

**PRODROMUS FOR A REVISION OF CERATOCYSTIS
(MICROASCALES, ASCOMYCETES) AND ITS
CONIDIAL STATES**

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SUMMARY

A new genus, *Ceratocystiopsis*, a segregate from *Ceratocystis*, is erected. Four new form genera are proposed for conidial states of *Ceratocystis* and *Ceratocystiopsis* species.

A revision of the genus *Ceratocystis* Ell. & Halst. emend. Bakshi, with a complete compilation of its multifarious conidial states, will be presented elsewhere. Our observations of taxa classified in *Ceratocystis* have convinced us that the genus is not homogeneous; 19 species are here segregated and placed in a new genus, *Ceratocystiopsis*, which is characterized by ascospores which are elongated, aseptate (sometimes 1-septate in at least one species), always possessing a hyaline, gelatinous sheath and attenuated at the ends (Fig. 4); the asci are fusiform or clavate. At present, 82 species remain in *Ceratocystis* proper. With slight modifications, we accept the division of *Ceratocystis* proposed by Olchowecki and Reid (1974) into three groups, (1) The Fimbriata group, (2) The Ips group, and (3) The Pilifera group. We consider *Europhium* Parker to be a synonym of *Ceratocystis*.

Even after the loss of 19 species to *Ceratocystiopsis*, the genus *Ceratocystis* appears to have greater diversity of conidial states than any other known ascomycete genus. These are listed in TABLE I. Of 16 imperfect genera into which the conidial states of *Ceratocystis* and *Ceratocystiopsis* fall, four are here proposed as new.

We note that the mononematous and synnematous analogues among these conidial states often represent two closely parallel series, and that the appropriate analogues may eventually be regarded as congeneric, thus slightly reducing the number of genera involved. In TABLE I, *Pesotum* is the synnematous analogue of *Verticicladiella*; *Graphium* is the synnematous analogue of *Leptographium*; and *Phialographium* is

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TABLE I
CONIDIAL STATES OF *Ceratocystis* AND *Ceratocystiopsis*

Perfect state	Imperfect state	Conidial ontogeny
<i>Ceratocystis</i>	1. <i>Hyalodendron</i>	holoblastic acropetal chains
	2. <i>Sporothrix</i>	holoblastic sympodial
	3. <i>Hyalorhinocladiella</i> ^a	holoblastic sympodial
	4. <i>Verticicladiella</i>	holoblastic sympodial
	5. <i>Pesotum</i>	holoblastic sympodial
	6. <i>Hyalopesotum</i> ^a	holoblastic sympodial
	7. <i>Pachnodium</i> ^a	holoblastic ?
	8. <i>Leptographium</i>	holoblastic annellidic
	9. <i>Graphium</i>	holoblastic annellidic
	10. <i>Graphilbum</i> ^a	holoblastic annellidic
	11. <i>Acremonium</i>	enteroblastic phialidic
	12. <i>Chalara</i>	enteroblastic phialidic
	13. (<i>Chalaropsis</i>) ^b	enteroblastic phialidic
	14. (<i>Thielaviopsis</i>) ^b	enteroblastic phialidic
	15. <i>Phialocephala</i>	enteroblastic phialidic
	16. <i>Phialographium</i>	enteroblastic phialidic
<i>Ceratocystiopsis</i> ^a	<i>Sporothrix</i>	holoblastic sympodial
	<i>Hyalorhinocladiella</i>	holoblastic sympodial
	<i>Verticicladiella</i>	holoblastic sympodial

^a New generic names.

^b Nag Raj and Kendrick (1975) consider hyphomycete generic names obligately based on the presence of two different conidial forms to be undesirable, and relegate *Chalaropsis* and *Thielaviopsis* to synonymy with *Chalara*.

the synnematosus analogue of *Phialocephala*. If the presence or absence of pigment were also to be disregarded, the number would be reduced still further. In TABLE I, *Hyalopesotum* is the hyaline analogue of *Pesotum*, *Graphilbum* is the hyaline analogue of *Graphium*. But such characters as pigmentation and conidiophore aggregation are widely used to separate hyphomycete genera, and we consider that in this diversified and, as yet, poorly understood group of ascomycetes, analysis should precede synthesis.

