  $6.4-7.2 \ge 4.8-5.6$  micra. They are released into the perithecial cavity first, and then escape through the ostiole en mass, held together by some mucilaginous substance. Fig.ll shows such a column of ascospores projecting(or oozing out) above the tuft of terminal hair.

This species has been found on sheep dung collected in the pastures near Morgan's Wood, St.Anne de Bellevue, June 24, 1961.



Fig.10. Chaetomium sp. (SA101): Perithecium, 78 X .



Fig.ll. Chaetomium sp.(SAlOl): Another perithecium taken from top view to show the column of ascospores. 78 X .

Chaetomium sp. (sample SE106)

Perithecia are spherical to subglobose when young, and ovoid to ellipsoid when mature . Young spherical ones are about 128 x 125 micra, covered with straight whitish-gray hairs each of which tapers to a point. Mature perithecia are about 260 x 245 micra. As the perithecium grows older, the ends of the terminal hairs begin to coil up into a loose spiral. The older the more spiral the hair. Terminal hair is about 4.8micra to 5.5 micra wide, septate, ending bluntly, and brownish. Lateral hair is straight, septate, 2.5 to 3.2 micra in diameter, tapers to a point, light brownish, and colour fading towards the tip. (Figs. 15-18 ).

Asci are short clavate, small, 8-spored, and very evanescent.

Ascospores are lemon-shaped, ends slightly apiculate, greenish hyaline, and about 6.4 x 4.8 micra.

The specimens were found on sheep dung culture from pastures near Morgan's Wood, St. Anne de Bellevue, June 24,1961.



Fig.12. Chaetomium sp.(SE106): Four perithecia of various ages. 78 X .



Fig.13. Chaetomium sp.(SE106): A young perithecium, 157 X.


Fig.14. Chaetomium sp. (SE106): An older perithecium, 78 X.



Fig.15. Chaetomium sp.(SE106): A much older perithecium with a column of ascospores above the tuft of terminal hairs. 78 X.

## <u>Coniochaeta</u> <u>discospora</u> (Auersw.) comb.nov. Cain. (Griffiths, 1901: Sordaria discospora Niessl)

Perithecia are black in colour, half-sunken, scattered, opaque, widest part near bottom, subglobose to slightly pyriform, covered with short dark brown to black bristles( 72-84 x 8 micra ) which are more abundant on the upper half of the ascocarp. Size varies from  $280-490 \ge 224-385$  micra. (Fig.16 ).

Asci are cyclindrical in shape, with very short stipes, operculate, and 8-spored. They measure 128-168 micra by 11.2-17 micra. (Fig.17).

Paraphyses are slightly longer than asci, many, septate, and filiform with a width of 2 to 4 micra.

Ascospores are discoid with a gelatinous sheath around the outside, uniseriately arranged. The elongated germ slit is seen on the narrower face(6.4-8 micra) of the ascospore. The wider side measures 7.2-11.2 micra, and the length is 13.8-18.4 micra. (Fig.17 ). The ascospore measurement is close to what is given by Griffiths ( 10-18 x 8-11micra), and by Cain (11-14 x8-12 x 6-8 micra).

This species has been found on dung of horse(Mt.Royal Park,April,1961) and cow (St.Anne de Bellevue,June.1961).



### Fig. 16.

Coniochaeta discospora: perithecium showing the prominent rigid short bristles at the apex. 157 X.



Fig. 17. Coniochaeta discospora: asci with uniseriate discoid ascospores; septate paraphyses can be seen at the upper right hand corner. 680 X.

## <u>Coniochaeta leucoplaca</u> (Berk.& R.) comb.nov. Cain (Griffiths, 1901: Sordaria leucoplaca)

Only a few perithecia have been seen. They are dark brown to black, superficial, subglobose with a very short papilliform beak, covered with brown bristles  $(20 \times 4.5 \text{ micra})$ . Perithecia are small with a diameter of 210-245 micra, looking very much like the perithecia of Coniochaeta discospora. (Fig. 18).

Asci are 8-spored, cyclindrical in shape with only a short stipe, 92.8-104 x 8 micra.

Ascospores are small, discoid and uniseriate(Figs.19-20). They are hyaline when young, and become dark brown with maturity. However, I have not noticed the presence of narrow gelatinous sheath mentioned by Griffiths and Cain. Ascospores are  $7.2-8 \ge 6.4 \ge 5-6$  micra. The measurement given by Griffiths is  $6.5-2 \ge 5-6$  micra, and by Cain is  $7-9 \ge 6-8 \ge 5-6$  micra.

This species has been found growing on horse dung from Mt.St.Hilaire,June 10,1961. It has been reported by Cain to be common in Ontario, growing on various kinds of dung; and growing on hare dung collected at the Hudson Bay area. It has been reported to be present in Manitoba and Saskatchewan by Bisby et al (1938).



### Fig. 18.

Coniochaeta <u>leucoplaca</u>: perithecium showing the presence of bristles on its surface. 157 X.



Fig. 19. Coniochaeta leucoplaca: crushed perithecium showing cellular structure and bristles, and clusters of asci. 157 X.



Fig. 20.

Coniochaeta leucoplaca: discoid ascospores uniseriately arranged in the asci ( the outline of which is not clear because this photograph was taken from a glycerine mounted slide); the difference in colour of the ascospores shows that they are of various ages. 680 X.

#### Sordaria anserina (Cest.) Winter

(Griffiths, 1901: Pleurage anserina (Rabh.) Kuntze).

Perithecia are half-sunken to superficial, scattered or aggregated in three's or more, pyriform, measuring  $385-595 \ge 280-420$  micra. The exposed part is black, whereas the sunken part is slightly greenish and transparent. The neck is conical, 105 micra long and 84 micra wide, curved, bearing tufts of hair on the convex side of the neck. The hairs are long, slender, but rather stiff in appearance, brown, sparingly septate, measuring 70-140  $\ge 2-3.5$  micra, and close together usually in two main groups. (Fig. 21).

Asci are 4-spored, cylindric-clavate, contracted below into a moderately long crooked stipe. The asci measure 192-280 x 21-28 micra. (Figs. 22-23).

