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DISPOSITION OF RECENTLY DESCRIBED SPECIES OF PENICILLIUM

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Hundred and twenty-two species, varieties, and new combinations of *Penicillium*, *Eupenicillium*, and *Talaromyces* described since 1977 have been studied taxonomically and screened for mycotoxin production. Only 48 taxa could be accepted: *Eupenicillium angustiporcatum*, *E. cryptum*, *E. lineolatum*, *E. limoneum*, *E. nepalense*, *E. sinaicum*, *Penicillium aethiopicum*, *P. coalescens*, *P. confertum*, *P. coprobium*, *P. coprophilum*, *P. dendriticum*, *P. eberhardtii*, *P. erythromellis*, *P. flavidostipitatum*, *P. heteromorphum*, *P. hispanicum*, *P. juguslavicum*, *P. lapatayae*, *P. loliense*, *P. maclennaniae*, *P. macrosporum*, *P. mariaecrucis*, *P. mononematosum*, *P. nodulum*, *P. oblatum*, *P. onobense*, *P. palmae*, *P. palmense*, *P. panamense*, *P. patens*, *P. pittii*, *P. primulinum*, *P. rubefaciens*, P. sabulosum, P. shennongjianum, P. siamense, P. smithii, P. vasconiae, *P. vonarxii*, *P. vulpinum*, *Talaromyces assiutensis*, *T. derxii*, *T. macrosporus*, and *T. mimosinus*. Eleven varieties are recognized in *P. aurantiogriseum*, *P. chrysogenum*, *P. glandicola*, *P. griseofulvum* and *P. hirsutum*. *Paecilomyces pascuus* Pitt & Hocking and *Geosmithia viridis* Pitt & Hocking are transferred to *Penicillium*.

Since 1977 122 new names have been described in *Penicillium*, *Talaromyces* and *Eupenicillium*, which were not included in the monograph of Pitt (1980). Morphological and chemical studies of the type strains in our laboratories showed that some of the recently described species are not new to science. In this paper we report the results of our studies based on morphology and production of known mycotoxins and other secondary metabolites.

MATERIALS AND METHODS

Type and additional cultures of the recently described species of *Penicillium* and associated teleomorphs were obtained from the CAB International Mycological Institute, Kew, England and from J.A. Quintanilla, Compania de Industrias Agricolas, Valladolid, Spain, C. Ramírez, Instituto Jaime Ferrán de Microbiologia, Madrid, Spain, J.I. Pitt, CSIRO Division of Food Research, Sydney, Australia, and Qi Zu-tong, Institute of Microbiology, Academia Sinica, Beijing, China.

The cultures were grown on CYA (Czapek-yeast autolysate agar), MEA (malt extract agar), YES (yeast extract-sucrose agar) (Frisvad & Filtenborg, 1983), oatmeal agar (Samson & Pitt, 1985), creatine-sucrose agar (Frisvad, 1985b) at 25°C and on CYA at 37°C (Samson & Pitt, 1985). The cultures were screened for mycotoxin production by a simple thin layer chromatography method (Frisvad & Filtenborg, 1983) and in some cases by HPLC (Frisvad, 1987).

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RESULTS AND DISCUSSION

The isolates examined are listed in Table I. The status of the validly published taxa is summarized in alphabetic order in Table II. Several new names which were proposed by Pitt (1980) for known anamorphs of *Eupenicillium* and *Talaromyces*, to comply with Art. 59 of the International Botanical Code of Nomenclature are not included in this list. A list of nomina nuda in *Penicillium* and the correct identity of isolates deposited in major culture collections is given in Table III. The results of a TLC screening for mycotoxins and secondary metabolites are also listed in Tables II and III. Accepted taxa are indicated in the following text with an asterisk (*).

GENUS EUPENICILLIUM

Eupenicillium angustiporcatum Takada & Udagawa *in* Trans. mycol. Soc. Japan 24: 143. 1983.

The ex-type culture produces only a few reduced conidiophores and, in spite of many attempts, no teleomorph could be observed in culture. According to Takada & Udagawa's description, the ascospores are ornamented with two prominent well-separated equatorial ridges and the valves show several low ribs. The species is probably related to *E. lineolatum*.

Eupenicillium cryptum Gochenaur *in* Mycotaxon 26: 349. 1986.

According to the description, *E. cryptum* is probably close to *E. javanicum*. It differs morphologically in producing ascospores with prominent equitorial ridges. The type strain shows an unstable colonial morphology and a restricted carbon nutrition. It does not produce the teleomorph any more.

Eupenicillium limoneum Gochenaur & Zlattner apud Stolk & Samson *in* Stud. Mycol. 23: 100. 1983.

The description of this species was included by Stolk & Samson (1983).

Eupenicillium lineolatum Udagawa & Horie *in* Mycotaxon 5: 493. 1977.

Eupenicillium lineolatum was reduced to a variety of *E. javanicum* by Stolk & Samson (1983), but we now regard the taxon as a distinct species (Frisvad & al., 1990a).

Eupenicillium nepalense Takada & Udagawa *in* Trans. mycol. Soc. Japan 24: 146. 1983.