NEW TAXA

Ceratocystiopsis Upadhyay & Kendrick, gen. nov.

FIGS. 3-4

Ophiostomataceae,² Microascales, Plectomycetes, Ascomycotina.

Perithecia sybhyalina vel brunnea vel nigra; bases globosae vel subglobosae, colla relative brevia, plerumque apicem versus angustata, hyphis ostiolaribus convergentibus vel divergentibus praedita; asci fusiformes vel clavati, evanescentes, octospori, hyalini; ascosporae hyalinae, aseptatae (raro 1-septatae), elongatae, falcatae, cum vagina gelatinosa. Status conidiales praediti cellulis conidiogenis sympodialiter proliferantibus; hyaloameroconidia holoblastica producentia.

² Although *Ophiostoma* is now a synonym of *Ceratocystis*, Art. 10 of the *International Code of Botanical Nomenclature* obviates any change in the family name.

Perithecia subhyaline to dark brown to black, bases globose to subglobose; necks relatively short, mostly tapered toward the apex, with conically arranged, or sometimes divergent, ostiolar hyphae; asci 8-spored, evanescent, fusiform or clavate, hyaline; ascospores hyaline, aseptate (sometimes 1-septate), elongate, falcate, always with a hyaline, gelatinous sheath. Conidial states with sympodially proliferating conidigenous cells, producing holoblastic hyaloameroconidia.

Species typica: **Ceratocystiopsis minuta** (Siemaszko) Upadhyay & Kendrick, comb. nov. \equiv *Ophiostoma minuta* Siem., *Planta Polonica* 7(3): 23, 1939.

Hyalorhinocладиella Upadhyay & Kendrick, gen. nov. FIGS. 1-2

Hyphomycetes, Fungi Imperfecti

Rhinocладиella similis, sed hyalina.

Rhinocладиella-like, but lacking pigmentation.

Species typica: **Hyalorhinocладиella minuta-bicolor** Upadhyay & Kendrick, sp. nov. [*Hyalorhinocладиella* state of **Ceratocystiopsis minuta-bicolor** (Davidson) Upadhyay & Kendrick, comb. nov. \equiv *Ceratocystis minuta-bicolor* Davids.]. A Latin description of the conidial state is given in *Mycopathol. Mycol. Appl.* 28: 280, 1966. Holotype: RWD 247, isol. from adult beetles (*Ips* sp.) from *Pinus ponderosa*, Roosevelt National Forest, W of Fort Collins, Colorado, U. S. A., 9.X.1962.