Ascospores are obliquely uniseriate( becoming irregular with swelling of ascus in water), ellipsoid, hyaline when young and maturing through olivaceous to dark brown ,  $32-38.5 \times 16-19.2$  micra. Primary appendage is present, cylindrical, shorter than the ascospore,  $17.6-27.2 \times 3.2-4.8$  micra. Lash like secondary appendages are present, one attached to the tip of the primary appendage, and the other 39

attached eccentrically to the apex of the ascospore. The apical secondary appendage measured about 64 micra long and 6.8 to 8 micra broad. Only in one case(H2A134) did I observe the presence of two short secondary appendages near the basal part of the primary one. (Figs.24-25).

This species has been isolated from cow dung(Mac-Donald College,St.Anne de Bellevue,June,1961; St.Elzéar de Laval and Village Cap St. Martin on Ile Jésus,July,1961; St.Basile le Grand,Sept.,1961), horse dung (roadside in Town of Point Aux Tremble,Oct.,1961; Mt.Royal Park,Oct., 1961; and Oka,Oct.,1961), and sheep dung (St. Anne de Bellevue,Nov.,1961). Cain (1934) reported it to be common in Ontario, growing on dung of various kinds. This species has also been reported to be present in Manitoba ( Bisby et al,1929) growing on horse dung.

40



Fig. 21.

Sordaria anserina Crushed perithecium with cluster of asci. Note the characteristic hair tufts on the convex side of the curved beak. 78 X.



Fig. 22. <u>Sordaria anserina</u> : Asci with uniseriate ascospores. 157 X.

Fig. 23. <u>Sordaria</u> <u>anserina</u> : Asci and ascospores. Note the appendages of the ascospores, and the biseriate condition in a few asci. 157 X.





Fig. 24. Sordaria anserina: Ascospore with its primary and long secondary appendages. The photograph is not big enough to include the apical part of the two long secondary appendages. 680 X.



Fig.25. Same as above except this shows more of the long secondary appendage attached to the tip of the primary one. The two short secondary appendages attached near the base of the primary one can be seen a bit out of focus.  $680~{\rm X}$ .

#### Sordaria coronifera Grove 1916

Perithecia are superficial, slightly sunken, broadly pyriform, covered with large tufts of agglutinated septate hair which are very prominent around the ostiole. Cain reported the finding of this species for the first time in North America in 1934. He described it as having a large papilliform neck of about 150-300 micra long by 250 micra wide at the base. However, I have not noticed the presence of such a large neck.

From the specimens I obtained, the asci had all collasped, so no description could be given regarding them. Cain's description is as follow: " 8-spored, clavate, contracted and rounded above, tapering below into a long slender stipe, 200-250 x 42-48 micra"

The identification of this species is based on the characteristic large tufts of hair(Fig26) and the ascospores which are larger than those of <u>S.curvula</u>. The ascospores are ellipsoid, acutely rounded at the apex and slightly truncated below,  $30.5-36 \times 14.5$  -16 micra. One ascospore was found to be 41.6  $\times 19.2$  micra. Since the specimens were from an old culture of cow dung(from Mac-Donald College), and were old, both primary and the two secondary appendages were not in good condition to be studied. Fig. 27 shows that the spores do have appendages.



Fig. 26. Sordaria coronifera:Large bunches of agglutinated hair found near the beak of the perithecium. 157 X.



Fig. 27. Sordaria coronifera: Ascospores showing the presence of primary and secondary appendages. 157 X.

#### Sordaria curvula deBary

(Griffiths, 1901: Pleurage curvula Kuntze)

Perithecia appear black when seen with the naked eyes or under a dissecting microscope. They are pyriform to ovoid, measuring 595-840 x 315-448 micra, superficial, scattered, or aggregated. The external surface is covered with short agglutinated septate hair ( the end cell of which tapers to a point). Hair tufts are more prominent around the short to slightly long papilliform beak. Ostiole is present and obvious. The beak has a darker color than the rest of the body which is transparent under the microscope. (Figs.28-30 ).

Asci are 8-spored, clavate, tapering into a rather long stipe, operculate, and swell up easily in water. They measure 200-317 x 21-39 micra. (Fig. 31 ).

Ascospores are ellipsoid, biseriate (this condition is not clear in all cases examined, I have observed uniseriate and biseriate conditions occurring in the same perithecium),  $21-27.5 \times 12-15.5$  micra. The ascospores range from hyaline( young ones ) through olivaceous to brown and opaque(mature ones). Primary appendage is short, 6-9 x 2-2.5 micra, with a short fine secondary appendage attached near its base ( only rarely 46

seen on ascospores examined) and a long slender one attached to its tip. Attached eccentrically to the apex of the spore is a long slender secondary appendage measuring 32 x 2.1 micra. The secondary appendages do not preserve well. (Fig. 32 ).

This species has been identified from dung of horse (Mt.Royal Park, April 21, Oct.23, 1961), cow(Mac-Donald College, St. Anne de Bellevue, June 24, 1961; St. Elzéar de Laval, Ile Jésus, July 6, 1961) and sheep (pastures near Morgan's Wood, St. Anne de Bellevue, June, 1961). This species has been reported by Cain (1934) to be very common, occurring on various kinds of dung, and widely distributed in Ontario. It has also been reported by Bisby et al (1929, 1938) to be present in Manitoba(on dung of porcupine, goat and rabbit) and Saskatchewan( on rabbit dung). 47



Fig. 28.

Sordaria curvula: Perithecium with bunches of agglutinated hairs on its surface. Asci can be seen faintly through the perithecial wall. 157 X.



Fig.29. <u>Sordaria</u> <u>curvula</u>: Perithecium on a small piece of substratum. 78 X.

Fig. 30. Sordaria curvula : Another form of perithecium. 157 X.





Fig. 31. Sordaria curvula: Mature and immature ascospores biseriately to irregularly arranged in the asci(the outlines of which are a bit out of focus). 680 X.



Fig. 32. Sordaria curvula: Ascospore showing primary and secondary appendages. The apical appendage is out of focus and partly covered by the scale. 680 X.