Eupenicillium nepalense is very close to *E. inusitanum* Scott but the penicilli of the latter species are biverticillate rather than monoverticillate and the ascospores of *E. nepalense* are smaller than those of *E. inusitanum* and *E. fractum*. The three taxa may be conspecific, and a detailed chemical study has still to be done.

Eupenicillium sinaicum Udagawa & Ueda *in* Mycotaxon 14: 266. 1982.

This species was discussed and accepted by Stolk & Samson (1983).

GENUS PENICILLIUM

Penicillium subgenus Aspergilloides

Penicillium alicantinum Ramírez & Martínez *in* Mycopathologia 72: 185. 1980.

Penicillium alicantinum is a synonym of *P. citreonigrum*, and this is further confirmed by the production of citreoviridin by all isolates of both taxa. Sclerotia were observed in the ex-type culture of *P. alicantinum* but also observed by Wicklow (1984) in an atypically vesiculate strain of *P. citreonigrum* producing citreoviridin.

Penicillium brevissimum Rai & Wadhwani *in* Curr. Sci. 45: 192. 1976.

The ex-type culture of *P. brevissimum* only produces few cylindrical conidia, but fits *P. capsulatum* Raper & Fennell and is therefore considered a synonym of this taxon.

Penicillium gallaicum Ramírez & al. *in* Mycopathologia 72: 30. 1980.

Like *P. alicantinum*, *P. gallaicum* is considered to be a synonym of *P. citreonigrum*. The type culture of *P. gallaicum* produces citreoviridin and forms sclerotia.

Penicillium gerundense Ramírez & Martínez *in* Mycopathologia 72: 182. 1980.

Because of its broadly ellipsoidal smooth-walled conidia, we consider *P. gerundense* a synonym of *P. dierckxii* Biourge.

Penicillium grancanariae Ramírez & al. *in* Mycopathologia 66: 79. 1978.

Penicillium grancanariae is conspecific with *P. thomii* Maire, differing slightly by the formation of rough-walled conidia with transverse striations.

****Penicillium heteromorphum*** Kong & Qi *in* Mycosystema 1: 107. 1988.

Penicillium heteromorphum strongly resembles species such as *P. cinereoatrum* Chalabuda, *P. arabicum* Baghdadi, *P. griseolum* G. Smith, and *P. dimorphosporum* Swart, characterized by the initial production of grey, smooth, subglobose to ellipsoidal conidia that later become globose and rough. According to the original description, *P. heteromorphum* differs from these species by its inability to utilize nitrate and no growth at 37°C. However, the cultures ex type kept at CBS and CMI all grew at 25°C and 37°C and reached a diameter of 10–12 mm on CYA after one week. *Penicillium heteromorphum* shares the inability to utilize nitrate with *P. griseolum*. A more detailed study is needed to elucidate its taxonomic position.

****Penicillium hispanicum*** Ramírez & al. *in* Mycopathologia 66: 77. 1978.

Frisvad & al. (1990c) have pointed out that *P. hispanicum* is the first available name for Raper & Thom's (1949) concept of *P. implicatum*, because the type of the latter species belongs in *P. citrinum* Thom. *Penicillium hispanicum* produces many specific secondary metabolites distinguishing it from other monoverticillate species.

****Penicillium juguslavicum*** Ramírez & Muntanola-Cvetkovic *in* Mycopathologia 88: 65. 1984.

The species is reminiscent of *P. bilaiae* and *P. charlesii*, but differs by its faster growth at Czapek agar.

Table I. Taxa of *Penicillium*, *Eupenicillium*, and *Talaromyces*, described since 1977, and isolates examined.

Name	Culture
P. aethiopicum	IMI 285624 (T)
P. alicantinum	IMI 253789 = CBS 164.81 (T)[1]
P. allii	CBS 131.89 (T), CBS 188.88
E. angustiporcatum	CBS 202.84 (T)
P. aragonense	IMI 253790 = CBS 171.81 (T)
T. assiutensis	CBS 147.78 (T)
P. asturianum	IMI 253788 = CBS 173.81 (T)
P. aurantioflammiferum	CBS 165.81 (T)
P. aurantiogriseum var. melanoconidium	IMI 321503 (T)
P. aurantiogriseum var. neoechinulatum	IMI 296937 = NRRL 13486 (T)
P. aurantiogriseum var. polonicum	CBS 222.28 (T)
P. brevicompactum var. magnum	IJFM 5954 (T)
P. brevissimum	CBS 763.68 (T)
P. brunneostoloniferum	CBS 317.50 (T)
P. burgense	CBS 325.89 (T)
P. caerulescens	Q 1147 (T), Q 1152, Q 1155, Q 1161, Q 1300[2]
P. castellae	CBS 272.83 = Q 1012 (T), Q 1024, Q 1036, Q 1349
P. castellonense	IMI 253791 = CBS 170.81 (T)
P. chalybeum	FRR 2660 = CBS 254.87 (T), FRR 2659, FRR 2658
P. chrysogenum var. *dipodomyis*	IMI 296926 = NRRL 13485 (T)
P. ciegleri	IJFM 7673 = CBS 275.73 (T)
P. cluniae	CBS 326.89 (T)
E. cryptum	ATCC 60138 = CBS 271.89 (T)
P. coalescens	CBS 104.83 = Q 1138 (T)
P. confertum	CBS 171.87 = IMI 296930 (T)
P. coprobium	IMI 293209 (T)
P. coprophilum	CBS 477.75
P. cordubense	CBS 162.81 (T)
P. corynephorum	FRR 2663 = CBS 256.87 (T), FRR 2676
P. dendriticum	CBS 660.80 = FRR 1885 (T), CBS 191.89
T. derxii	NHL 2982 = CBS 413.89 (T) + NHL 2981 = CBS 412.89 (T)
P. eberhardtii	- -
P. erythromellis	CBS 644.80 (T)
P. fagi	CBS 689.77 (T)
P. flavidostipitatum	CBS 202.87 = IJFM 7824 (T)
P. gaditanum	IMI 253792 = CBS 169.81 (T)
P. gallaicum	IMI 253794 = CBS 333.79 (T)
P. gerundense	IMI 253804 = CBS 334.79 (T)
P. glandicola var. *confertum*	IMI 296930 = NRRL 13488 (T)

