

New cleistothecial Sordariaceae and a new family, Coniochaetaceae¹

DAVID MALLOCH AND R. F. CAIN

Department of Botany, University of Toronto, Toronto, Ontario

Received July 17, 1970

MALLOCH, D., and R. F. CAIN. 1971. New cleistothecial Sordariaceae and a new family, Coniochaetaceae. *Can. J. Bot.* 49: 869-880.

The family Sordariaceae is briefly defined and a list of cleistothecial genera given. Two species of *Anixiella* Saito & Minoura ex Cain, *A. endodonta* sp. nov., and *A. monospora* sp. nov. are described and a key to the four species of the genus included. *Apodus deciduus* gen. et sp. nov. is described. Two new combinations in *Echinopodospora* Robison, *E. spinosa* (Cailleux) Malloch & Cain and *E. verruculosa* (Cailleux) Malloch & Cain, are proposed to accept transfers from *Tripterospora* Cain and are followed by a key to species of *Echinopodospora*. The concept of *Zopfiella* Winter is broadened to include *Z. pleuropora* sp. nov. and three new combinations, *Z. inermis* (Cailleux) Malloch & Cain, *Z. latipes* (Lundqvist) Malloch & Cain, and *Z. leucotricha* (Speg.) Malloch & Cain, transferred from *Tripterospora*. A key to the six species of *Zopfiella* is presented. The new family Coniochaetaceae is proposed to accommodate the new genus *Coniochaetidium* and *Coniochaeta* (Sacc.) Massee. Two species of *Coniochaetidium* are described, *C. ostreum* sp. nov. and *C. savoryi* (Booth) Malloch & Cain, comb. nov., based on *Thielavia savoryi* Booth.

Sordariaceae

The Sordariaceae was established by Winter (1884) to accommodate a group of mainly coprophilous genera with dark ascocarps and ascospores. Included in the Sordariaceae were a number of unrelated genera which are now distributed among several families. The Sordariaceae is maintained here (as by numerous previous authors) to include forms with non-stromatic ascocarps, unitunicate asci, and hyaline to dark olive-green to brown ascospores with germ pores (lacking in *Lasiochaeria* Ces. & De Not.). The mycelium is frequently dark green to brown and the asci often have a simple ring or pore at the apex. Conidia, when present, are small phialospores borne on short phialides. Catenulate blastospores and aleuriospores have been reported for a few species. Most Sordariaceae are coprophilous but a number are also known from soil and other habitats.

The cleistothecial Sordariaceae differ little from the ostiolate forms. The cultural features and ascospore forms are especially characteristic. Thus we include in the Sordariaceae the cleistothecial genera *Anixiella* Saito & Minoura

ex Cain (1961), *Boothiella* Lodhi & Mirza (1962), *Copromyces* Lundqvist (1967), *Diplogelasinospora* Cain (1961), *Echinopodospora* Robison (1970), *Tripterospora* Cain (1956), *Tripterosporella* Subramanian and Lodha (1968), and *Zopfiella* Winter (1884).

The purpose of the first part of this paper is to present some new species of cleistothecial Sordariaceae and one new genus.

Anixiella Saito & Minoura ex Cain. *Can. J. Bot.* 39: 1668. 1961.

TYPE SPECIES: *Thielavia reticulata* Booth & Ebben.

Anixiella is essentially a cleistothecial *Gelasinospora* Dowding. Like *Gelasinospora* it produces dark, pitted ascospores. The closeness of these two genera was emphasized by Maniotis (1965), who reported isolating *Anixiella reticulata* (Booth & Ebben) Cain as a cleistothecial mutant from a culture of *Gelasinospora calospora* (Mouton) C. & M. Moreau.

¹Support from the National Research Council of Canada as grants to the junior author and a scholarship to the senior author is gratefully acknowledged.

KEY TO THE SPECIES

1. Ascocarps up to 1000 μ in diameter; peridium cephalothecoid, consisting of polygonal plates which separate at maturity along well-defined lines of dehiscence. Asci one-spored.....*A. monospora*
1. Ascocarps less than 500 μ in diameter; peridium pseudoparenchymatous, without polygonal plates. Asci not one-spored..... 2
2. Pits extending into the ascospores as conical spines.....*A. endodonta*
2. Pits not extending into the ascospores as spines, of equal diameter throughout their length.... 3
3. Ascospores subglobose, 28-31 \times 24-27 μ , reticulate.....*A. indica*
3. Ascospores ellipsoidal, 24-34 \times 18-24 μ , pitted.....*A. reticulata*

Anixiella endodonta Malloch & Cain, sp. nov.

Figs. 1-5

Coloniae in agaro YpSs rapide crescentes, secundum diametrem aetate 5 dierum 9 cm, hyalinae vel pallide brunneae; ascocarpae 95-250 μ crassae, globosae, fusco-brunneae, nonostiolatae; asci 77-165 \times 14-39 μ , cylindranei vel clavati, evanescentes, stipitati, octospori, in fasciculo ad basas dispositi; ascospores 25-30 \times 18-22 μ , ellipsoideae, fusco-brunneae, interne spinosae, externe foveolatae, ambitu porosae; conidia nulla.

HOLOTYPE: In solo, Halls Gap, Grampians, Victoria, Australia, Feb. 1963, *Warcup 281/2*, TRTC 45305. In Cryptogamic Herbarium, University of Toronto.

ETYMOLOGY: Greek, *endon* = within, and *odontos* = tooth, referring to the inwardly spiny ascospores.

Colonies on YpSs medium (Emerson 1958) spreading very rapidly, attaining a diameter of 9 cm in 4 to 7 days at room temperature, colorless to light brown, becoming darker as the ascocarps mature; *mycelium* of two types of hyphae, (1) wide (up to 12 μ), which develops as the substrate is first invaded and (2) narrow (2-10 μ) and highly branched, which develops after the substrate has been occupied by the first type; *ascocarp initials* usually produced as branches of the wider hyphae, consisting of short curved or sparingly coiled organs which soon become entangled with the neighboring mycelium to form a compact mass; *ascocarps* 95-250 μ diameter, numerous and superficial on the agar surface, globose, at first light colored but soon darkening, brown by transmitted light, black by reflected light, somewhat hairy as a result of adhering mycelium, splitting open irregularly at maturity; *ascocarp peridium* consisting of a dark outer and a hyaline inner tissue; peridial cells of the outer layer 2-25 \times 2-17 μ , pseudoparenchymatous in surface view, flattened in cross section, brown, one to three cells deep in cross section and forming a layer 3-25 μ thick; peridial cells of the inner layer hyaline, evanescent, strongly flattened; *asci* 77-165 \times 14-39 μ , arising from croziers in a basal fascicle, eight-spored, rarely four- to seven-spored, cylindrical to clavate, evanescent, with a ring at the apex about 3 μ in diameter, with a stipe 6-55 μ in length; *paraphyses* short, septate, simple or branched, extremely delicate,

constricted at the septa, 10-15 μ broad; *ascospores* 25-30 \times 18-22 μ , ellipsoidal, dark olive-green to black, black in mass, marked with pits about 1 μ in diameter with margins projecting inwardly as conical spines about 1.5-2.0 μ in length, with a germ pore, at each end (see discussion below), uniseriate in the ascus but easily becoming biseriata at maturity; conidia none.

