

# THE PERFECT STATES OF *ASPERGILLUS*\*

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**R**ECENT interest in conidium ontogeny as a criterion in the classification of Hyphomycetes has evoked justifiable interest in their perfect states as a means of obtaining correlations between these states and using such correlations, if any, as adjuncts to a sound classification of these fungi. Though it is unlikely that perfect state connections for all Hyphomycetes will be established, it seems plausible that perfect-imperfect state correlations can prove helpful in determining relationships or at least in refining the present unsatisfactory systems of classification of both perfect and imperfect states. There is no doubt that we need an integrated approach to the study of both imperfect and perfect states. As part of a programme of work on this problem, some genera of "phialidic" Hyphomycetes and their perfect states have been taken up for study. This paper deals with the perfect states of *Aspergillus* Mich. ex Fries.

So far as we know, the genus *Aspergillus* is characterized by conidia ("phialoconidia") that are produced in simple, basipetal, persistent chains<sup>1,2</sup> from conidiogenous cells ("phialides"). The conidia are synechidic, novitunicogenous, porrectic and dry<sup>3</sup>. That several *Aspergilli* produce perfect states is well known and, despite the arguments for separate generic designations for some of these perfect states<sup>4</sup>, opinion is divided on the question. Thom and Raper<sup>5</sup>, and Raper and Fennell<sup>6</sup>, who have made very valuable contributions to our knowledge of this group of fungi, retain the generic name *Aspergillus* for both perfect as well as imperfect states. Those who believe that separate designations are needed for the perfect state—and this will be in conformity with the International Code—will find that perfect states of some *Aspergilli* cannot be placed in the three genera (*Eurotium*, *Emericella*, *Sartorya*) recognized by Benjamin<sup>7</sup> or the recently described genus *Hemicarpenteles*<sup>7</sup>. Accordingly, some new genera are proposed here to accommodate these perfect states and this has necessitated new designations for several perfect states currently classified in *Aspergillus*. One cannot be certain if the various genera considered here to be perfect states of *Aspergillus* are closely related, but quite obviously some are not. Thorough developmental

studies of ascocarps of the different genera are needed and, in time, may strengthen the expectation that not all of them may be closely related, despite the fact that their conidial states are similar and appear to be congeneric.

The following Key to the perfect states of *Aspergillus* is intended to highlight the differences and similarities between them. The Key is followed by a listing of the species in each of these genera.

## KEY TO THE PERFECT STATES OF *Aspergillus*

- |   |                  |
|---|------------------|
| 1. Ascocarp none  | EDYUILLIA        |
| 1. Ascocarp present   | 2                |
| 2. Ascocarp developing within sclerotium or sclerotic tissue                      | 3                |
| 3. Ascocarp in the form of multiple "cleistothecia" in sclerotic tissue . . . . . | SYNCLEISTOSTROMA |
| 3. Ascocarp not so : single ascocarp developing within sclerotic body             | 4                |
| 4. Ascocarp wall thick and many-layered ; ascospores hyaline . . . . .            | HEMICARPENTELES  |
| 4. Ascocarp wall one-layered ; ascospores coloured . . . . .                      | SCLEROCLEISTA    |
| 2. Ascocarp not developing within sclerotium or sclerotic body                    | 5                |
| 5. Ascocarp without trace of definite wall ; ascospores not lenticular            | WARCUPIELLA      |
| 5. Ascocarp with definite wall ; ascospores lenticular                            | 6                |
| 6. Ascocarp surrounded by hülle cells . . . . .                                   | EMERICELLA       |
| 6. Ascocarp not surrounded by hülle cells   | 7                |

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7. Ascocarp wall composed of single layer of flattened cells . . . . . EUROTIUM
7. Ascocarp wall composed of layers of flattened hyphae . . . . . 8
8. Ascocarp wall without appendages . . . . . SARTORYA
8. Ascocarp wall with projecting sterile hyphae . . . . . CHAETOSARTORYA

## THE GENERA AND THE SPECIES

**EDYUILLIA** genus novum ascomycetarum

Ascocarpus verus nullus. Asci in nudis acervis, probabiliter crescentes in spira ascogoniali, hyphis adjacentibus indistinctis, globosis vel subglobosis, 8-sporati. Ascospores raro observatae extra ascos, lenticulare, leves, crassitunicatae. Status conidialis *Aspergillus*.