#### Sordaria decipiens Winter

(Griffiths, 1901: Pleurage decipiens Kuntze)

Perithecia are half immersed, pyriform to subglobose with a moderately long black neck which may be straight or bent (being positively phototropic), transparent so asci and ascospores can be distinguished (Fig. 34 ). Some perithecia have been seen with flexuous hyphae attached to the lower half of the body(Fig. 33 ). Measurements of the perithecia are 350-770 x 210-525 micra, most of them are between 450-600 x 300-400 micra.

Asci are 8-spored, clavate, widest in the middle, contracted at the base to a stipe of half to one times the length of the sac. Asci are  $260-315 \times 40-56$  micra. (Fig. 35 ).

Ascospores are biseriate to irregular( probably due to asci swelling in water), ellipsoid, hyaline when young, maturing to dark brown, 32-40 x 19-24 micra. Primary appendage present, 38-53 x 6-8 micra, with five to six fine short secondary appendages attached to its base (Fig. 36). At the apex of the ascospore is a lyre shaped tuft of very fine secondary appendages. The tuft measured 24-44 x 11-13 micra at the base. (Fig. 37).

This species is common and occurred in abundance.

Specimens have been obtained for examination from dung of horse (Mt. Royal Park, April 21,1961; Fletcher's Field, Oct.7,1961), cow (MacDonald College, St. Anne de Bellevue, June 24,1961) and sheep ( pastures near Morgan's Wood, St. Anne de Bellevue, June 24,1961).

According to Cain(1934), this species is common, grows on various kinds of dung, and is widely distributed in Ontario. This species has also been reported by Bisby et al (1929,1938) to be present in Manitoba(on horse dung) and Saskatchewan( on rabbit dung).



Fig. 33. <u>Sordaria decipiens</u>: Perithecia with long bent beaks. 78 X.



Fig. 34.

Sordaria decipiens : A perithecium with shorter beak. The asci can be vaguely distinguished through the transparent wall of the perithecium. 78 X.



Fig. 35.

Sordaria decipiens : A smaller perithecium, crushed, showing asci and appendaged ascospores. 78 X.



Fig. 36. Sordaria decipiens : Ascospore with the primary appendage in focus. Note also the short secondary appendages attached near the base of the primary one. 680 X.



Fig. 37. Same as above except the apical secondary appendage is in focus, showing that it is probably much longer than previously described. 680 X. Sordaria fimicola (Rob.) Ces.& DeNot. 1887.

Perithecia are scattered or aggregated, many, sunken to erumpent or superficial, black, smooth, having a short neck(70 x 56 micra), body is transparent. Ostiole at tip of beak is prominent. In some specimens, the neck is rather long. Specimens with two necks each have been obtained from sample H2A (Fig. 39 ). Perithecia were found growing on the dung substratum and also on the filter paper used in the culture chamber. Perithecia are pyriform, measuring 252-420 x 189-336 micra. (Fig. 38 ).

Asci are 8-spored, cylindrical with perforated apices , having a stipe of moderate length, and are about 157-232 x 14.4-19.2 micra in size. (Fig.41 ).

Ascospores are uniseriate, ellipsoid, one end acutely pointed( though Fig. 42 does not show this character clearly), surrounded by a gelatinous sheath (which swells up in water) except for the acutely pointed lower end. Ascospores are hyaline when young, but maturing into olive brown color. They are 16-22.4 micra long and 9.6-14.4 micra at the widest part. Most of them are in the range of 17-19 x 11-12 micra.

This species occurs abundantly, and has been found on dung of horse(St.Elzéar de Laval, July, 1961; Town of Point Aux Tremble, Oct., 1961; Bas St. Martin, July, 1961; Mt. Royal Park, Oct., 1961) and cow (MacDonald College, St. Anne de Bellevue, June 24, 1961; and Village Cap St. Martin, July. 1961). It has been found by Cain(1934) on various kinds of dung, moist paper and decaying vegetation; very common and widely distributed in Ontario. It has also been reported by Bisby et al(1929, 1938) to be present in Manitoba and Saskatchewan. Barr(1953) reported finding of this species on horse dung in British Columbia. In 1950, Wehmeyer reported the presence of this species on moose dung in Halifax, Nova Scotia. It has also been found as far north as the Hudson Bay area (Cain, 1957) on dung of fox, lemming and caribou.

57



# Fig. 38 .

Sordaria fimicola : Five perithecia that have been removed from the substratum. 78 X.



Fig. 39. Sordaria fimicola: Perithecium with two beaks. 78 X.

Fig. 40. <u>Sordaria fimicola</u> : Crushed perithecium showing the large quantity of asci. 78 X.





Fig. 41. Sordaria fimicola: Asci and ascospores. 157 X.



Fig.42. Sordaria fimicola : Ascospores. The round globule in each ascospore appeared after 15% glycerine has been added to the slide. 680 X.

## <u>Sordaria fimiseda</u> Ces. & DeNot. 1863 (Griffiths, 1901: <u>Pleurage fimiseda</u>)

Perithecia are large ( 700-1190 x 315-700 micra), superficial or with base slightly sunken into the fibrous material of the substratum, scattered or aggregated into small groups. The exposed portion is densely covered by fine short septate grayish hair(looks brownish under the microscope) measuring 35-56 x 3-4 micra(Fig.49.). The lower part of the perithecium is transparent. The neck is black and varies from broadly conical to papilliform (Figs. 43-46 ).

Asci are 8-spored, clavate, contracted above to an acutely rounded apex, and below narrows gradually into a rather long stipe which can be as long as 105 micra, easily burst in water. They are 350-480 x 40-61 micra. (Figs. 47-48 ).

Ascospores are large, biseriate, ranging from hyaline when young through olivaceous to dark brown and opaque when mature,  $42-56 \ge 24-32$  micra. Primary appendage is clavate, slightly shorter than the ascospore, widest towards the tip(8-10 micra),  $28-48 \ge 5-6.5$  micra at the base. Attached to its tip is a long lash like secondary appendage which at times appears to be made up of two filaments measuring  $72-420 \ge 8$  micra. Another long

61

secondary appendage, measuring 73-420 x 9-17.6 micra at the base, is eccentrically attached to the apex of the ascospore. It too appears at times to be made up of two filaments. However, Cain regarded the secondary appendage to be a cylinder like structure instead of being made up of two filaments. (Figs. 47-50).