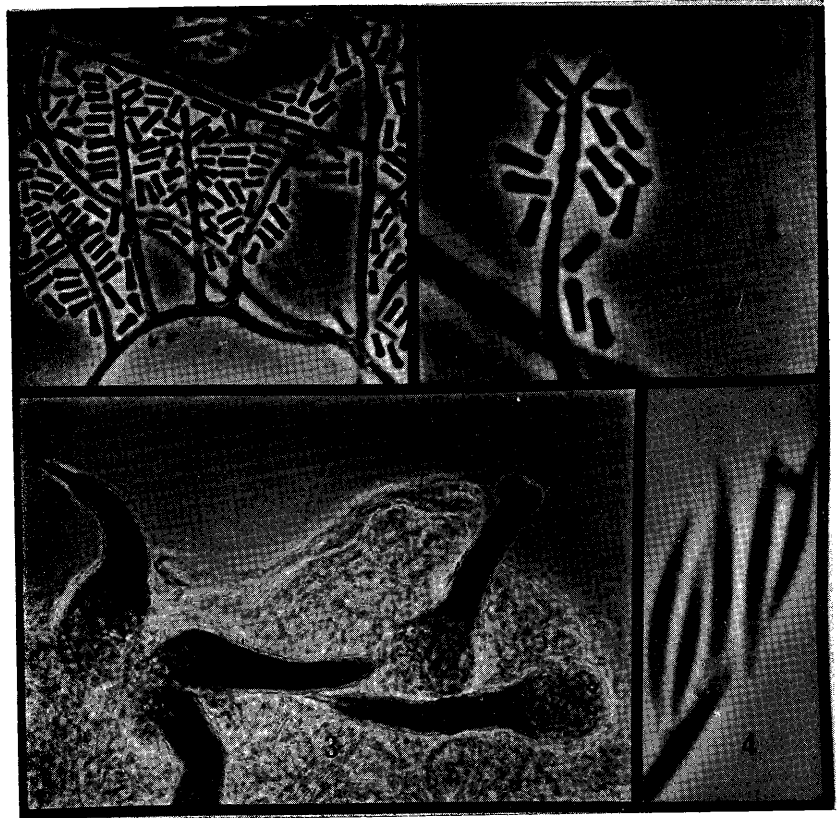
Graphilbum Upadhyay & Kendrick, gen. nov. FIGS. 5-7

Hyphomycetes, Fungi Imperfecti

Mycelium hyalinum; conidiophora synnemata; synnemata recta, cremea; cellulae conidiogenae percurrentes, annellidicae, penicillatae, cylindricae vel subulatae, hyalinae; hyaloameroconidia holoblastica, in muco stramineo aggregata.

Mycelium hyaline; conidiophores synnematus; synnemata erect, creamy white; constituent hyphae branched above 1-several times; conidigenous cells percurrent, annellidic, penicillately arranged, cylindrical or subulate, hyaline; hyaloameroconidia holoblastic, accumulating in a yellowish-white, slimy mass.

Species typica: **Graphilbum sparsum** Upadhyay & Kendrick, sp. nov. [*Graphilbum* state of *Ceratocystis sparsa* Davidson]. A Latin de-



FIGS. 1-4. *Ceratocystiopsis minuta-bicolor* and its *Hyalorhinocladiella* state.
 1. Hypha showing development of simple conidiophores, $\times 1,160$. 2. Portion of conidiophore showing sympodially produced conidia and conidial scars, $\times 2,320$.
 3. Perithecia, $\times 235$. 4. Ascospores surrounded by gelatinous sheath which is drawn out into a fine point at each end, $\times 2,320$.

scription of the conidial state is given in *Mycologia* 63: 14, 1971.
 Holotype: RWD 723-F, isol. from *Picea glauca*, nr. Fairbanks, Alaska, U. S. A., 1965.

Hyalopesotum Upadhyay & Kendrick, gen. nov.

FIGS. 8-10

Hyphomycetes, Fungi Imperfecti

Mycelium hyalinum; conidiophora synnemata; synnemata crenea, recta vel laxa; cellulae conidiogenae sympodialiter proliferantes et penicillatae, cylindricae vel subulatae, hyalinae; hyaloameroconidia holoblastica, solitaria deinde in muco stramineo aggregata.

Mycelium hyaline; conidiophores synnematosus; synnemata creamy white, erect to lax; constituent hyphae unbranched or branched 1–several times; conidiogenous cells sympodially proliferating, penicillately arranged, cylindrical or subulate, hyaline; hyaloameroconidia holoblastic, formed serially but accumulating in a yellowish-white slimy head.

Species typica: *Hyalopesotum introcitrina* Upadhyay & Kendrick, sp. nov. [*Hyalopesotum* state of *Ceratocystis introcitrina* Olchowecki & Reid]. A Latin description of the conidial state is given in *Canad. J. Bot.* 52: 1706, 1974. Holotype: WIN (M) 6947–2, isol. from *Betula papyrifera*, Sandilands Forest Reserve, Manitoba, Canada, 9.VI.1969.