SPECIMENS EXAMINED: AUSTRALIA: Victoria, Grampians, Halls Gap, cultures from soil, Feb. 1963, *Warcup 281/2* (TRTC 45305).

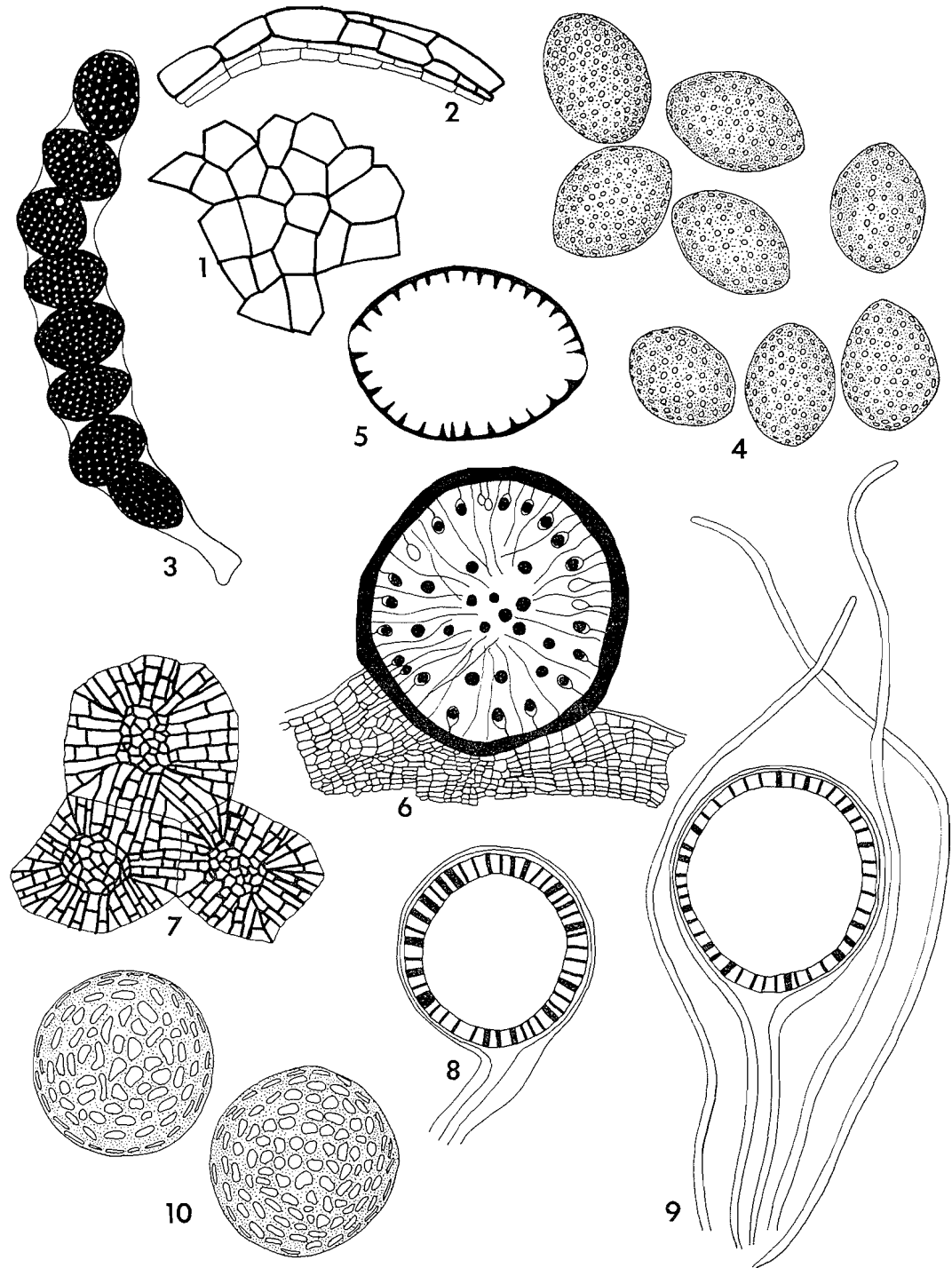
Cultures of this and the isolate discussed below have been deposited with the American Type Culture Collection (ATCC), the Centraalbureau voor Schimmelcultures (CBS), and the Commonwealth Mycological Institute (IMI).

A. endodonta differs from the other species of *Anixiella* in having inwardly spiny ascospores. While the ascospore pits in the other species extend inward through a thick spore wall, the pits of *A. endodonta* project inwardly as tapering spines (cf. Figs. 5 and 8). When broken, the ascospore wall often everts, giving the impression of an echinulate ascospore. Although most species of *Gelasinospora* have ascospores with thick walls and parallel-sided pits, those of *G. tetrasperma* Dowding are inwardly spiny like those of *A. endodonta*.

We have two collections representing this species, both from the same locality. These two isolates resemble each other exactly, except that one (TRTC 45306) has one germ pore and TRTC 45305 (the type) has two. Ordinarily this would be grounds for assigning the two isolates to separate species. However, because they correspond almost exactly, character for character, and because they come from exactly the same locality it seems wise to refer them to the same species until further study is made. The isolate with two germ pores was chosen as the type specimen in that it seems most likely that if a mutation had occurred it would result in the loss rather than the acquisition of a germ pore. In addition, the collection with only one germ pore is also quite variable in the number of ascospores per ascus.

Anixiella indica Rai, Wadhvani & Tewari. Can. J. Bot. 45: 479. 1967.

This species is distinguished by subglobose ascospores measuring 28-31 \times 24-27 μ . The pits



FIGS. 1-5. *Anixiella endodonta*. Fig. 1. Peridium surface ($\times 650$). Fig. 2. Peridium cross section ($\times 650$). Fig. 3. Ascus ($\times 500$). Fig. 4. Ascospores ($\times 650$). Fig. 5. Ascospore in optical section showing spines. FIGS. 6-10. *Anixiella monospora*. Fig. 6. Cross section of ascocarp in host tissue ($\times 29$). Fig. 7. Peridial plates ($\times 325$). Fig. 8. Ascus ($\times 650$). Fig. 9. Ascus and paraphyses ($\times 650$). Fig. 10. Ascospores ($\times 650$).

are very large and give a reticulate appearance. It is illustrated in the original publication.

Anixiella monospora Malloch & Cain, sp. nov.