True ascocarps none. Asci in naked clusters, presumably developing in ascogonial coil, adjacent hyphae remaining undifferentiated, globose to subglobose, 8-spored. Ascospores rarely observed outside asci, lenticular, smooth, thick-walled. Conidial state *Aspergillus*.

Type species :

*Edyuillia athecia* (Raper and Fennell) comb. nov.

= *Aspergillus athecicus* Raper and Fennell, 1965 ; *The genus Aspergillus*, pp. 183-184, Fig. 43.

Type : culture isolated from coffee beans by Edward Yuill (IMI 32048).

The generic name is in honour of Ed(ward) Yuill who isolated the culture on which the description of the type species is based and who has made notable contributions to our knowledge of the *Aspergilli*.

The ascospores in the species show only a trace of an equatorial furrow, and no crests.

**SYNCLEISTOSTROMA** genus novum ascomycetarum.

Ascocarpus forma "cleistotheciae" multiplicis crescens intra massam persistentem texturae scleroticae. Corpus scleroticum primo album denique nigrescens, compositum ex textura sclerenchymatosa crassitunicata. Cleistothecia singularia cum peridio unius strati cellularum irregularium applanatarum, plus minusve globosa, lente maturescentia, tandem liberantia ascosporas intra cavitatem corporis sclerotici per fractionem peridii ; collective, cleistothecia complentia corpus scleroticum excepto duro septo exteriori. Asci ovales vel globosi, 8-sporati,

evanescentes post maturationem sporarum. Ascospores hyalinae, ellipticae, tenuitunicatae, leves, sine evidetia sulci equatorialis tempore maturitatis. Ascospores germinatio simplex, non valvata. Status conidialis *Aspergillus*.

Ascocarp in the form of multiple "cleistothecia" developing within a persistent mass of sclerotic tissue. Sclerotic body at first white, finally becoming black, composed of thick-walled sclerenchymatous tissue. Individual "cleistothecia" with a peridium of a single layer of irregular, flattened cells, globose or nearly so, maturing slowly, ultimately freeing ascospores within the cavity of the sclerotic body by rupture of the peridium : collectively, "cleistothecia" filling the sclerotic body except for a tough outer wall. Asci oval to globose, 8-spored, evanescent after maturation of spores. Ascospores uncoloured, elliptical, thin-walled, smooth, with little evidence of an equatorial furrow at maturity. Ascospore germination simple, not valvular. Conidial state *Aspergillus*.

Type species :

*Syncleistostroma alliacea* (Thom and Church em. Fennell and Warcup) comb. nov.

= *Aspergillus alliaceus* Thom and Church em. Fennell and Warcup, 1959, *Mycologia* 51 : 411-413, Figs. 1-2 ; Thom and Church, 1926, *The Aspergilli*, p. 163. see also Raper and Fennell<sup>6</sup> (pp. 273-77, Figs. 62, 63).

Type : culture isolated from a dead blister beetle (*Macrobasis albida*) at the Pharmacognosy Laboratory of the Bureau of Chemistry, Washington, D.C. Thom 4656 (QM 1885).

Conidial state : *Aspergillus alliaceus* Thom and Church.

The generic name is derived from Gr. *syn* = with + *cleistos* = closed + *stroma*, and is suggestive of a stroma with several "cleistothecia".

HEMICARPENTELES Sarbhoy and Elphick. 1968, *Trans. Br. mycol. Soc.*, 51 : 156.

Type species :

*Hemicarpenteles paradoxus* Sarbhoy and Elphick. 1968, *Trans. Br. mycol. Soc.* 51 : 156-57, Plate 10, Figs. 1-6. Conidial state : *Aspergillus paradoxus* Fennell and Raper.

Other species :

*Hemicarpenteles acanthosporus* Udagawa and Takada, 1971, *Bull. natn. Sci. Mus., Tokyo* 14 : 503-506, Fig. 59. Conidial state : *Aspergillus acanthosporus* Udagawa and Takada.