Pachnodium Upadhyay & Kendrick, gen. nov.

FIGS. 11–18

Hyphomycetes, Fungi Imperfecti

Mycelium plerumque immersum, ex hyphis hyalinis vel olivaceo-brunneis, compositum; conidiophora synnemata; synnemata recta vel laxa, brunnea vel atrobrunnea vel nigra ad basim sed hyalinascentia et ferentia apparatus conidiogenum apicem versus; cellulae conidiogenae in conidiophoris incorporatae, terminales, hyalinae et penicillatae, cum vel sine tumoribus terminalibus vel intercalariibus; hyaloameroconidia holoblastica, solitaria vel catenata, spherica, ovoidea, limoniformia, ellipsoidia vel oblonga, in capitulis stramineis mucosis vel siccis aggregata.

Conidiophora mononematica hyalina, sympodialiter proliferantia, *Sporothrix* similia, etiam adsunt.

Mycelium mostly immersed, hyphae hyaline to olivaceous brown; conidiophores synnematosus; synnemata erect to lax, brown to dark brown or black at the base, but becoming hyaline and bearing a conidiogenous apparatus at the apex; conidiogenous cells integrated, terminal, hyaline, penicillately arranged, with or without terminal or intercalary swellings; hyaloameroconidia holoblastic, single or catenate, spherical to ovoid to limoniform to ellipsoidal, formed serially but accumulating in straw-colored slimy to dry heads.

In addition to the state just described, mononematous *Sporothrix*-like conidiophores are present, producing conidia singly or in chains on short denticles.

Species typica: *Pachnodium canum* Upadhyay & Kendrick.

Pachnodium canum Upadhyay & Kendrick, sp. nov.