Figs. 6–10

Ascocarpae 250–1000 μ crassae, immersae, globosae, nigrae, glabrae, nonostiolatae, cum peridio cephalothecoidio; asci 60–100 \times 40–60 μ , globosi vel clavati, unispori, evanescentes, stipitati, in pariete interiore ascocarpae aequaliter dispositi; ascosporeae 43–58 μ crassae, globosae, fusco-brunneae, reticulatae; conidia ignota.

HOLOTYPUS: In rhizomatibus *Iridis* sp., Iran, TRTC 44885. In Cryptogamic Herbarium, University of Toronto.

ETYMOLOGY: Greek, *monos* = one and *spora* = seed, referring to the one-spored asci.

Ascocarps 250–1000 μ in diameter, immersed one third to one half in the substrate, becoming more exposed as development proceeds, globose, black, shining, glabrous, nonostiolate; *ascocarp peridium* 30–80 μ thick, cephalothecoid, consisting of polygonal plates of cells which separate at maturity along well-defined lines of dehiscence, carbonaceous; peridial cells 20–35 \times 2–6 \times 3–11 μ , elongated in surface view, somewhat flattened in cross section, with thickened longitudinal walls up to 3 μ thick and with very thin and inconspicuous cross walls; *asci* arising from croziers in a layer evenly lining the inner wall of the ascocarp, clavate to globose, thin-walled, evanescent, one-spored, contracted into a long stipe 20–60 μ in length, upper part swollen around and closely adhering to the single mature ascospore; *paraphyses* interspersed among the asci, septate, very long, 1.5 μ wide; *ascospores* 43–58 μ in diameter, subglobose to globose, dark brown by transmitted light, black in mass, reticulate with ridges 1.5–3.0 μ wide, which delimit light-colored irregular pits 1.5–7.0 μ in diameter, without evident germ pores; conidia unknown.

SPECIMEN EXAMINED: On rhizome of *Iris* sp., Iran (intercepted at Hoboken, New Jersey, U.S.A. by the U.S.D.A. Plant Quarantine Division), TRTC 44885.

A. monospora is unique with large one-spored asci, filiform paraphyses and globose ascospores without germ pores. The peridium is cephalothecoid in type, similar to that of the related sordariaceous species *Diplogelasinospora princeps*

Cain and *Zopfiella tabulata* (Zopf.) Winter. It is interesting to note that the unrelated *Zopfia rhizophila* Rabenh., growing on the same rhizome with this collection, also has a cephalothecoid peridium. The taxonomic significance of this peridium type was discussed in greater detail in another paper (Malloch and Cain 1970).

We were unable to study cultures of this species and thus could not compare it thoroughly with the other species. It is possible that cultural studies may show it to belong in another genus.

Anixiella reticulata (Booth & Ebben) Cain. Can. J. Bot. 39: 1668. 1961.

\equiv *Thielavia reticulata* Booth & Ebben. Trans. Brit. Mycol. Soc. 44: 214. 1961.

\equiv *Anixiella reticulisporea* Saito & Minoura. J. Ferment. Technol. 26: 4. 1948. (In Japanese without validating Latin description.)

A. reticulata closely resembles *Gelasinospora calospora*. The pits are cylindrical and never project inwardly as spines as in *A. endodonta*. The ascospores measure 24–34 \times 18–24 μ and have a germ pore at each end. It has been described and illustrated by Booth and Ebben (1961) and Cain (1961).

Apodus Malloch & Cain, gen. nov.

Ascocarpae subglobosae vel globosae, fusco-brunneae, crinitae, nonostiolatae. Asci irregulariter dispositi, clavati vel cylindranei, evanescentes. Ascosporeae ellipsoideae, fusco-brunneae, unicellares, raro uniseptatae, laeves, cum poro unico. Conidia nulla.

TYPUS GENERIS: *Apodus deciduus* Malloch & Cain.

ETYMOLOGY: Greek, *a* = without, and *podus* = foot, refers to the lack of a hyaline ascospore cell.

Ascocarps subglobose to globose, dark brown, nonostiolate, covered with long hairs. Asci irregularly disposed, clavate to cylindrical, evanescent. Ascospores ellipsoid, dark brown at maturity, one-celled, rarely two-celled, smooth, with a single germ pore. Conidia none.

Apodus deciduus Malloch & Cain, sp. nov.