**SCLEROCLEISTA** genus novum ascomycetarum.

Ascocarpus globosus vel subglobosus, primo omnino parenchymatus, dein ut paulatim planus ascis et ascosporis in maturitate; peridium compositum ex cellulis polyhedricis irregularibus, involutum tegumento hypharum sterilium. Ascus plus minusve globosus, 8-sporatus. Ascosporae lenticulares, incolores vel postea brunneolae, leves vel asperae, crinitae. Status conidialis *Aspergillus*.

Ascocarp globose to subglobose, at first parenchymatous throughout, becoming filled with asci and ascospores at maturity; peridium composed of irregular polyhedral cells, enveloped by a mantle of sterile hyphae. Ascus globose or nearly so, 8-spored. Ascospores lenticular, colourless or later assuming brown shades, smooth or rough, crested. Conidial state *Aspergillus*.

Type species:

*Sclerocleista ornata* (Raper, Fennell and Tresner) comb. nov.

= *Aspergillus ornatus* Raper, Fennell and Tresner, 1953, *Mycologia* 45: 678-682, Figs. 3, 4.

Type: isolated from soil in an oak wood, west of Madison, Wisconsin, U.S.A. (WB 2256).

Conidial state: *Aspergillus ornatus* Raper, Fennell and Tresner.

The generic name is from Gr. *skleros* = hard + *cleistos* = closed, and is suggestive of a cleistothecium developing within a sclerotium or sclerotic tissue.

Other species:

*Sclerocleista thaxteri* sp. nov.

Ascocarpus plus minusve globosus, variabilis magnitudinis, generatim 300-500  $\mu$  diametri, purpurascens, ascis et ascosporis plenus in maturitate. Peridium relative tenue in maturitate, compositum cellulis polyhedricis 10-12  $\mu$  diametri, cum vel sine involucri reticulato hypharum ramosarum, crassarum. Ascus plus minusve globosus, circiter 12  $\mu$  diametri. Ascosporae lenticulares, tenuitunicatae, 7.5-8.5  $\times$  5.0-6.0  $\mu$ , unaquaeque cum una fascia equatoriali. Status conidialis: *Aspergillus citrisporus* v. Hoehnel.

Typus: in stercore, "Kittery Point", leg. R. Thaxter ex Farlow Herbarium, Harvard University.

Ascocarp globose or nearly so, variable in size, mostly 300-500  $\mu$  in diam., purplish, filled with asci and ascospores at maturity. Peridium relatively thin at maturity, composed of polyhedral cells 10-12  $\mu$  in diam., with or without enveloping network of much-branched, coarse hyphae. Ascus globose or nearly so, about 12  $\mu$  in diam. Ascospores

lenticular, smooth-walled, 7.5-8.5  $\times$  5.0-6.0  $\mu$ , each with a single (?) broad equatorial band (based on Raper, Fennell and Tresner). Conidial state: *Aspergillus citrisporus* v. Hoehnel.

Type: on caterpillar dung, "Kittery Point", coll. R. Thaxter ex Farlow Herbarium, Harvard University.

Raper *et al.*<sup>8</sup> made a critical study of Thaxter's material (here cited as the TYPE) and a culture with the number NRRL 2292 which, according to them, must have stemmed from this material or from an earlier collection of the same fungus, viz., labelled "Chocorua, N. H., August, 1909". According to Thom and Church (*see* Raper *et al.*<sup>8</sup>, p. 672), Thaxter's fungus is identical with *Aspergillus citrisporus* v. Hoehnel<sup>9</sup> (p. 1036) described on dung of larvae from Austria. This opinion, coupled with the general thesis that the generic name *Aspergillus* could be retained for the perfect state also, explains the acceptance of the binomial *Aspergillus citrisporus* v. Hoehnel [cited as "*Aspergillus citrisporus* (v. Hoehnel) Raper, Fennell and Tresner" in Raper and Fennell<sup>6</sup>, p. 201] for this fungus. However, v. Hoehnel's description relates only to the imperfect (*Aspergillus*) state and since the description of the perfect state is based on Thaxter's material, it is best to give a new name to this perfect state and cite *Aspergillus citrisporus* v. Hoehnel as its conidial state.