This species has been found on horse dung(Oka,Oct. 14, 1961; St. Elzéar Road,Ile Jésus,July 6,1961; Mt. St. Hilaire,June 10,1961) and cow dung (MacDonald College, St.Anne de Bellevue, June 24,1961). So far it has only been reported to be present and common on dung of various kinds in Ontario (Cain,1934).



## Fig. 43.

Sordaria fimiseda : Perithecium. Note presence of fine short hairs on the surface. The lighter area at the apex of the beak is the ostiole. 78 X.



Fig. 44 .

Same perithecium as the one above, but from the side showing the bending of the beak. 78 X.



Fig. 45 . Sordaria fimiseda : Perithecium and ascospores. 78 X.



Fig. 46. Another perithecium of S.fimiseda. 78 X.



### Fig. 47.

Sordaria fimiseda : Asci with immature ascospores in which the primary appendages are still densely cytoplasmic. 157 X.



Fig. 48. S.fimiseda: Clavate asci showing biseriate arrangement of the ascospores. 157 X.



Fig. 49. Sordaria fimiseda: Fine short septate hairs on surface of perithecium. 680 X .



Fig. 50. S.fimiseda :Ascospore showing pestle-like primary appendage, and the two lash-like secondary ones(the apical one being the more massive). 157 X.

#### Sordaria humana (Fuckel) Winter 1872

Perithecia are scattered or aggregated, sunken to erumpent, subglobose to pyriform with papilliform beaks, black, about 350 x 280 micra. (Fig. 51).

Asci are cylindrical with short stipes, 8-spored, operculate, about 189 x 17.5 micra. (Fig. 52).

Ascospores are uniseriate, obovoid, acutely pointed below, hyaline sheath not covering the acutely pointed end. The ascospores are hyaline when young, filled with many small greenish refractive bodies. Mature ascospores are brown in colour, and are 19.2 to 20.8 micra long and 14.4-16 micra wide. (Fig. 53).

Careful observation is required to distinguish this species from S<u>ordaria fimicola</u> which has ellipsoid ascospores.

This species has been found on sheep dung collected in Oka,Oct. 14,1961. Ontario is the only other province in which this species has been reported (Cain,1934) to be found on dung of various kinds and also on the surface of strawberry roots.



Fig. 51 .

Sordaria humana : A perithecium removed from the substratum. 157 X.


Fig. 52. Sordaria humana : A cluster of asci. 157 X.



Fig.53. S. humana : Ascospores with one end acutely pointed. Hyaline sheath is not obvious due to specimen being mounted in glycerine. 680 X.

#### Sordaria minuta Fuckel 1873

(Griffiths, 1901: Pleurage minuta)

Perithecia are pyriform, superficial with base slightly sunken in the substratum, and are covered with short small bunches(finer than those of <u>Sordaria</u> <u>curvula</u>) of agglutinated hair. Neck is comparatively short, black and usually bent to one side. Body is transparent. Ostiole is prominent. Measurement of the perithecia is 420-665 x 140-250 micra. (Figs.54-55).

Asci are 8-spored, cylindrical to clavate, tapering below into a long stipe(about 80 micra long), and are 182-208 micra long and 16-21 micra at the widest part. Young asci are mostly cylindrical in shape. (Figs. 56, 58).

Ascospores are ellipsoid, uniseriate( at times biseriate condition has been seen; this might have been caused by swelling of asci), 17.5 to 21 micra long and 10 to 11.2 micra at the widest part. Young ascospores are hyaline while mature ones are dark brown. Fine primary and secondary appendages are present. Primary ones measured 7.2-9.6 x 1.6 micra. The secondary ones are long lash like structures. (Fig. 57 ).

This species has been found to occur in abundance, and very often was found growing on the same dung cultures where <u>S.curvula</u> was also found . It has been found on sheep dung (pastures near Morgan's Wood,St.Anne de Bellevue,June,1961), cow dung(MacDonald College,St. Anne de Bellevue,June,1961) and horse dung (Mt. Royal Park, April,1961). According to Cain(1934), this species is common, growing on various kinds of dung, and widely distributed in Ontario. Bisby et al (1929,1938) reported the presence of this species in Saskatchewan( on rabbit dung) and Manitoba ( on horse dung).



Fig. 54. Sordaria minuta: Perithecium with very small bunches of agglutinated hairs. 78 X.



Fig. 55. S. minuta: Three perithecia. 78 X.



Fig. 56. Sordaria minuta: Asci. Ascospores in some of them appeared to be biseriately rather than uniseriately arranged. 157 X.



Fig. 57. S. minuta: Ascospores showing primary and secondary appendages(in glycerine mount). 680 X.



## Sordaria pleiospora Winter 1871

(Griffiths, 1901: Pleurage pleiospora Kuntze 1898)

Perithecia resemble those of <u>S. decipiens</u> in appearance, and are about 560 x 350 micra. The neck itself measures  $140 \times 105$  micra.

Asci are broadly clavate. They are so evanescent that in the specimens obtained for study, no mature asci were found, all the mature ascospores were free, thus the actual number of ascospores per ascus could not be ascertained and no measurement of mature asci could be obtained. An immature ascus was found which had more than eight ascospores. However, it was impossible to count the actual number of ascospores that were in it. The immature ascus measured 224 x 35 micra. The measurement given by Griffiths is 250-300 x 60-110 micra. Cain found it to be 310-350 x 60-100 micra. (Fig. 59 ).

Ascospores are ellipsoid, and resemble those of <u>S. decipiens</u>, only smaller,  $24-30.4 \times 14.5-16$  micra. Primary appendage is cylindrical, 25.5 to 33.6 micra long and 6.5 to 8 micra broad. Attached near to the base of the primary appendage are a few fine short secondary appendages. The apex of the ascospore has numerous fine short secondary appendages united

into a tuft measuring 19.2-24 x 4.8-6.4 micra. This apical tuft of secondary appendages is definitely narrower than the one of <u>S</u>. decipiens. (Fig. 60 ).

This is a rare species which I have come across only once on a cultured sample(cow dung from MacDonald College,St.Anne de Bellevue,June,1961) on which <u>Sordaria</u> <u>decipiens</u> was also found growing. Cain(1934) has reported it to be growing on dung of various kinds, widely distributed in Ontario, but not common. He mentioned that specimens on rabbit dung from Saskatchewan have 16-spored asci and ascospores measuring 31-36 x 20-24 micra. This species has also been found by Barr(1957) on horse dung collected in Gasperian Park,Quebec.