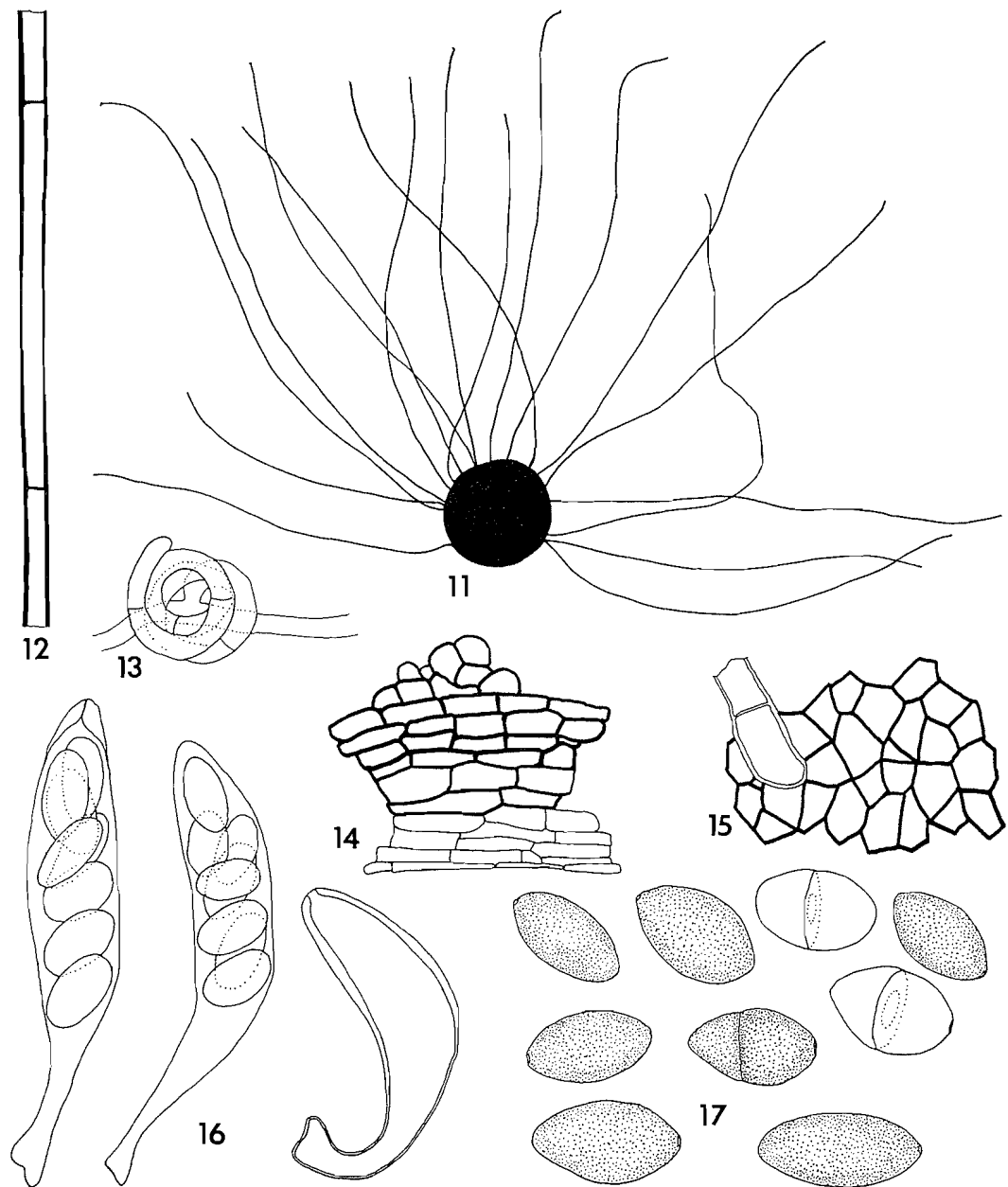
Figs. 11–17

Coloniae in agar "corn meal" secundum diametrem aetate 21 dierum 3.5 cm, appressae, fusco-olivaceae vel fusco-brunneae, azonatae; mycelium hyalinum vel fusco-brunneum, cum hyphae 1.0–4.5 μ crassae; ascocarpae 150–400 μ crassae, sub-

globosae vel globosae, fusco-brunneae, crinitae, nonostiolatae; asci 35–50 × 8–10 μ, irregulariter dispositi, clavati vel cylindranei, octospori, evanescentes, stipitati; ascospores 12–16 × 7.0–10.5 μ, ellipsoideae, unicellares, raro uniseptatae,

fusco-brunneae, laeves, ad extremum uniporosae; conidia nulla.

HOLOTYPE: In fimo *Neotomatis fuscipedis*, Crystal Springs Reservoir, San Mateo Co., California, U.S.A., 30 Dec. 1969, Malloch,



FIGS. 11–17. *Apodus deciduus*. Fig. 11. Ascocarp (× 55). Fig. 12. Ascocarp hair (× 1500). Fig. 13. Ascocarp initials (× 1500). Fig. 14. Cross section of peridium (× 1500). Fig. 15. Peridium surface (× 1500). Fig. 16. Asci (× 1500). Fig. 17. Ascospores (× 1500).

TRTC 45704. In Cryptogamic Herbarium, University of Toronto.

ETYMOLOGY: Latin, *deciduus* = falling off, referring to the ascocarp hairs which fall off easily at maturity.

Colonies on cornmeal agar (Grosklags and Swift 1957) attaining a diameter of 3.5 cm in 3 weeks at room temperature, appressed, dark olive-green to brownish black, azonate; reverse black; *ascocarp initials* consisting of coiled or contorted side branches of the aerial or substrate mycelium which soon proliferate to form compact masses; *mycelium* hyaline to dark olivaceous brown; *hyphae* 1.0–4.5 μ in diameter, abundantly septate, branched, frequently anastomosing; *ascocarps* 150–400 μ in diameter, subglobose to globose, dark reddish brown by transmitted light, black by reflected light, covered with long dark hairs, nonstiolate; *ascocarp hairs* dark brown, hyaline at the tips, flexuous, septate, variable in length, often longer than 600 μ , tapering from 4.5–5.5 μ in diameter at the base to 2.5–3.0 μ at the apex, readily falling off at maturity; *ascocarp peridium* 25–45 μ thick, consisting of a dark outer and a hyaline inner tissue; peridial cells of the outer layer 3.5–12.0 \times 2.0–3.5 μ , pseudoparenchymatous in surface view, flattened in cross section, dark brown, thick-walled, three to five cells deep in cross section; peridial cells of the inner layer hyaline, thin-walled, evanescent, strongly flattened in cross section, up to 25 (or more) \times 1.5–3.0 μ ; *asci* 35–50 \times 8–10 μ , arising from croziers, irregularly disposed, clavate to nearly cylindrical, often with a very indistinct apical structure, eight-spored, evanescent, short-stipitate; *ascospores* 12–16 \times 7.0–10.5 μ , ellipsoidal, usually one-celled but often producing a single septum in culture, at first olive-green, later becoming dark brown by transmitted light, black in mass, smooth, with a single apical germ pore, with a de Bary bubble; conidia none.

SPECIMENS EXAMINED: U.S.A.: California: San Mateo Co.: Crystal Springs Reservoir, on dung of dusky-footed wood rat in nest, 30 Dec. 1969, Malloch, TRTC 45704. California, on rat dung, Dec. 1916, Thaxter 888 (FH).

Cultures derived from the type have been deposited at ATCC, CBS, and IMI.

A. deciduus appears to be most closely related to *Tripterospora erostrata* (Griff.) Cain. The cultural characteristics and ascocarp morphology

of the two are especially similar. The fact that *A. deciduus* occasionally produces two-celled ascospores is some indication that it may have evolved from an ancestor with two-celled ascospores.

Although, as noted above, *A. deciduus* appears very similar to *Tripterospora erostrata* it cannot be included in *Tripterospora* as its ascospores lack a hyaline lower cell. Its slow growth, dark colonies and small ascospores exclude it from *Boothiella*, a genus probably related to *Sordaria* Ces. & De Not.

When *A. deciduus* was first discovered on the natural substrate the ascocarp hairs were lacking and the asci had dissolved. With only ascospores available it was identified as *Thielavia terricola* (Gilman & Abbott) Emmons. Once in culture, however, it was immediately recognized as a member of the Sordariaceae. *Thielavia* Zopf is probably a member of the Chaetomiaceae and never produces dark-colored mycelium or any indication of ascospore septation. In addition, the asci of *Thielavia* (or any of the Chaetomiaceae) in contrast to the Sordariaceae, exhibit no apical structures.

Echinopodospora Robison. Trans. Brit. Mycol. Soc. 5: 318. 1970.

Robison (1970) erected the genus *Echinopodospora* to accommodate two species, *E. jamaicensis* and *E. sacchari*, characterized by ascospores with a dark spiny upper cell and a hyaline, smooth, appendage-like lower cell. The genus appears to be a cleistothecial counterpart to the genus *Apiosordaria* von Arx and Gams. Recently Cailleux (1970) published two new species of *Tripterospora* Cain, *T. spinosa* and *T. verruculosa*, that we consider to be representatives of *Echinopodospora*. One of these, *T. verruculosa*, differs from previously described species of *Echinopodospora* in having warted, rather than spiny, ascospores, but we do not consider this one character to be a valid basis for generic separation. Neither of these two new species should be maintained in *Tripterospora*, as all the species of that genus have smooth ascospores.

The two new combinations are as follows.

Echinopodospora spinosa (Cailleux) Malloch and Cain, comb. nov.