In both species of *Sclerocleista* the young ascocarps are white but become purple at maturity.

**WARCUPIELLA** genus novum ascomycetarum.

Ascocarpus sine illo vestigio septi definiti, globosus, compositus ex hyphis laxo intertextis, circumtextus trama hypharum. Ascus ovoidi vel elongati, 8-sporati. Ascosporae hyalinae, ellipticae, crassitunicatae, simplices sine costa equatoriali vel lirella. Status conidialis *Aspergillus*.

Ascocarp without trace of a definite wall, globose, composed of loosely interwoven hyphae, surrounded by a web of hyphae. Ascus ovoid to elongate, 8-spored. Ascospores hyaline, elliptical, thick walled, simple without equatorial ridges or furrow. Conidial state *Aspergillus*.

Type species:

*Warcupiella spinulosa* (Warcup) comb. nov.

= *Aspergillus spinulosus* Warcup in Raper and Fennell, 1965, *The genus Aspergillus*, pp. 204-206, Fig. 46,

Type: culture isolated from a sample of jungle soil. Berakas-Muara, Brunei, Borneo, October 1957, J. H. Warcup (A 41/4).

Conidial state: *Aspergillus spinulosus* Warcup.

The generic name is in honour of J. H. Warcup who isolated the culture on which the description of the type species is based and whose contributions to our knowledge of soil fungi are well known.

EMERICELLA Berk. and Br., in Berk., 1857, *Introduction to Cryptogamic Botany*, p. 340.

Type species:

*E. varicolor* Berk. and Br., in Berk., 1857, *Ibid.*, p. 340.

The species:

1. *Emericella aurantiobrunnea* (Atkins, Hindson and Russell) Malloch and Cain, 1972, *Can. J. Bot.* 50: 61.

= *Emericella nidulans* (Eidam) Vuill. v. *aurantiobrunnea* Atkins, Hindson and Russell, 1958, *Trans. Br. mycol. Soc.* 41: 501-504.

Conidial state: *Aspergillus aurantiobrunneus* (Atkins, Hindson and Russell) Raper and Fennell.

2. *Emericella cleistominuta* Mehrotra and Prasad, 1969, *Trans. Br. mycol. Soc.* 52: 333, Fig. 2.

Conidial state: *Aspergillus*.

3. *Emericella fruticulosa* (Raper and Fennell) Malloch and Cain, 1972, *Can. J. Bot.* 50: 61.

= *Aspergillus fruticulosus* Raper and Fennell, 1965, *The Genus Aspergillus*, pp. 506-509, Fig. 110.

Conidial state: *Aspergillus fruticulosus* Raper and Fennell.

4. *Emericella heterothallica* (Kwon, Fennell and Raper) Malloch and Cain, 1972, *Can. J. Bot.* 50: 62.

= *Aspergillus heterothallicus* Kwon, Fennell and Raper, in Raper and Fennell, 1965, *The Genus Aspergillus*, pp. 502-506, Fig. 108.

Conidial state: *Aspergillus heterothallicus* Kwon, Fennell and Raper.

5. *Emericella nidulans* (Eidam) Vuill., 1927, *C.R. Acad. Sci. Paris* 184: 137.

= *Sterigmatocystis nidulans* Eidam in Cohn, 1883, *Beitr. Biol. Pflanz.* 3: 392-411, Pls. 20-22,

Conidial state: *Aspergillus nidulans* (Eidam) Wint.

6. *Emericella nidulans* (Eidam) Vuill. v. *acristata* (Fennell and Raper) comb. nov.

= *Aspergillus nidulans* (Eidam) Wint. v. *acristatus* Fennell and Raper, 1955, *Mycologia* 47: 79, Fig. 4 B.

Conidial state: *Aspergillus nidulans* (Eidam) Wint. v. *acristatus* Fennell and Raper.

7. *Emericella nidulans* (Eidam) Vuill. v. *dentata* (Sandhu and Sandhu) comb. nov.