[1] T: culture ex type.

[2] Q: from the collection of J.A. Quintanilla.

Name	Culture
P. glandicola var. *glandicola*	CBS 333.48
P. glandicola var. *glaucovenetum*	IMI 293197 (T)
P. glandicola var. *mononematosum*	IMI 296925 = NRRL 13482 (T)
T. gossypii	CBS 645.80 (T)
P. granatense	IMI 253795 = CBS 166.81 (T)
P. grancanariae	IMI 253783 = CBS 687.77 (T)
P. granulatum var. *globosum*	IMI 299049 (T), IMI 297543
P. griseofulvum var. *dipodomyicola*	IMI 296935 = NRRL 13487 (T)
P. heteromorphum	AS 3.4525 = CBS 226.89 (T)
P. hirsutum var. *albocoremium*	IMI 285511
P. hirsutum var. *allii*	CBS 131.89 (T)
P. hirsutum var. *hordei*	CBS 701.68 (T)
P. hirsutum var. *venetum*	IMI 321520
P. hispalense	- -
P. hispanicum	CBS 691.77 (T)
P. ilerdanum	IMI 253793 = CBS 335.79 (T)
P. juguslavicum	IJFM 7785 = CBS 192.87 (T)
P. lacus-sarmientei	IJFM 19078 = CBS 685.85 (T)
P. lapatayae	IJFM 19012 = CBS 203.87 (T)
E. limoneum	CBS 650.82 (T)
E. lineolatum	CBS 188.77 (T)
P. loliense	CBS 643.80 (T)
P maclennaniae	IJFM 7852 = CBS 196.81 (T), CBS 197.81, CBS 198.81
T. macrosporus	CBS 317.63
P. malacaense	IMI 253801 = CBS 160.81 (T)
P. mali	CBS 500.73
P. mariaecrucis	CBS 270.83 (T), Q 1022, Q 1049, Q 1118
P. mediolanense	ATCC 44200 = IJFM 7812 (T)
P. melanochlorum	CBS 487.75 (T), CBS 140.86, CBS 141.86 – 146.86
P. michaelis	CBS 144.83, Q 1150
T. mimosinus	CBS 659.80 (T)
P. mononematosum	CBS 172.87 = IMI 296925 (T)
P. murcianum	CBS 161.81 = IMI 253800
E. nepalense	CBS 203.84
P. nodulum	AS 3.4524 = CBS 227.89
P. nordicum	IJFM 7813 (T)
P. oblatum	FRR 2234 = CBS 258.87 (T), FRR 2233
P. olivicolor	CBS 246.32 (T)
P. onobense	IMI 253787 = CBS 174.81 (T)
P. ovetense	CBS 163.81 (T)
P. palmae	CBS 442.88 (T), CBS 829.88
P. palmense	CBS 336.79 (T)
P. panamense	CBS 128.89 = IMI 297546 (T), IMI 297558 = CBS 129.89
P. patens	FRR 2661 = CBS 260.87 (T)

Name	Culture
P. pittii	CBS 139.84 = Q 1240 (T)
P. primulinum	CBS 321.48 = NRRL 1074 (T)
P. pulvillorum var. *echinulatum*	- -
P. rademiricii	CBS 140.84 = Q 1248 (T)
P. radiatolobatum	CBS 340.79 = IJFM 7845 (T)
P. resinae	CBS 324.83 (T)
P. roqueforti var. *carneum*	IMI 293204 (T)
P. rubefaciens	CBS 145.83 = Q 1133 (T)
P. sabulosum	FRR 2743 = CBS 261.87 (T)
P. sajarovii	CBS 277.83 = IJFM 7674 = Q 1099 (T)
P. samsonii	CBS 137.84 = Q 1032 (T), Q 1100
P. severskii	IJFM 19000 = CBS 438.88 (T)
P. shennongjianum	AS 3.4526 = CBS 228.89 (T)
P. siamense	CBS 475.88 (T)
E. sinaicum	CBS 279.82 (T)
P. solitum var. *crustosum*	IMI 91917 (T)
P. terraconense	IMI 283803 = CBS 177.81 (T)
P. turolense	CBS 176.81 (T)
P. turrispainense	CBS 204.87 (T), CBS 686.85
P. vaccaeorum	IJFM 7756 = Q 1134 = CBS 148.83 (T)
P. valentinum	IMI 253789 = CBS 338.79 (T)
P. vasconiae	IMI 253786 = CBS 339.79 (T)
P. vonarxii	CBS 348.51 (T)
P. vulpinum	CBS 126.63
P. zacinthae	CBS 178.81 (T)
Geosmithia viridis	FRR 1963 = CBS 252.87 (T)
Paecilomyces pascuus	FRR 1925 = CBS 253.87 (T)