BASIONYM: *Tripterospora spinosa* Cailleux. Cah. La Maboké, 8: 16. 1970.

Echinopodospora verruculosa (Cailleux) Malloch and Cain, comb. nov. Cah. La Maboké, 8: 16. 1970.

BASIONYM: *Tripterospora verruculosa* Cailleux,

The following key will serve to separate the four species of *Echinopodospora*.

KEY TO THE SPECIES OF *Echinopodospora*

- | | |
|---|-----------------------|
| 1. Dark cell of ascospores distinctly spiny..... | 2 |
| 1. Dark cell of ascospores nearly smooth to warted or rugulose..... | <i>E. verruculosa</i> |
| 2. Hyaline cell of ascospores 6-8 × 4-5 μ..... | <i>E. spinosa</i> |
| 2. Hyaline cell of ascospores longer than 10 μ..... | 3 |
| 3. Ascospores 33-46 × 18-34 μ (including hyaline cell)..... | <i>E. jamaicensis</i> |
| 3. Ascospores 44-60 × 25-31 μ (including hyaline cells)..... | <i>E. sacchari</i> |

Zopfiella Winter in Rabenhorst, Krypt.-Fl. 1 (Abt. 2): 56. 1884.

TYPE SPECIES: *Z. tabulata* Winter

Zopfiella Winter appears to be a cleistothecial counterpart of the ostiolate genus *Triangularia* Boedijn. *Zopfiella* and *Triangularia* can be distinguished from similar genera, such as *Podospora* Cesati and *Tripterospora* Cain, in that they produce ascospores with a broad, conical hyaline cell. This hyaline cell in *Podospora* and *Tripterospora* is cylindrical or clavate, is very delicate, and is differentiated very early in ascospore development. In *Zopfiella* and *Triangularia* the hyaline ascospore cell is thicker walled and usually persists (at least the upper part) in older spores, but is not differentiated as early. The young ascospores are ellipsoidal or cylindrical rather than the usual clavate shape of those of *Podospora* and *Tripterospora*.

In the past *Zopfiella* has been characterized as having a septum in the dark cell of the asco-

spores, thus distinguishing it from *Tripterospora*. In the present paper we have transferred to *Zopfiella* three species of *Tripterospora*, which, although lacking this characteristic septum, have ascospores fitting the *Zopfiella-Triangularia* pattern described above. With the removal of these two species, *Tripterospora* becomes a genus with *Podospora*-like ascospores.

We do not consider the presence or absence of a septum in the dark cell of the ascospores to be of taxonomic significance above the species level in *Zopfiella* and *Tripterospora*. The genera *Bombardia* Fries and *Podospora* also have species with septate dark ascospore cells. In these genera, and in *Apodus*, the septum may be present under some conditions and absent under others.

The transfers mentioned above and the description here of a new species brings the total number of *Zopfiella* species to five. These can be separated by the following key:

KEY TO THE SPECIES OF *Zopfiella*

- | | |
|--|-----------------------|
| 1. Peridium cephalothecoid, composed of plates of radiating cells which separate at maturity along well-defined lines of dehiscence..... | 2 |
| 1. Peridium not as above..... | 3 |
| 2. Asci subglobose to globose, eight-spored; ascospores strongly asymmetrical..... | <i>Z. curvata</i> |
| 2. Asci clavate, four-spored; ascospores nearly symmetrical..... | <i>Z. tabulata</i> |
| 3. Dark cell of ascospores with a septum..... | <i>Z. pleuropora</i> |
| 3. Dark cell of ascospores nonseptate..... | 4 |
| 4. Upper cell of ascospores 28-32 × 18-21 μ; hyaline cell of ascospores 3-6 μ long, 5-7 μ wide..... | <i>Z. inermis</i> |
| 4. Ascospores smaller..... | 5 |
| 5. Upper cell of ascospores 16.5-20.5 × 10-13 μ, with a subapical germ pore; hyaline ascospore cell 6.3-7.7 μ long; conidia produced as aleuriospores (<i>Humicola</i>)..... | <i>Z. latipes</i> |
| 5. Upper cell of ascospores 18-26 × 12-17 μ, with an apical germ pore; hyaline ascospore cell 3.5-5.0 μ long; conidia lacking..... | <i>Z. leucotricha</i> |

Zopfiella curvata (Fuckel) Winter. In Rabenhorst, Krypt.-Fl. 1 (Abt. 2): 56. 1884.

≡ *Cephalotheca curvata* Fuckel. Symbol. Mycol. Nachtr. 1: 298. 1871.

≡ *Crepinula curvata* (Fuckel) Kunze. Rev. Gen. Pl. 2: 850. 1891.

Z. curvata is characterized by a cephalothecoid peridium, globose asci, and ascospores which are

highly asymmetrical. These ascospores are shaped like sections of an orange and thus form a spherical mass within the ascus. They measure $14-16 \times 6-7 \mu$ (dark portion). It is only known from decayed wood in Germany. We have examined Fuckel's material and will describe it in a later publication.

Zopfiella latipes (Lundqvist) Malloch & Cain, comb. nov.

BASIONYM: *Tripterospora latipes* Lundq. Bot. Notis. 122: 592. 1969.

Z. latipes appears similar to *Z. pleuropora* but differs in having the dark cell of the ascospores nonseptate and in producing dark ascocarps. In addition, it is reported from soil and from wood immersed in seawater while *Z. pleuropora* is known only from dung. Finally, *Z. latipes* produces a *Humicola* conidial stage, and is thus distinct.

Zopfiella inermis (Cailleux) Malloch and Cain, comb. nov.

BASIONYM: *Tripterospora inermis* Cailleux. Cah. La Maboké, 8: 15. 1970.

Z. inermis has the largest ascospores in the genus. The ascospores are characterized by a nonseptate dark cell and a hyaline cell that is broader than long and resemble in this respect, those of *Z. leucotricha*.

Zopfiella leucotricha (Speg.) Malloch & Cain, comb. nov.

BASIONYM: *Sordaria leucotricha* Spegazzini. Michelia, 1: 225. 1878.

≡ *Podospora leucotricha* (Speg.) Niessl. Hedwigia, 22: 156. 1883.

≡ *Pleurance leucotricha* (Speg.) Kunze. Rev. Gen. Pl. 3: 505. 1898.

≡ *Tripterospora leucotricha* (Speg.) Lundqvist. Bot. Notis. 122: 596. 1969.

= *Chaetomium fuscicola* Petrak. Ann. Mycol. 13: 45. 1915 (fide Lundqvist 1969).

= *Tripterospora brevicaudata* Cain. J. Bot. 34: 701. 1956.

Although the hyaline cell is shorter in this species than in most others it is thick-walled at its upper end and is thus persistent as a thickened ring, typical of the genus.

We have examined Spegazzini's type material of *Sordaria leucotricha* (from LPS) and it is, without doubt, identical with Cain's *Tripterospora brevicaudata*.