= *Aspergillus nidulans* (Eidam) Wint. v. *dentatus* Sandhu and Sandhu, 1963, *Mycologia* 55: 297-299, Figs. 1-3.

Conidial state: *Aspergillus nidulans* (Eidam) Wint. v. *dentatus* Sandhu and Sandhu.

8. *Emericella nidulans* (Eidam) Vuill. v. *echinulata* (Fennell and Raper) comb. nov.

= *Aspergillus nidulans* (Eidam) Wint. v. *echinulatus* Fennell and Raper, 1955, *Mycologia* 47: 79-80, Fig. 4 C.

Conidial state: *Aspergillus nidulans* (Eidam) Wint. v. *echinulatus* Fennell and Raper.

9. *Emericella nidulans* (Eidam) Vuill. v. *lata* (Thom and Raper) comb. nov.

= *Aspergillus nidulans* (Eidam) Wint. v. *latus* Thom and Raper, 1939, *Mycologia* 31: 657.

Conidial state: *Aspergillus nidulans* (Eidam) Wint. v. *latus* Thom and Raper.

10. *Emericella parvathecica* (Raper and Fennell) Malloch and Cain, 1972, *Can. J. Bot.* 50: 62.

= *Aspergillus parvathecicus* Raper and Fennell, 1965, *The Genus Aspergillus*, pp. 509-511, Fig. 111.

Conidial state: *Aspergillus parvathecicus* Raper and Fennell.

11. *Emericella quadrilineata* (Thom and Raper) Benjamin, 1955, *Mycologia* 47: 680.

= *Aspergillus quadrilineatus* Thom and Raper, 1939, *Mycologia* 31: 660.

Conidial state: *Aspergillus quadrilineatus* Thom and Raper.

12. *Emericella rugulosa* (Thom and Raper) Benjamin, 1955, *Mycologia* 47: 680-681.

= *Aspergillus rugulosus* Thom and Raper, 1939, *Mycologia* 31: 660-663, Fig. 4.