Fig. 59. Sordaria pleiospora: Asci and ascospores in 15% glycerine mount. The size, shape and appearance of the asci indicated that there are more than 8 spores per ascus. 157 X.



Fig. 60. S.pleiospora: Ascospore in glycerine mount; appendages not well preserved. 680 X .

### Sordaria vestita Zopf. 1883.

(Griffiths, 1901: Pleurage vestita).

Perithecia are pyriform, 630-770 x 380-420 micra, semi-immersed with beak above substratum. Neck is black, cylindrical, and may be bent, about a third of the entire length of the perithecium. The rest of the perithecium is covered with flexuous hyphae, and is greenish and transparent. (Fig. 61 ).

Asci are 8-spored, clavate, contracted and acutely rounded above, tapering gradually below into a medium length crooked stipe(about 1/5 to 1/4 of the total length of the ascus), and collapse easily in water. They are 216 to 240 micra long, and 25(in young asci) to 48 micra wide. (Fig. 62 ).

Ascospores are broadly ellipsoid, obliquely biseriate, more acutely pointed above. Young ones are hyaline. Mature ones are dark brown and opaque. Ascospores are  $30.4-32.5 \times 17.6-20.8$  micra. One ascospore was found to reach a length of 36 micra. Primary appendage is shorter than the ascospore, cylindrical, narrower at the tip(where it is 4.8 to 6.5 micra wide), and wider at the base( 8 micra). Length of the primary appendage varies from 20.8 to 25 micra. Both the tip of the primary appendage and the apex of the ascospore are tipped by about four fine short secondary appendages each of which tapers to a point. (Fig. 63 ).

This species was found on cow dung collected at St. Elzéar de Laval, Ile Jésus, July, 1961. According to Cain(1934) this species occurs on dung of various kinds, is very common and widely distributed in Ontario. <u>S. vestita</u> has also been reported by Bisby et al(1929, 1938) to be present in Manitoba ( on dung of horse and goat) and Saskatchewan( on rabbit dung ).



Fig. 61 . <u>Sordaria vestita</u> : A crushed perithecium. 78 X.



Fig. 62. <u>S.vestita</u>: Clavate asci with biseriately arranged ascospores. 157 X.



# Fig. 63 .

Sordaria vestita :Ascospores showing cylindrical primary appendage and the secondary appendages. The short secondary appendages attached to the apex of the ascospore, though slightly out of focus, can still be distinguished. 680 X.

# Sordaria zygospora Speg. 1878. (Griffiths,1901: Pleurage zygospora Kuntze 1898)

Perithecia are large, 665-945 x 420-630 micra(mostly 750-800 x 500 micra), semi-immersed to becoming superficial, pyriform, more or less covered with long slender flexuous septate hairs, greenish and some what transparent below, black in the exposed portion. The black part extends into an elongated cylindrical neck which is either straight or curved. (Fig. 64 )

Asci are 8-spored, clavate, broadly rounded above, contracted below into a long crooked stipe. Very evanescent. Asci have a length extending beyond 240 micra, and a width of 38-59 micra. (Fig. 65 )

Young ascospore is greenish hyaline and cylindrical in shape. As growth continues, the ascospore becomes longer, intertwining with the other ascospores in the same ascus; the two ends swell up and finally cross walls are laid down cutting the ascospore into three cells: an ellipsoid fertile cell at each end, and a long filamentous like cell(about 130-180 x 35-36 micra) in the middle. When matured, the two end cells become dark brown and opaque measuring 25.6-33.6 x 14.4-18.4 micra. Attached to the apex of each fertile cell are a number of rather short (about 8 x 3.2 micra) hyaline secondary appendages(usually four), each of which tapers towards the tip. In some specimens, secondary appendages are found at both ends of the fertile cell. (Figs.66-67).

This species has been found on cow dung(St.Elzéar de Laval,Ile Jésus,July,1961) and on sheep dung from pastures near Morgan's Wood,St.Anne de Bellevue,June,1961. It has also been reported to be present in Manitoba( on horse dung) and Saskatchewan(on rabbit dung) by Bisby et al(1929,1938). Cain(1934) has also reported <u>S. zygospora</u> to be present on dung of various kinds, especially cow and horse dung; and is widely distributed in Ontario and fairly common.



Fig. 64. Sordaria zygospora : Perithecium. 78 X .



Fig. 65. S. zygospora : Asci and ascospores. Note coiling of the long filaments connecting the fertile cells. 157 X.





Sordaria zygospora : Ascospore showing the two fertile cells at each end of the filament. 157 X.



# Fig. 67.

S.zygospora: Higher magnification of one fertile cell in Fig.66 to show the presence of short secondary appendages at both ends of the cell. 680  $\,\rm X$  .

## Sporormia minima Auersw. 1868.

Perithecia are very small, abundant and scattered, immersed with beaks(a third of the entire length of the perithecium) emerging above the substratum appearing as black dots. Under the microscope the beak is transparently brownish. Perithecia are 140 to 259 micra in height, and 84 to 140 micra at the widest part. (Fig.68 ).

Asci are 8-spored, clavate, widest near the middle, contracted below into a short stipe. When mounted in water, the inner wall stretched out extensively breaking the outer wall into two parts. In one case, it has been noted that the inner wall stretched out through the tip of the ascus. Asci are 64-100 x 9.5-16 micra, and can stretch to 176 micra long.

Ascospores are cylindrical, 4-celled, lying obliquely in the ascus in 2 to 3 series, olivaceous to dark brown in colour. They have hyaline gelatinous sheaths. Septa between the cells are transverse. The ascospores are straight or curved, obtusely rounded at the ends, 28-32 x 4.8-5.5 micra. The cells are easily separable, usually into units of two. Terminal cells are 8 to 9.6 micra long, and the centre ones are 6.5 to 8 micra long. (Fig. 69 ). This species has been found on dung of sheep(pastures near Morgan's Wood, St. Anne de Bellevue, June, 1961) and cow (MacDonald College, St. Anne de Bellevue, June, 1961; Village Cap St. Martin, Ile Jésus, July, 1961; and Oka, Oct., 1961). Cain(1934) has reported this species to be very common, growing on various kinds of dung, and widely distributed in Ontario. Sporormia minima has also been reported to be present in Manitoba(on dung of deer, cow and rabbit) by Bisby et al(1929, 1938). Barr(1957) has reported finding of this species on moose dung collected at Gasperian Park, Quebec.