Zopfiella pleuropora Malloch & Cain, sp. nov.

Figs. 18-24

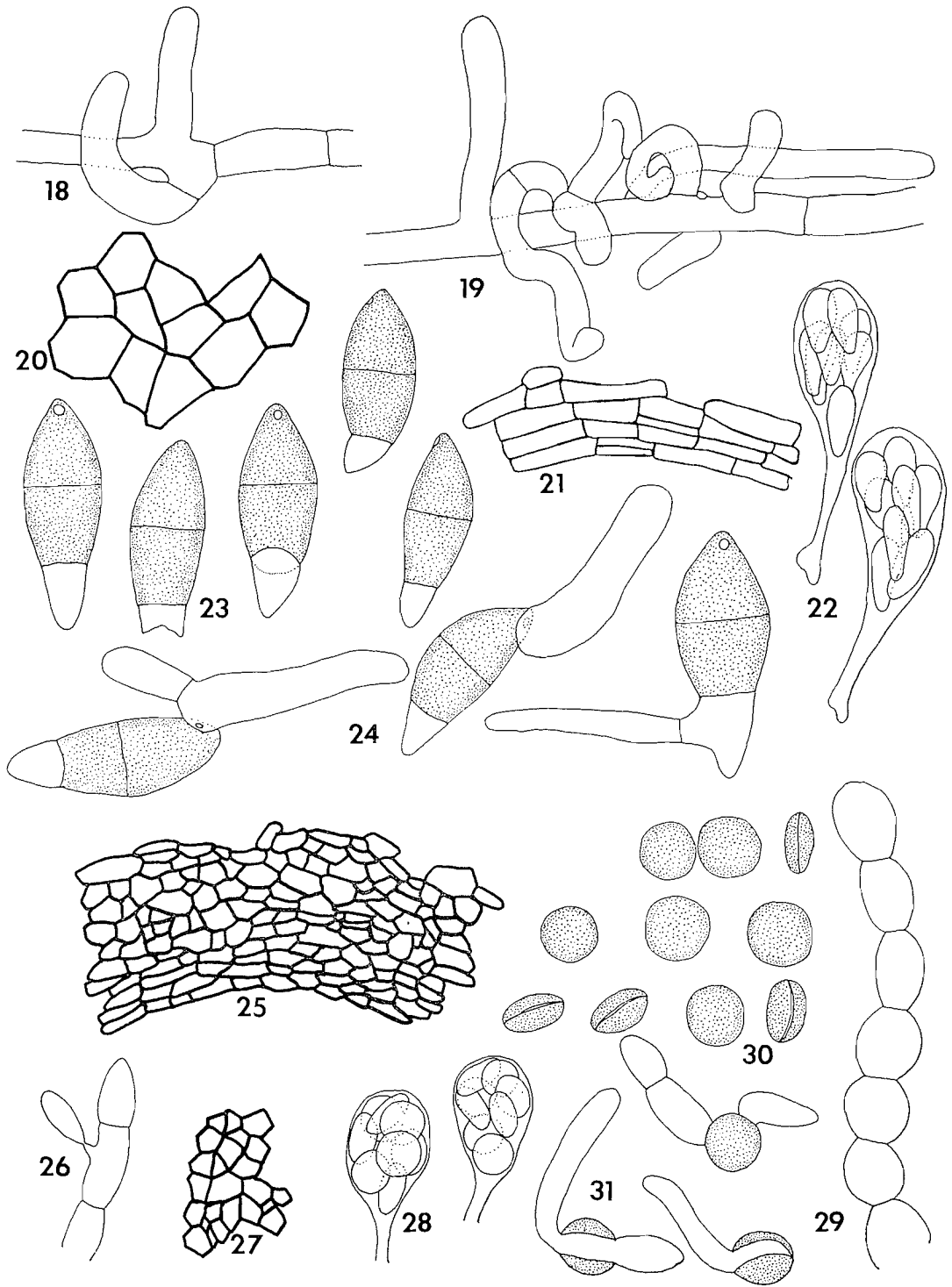
Coloniae in agar "Leonian" secundum diametrem aetate 9 dierum 6.5 cm, arachnoideae, hyalinae vel brunneae, azonatae; ascocarpae 100-400 μ crassae, subglobosae vel globosae, translucidae, pallide luteae, nonstiolatae; asci 50-80 \times 14-24 μ (pars sporif. 43-53 \times 14-24 μ), fasciculati, clavati, octospori, stipitati, evanescentes; ascosporae 23-29 \times 8-11 μ , applanatae-ellipsoideae, biseptatae; loculus apicalis ascospori 9-14 \times 8-10 μ , poro subapicali praeditus; loculus medius ascospori 6-11 \times 8-11 μ ; localus infirmus ascospori hyalinus conicus, 5.5-8.5 \times 5.0-6.5 μ .

HOLOTYPE: In fimo *Odocoilei virginiani*, S of Dorset Haliburton Co., Ontario, Canada, 16 Sept. 1966, Malloch, TRTC 44801. In Cryptogamic Herbarium, University of Toronto.

ETYMOLOGY: Greek, *pleura* = side, and *poros* = pore, referring to the subapical germ pore of the ascospores.

Homothallic; colonies on Leonian's medium (Leonian 1924) plus 1 g/l yeast extract, attaining a diameter of 6.5 cm in 9 days at room temperature, arachnoid, hyaline to brownish, azonate, producing a yellow-brown pigment that diffuses into the medium; reverse yellow-brown; mycelium 2.0-5.5 μ in diameter, hyaline to light brown, septate, branched, frequently anastomosing; ascocarp initials appearing within 3 days, produced as side branches of the mycelium, becoming surrounded by the neighboring hyphae; ascocarps 100-400 μ in diameter, subglobose to globose, glabrous, semitransparent, light yellow

Figs. 18-24. *Zopfiella pleuropora*. Fig. 18. Ascocarp initials (\times 1500). Fig. 19. Ascocarp initials (\times 1500). Fig. 20. Peridium surface (\times 1500). Fig. 21. Peridium cross section (\times 1500). Fig. 22. Asci (\times 650). Fig. 23. Ascospores (\times 1500). Fig. 24. Germinating ascospores (\times 1500). Figs. 25-31. *Coniochaetidium ostreum*. Fig. 25. Peridium cross section (\times 650). Fig. 26. Aleuriospore (\times 1500). Fig. 27. Peridium surface (\times 650). Fig. 28. Asci (\times 1500). Fig. 29. Moniloid hyphae (\times 1500). Fig. 30. Ascospores (\times 1500). Fig. 31. Germinating ascospores (\times 1500).



to yellowish orange, becoming black in the center as the ascospores mature, nonostiolate; *ascocarp peridium* of one type of cell, hyaline to yellow; peridial cells $4-20 \times 2-3 \mu$, fragile, thickest at the outside, dissolving in the inner layers as the asci expand into the centrum, pseudoparenchymatous in surface view, flattened in cross section; *asci* $50-80 \times 14-24$ (part sporif. $43-53 \times 14-24 \mu$), borne on croziers in a fascicle, clavate, eight-spored, evanescent, stipitate; ascus stipe $6-25 \mu$ long; *ascospores* $23-29 \times 8-11 \mu$ (including the hyaline cell), inequilaterally ellipsoidal, three-celled, with two dark olive-green to brown upper cells and a hyaline lower cell; upper ascospore cell $9-14 \times 8-10 \mu$; middle ascospore cell $6-11 \times 8-11 \mu$; lower cell conical, hyaline, $5.5-8.5 \times 5.0-6.5 \mu$, with upper part thick and rigid, lower part thin and collapsing; germ pore subapical in the upper cell, on the flattened face of the spore, round, about 1.5μ in diameter; ascospores germinating by means of a single germ tube through the germ pore or rarely from the hyaline cell.