Conidial state: *Aspergillus rugulosus* Thom and Raper,

13. *Emericella striata* (Rai, Tewari and Mukerji) Malloch and Cain, 1972, *Can. J. Bot.* 50 : 62.  
= *Aspergillus striatus* Rai, Tewari and Mukerji, 1964, *Can. J. Bot.* 42 : 1521-1524, Figs. 1, 2.  
Conidial state : *Aspergillus striatus* Rai, Tewari and Mukerji.
14. *Emericella unguis* Malloch and Cain, 1972, *Can. J. Bot.* 50 : 62.  
= *Aspergillus unguis* (Emile-Weil and Gaudin) Thom and Raper em. Fennell and Raper, 1955, *Mycologia* 47 : 78-79, Fig. 4 A.  
= *Sterigmatocystis unguis* Emile-Weil and Gaudin, 1919, *Arch. med. exptl. anal. pathol. Paris* 28 : 463-465, Fig. 4.  
Conidial state : *Aspergillus unguis* (Emile-Weil and Gaudin) Thom and Raper.
15. *Emericella varicolor* Berk. and Br. in Berk., 1857, *Introduction to Cryptogamic Botany*, p. 340, Fig. 76.  
Conidial state : *Aspergillus stellatus* Curzi.
16. *Emericella varicolor* Berk. and Br. v. *astellata* (Fennell and Raper) Benjamin, 1955, *Mycologia* 47 : 679.  
= *Aspergillus varicolor* (Berk. and Br.) Thom and Raper v. *astellatus* Fennell and Raper, 1955, *Mycologia* 47 : 81-82, Fig. 5.  
Conidial state : *Aspergillus stellatus* Curzi v. *astellatus* (Fennell and Raper) comb. nov. [= *Aspergillus varicolor* (Berk. and Br.) Thom and Raper v. *astellatus* Fennell and Raper, 1955, *Mycologia* 47 : 81-82]
17. *Emericella violacea* (Fennell and Raper) Malloch and Cain, 1972, *Can. J. Bot.* 50 : 62.  
= *Aspergillus violaceus* Fennell and Raper, 1955, *Mycologia* 47 : 75-78, Fig. 3.  
Conidial state : *Aspergillus violaceus* Fennell and Raper.
- EUROTIIUM Link ex Fries, 1829, *Syst. Mycol.* 3 : 331.  
Type species : *E. herbariorum* [Pers.] Link ex Fries, 1829, *Syst. Mycol.* 3 : 332.  
The species :
1. *Eurotium amstelodami* Mangin, 1909, *Ann. Sci. Nat. Bot. Ser.* 9, 10 : 360-361.  
Conidial state : *Aspergillus amstelodami* (Mangin) Thom and Church.
2. *Eurotium carnoyi* Malloch and Cain, 1972, *Can. J. Bot.* 50 : 63.  
= *Eurotium carnoyi* (Biourge ex Thom and Raper) Benjamin, 1955, *Mycologia* 47 : 675 [as *Eurotium carnoyi* (Thom and Raper) comb. nov.].  
= *Aspergillus carnoyi* Biourge ex Thom and Raper, 1941, *Misc. Publ. U.S. Dept. Agric.* 426 : 34.  
Conidial state : *Aspergillus carnoyi* Biourge ex Thom and Raper.
3. *Eurotium chevalieri* Mangin, 1909, *Ann. Sci. Nat. Bot. Ser.* 9, 10 : 361-362, Fig. 12.  
Conidial state : *Aspergillus chevalieri* (Mangin) Thom and Church.
4. *Eurotium chevalieri* Mangin v. *intermedium* (Thom and Raper) Malloch and Cain, 1972, *Can. J. Bot.* 50 : 64.  
= *Aspergillus chevalieri* (Mangin) Thom and Church v. *intermedius* Thom and Raper, 1941, *U.S. Dept. Agric. Misc. Publ.*, 426 : 21, Figs. 8 D, 9 B.  
Conidial state : *Aspergillus chevalieri* (Mangin) Thom and Church v. *intermedius* Thom and Raper.
5. *Eurotium cristatum* (Raper and Fennell) Malloch and Cain, 1972, *Can. J. Bot.* 50 : 64.  
= *Aspergillus cristatus* Raper and Fennell, 1965, *The Genus Aspergillus*, pp. 169-70, Fig. 39.  
Conidial state : *Aspergillus cristatus* Raper and Fennell.
6. *Eurotium echinulatum* Delacr., 1893, *Bull. Soc. Mycol. Fr.* 9 : 266, Pl. XIV, Fig. 3.  
Conidial state : *Aspergillus echinulatus* (Delacr.) Thom and Church.
7. *Eurotium halophilicum* Christensen, Papavizas and Benjamin, 1959, *Mycologia* 51 : 636-638, Figs. 2-6.  
Conidial state : *Aspergillus halophilicus* Christensen, Papavizas and Benjamin.
8. *Eurotium herbariorum* [Pers.] Link ex Fries, 1829, *Syst. Mycol.* 3 : 332.  
Conidial state : *Aspergillus*.
9. *Eurotium heterocaryoticum* Christensen, Lopez and Benjamin, 1965, *Mycologia* 57 : 535-536, Figs. 1-2.  
Conidial state : *Aspergillus heterocaryoticus* Christensen, Lopez and Benjamin.
10. *Eurotium leucocarpum* Hadlok and Stolk, 1969, *Antonie van Leeuwenhoek* 35 : 9.  
Conidial state : *Aspergillus leucocarpus* Hadlok and Stolk.