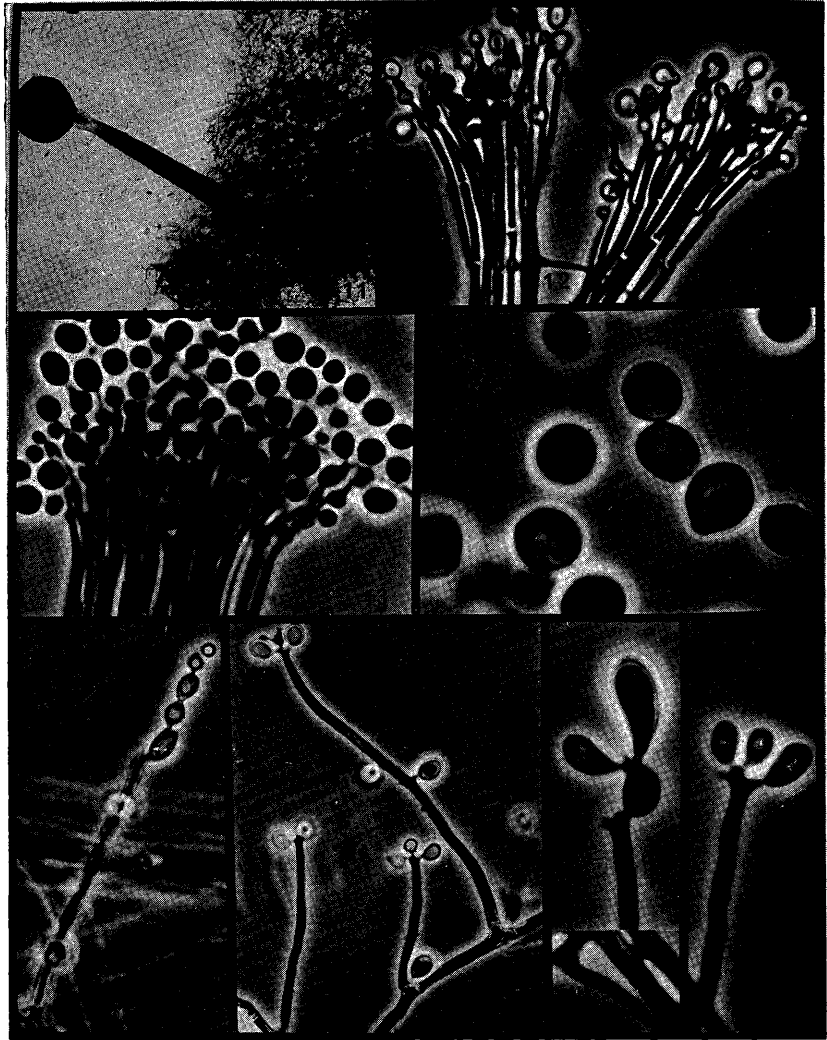
FIGS. 11–18

[*Pachnodium* state of *Ceratocystis cana* (Münch) C. Moreau].

Coloniae effusae in agar malt dictu 35 mm diam in aetate 12 dierum, 22 C, primum albae, deinde stramineae, brunneae vel atrobrunneae; synnemata 85–800 ×



FIGS. 5-7. *Graphilbum* state of *Ceratocystis sparsa*. 5. Synnemata, $\times 500$. 6-7. Conidiogenous cells and conidia, $\times 2,480$. FIGS. 8-10. *Hyalopesotum* state of *Ceratocystis introcitrina*. 8. Two synnemata, $\times 155$. 9. Conidiogenous apparatus at apex of synnema showing sympodial conidiogenous cells (arrow) with conidia, $\times 1,240$. 10. Conidia, $\times 2,480$.



FIGS. 11-18. *Pachnodium* state of *Ceratocystis cana*. 11. Synnema, $\times 75$. 12, 13. Conidiogenous apparatus showing conidiogenous cells with conidia, $\times 720$, $\times 925$ respectively. 14. Conidia derived from synnema, $\times 1,850$. 15-18. Mononematous conidiophores bearing conidia on short denticles. 15-16, $\times 925$; 17-18, $\times 1,850$.

9.5-25 μm , ad apicem expansa; hyphae constitutatae septatae, laeves, 1.5-3 μm diam; cellulae conidiogenae 9-28(-32) \times 1.5-3 μm ; conidia 2-8 μm diam.

Conidiophora mononematica, hyalina (*Sporothrix* similia), 30-115 μm long., 1.5-5 μm diam ad basim; dentes conidiogeni usque ad 2.5 μm long.; conidia 2-12 \times 1.5-6.5 μm .

Colonies on MEA at 22 C reaching 35 mm in diam in 12 da, effuse, forming a dense white mycelial mat at first, becoming straw colored, brown or dark brown; synnemata $85-800 \times 9.5-25 \mu\text{m}$, flaring at the tip; constituent hyphae septate, smooth, $1-3 \mu\text{m}$ thick; conidiogenous cells $9-28(-32) \times 1.5-3 \mu\text{m}$; conidia $2-8 \mu\text{m}$ in diam. (FIGS. 11-14).

Mononematous *Sporothrix-like* conidiophores hyaline, $30-115 \mu\text{m}$ long, $1.5-6.5 \mu\text{m}$ thick at the base; conidiogenous denticles up to $2.5 \mu\text{m}$ long; conidia $2-12 \times 1.5-6.5 \mu\text{m}$ (FIGS. 15-18).

Specimens examined: Strains NFRI ³—1652/2 and 6368/12, both isol. from *Pinus sylvestris* in Norway; AMK ⁴—B-1 and B-4, both isol. from *Pinus sylvestris* in Sweden; BPI-2107 (Holotype), BPI-2110, and FP (BPI) 14394: these three exsiccata originated with Münch who sent them to Hedgcock in 1909. They were subsequently deposited at BPI.

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