Fig. 68.

<u>Sporormia minima</u> : Crushed perithecium. 157 X.



Fig. 69. Sp. minima: Asci showing extended inner wall. 4-celled ascospores, most of them have separated into 2- and 1-celled units. 680 X.

#### Sporormia obliquisepta Speg. 1887.

Perithecia are immersed with only the neck appearing above the substratum, scattered, black in colour,  $231-455 \ge 154-280$  micra. In some specimens the neck is rather long. (Fig. 70)

Asci are 8-spored, cylindric-clavate, widest near the apex which is broadly rounded, and gradually tapered below into a short stipe. The inner wall of the ascus can stretch to 240 x 13 micra. Generally the asci are  $138-180 \times 16-21$  micra. (Fig. 71 )

Paraphyses are filiform and septated, and are 2.5 to 3.6 micra wide. They do not appear to be longer than the asci.

Ascospores are 4-celled, in 2 to 3 series above, and 1 to 2 series below. The ascospores are hyaline when young, and mature ones are brown, 35 to 43 micra long and 6.4 to 8 micra at the widest part. A hyaline gelatinous sheath surrounds the ascospore. The apical terminal cell is acutely rounded, while the basal terminal cell is obtusely rounded. The terminal cells are longer( 10.5 to 12.8 micra) than the centre cells. Septa are oblique(only slightly so in most cases). The cells are easily separated. Each cell has a diagonal (only slightly so in most cases) germ slit.

This species has been found on horse dung collected at Mt. Royal Park(April,1961) and the stable on Mt. St. Hilaire(June,1961). This species has also been reported (Cain,1934) to be present in Ontario growing on various kinds of dung, common and widely distributed.



Fig. 70.

Sporormia obliquisepta : Perithecium with fourcelled ascospores escaping through its ostiole. 157 X.

# Fig. 71.

<u>Sp. obliquisepta</u> : Asci , some with inner wall extended. 157 X .



#### Sporormia octomera Auersw. 1868.

Perithecia are immersed with neck protruding above the substratum, globose to subglobose with a papilliform to conical neck or beak (84-105 x 70-98 micra). Perithecia are 315 to 399 micra long, including the neck; and 224 to 350 micra at the widest part, dark brown in colour and without hair.

Asci are 8-spored, clavate, widest near the apex, gradually tapering into a long slender crooked stipe. They stretch out in water mount. The measurement obtained from the asci studied is :  $152-208 \times 17.6-22$  micra. (Fig. 72)

Paraphyses are filiform, septate, slightly longer than the asci, and are 2.4 to 3.2 micra wide.

Ascospores are 8-celled, cylindrical, obliquely biseriate above and uniseriate below. The two terminal cells are longer (6-8 x 5.6-6.4 micra) than the other cells( 3.5 to 5 micra long). The apical cell is acutely pointed, while the basal terminal cell is bluntly rounded. The third cell from the apex is wider than all the other cells. Ascospores are hyaline when young, and dark brown when matured. They are 41.5-48 x 6.5-8 micra. One asco-

spore was found to have a length of 54.4 micra. (Fig.73).

This species has been found growing on horse dung collected at two localities on Mt.Royal Park,April,1961. According to Cain(1934), this species has been found on dung of various kinds, is common and widely distributed in Ontario. He also reported(1957) finding of <u>Sporormia</u> <u>octomera</u> on ptarmigan dung collected at the Hudson Bay area. This species has also been reported(Bisby et al, 1929,1938) to be present in Manitoba(on dung of horse and porcupine) and Saskatchewan(on rabbit dung).



Fig. 72. Sporormia octomera: Crushed perithecium. 157 X.



Fig. 73. Sp. octomera: Asci and 8-celled ascospores. 680 X.

#### Sporormia vexans Auersw. 1868

Perithecia are small, dark brown in colour, globose with a rather long neck(about half the entire length of the perithecium) emerging above the substratum. They are  $350 \times 175-189$  micra. (Fig. 74)

Asci are 8-spored, clavate, widest near the apex, broadly rounded above, tapering gradually into a short stipe. They are 112-176 x 16-19.2 micra. (Fig. 75)

Paraphyses are filiform in shape, septate, about 3 to 4.5 micra wide, longer than asci.

Ascospores are 7-celled, cylindrical, biseriate above and uniseriate below. Young ones are hyaline, and mature ones are brown. They are 30 to 41.6 micra long and 6.4 to 8 micra wide. The third apical cell is the widest of all the cells in the ascospore. The terminal cells are longer than broad, and are longer than the other cells which are broader than long. (Fig. 76 )

This species resembles <u>Sp.octomera</u> in many respects except that it has 7-celled instead of 8-celled ascospores. This species has been found on horse dung(from Mt.Royal Park,April,1961) where <u>Sp. octomera</u> was also found . Cain(1934) reported finding of this species on dung of rabbit and porcupine in Ontario, and considered it rare. He also found it on deer dung from Hudson Bay area(1957).





Sporormia vexans: Crushed perithecium. Note the long neck. 157 X .



Fig. 75. Sporormia vexans: Extended asci with sevencelled ascospores. Approximately 600 X.



Fig. 76. Sp.vexans: Ascospores showing third cell from the apex is the broadest. Apices of asci are facing to the right. Outline of asci is out of focus. Approximately 1,600 X.

Though this present work is on Coprophilous Pyrenomycetes, I feel that I should include here also two species of Coprophilous Discomycetes which I have come across rather frequently in the course of this study. They are <u>Ascobolus immersus</u> and <u>Lasiobolus equinus</u>.