11. *Eurotium minor* (Mangin) comb. nov.  
= *Eurotium herbariorum* [Pers.] Link ex  
Fries ser. *minor* Mangin, 1909, *Ann. Sci.  
Nat. Bot. Ser.*, 9, 10 : 365.  
Conidial state : *Aspergillus mangini* Thom  
and Raper [non *Aspergillus minor* Bainier,  
1880].
12. *Eurotium medius* Meiss., 1897, *Bot. Zeit.*, 55 :  
536.  
Conidial state : *Aspergillus medius* Meiss.
13. *Eurotium montevidense* (Talice and Mackin-  
non) Malloch and Cain, 1972, *Can.  
J. Bot.* 50 : 64.  
= *Aspergillus montevidensis* Talice and  
Mackinnon, 1931, *C.R. Soc. Biol.*  
108 : 1007-1009.  
Conidial state : *Aspergillus montevidensis*  
Talice and Mackinnon.
14. *Eurotium niveo-glaucum* (Thom and Raper)  
Malloch and Cain, 1972, *Can. J. Bot.*  
50 : 64.  
= *Aspergillus niveo-glaucus* Thom and  
Raper, 1941, *U.S. Dept. Agric. Misc.  
Publ.* 426 : 35.  
Conidial state : *Aspergillus niveo-glaucus*  
Thom and Raper.
15. *Eurotium pseudoglaucum* (Blochwitz) Malloch  
and Cain, 1972, *Can. J. Bot.* 50 : 64.  
= *Aspergillus pseudoglaucus* Blochwitz,  
1929, *Ann. Mycol. Berl.* 27 : 207.  
Conidial state : *Aspergillus pseudoglaucus*  
Blochwitz.
16. *Eurotium repens* de Bary in de Bary and  
Woronin, 1870, *Beitr. Morph. u. Phys.  
Pilze* 3 ; 1, Figs. 2, 9.  
Conidial state : *Aspergillus repens* (Corda)  
de Bary.
17. *Eurotium rubrum* König, Spieckerman and  
Bremer, 1901, *Z. Untersuch. Nahr. u.  
Genussm.*, 4 : 726.  
Conidial state : *Aspergillus ruber* (König,  
Spieckerman and Bremer) Thom and Church.
18. *Eurotium tonophilum* Ohtsuki, 1962, *Bot.  
Mag. Tokyo* 75 : 438-440, Fig. 2.  
Conidial state : *Aspergillus tonophilus*  
Ohtsuki.
19. *Eurotium umbrosum* (Bainier and Sartory)  
Malloch and Cain, 1972, *Can. J. Bot.*  
50 : 64.  
= *Aspergillus umbrosus* Bainier and  
Sartory, 1912, *Bull. Soc. mycol. Fr.*  
28 : 267-269, Pl. XII.  
Conidial state : *Aspergillus umbrosus* Bainier  
and Sartory.
- SARTORYA Vuill., 1927, *C.R. Acad. Sci. Paris*  
184 : 136.
- Type species :
- Sartorya fumigata* Vuill., 1927, *C.R. Acad. Sci.  
Paris* 184 : 136.
- The species :
1. *Sartorya aurata* (Warcup) comb. nov.  
= *Aspergillus auratus* Warcup in Raper  
and Fennell, 1965, *The Genus Aspergillus*,  
pp. 263-264, Fig. 61, E-H.  
Conidial state : *Aspergillus auratus* Warcup.
  2. *Sartorya aureola* (Fennell and Raper) comb.  
nov.  
= *Aspergillus aureolus* Fennell and Raper,  
1955, *Mycologia* 47 : 71-75, Fig. 2.  
Conidial state : *Aspergillus aureolus* Fennell  
and Raper.
  3. *Sartorya fumigata* Vuill., 1927, *C.R. Acad.  
Sci. Paris* 184 : 136.  
Conidial state : *Aspergillus fischeri* Wehmer.
  4. *Sartorya fumigata* Vuill. v. *glabra* (Fennell  
and Raper) Udagawa and Kawasaki, 1968,  
*Trans. mycol. Soc. Japan* 8 : 115.  
= *Aspergillus fischeri* Wehmer v. *glaber*  
Fennell and Raper, 1955, *Mycologia*  
47 : 75.  
Conidial state : *Aspergillus fischeri* Wehmer  
v. *glaber* Fennell and Raper.
  5. *Sartorya fumigata* Vuill. v. *spinosa* (Raper  
and Fennell) Udagawa and Kawasaki,  
1968, *Trans. mycol. Soc. Japan* 8 : 117.  
= *Aspergillus fischeri* Wehmer v. *spinosus*  
Raper and Fennell, 1965, *The Genus  
Aspergillus*, pp. 256-257, Fig. 59 B.  
Conidial state : *Aspergillus fischeri* Wehmer  
v. *spinosus* Raper and Fennell.
  6. *Sartorya fumigata* Vuill. v. *verrucosa* Uda-  
gawa and Kawasaki, 1968, *Trans. mycol.  
Soc. Japan* 8 : 118.  
Conidial state : *Aspergillus fischeri* Wehmer  
v. *verrucosus* Udagawa and Kawasaki.
  7. *Sartorya quadricincta* (Yuill) Udagawa and  
Kawasaki, 1968, *Trans. mycol. Soc. Japan*,  
8 : 119.  
= *Aspergillus quadricinctus* Yuill, 1953,  
*Trans. Br. mycol. Soc.* 36 : 58-59,  
Figs. 1-3, Pl. III.  
Conidial state : *Aspergillus quadricinctus*  
Yuill.