Penicillium lacus-sarmientei Ramírez *in* Mycopathologia 96: 29. 1986.

Penicillium lacus-sarmientei is regarded as a faster growing variant of *P. roseopurpureum* Dierckx. The ex-type culture produced beta-hydroxycurvularin and roseopurpurin. The production of this compound has been reported by Turner & Aldridge (1983) for *P. roseopurpureum*, and roseopurpurin for *P. roseopurpureum* (Posternak, 1940) and from *P. carminoviolaceum* (Hind, 1940 a and b).

****Penicillium lapatayae*** Ramírez *in* Mycopathologia 91: 97. 1985.

Penicillium lapatayae is a distinctive sclerotial species and it is accepted as new. It has a certain resemblance to the anamorph of *E. pinetorum*.

Penicillium malacaense Ramírez & Martínez *in* Mycopathologia 72: 186. 1980.

Examination of the ex-type culture showed that *P. malacaense* is a synonym of the variable *P. restrictum* Gilman & Abbott.

Penicillium nodulum Kong & Qi *in* Mycosystema 1: 108. 1988.

Penicillium nodulum is characterized by its ellipsoidal smooth conidia, its dark green reverse on all substrates, its good growth on creatine-sucrose agar and restricted growth on all media (7–17 mm diam. after one week at 25°C). It is therefore accepted as a good species.

Penicillium ovetense Ramírez & Martínez *in* Mycopathologia 74: 39. 1981.

Penicillium ovetense is regarded as a synonym of *P. phoeniceum*. The illustration of this species is similar to that of a strain (CBS 583.68) of *E. cinnamopurpureum* Scott & Stolk (compare Ramírez, 1982: 318 and Stolk & Samson, 1983: 63, fig. 30 e).

****Penicillium palmense*** Ramírez & al. *in* Mycopathologia 66: 80. 1978 (as *'P. palmensis'*).

This species resembles *P. thomii* by its ellipsoidal conidia, but it also shares characters with isolates of the variable *P. glabrum*. For the time being, we accept this taxon, but a more detailed study is necessary to determine its identity.

****Penicillium patens*** Pitt & Hocking *in* Mycotaxon 22: 205. 1985.

Penicillium patens resembles *P. homii*. The conidia of *P. patens* are smooth (like in *P. quercetorum* Baghdadi, another synonym of *P. thomii*), but colony colours are quite different from those of typical *P. thomii*. A more detailed biochemical study of these species should be performed before a final conclusion is drawn.

Penicillium terraconense Ramírez & Martínez *in* Mycopathologia 72: 187. 1980.

The drawings and description of *P. terraconense* indicate that it is a monoverticillate species with small conidia and rough stipes. However, the type culture of this species was contaminated, and is a typical *P. digitatum*. Since no holotype material was designated, this taxon is considered to be of doubtful identity and the name can be discarded as being invalidly described.

Penicillium vaccaeorum Quintanilla *in* Mycopathologia 80: 77. 1982.

Like *P. lacus-sarmientei*, *P. vaccaeorum* is considered to be a fast-growing isolate of *P. roseopurpureum*.

Penicillium valentinum Ramírez & Martínez *in* Mycopathologia 72: 183. 1980.

Penicillium valentinum strongly resembles non-sclerotial isolates (e.g. CBS 338.61) of *P. thomii* and it is therefore regarded as a synonym of this species.

Penicillium subgenus Furcatum

Penicillium aragonense Ramírez & Martínez *in* Mycopathologia 74: 41. 1981.

The drawing of this taxon suggests a typical *P. oxalicum*. However, cultures derived from the type and received from CMI were *P. glabrum* and may have been confused. Since no holotype material was designated, this taxon is considered to be of doubtful identity and the name can be discarded as being invalidly described.

Penicillium asturianum Ramírez & Martínez *in* Mycopathologia 74: 42. 1981.

This species is regarded as a synonym of *P. oxalicum*. The ex-type culture produces the typical profile of secondary metabolites from *P. oxalicum* including secalonic acid D, oxaline and bluish fluorescent compounds.

Penicillium burgense Quintanilla in Mycopathologia (in press).

The profile of secondary metabolites and morphology of the ex- type culture is identical with *Eupenicillium lapidosum*.

Penicillium caerulescens Quintanilla *in* Mycopathologia 82: 101. 1983.