SPECIMENS EXAMINED: CANADA: Ontario: Haliburton Co.: S of Dorset, on deer dung, 16 Sept. 1966, Malloch, HOLOTYPE TRTC 44801. U.S.A.: California: San Mateo Co.: Crystal Springs Reservoir, on dung of dusky-footed wood rat in nest, 30 Dec. 1969, Malloch, TRTC 45702 and 45703.

Cultures of the above isolates have been deposited at ATCC, CBS, and IMI.

As noted in the key, *Z. pleuropora* is characterized by a nearly colorless ascocarp peridium. The ascospores differ from those of the other species of *Zopfiella* (except *Z. latipes*) in general morphology and in having a subapical germ pore. Unlike *Z. tabulata*, *Z. pleuropora* grows very rapidly and fruits within 2 weeks. Cultures of *Z. curvata* are not available for comparison.

The two isolates from the United States (TRTC 45702 and 45703) differ from the type collection in having slightly smaller hyaline ascospore cells ($5.0-6.5 \times 3.5-5.5 \mu$). In addition, one of these (TRTC 45703) produces a few spermatia or conidia on simple phialides measuring about $15 \times 2 \mu$. The conidia are ovoid, hyaline, and measure about $3 \times 1.5 \mu$. Because these isolates do not differ greatly from the type collection they are not considered as separate species.

Zopfiella tabulata Winter. In Rabenh. Krypt.-Fl. 1 (Abt. 2): 56. 1884.

Z. tabulata is a coprophilous species which commonly occurs on porcupine dung. It is characterized by yellowish tomentose ascocarps with a cephalothecoid peridium, clavate four-spored asci and nearly symmetrical ascospores. The colonies are slow-growing and bright yellow. The ascospores measure $21-32 \times 9-12 \mu$. It will be described and illustrated in a later publication.

Coniochaetaceae

Coniochaetaceae Malloch & Cain, fam. nov.

Mycelium hyalinum vel brunneum. Ascogonia helicoidea vel contorta. Ascocarpaceae subgloboseae vel globosae vel pyriformes, ostiolatae vel nonostiolatae, glabrae vel setosae, brunneae vel nigrae, nonstromaticae. Asci subglobosi vel cylindracei, evanescentes et sine poro vel persistentes et porum apicalem exhibentes. Ascosporae discoideae vel ellipsoideae, cum fissura germinativa, fuscae, laeves, unicellares. Conidia ex phialidis producta, raro instar aleuriospora.

TYPUS FAMILIAE: *Coniochaeta* (Sacc.) Masee

The family is established to accommodate *Coniochaeta* and the new genus *Coniochaetidium*. Species of the Coniochaetaceae differ from those of the Sordariaceae in having ascospores with elongated germ slits. Cultures are frequently characterized by pink or orange colors and a yeast-like appearance. They usually grow better at low temperatures and the conidia are produced abundantly as phialospores or rarely aleuriospores. The species are often characterized by thick-walled ascocarp spines. They are most readily distinguished from members of the Sordariaceae by their ascospores with germ slits, and from the Xylariaceae (sensu Martin 1967) in lacking stromatic tissue.

Although at present only two genera are included, the genus *Ascotricha* Berk. may also belong here. *Coniochaeta* and *Coniochaetidium* are easily distinguished in that the former is ostiolate and the latter cleistothecial.

Coniochaetidium Malloch & Cain, gen. nov.

Ascocarpaceae subgloboseae vel globosae pallide brunneo-luteae vel fusco-brunneae, glabrae vel setosae, nonostiolatae. Asci fasciculati vel irregulariter dispositi, ovoidei vel cylindracei, evanescentes, quadro- vel octo-spori. Asco-

spora unicellares, fusioideae vel discoideae, fusco-brunneae, laeves, cum fissura germinali laterali vel aequatoriali. Aleuriosporae raro productae.

TYPUS GENERIS: *C. ostreum* Malloch & Cain

ETYMOLOGY: The genus *Coniochaeta* and the Latin diminutive suffix *-idium*, referring to the related genus *Coniochaeta*.

Ascocarp initials consisting of simple or contorted mycelial branches. Ascocarps subglo-

bose to globose, pale yellow-brown to almost black, glabrous to setose, nonostiolate. Asci irregularly disposed or arranged in a basal fascicle, ovoid to cylindrical, evanescent, four- to eight-spored. Ascospores one-celled, fusoid to discoid, dark brown, smooth, with a lateral or equatorial germ slit. Conidia produced as aleuriospores or absent.

The two species of *Coniochaetidium* recognized here can be separated by the following key.

KEY TO THE SPECIES

1. Ascospores fusoid, slightly flattened on one side, 14–21 μ long.....*C. savoryi*
1. Ascospores discoid to ellipsoidal, strongly flattened on two sides, less than 14 μ long.....*C. ostreum*

***Coniochaetidium ostreum* Malloch & Cain,**
sp. nov. Figs. 25–31

Coloniae in agar "Leonian" secundum diametrem aetate 42 dierum 9 cm, appressae vel coactae, roseo-aurantiacae vel olivaceae, zonatae, rugosae; ascocarpae 150–400 μ crassae, subgloboseae vel globosae, fusco-brunneae vel nigrae, glabrae, subrugulosae, nonostiolatae; asci 12–21 \times 7–10 μ , irregulariter dispositi, ovoidei, stipitati, octospori, evanescentes; ascosporae 5.0–8.0 \times 4.0–5.5 μ , oblatae vel discoideae, fusco-brunneae, laeves, cum fissura aequatoriali; aleuriosporae 8–12 \times 2.5–3.5 μ , clavatae vel ovoideae, laeves, hyalinae; conidiophorae desunt.

HOLOTYPE: In ramis *Larrea divaricatae*, Gila Bend, Arizona, U.S.A., 9 April 1960, *Martin* 8998, TRTC 45407. In Cryptogamic Herbarium, University of Toronto.

ETYMOLOGY: Latin, *ostrea* = oyster, referring to the bivalved ascospores.