## Ascobolus immersus Pers. 1796.

Apothecia are greenish yellow, superficial, subglobose when young, but the top flattens out with maturity looking a bit like a muffin (Fig. 77 ), usually scattered, and occasionally gregarious. The diameter of the ascocarp varies from 420 to 700 micra. Large mature apothecia usually have three to four asci protruding out at the same time; but, smaller ones usually have one to two asci protruding above the hymenial surface at a time. Young apothecium is subglobose, having a crusty brownish yellow layer covering a greenish yellow surface.

Asci are 8-spored, and clavate in shape, measuring  $350-600 \times 91-112$  micra. They protrude above the hymenium when the ascospores are mature (Fig. 78). They stretch and swell up a bit in water. Some have been observed to have only four to six ascospores. There is an operculum near the apex for the escape of ascospores (Fig. 79).

It has been seen that an ascus in a water mount shrank in size after the discharge of the ascospores. It has also been observed that the ascospores(sometimes still in a mass, Fig. 80) were ejected to a distance of about 770 micra away from the apex of the ascus.

Ascospores are comparatively very large, broadly ellipsoid, biseriate to irregularly arranged. They are hyaline when young, and become purple to brown and sculptured with maturity. Ascospore sculpturing has been described as sparse, and appears as anastomosing bands(looking like cracks on the ascospore surface, Fig. 81 ). However, upon closer examination under higher magnification, the entire surface of the ascospore is minutely roughened or warty(Fig. 83 ). The ascospores are 46 to 64 micra long and 26 to 35 micra in diameter.

Paraphyses are many, slender, septate, 2-3 micra wide, and having a pale greenish yellow colour.

This species is common and occurs in abundance. It has been found on dung of horse(Bas St.Martin, and St. Elzéar on Ile Jésus, July 7, 1961), cow (MacDonald College, St.Anne de Bellevue, June 24, 1961; St.Elzéar de Laval and Village Cap St.Martin, Ile Jésus, July, 1961; and St.Basile le Grand, Sept. 23, 1961) and sheep (pastures in St.Anne de Bellevue, June 24 and Nov. 22, 1961).



Fig. 77.

Ascobolus immersus : Apothecium with asci projected above the hymenial surface. 78 X .



Fig. 78. <u>A. immersus</u>: Asci projected above the hymenial surface. Paraphyses held together by some mucilaginous substance. In some asci the ascospores are seen bound by a hyaline substance. 78 X.



Fig. 79. <u>Ascobolus immersus</u> : showing aperture of ascus and a closer view of paraphyses. 157 X.

# Fig. 80.

<u>Ascobolus immersus</u> : ascospores held together by a mass of hyaline substance.

157 X.





Fig. 81.

Ascobolus immersus : Asci and ascospores. The sparse anastomosing sculpturing(ridges or cracks) can be seen on the spores. 157 X.



Fig. 82. Ascobolus immersus: Basal part of an ascus with two thick-walled immature ascospores. 680 X.



Fig.83. <u>A. immersus: Warty appearance of the entire</u> surface of the ascospores. 680 X.

## Lasiobolus equinus (Mull) Karst 1885.

Apothecia are at first "closed" globose in shape, then expanding out during the process of maturation and become discoid(Fig. 84 ). They appeared as hyaline discs to the maked eye, but have a pale faint orange colour when viewed under the dissecting microscope. They have a height of 210 to 280 micra, and a diameter of 259 to 385 micra, externally clothed with very conspicuous, rather stiff looking hairs. The hairs are rigid, nonseptate , thick-walled, swollen and sort of crooked at the base, and gradually taper to a point at the apex, measuring 154-176 x 7-11.2 micra. (Fig. 87 ).

Asci are 8-spored, cylindrical-clavate, broad above but taper below into a long stipe( $32 \times 4.8$  micra) which breaks off easily, so most of the detached asci were seen without the stipe. They are 128-176 micra long and 24 to 32 micra in diameter at the widest part.

Paraphyses are many, slender, septate, slightly swollen at the tip (Fig. 87), and have a tinge of green, 2 to 3 micra in diameter. Some are branched.

Ascospores are broadly ellipsoid ( or almost ovoid ), uniseriate to irregular, hyaline to having a very faint greenish colour. They are 19.2 to 22.4 micra long and
11.2 to 15 micra in diameter at the widest part. (Figs. 87-89).

This species has been found on dung of horse(collected at Mt.Royal Park,Oct. 23,1961) and sheep(pastures at Mac-Donald College,St.Anne de Bellevue,June and Nov.,1961).



Fig. 84. Lasiobolus equinus: Four apothecia at various stages of development. 78 X.



Fig. 85. L.equinus: Surface view of apotheciumshowing apical view of asci. The black spots on the bristles are artifects caused by air bubbles in the water mount(same in Fig. 84 ). 78 X.



Fig. 86. L.equinus: Crushed apothecium showing bristles, paraphyses, asci and ascospores. 157 X.



Fig. 87. L.equinus: Showing basal part and wall thickness of bristles; tips of paraphyses can be seen even though slightly out of focus. 680 X.



Fig. 88. L. equinus: Apex of ascus, and broadly ellipsoid ascospores. 680 X .



Fig.89. L.equinus: Showing the moderately long crooked stipe of the ascus. 680 X.

### DISCUSSION AND CONCLUSION

From this study one may conclude that most of the species of coprophilous Pyrenomycetes are not restricted to growing on one kind of dung. Most of the species that have been observed in this survey have been reported by Cain to be common and obtainable from dungs of various kinds in Ontario. Cain(1934) reported Sordaria coronifera to be rare in Ontario, and has so far been found on cow dung only. My present finding of this species agrees with his. This species so far has not been reported from other parts of Canada, but it will be no surprise should it eventually be found in other parts of the country should there be an extensive survey of coprophilous Ascomycetes carried out. As Griffiths had stated that those species which were once reported to be rare in Europe were found to be common in North America, and he felt that the rarity was due to lack of acquaintance with the fungi. For example in 1901, Griffiths reported Sordaria fimiseda on horse dung in London, Ontario; but in 1934, Cain reported this species to be growing on various kinds of dung from numerous localities in Ontario.

<u>Sporormia</u> vexans has so far been reported by Cain to be present in Ontario(1934) growing on rabbit 109

and porcupine dung, and in Lake Ouareau area of Quebec (1957) growing on deer dung. Specimens of this species have been obtained by the present writer from horse dung collected from Mt.Royal Park. So, it appears rather likely that this species may be found on horse dung in Ontario with further investigation.