8. *Sartorya stramenia* (Novak and Raper)  
comb. nov.

= *Aspergillus stramenius* Novak and Raper, in Raper and Fennell, 1965, *The Genus Aspergillus*, pp. 260-263, Fig. 61, A-D.

Conidial state: *Aspergillus stramenius* Novak and Raper.

**CHAETOSARTORYA** genus novum ascomycetarium

Ascocarpi globosi vel subglobosi, protecti in hyphis laxe reticulatis. Peridium compositum ex uno strato cellularum irregulariter applanatum et habens hyphas steriles protrudentes. Asci globosi vel subglobosi, 8-sporati. Ascosporae lenticulares, fere sine colore, rugulosae et/vel crinitae. Status conidialis *Aspergillus*.

Ascocarps globose to subglobose, produced in a loose network of hyphae. Peridium composed of one layer of irregularly flattened cells and provided with projecting sterile hyphae. Asci globose to subglobose, 8-spored. Ascospores lenticular, colourless or nearly so, crested or furrowed or both.

Conidial state: *Aspergillus*.

Type species:

*Chaetosartorya chrysella* (Kwon and Fennell)  
comb. nov.

= *Aspergillus chrysellus* Kwon and Fennell in Raper and Fennell, 1965, *The Genus Aspergillus*, pp. 424-425, Fig. 87.

Type: isolated from forest soil, Province of Puntarenas, Costa Rica, WB 5084.

Conidial state: *Aspergillus chrysellus* Kwon and Fennell.

The generic name is from Gr, *chaite* = hair + *Sartorya*, and is suggestive of the appendaged ascocarps which are otherwise similar to those of *Sartorya*.

Other species:

*Chaetosartorya cremea* (Kwon and Fennell)  
comb. nov.

= *Aspergillus cremeus* Kwon and Fennell in Raper and Fennell, 1965, *The Genus Aspergillus*, pp. 418-420, Fig. 85.

Conidial state: *Aspergillus cremeus* Kwon and Fennell.

The designations of the conidial states for each of the species of the genera listed above have been indicated. The relationship of the various genera

to the various "groups" of *Aspergilli* recognized by Raper and Fennell<sup>6</sup> is given below:

EUROTIIUM	}	<i>A. glaucus</i> group
EDYUILLIA		
SCLEROCLEISTA	}	<i>A. ornatus</i> group
HEMICARPENTELES		
WARCUPIELLA		
SARTORYA		<i>A. fumigatus</i> group
SYNCLEISTOSTROMA		<i>A. ochraceus</i> group
CHAETOSARTORYA		<i>A. cremeus</i> group
EMERICELLA		<i>A. nidulans</i> group

It is interesting to note that no one genus is associated with conidial states belonging to more than one "group" among the *Aspergilli* recognized by Raper and Fennell<sup>6</sup>. This can be construed as strengthening the concept and nomenclature of the perfect states that is the keynote of this contribution. However, the fact that species representative of the *A. glaucus* group have perfect states in two apparently unrelated genera (*Eurotium*, *Edyuillia*), and that those of the *A. ornatus* group have perfect states in three genera (*Sclerocleista*, *Hemicarpenteles* and *Warcupiella* of which the last is apparently not related to the former two), only proves that the classification of a form genus into groups, though extremely useful and suggestive of relationships sometimes, may not always be so. I hope this paper will stimulate further work on the developmental morphology and taxonomy of these fungi and lead to further modification or amplification of the ideas set forth here.

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