Colonies on Leonian's medium (Leonian 1924), plus 1 g/l yeast extract, attaining a diameter of 9 cm in 6 weeks at room temperature, appressed to felty, pinkish orange to olivaceous, black where fruiting, obscurely zonate, somewhat radiately wrinkled; reverse black at the center, orange toward the margin; *mycelium* hyaline, dark in the immediate vicinity of the ascocarps; *hyphae* 1.5–7.0 μ wide, thin-walled, abundantly septate, branched, frequently anastomosing, often swollen at each cell and constricted at the septa and thus appearing moniliform (Fig. 29); *ascocarp initials* at first simple branches of the vegetative mycelium, soon becoming compact and contorted due to profuse branching, absorb-

ing lactofuchsin stain slightly more than the vegetative mycelium; *ascocarps* 150–400 μ in diameter, subglobose to globose, dark brown to black by reflected light, opaque, glabrous, somewhat roughened as a result of irregularities in the outer peridial layers, nonostiolate; *ascocarp peridium* 30–55 μ thick, of one type of cells; peridial cells 4.0–15.0 \times 2.0–10.5 μ , pseudoparenchymatous in surface view, somewhat flattened in cross section, dark brown, thick-walled, becoming irregular and somewhat evanescent in the outer layers, 8 to 16 cells deep in cross section; *asci* 12–21 \times 7–10 μ , borne on croziers, irregularly disposed, ovoid, evanescent, short-stipitate, eight-spored; *ascospores* 5.0–8.0 \times 4.0–5.5 μ , oblate to discoid, brown by transmitted light, blackish in mass, smooth, with an equatorial germ slit dividing the spore into two equal valves, upon germination splitting apart at the germ slit and producing one to three germ tubes; *conidia* 8–12 \times 2.5–3.5 μ , infrequent, produced as clavate to ovoid aleuriospores directly on the vegetative mycelium, smooth, hyaline.

SPECIMENS EXAMINED: U.S.A.: Arizona: Gila Bend, on twigs of *Larrea divaricata*, 9 April 1960, *Martin* 8998, HOLOTYPE TRTC 45407.

Cultures from the type collection have been deposited at ATCC, CBS, and IMI.

C. ostreum is the only known species of *Coniochaetidium* with discoid ascospores. There are, however, two collections from dead wood, in the Cryptogamic Herbarium of the University of Toronto, with strongly flattened ellipsoidal ascospores with germ slits. These probably represent a new species of *Coniochaetidium*. One

of these (TRTC 33447) has ascospores measuring $10-12 \times 8-9 \times 3.5-4.0 \mu$, while the other (TRTC 45662) has ascospores $12-14 \times 9-10 \times 4.5 \mu$. Both have hyaline equatorial flanges on the ascospores. The asci are clavate and long-stipitate. In both cases there are numerous *Graphium*-like synnemata accompanying the ascocarps. If these two stages belong together, then it would be the first report of a *Graphium* imperfect stage in this group. However, it is most likely that the *Graphium* represents another fungus altogether. Since the only material available of both collections is mounted on slides it is considered better to leave them undescribed until fresh material or cultures can be examined.

Coniochaetidium savoryi (Booth) Malloch & Cain, comb. nov.

BASIONYM: *Thielavia savoryi* Booth. Commonw. Mycol. Inst. Mycol. Pap. 83: 3. 1961.

C. savoryi is a species with ascospores that are not discoid or strongly flattened. It is comparable to certain species of *Coniochaeta* such as *C. subcorticalis* (Fuckel) Munk and *C. ellipsoidea* Udagawa which have ellipsoidal to fusoid ascospores. It might be fairly easy to mistake a species such as this for a member of the Xylariaceae (sensu Martin 1967). The pink colonies which occur on some media (such as PDA or Weitzman and Silva-Hutner's), and four-spored asci, however, are common in the Coniochaetaeaceae and rare or absent in the Xylariaceae. In addition there is no stroma or aleuriospore conidial stage as in the Xylariaceae.

Although *C. savoryi* was first described as a *Thielavia* its ascospores with germ slits would eliminate it from that group.

Acknowledgments

We thank Dr. G. W. Martin, Dr. J. H. Warcup, Mr. A. L. Brown, and Prof. J. C. Lundqvist for sending some of the collections described, and Dr. B. Boivin for correcting the Latin.

- BOOTH, C., and M. H. EBBEN. 1961. *Thielavia reticulata* sp. nov. Trans. Brit. Mycol. Soc. **44**: 214-216.
- CAILLEUX, R. 1970. Champignons stercoraux de République Centrafricaine IV. *Tripterospora*. Cah. La Maboké, **8**: 5-16.
- CAIN, R. F. 1956. Studies of coprophilous Ascomycetes. 4. *Tripterospora*, a new cleistocarpous genus in a new family. Can. J. Bot. **34**: 699-710.
- 1961. *Anixiella* and *Diplogelasinospora*, two genera with cleistothecia and pitted ascospores. Can. J. Bot. **39**: 1667-1677.
- EMERSON, R. 1958. Mycological organization. Mycologia, **50**: 589-621.
- GROSKLAGS, J. H., and M. E. SWIFT. 1957. The perfect stage of an antibiotic-producing *Cephalosporium*. Mycologia, **49**: 305-317.
- LEONIAN, L. H. 1924. A study of factors promoting pycnidium formation in some Sphaeropsidales. Amer. J. Bot. **11**: 19-50.
- LODHI, S. A., and F. MIRZA. 1962. A new genus of the Eurotiales (*Boothiella*). Mycologia, **54**: 217-219.
- LUNDQVIST, N. 1967. On spore ornamentation in the Sordariaceae, exemplified by the new cleistocarpous genus, *Copromyces*. Ark. Bot. Ser. 2, **6**: 327-337.
- 1969. *Tripterospora* (Sordariaceae s. lat., Pyrenomyces). Bot. Notis. **122**: 589-603.
- MALLOCH, D., and R. F. CAIN. 1970. Five new genera in the new family Pseudeurotiaceae. Can. J. Bot. **48**: 815-825.
- MANOTIS, J. 1965. A cleistothecial mutant of the perithecial fungus *Gelasinospora calospora*. Mycologia, **57**: 23-35.
- MARTIN, P. 1967. Studies in the Xylariaceae: I. New and old concepts. J. S. Afr. Bot. **33**: 205-240.
- ROBISON, B. M. 1970. A new cleistocarpous genus *Echinopodospora* with two new species. Trans. Brit. Mycol. Soc. **54**: 318-322.
- SUBRAMANIAN, C. V., and B. C. LODHA. 1968. Two interesting coprophilous fungi from India. Current Sci. **37**: 245-248.
- WINTER, G. 1884. Sordariaceae. In Rabenhorst's Kryptogamen-Flora von Deutschland, Oesterreich und der Schweiz. **1** (Abt. 2): 161-187.