Among all the species that have been reported to be common, Sordaria fimicola is by far the most common species, and the most widely distributed one in North America. Griffiths(1901) reported it to be common and widely distributed in the U.S.A. He found it on cultures of horse, cow, sheep, goat, rabbit and deer dungs; and on paper. He also found this species growing on horse, cow and rabbit dungs obtained from London, Ontario. Wilson(1947) reported its presence on horse and cow dung in Virginia. Cain(1934) reported this species to be common and widely distributed in Ontario on dung of various kinds, moist paper, and decaying vegetation. Dr. A.A.Hildebrand has isolated this species from surface of strawberry roots at St.Catherine, Ontario (Cain, 1934). Sordaria fimicola is also present in Manitoba and Saskatchewan on dung(Bisby et al, 1929, 1938), and in British Columbia on horse dung and seeds of Cucurbita maxima and Daucus carota(Barr, 1953). This fungus has also been reported(Cain, 1957) to be present

as far north as the Hudson Bay area. It has been found on wolf(or fox) dung from Churchill, lemming and caribou dung from Ungava, and fox dung from Lake Mistassini area in Quebec . This species has also been reported by Wehmeyer to be present in Nova Scotia(1940). In 1960, Petersen reported this species growing on horse dung collected in Tahiti and Moorea in the South Pacific. The present writer has seen it frequently on horse and cow dung collected from localities covered in the present survey. The wide range of distribution shows that this species is adapted to a wide range of environment. One may conclude that its common occurrence and wide range of distribution are due to the fact that this species is not restricted to any particular kind of dung for its development and that it is not an obligate coprophile, for Cain and Groves(1948) have also reported finding of this species on a great variety of seeds.

<u>Chaetomium murorum</u> Corda is the only member of coprophilous Sphaeriales which has been found only on sheep dung in this survey, and was not reported by Cain in 1934 to be present in Ontario. I have not found any reference which indicates the finding of this species in Ontario since 1934. This species is present in Manitoba (Bisby et al,1929). Chivers(1915) reported it to be com-

111

mon and on various kinds of dung.

In this study the writer has noticed that the occurrence of some species of coprophilous Ascomycetes indicates a preference or adaption for a particular kind of dung. <u>Ascobolus immersus</u> has been observed by the writer to be present on cow, sheep and horse dung, but, it is much more frequently found and in greater numbers on cow dung than on sheep or horse dung. <u>Chaetomium</u> species appear to be more common on sheep dung. Only in one sample of horse dung has <u>Chaetomium</u> species been found. None has been found on cow dung. However, Chivers(1915) reported finding of <u>Chaetomium</u> species on various kinds of dung.

The resemblance in the external features of the ascocarps of some species is a drawback in making up the presence list in the survey. For example, perithecia of <u>Sordaria zygospora</u>, <u>S.vestita</u> and <u>S.decipiens</u> are rather similar in appearance, so much so that often one is not sure of which species one has until the ascocarp has been crushed and carefully studied. To make things more difficult, species which resemble one another in gross external morphology are usually also found growing on the same piece of dung. <u>Sordaria zygospora</u> and <u>S.vestita</u> have been found on the same piece of cow dung, and the former have been observed to be present along side with <u>S.decipiens</u> on the same pellet of sheep dung.

On the whole, much more information is needed about this group of fungi in order to determine to what extent they depend on their particular habitat. The author also believes that there is a great need of establishing a standard system of describing the colour of ascocarps, ascospores etc. This is especially true for the Discomycetes. Such a system would facilitate future survey and investigation of this kind.

#### SUMMARY

In this present survey of coprophilous Pyrenomycetes on the Island of Montreal and vicinity, only horse, cow and sheep dungs were examined for study. Nineteen species of Pyrenomycetes have been found and identified, belonging to the following genera:- <u>Bombardia</u> ( 1 species), <u>Chaetomium(1 sp.),Coniochaeta(2 spp.), Sordaria(11 spp.),</u> and <u>Sporormia(4 spp.)</u>. Included in this report are two species of coprophilous Discomycetes which occurred quite frequently and have been identified. They are <u>Ascobolus</u> immersus and Lasiobolus equinus.

Photomicrographs are used to supplement the description of the species found and identified.

### APPENDIX I.

It was near the completion of this thesis that the present writer read a recent article(Can. J. Bot., Vol.40, March,1962) by Cain in which he stated that he now considers <u>Podospora</u> as the valid name for a group of species in which the ascospores have appendages but no gelatinous sheath. He is also of the opinion that there are several genera, other than <u>Podospora</u>, to be segregated from Sordaria.

## APPENDIX II.

# Table of distribution of the species found and identified

Coprophilous Ascomycetes found in Montreal & Vicinity	Ontario	Hudson Bay Area	Gasperian Park	Nova Scotia	Manitoba	Saskatchewan	British Columbia
Bombardia arachnoidea	X				D,P,X.	R	
Chaetomiun murorum		X			X	1.1.1.1.1	. Same of
Coniochaeta discospora	X	Ha			R,P,Pt,X	R	
Coniochaeta leucoplaca	X	Ha			P,R	R	
Sordaria anserina	X	·			H		
S. coronifera	X			1			
S. curvula	X		-		P,G,R	R	
S. decipiens	X				Н	R	
<u>S.</u> <u>fimicola</u>	X	F,L,Ca		x	X	X	H
S. fimiseda	X						
S. humana	X					1	
S. minuta	X				Н	R	
S. pleiospora	X	-	H	-		R	
S. vestita	X				H,G	R	
S. zygospora	X				H	R	
Sporormia minima	X		M		D,C,R		
Sporormia obliquisepta	, X						
Sporormia octomera	X	Pt			P,H	R	The second second
Sporormia vexans	X	D					•
Ascobolus immersus					* x		
Lasiobolus equinus				X	X		

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B....bear dung C....cow dung Ca...caribou dung D....deer dung F....fox dung G....goat dung H .... horse dung Ha...hare dung L....lemming dung M....moose dung P....porcupine dung Pa...patridge dung Pt...ptarmigan dung R....rabbit dung S....sheep dung X....dung of various kinds.

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