Penicillium caerulescens is a synonym of *P. raciborskii* sensu stricto. Isolates of *P. raciborskii*, including the ex-type culture of *P. caerulescens*, are very good producers of mycophenolic acid.

Penicillium castellae Quintanilla *in* Avan. Nutr. Mej. anim. Alim. 23: 336. 1982.

This is a typical *P. raistrickii*. Quintanilla (l.c.) stated that the isolates produce griseofulvin and penicillic acid and this was confirmed in this study. These two mycotoxins are also produced by the ex-type and all other isolates investigated of *P. raistrickii*.

Penicillium castellonense Ramírez & Martínez *in* Mycopathologia 74: 46. 1981.

Penicillium castellonense is morphologically and biochemically identical with *P. matriti*. The ex-type culture is a good producer of penicillin and penicillic acid (Frisvad & Emborg, unpubl.).

Penicillium chalybeum Pitt & Hocking *in* Mycotaxon 22: 204. 1985.

The ex-type culture of *P. chalybeum* produces sclerotia on MEA, a feature not recorded by Pitt & Hocking (l.c.). It is regarded here as a synonym of *Eupenicillium terrenum*.

Penicillium ciegleri Quintanilla *in* Avan. Nutr. Mej. anim. Alim. 23: 338. 1982 (as *'P. cieglerii'*).

Penicillium ciegleri is a typical *P. pulvillorum*. Some isolates of *P. pulvillorum*, such as the ex-type culture of *P. ciegleri* and isolates assigned to *P. novae-caledoniae*, have a bright red reverse colour and often a slow growth rate on MEA.

Penicillium cluniae Quintanilla *in* Mycopathologia (in press).

Penicillium cluniae is a synonym of *P. cremeogriseum* Chalabuda: among other features, it shares a fast growth rate at 37 °C and the production of brefeldin A.

Penicillium corynephorum Pitt & Hocking *in* Mycotaxon 22: 202. 1985.

Penicillium corynephorum is considered conspecific with *P. smithii* Quintanilla though it differs from it by less roughened conidiophore stipes. The type cultures of both species produce the same profile of secondary metabolites (including citreoviridin) and they have identical growth rates and conidial colours.

Penicillium fagi Martínez & Ramírez *in* Mycopathologia 63: 57. 1978.

Penicillium fagi, a good producer of mycophenolic acid, is the same as *P. raciborskii* sensu stricto. Like *P. caerulescens*, *P. fagi* produces a glaucous-black pigment in the reverse on MEA after 1–3 weeks storage at 0°C.

****Penicillium flavidostipitatum*** Ramírez & González *in* Mycopathologia 88: 3. 1984.

Penicillium flavidostipitum morphologically resembles *P. brasilianum* Batista apud Batista & Maia. However, the two species markedly differ in their profiles of secondary metabolites, growth rates and conidial colour.

Penicillium granatense Ramírez & al. *in* Mycopathologia 72: 31. 1980.

The morphology, profile of secondary metabolites and colony characteristics of *P. granatense* are similar to *P. janczewskii*, and therefore the species is considered a further synonym of that species (also compare Fassatiová & Kubatová, 1990).

****Penicillium maclennaniae*** Yip *in* Trans. Br. mycol. Soc. 77: 202. 1981.

In agreement with Ramírez (1985), we consider this species to be a distinct taxon characterized by the fast growth and conspicuously ornamented conidia.

****Penicillium mariaecrucis*** Quintanilla *in* Avan. Nutr. Mej. anim. Alim. 23: 334. 1982.

Quintanilla (l.c.) described this sclerotial species as having strongly inflated metulae and phialides, but in our cultures of *P. mariaecrucis* the conidiophores, phialides, and conidia duplicate those of *P. pulvillorum*, though some atypical inflated structures were also observed. *Penicillium mariaecrucis* was found to be a good producer of xanthomegnin and viomellein. These nephrotoxins are also produced by *P. simplicissimum*, a species closely related to *P. pulvillorum*. *Penicillium pulvillorum* itself produces penicillic acid and pulvilloric acid, while *P. mariaecrucis* produces the naphthoquinones mentioned above, so there is a marked chemical difference between the two taxa. Also the dark reddish brown colonies of *P. mariaecrucis* are different from the quite weakly coloured strains of *P. pulvillorum*. The status of this species is therefore difficult.

Penicillium michaelis Quintanilla *in* Mycopathologia 80: 79. 1982.

Penicillium michaelis is in all aspects a typical *P. soppii*.

Penicillium murcianum Ramírez & Martínez *in* Mycopathologia 74: 37. 1981.

Penicillium murcianum is identical with *P. canescens* Sopp. Isolates like *P. murcianum* resemble those intermediate between *P. canescens* and *P. janczewskii* Zaleski described by Pitt (1980).

Penicillium jensenii (finely roughened conidia, smooth-walled stipes) through *P. canescens* (smooth to finely roughened conidia, rough stipes) to *P. janczewskii* (very rough conidia, smooth to finely roughened stipes) form a continuum of species, nearly all producing the same total profile of metabolites.

Table II. The status of taxa of *Penicillium* and their teleomorphs, described since 1977, and their production of known mycotoxins.

New taxa	Synonym of	Mycotoxins produced
P. aethiopicum	- -	Viridicatumtoxin
P. alicantinum	*P. citreonigrum*	Citreoviridin
P. allii	*P. hirsutum* var. *allii*	Roquefortine C, meleagrin
E. angustiporcatum	- -	-
P. aragonense	*P. oxalicum*	NT[3]
T. assiutensis		Glauconic acid
P. asturianum	*P. oxalicum*	Secalonic acid D, oxaline
P. aurantioflammiferum	*P. islandicum*	Emodin, skyrin, luteoskyrin, rugulosin
P. aurantiogriseum var. *melanoconidium*	- -	Penicillic acid, oxaline, penitrem A, verrucosidin
P. aurantiogriseum var. *neoechinulatum*	- -	Cyclopenin, viridicatin, penicillic acid
P. aurantiogriseum var. *polonicum*	- -	Penicillic acid, verrucosidin
P. brevicompactum var. *magnum*	*P. olsonii*	-[4]
P. brevissimum	*P. capsulatum*	-
P. brunneostoloniferum	*P. brevicompactum*	Raistrick phenols, mycophenolic acid, breviana-mide A and B
P. burgense	*E. lapidosum*	-
P. caerulescens	*P. raciborskii*	Mycophenolic acid
P. castellae	*P. raistrickii*	Penicillic acid, griseofulvin
P. castellonense	*P. matriti*	Penicillin, penicillic acid
P. chalybeum	*E. terreneum*	-
P. chrysogenum var. *dipodomyis*	- -	Penicillin
P. ciegleri	*P. pulvillorum*	Penicillic acid
P. cluniae	*P. cremeogriseum*	Brefeldin A
E. cryptum	- -	-
P. coalescens	- -	-
P. confertum	- -	Meleagrin
P. coprobium	- -	Patulin
P. coprophilum	- -	Griseofulvin, roquefortine C, meleagrin
P. cordubense	*P. aurantiogriseum*	Penicillic acid, xanthomegnin, viomellein, viridicatin
P. corynephorum	*P. smithii*	Citreoviridin
P. damascenum	*P. westlingii*	Citrinin
P. dendriticum	- -	Mitorubrinic acid, secalonic acid D
T. derxii	- -	-
P. eberhardtii	- -	NT
P. erythromellis	- -	-

[3] NT: not tested.

[4] -: no known mycotoxins produced.

New taxa	Synonym of	Mycotoxins produced
P. fagi	*P. raciborskii*	Mycophenolic acid
P. flavidostipitatum	- -	
P. gaditanum	*P. minioluteum*	Mitorubrinic acid, mitorubrin, mitorubrinol
P. gallaicum	*P. citreonigrum*	Citreoviridin
P. gerundense	*P. restrictum*	-
P. glandicola var. *confertum*	*P. confertum*	Meleagrin
P. glandicola var. *glandicola*	- -	Penitrem A, patulin, roquefortine C
P. glandicola var. *glaucovenetum*		
P. glandicola var. *mononematosum*	*P. mononematosum*	Viriditoxin, cyclopaldic acid, isochromantoxin, verrucologen
T. gossyppii	*T. assiutensis*	Glauconic acid
P. granatense	*P. janczewskii*	Griseofulvin, penicillic acid, penitrem A
P. grancanariae	*P. thomii*	-
P. granulatum var. *globosum*	*P. glandicola*	NT
P. griseofulvum var. *dipodomyicola*	- -	Griseofulvin, patulin, cyclopiazonic acid
P. heteromorphum	- -	NT
P. hirsutum var. *albocoremium*	- -	Citrinin, roquefortine C, terrestric acid, meleagrin
P. hirsutum var. *allii*	- -	Roquefortine C, meleagrin
P. hirsutum var. *hordei*	- -	Roquefortine C, terrestric acid
P. hirsutum var. *venetum*	- -	Roquefortine C, terrestric acid
P. hispalense	*P. hirsutum*?	NT
P. hispanicum	- -	-
P. ilerdanum	*P. piceum*	Rugulosin
P. jugoslavicum	- -	-
P. lacus-sarmientei	*P. roseopurpureum*	Beta-hydroxycurvularin, roseo purpurin
P. lapatayae	- -	-
E. limoneum	- -	-
E. lineolatum	- -	-
P. loliense	- -	-
P. maclennaniae	- -	-
T. macrosporus	- -	Duclauxin
P. malacaense	*P. restrictum*	-
P. mali	*P. solitum*	Cyclopenin
P. mariaecrucis	- -	Xanthomegnin, viomellein
P. mediolanense	*P. verrucosum*	Ochratoxin A
P. melanochlorum	*P. solitum*	Cyclopenin
P. michaelis	*P. soppii*	Terrein, asperentin
T. mimosinus	- -	-

New taxa	Synonym of	Mycotoxins produced
P. mononematosum	- -	-
P. murcianum	*P. canescens*	Griseofulvin, penicillic acid
E. nepalense	- -	-
P. nodulum	- -	-
P. nordicum	*P. verrucosum*	Ochratoxin A and B
P. oblatum	- -	-
P. olivicolor	*P. aurantiogriseum* var. *viridicatum*	Brevianamide A, viridicatin
P. onobense	- -	Brefeldin A
P. ovetense	*P. phoeniceum*	-
P. palmae	- -	Mitorubrin, mitorubrinol, mitorubrinol acetat
P. palmense	?	-
P. panamense	- -	Mitorubrin, mitorubrinic acid, vermicellin
P. patens	- -	-
P. pittii	- -	-
P. primulinum	- -	-
P. pulvillorum var. *echinulatum*	*E. zonatum*	NT
P. rademiricii	*P. diversum*	-
P. radiatolobatum	*P. canescens*	-
P. resinae	*P. asperosporum*	-
P. roqueforti var. *carneum*	- -	Patulin, roquefortine C, mycophenolic acid
P. rubefaciens	- -	-
P. sabulosum	- -	-
P. sajarovii	*?P. cremeogriseum*	Brefeldin A
P. samsonii	*P. minioluteum*	Mitorubrins
P. severskii	*P. soppii*	Terrein
P. shennongjianum	- -	-
P. siamense	- -	Mitorubrins
E. sinaicum	- -	-
P. smithii	- -	Citreoviridin
P. solitum var. *crustosum*	*P. crustosum*	NT
P. terraconense	*P. digitatum*	-
P. turolense	*P. westlingii*	Citrinin
P. turrispainense	*P. namyslowskii*	-
P. vaccaeorum	*P. roseopurpureum*	Roseopurpurin, beta-hydroxy-curvularin
P. valentinum	*P. thomii*	-
P. vasconiae	- -	-
P. vonarxii	- -	-
P. vulpinum	- -	Patulin, roquefortine C
P. zacinthae	*P. allahabadense*	Rugulosin
Geosmithia viridis	*P. viride*	-
Paecilomyces pascuus	*P. pascuum*	-

Penicillium novae-caledoniae G. Smith var. ***album*** Ramírez & Martínez *in* Mycopathologia 74: 47. 1981.

Penicillium novae-caledoniae G. Smith (the type culture was lost but another representative isolate is IMI 140441) and its variety *album* (IJFM 7181) are both considered as synonyms of *P. pulvillorum*.

****Penicillium onobense*** Ramírez & Martínez *in* Mycopathologia 74: 44. 1981.

The ex-type culture of *P. onobense* morphologically resembles *P. brasilianum*, but the taxon has different secondary metabolites. Being a good producer of brefeldin A, *P. onobense* resembles *E. ehrlichii* (= *E. brefeldianum*), but the anamorph of the latter has subglobose conidia without striations and less roughened conidiophore stipes.

Penicillium pulvillorum Turfitt var. ***echinulatum*** Basu & Mehrotra *in* Nova Hedwigia 27: 786. 1976.

The ex-type culture (CBS 654.82) of this variety was lost and a dried specimen was never prepared. Stolk & Samson (1983) considered this variety as a synonym of the anamorph of *E. javanicum* (van Beyma) Stolk & Scott var. *javanicum*, under which they also synonymized *E. zonatum* Hodges & Perry. Recently Frisvad & al. (1990a) considered *E. zonatum* a separate species, characterized by its distinct profile of secondary metabolites and very rough conidia. *Penicillium pulvillorum* var. *echinulatum* may very well represent the anamorph of this species.

Penicillium radiatolobatum Lorinczi *in* Publ. Soc. Nat. Rom. Pent. Stiinta Sol. 10B: 435. 1972.

Penicillium radiatolobatum is considered to be a synonym of *P. canescens*. Like *P. murcianum* it is a transition form towards *P. janczewskii*.

****Penicillium rubefaciens*** Quintanilla *in* Mycopathologia 80: 73. 1982.

Penicillium rubefaciens resembles *P. raciborskii*, but it has a distinct profile of secondary metabolites.

****Penicillium sajarovii*** Quintanilla *in* Avan. Nutr. Mej. anim. Alim. 22: 539. 1981.

This species is related to *P. simplicissimum* and *P. canescens*. The growth rate of the ex-type culture is similar to that of *P. simplicissimum*, but the identity has not been confirmed chemically.

Penicillium severskii Schechovtsov *in* Microbiologia 43: 122. 1981.

Penicillium severskii is a synonym of *P. soppii*, based on the morphology and identical secondary metabolite profiles. It is not a synonym of *P. raciborskii* as stated by Ramírez (1985).

****Penicillium shennongjianum*** Kong & Qi *in* Mycosystema 1: 110. 1988.

The taxon is here accepted, being close to *P. citrinum* and *P. miczynskii*. It differs from these taxa by slow growth on all media (12–16 mm diam. after one week at 25°C), its inabil-

ity to grow on nitrate as sole nitrogen source and to grow at 37 °C. The profile of secondary metabolites does not include citrinin and citreoviridin characteristic for *P. citrinum* and *P. miczynskii*, respectively, but other compounds.

Penicillium smithii Quintanilla *in* Avan. Nutr. Mej. anim. Alim. 23: 340. 1982.

Penicillium smithii is here accepted as a distinct species and not a synonym of *P. raciborskii*, as supposed by Ramírez (1985). These two species differ in their growth rates, their ability to produce sclerotia, the roughness of the stipes and profiles of secondary metabolites. The two species have a wide distribution and have been found repeatedly in soil, peat, wood, and on dried fish. All isolates produced great amounts of citreoviridin.

Penicillium turolense Ramírez & Martínez *in* Mycopathologia 74: 36. 1981.

Penicillium turolense is a synonym of *P. westlingii* Zaleski (Frisvad & Filtenborg, 1990). Both species produce large amounts of citrinin.

Penicillium vasconiae Ramírez & Martínez *in* Mycopathologia 72: 189. 1980.

Penicillium vasconiae is a good species, related to *P. daleae* Zaleski, but with conidia lacking transverse ridges.

Penicillium subgenus Penicillium

Penicillium aethiopicum Frisvad apud Frisvad & Filtenborg *in* Mycologia 81: 847. 1989.

Isolates of this species has been identified by other taxonomists as *P. cyclopium*, *P. verrucosum* var. *corymbiferum*, *P. crustosum* or *P. expansum*. Bridge & al. (1989a and b) regarded it as a tropical variant of *P. expansum*, while Pitt & Cruickshank (1990) accepted *P.* aethiopicum. It differs from all the species mentioned above in its growth at 37 °C, yellow reverse colours on CYA, MEA and YES, long coherent chains of ellipsoidal conidia, poor growth on creatine-sucrose agar, rough-walled stipes on MEA and the production of griseofulvin and viridicatum-toxin.

Penicillium allii Vincent & Pitt *in* Mycologia 81: 300. 1989.

When describing *P. allii*, Vincent & Pitt (l.c.) regarded it as being closely related to *P. crustosum* and *P. roqueforti*, but they stated that amylase isoenzyme patterns resemble those of *P. hirsutum* and *P. hordei*. This relationship has been further confirmed in that several secondary metabolites in *P. hirsutum* and its varieties are also found in *P. allii* (Frisvad & Filtenborg, 1989). Because of other similarities also (fast growth on most media, rough stipes, smooth globose conidia and association with bulbs and onions) we regard *P. allii* only as a variety of *P. hirsutum* (see also below).

Penicillium aurantiogriseum Dierckx var. ***melanoconidium*** Frisvad apud Frisvad & Filtenborg *in* Mycologia 81: 848. 1989.

This variety was distinguished from *P. aurantiogriseum* var. *aurantiogriseum* by dark green conidia, a yellow reverse on CYA, rich sporulation on YES and consistent production of

oxaline and penitrem A. Isolates of this variety formed a distinct cluster in the numerical taxonomy of subgenus *Penicillium* by Bridge & al. (1989a).

***Penicillium aurantiogriseum** Dierckx var. **neoechinulatum** Frisvad & al. *in* Can. J. Bot. 65: 767. 1987.

The variety *neoechinulatum* is reminiscent of *P. echinulatum* Raper & Thom ex Fassatiová, but differs from it by smaller blue-green conidia, poor growth on creatine-sucrose agar and production of aurantiamin, penicillic acid and questiomycin. This variety was also considered distinct by Bridge & al. (1989a).

***Penicillium aurantiogriseum** Dierkx var. **polonicum** (Zaleski) Frisvad apud Frisvad & Filtenborg *in* Mycologia 81: 849. 1989.

Penicillium polonicum Zaleski was considered to be close to *P. aurantiogriseum* var. *aurantiogriseum:* it only differs from it by the faster growth rates on all media, good sporulation on YES agar, consistent production of penicillic acid and verrucosidin combined with inability to produce xanthomegnin, and terrestric acid. Perhaps only studies on DNA-RNA relationships between the different varieties of *P. aurantiogriseum* can elucidate whether some or all of them should be regarded as species, varieties or chemotypes.

***Penicillium brevicompactum** Dierckx var. **magnum** Ramírez *in* Man. Atlas Penicillia: 398. 1982.

In its morphology, growth rates, and profile of secondary metabolites this taxon is indistinguishable from *P. olsonii* Bain. & Sartory.

***Penicillium brunneostoloniferum** Abe ex Ramírez *in* Man. Atlas Penicillia: 412. 1982.

Except for its brown conidia, probably caused by a mutation in the biochemical pathway to melanin, this taxon duplicates typical isolates of *P. brevicompactum* in all aspects. *Penicillium brunneostoloniferum,* like *P. brevicompactum* produced brevianamide A, mycophenolic acid and other bluish fluorescent compounds (short-wave UV light).

***Penicillium chrysogenum** Thom var. **dipodomyis** Frisvad & al. *in* Can. J. Bot. 65: 766. 1987.

This variety was distinguished from *P. chrysogenum* Westling var. *chrysogenum* by its very dark green conidia, rough conidiophore stipes, production of some unique secondary metabolites and faster growth rate on CYA at 37 °C.

***Penicillium confertum** (Frisvad & al.) Frisvad apud Frisvad & Filtenborg *in* Mycologia 81: 851. 1989.

This name was introduced to raise the variety *P. glandicola* var. *confertum* Frisvad & al. to specific level (see below).

***Penicillium coprobium** Frisvad apud Frisvad & Filtenborg *in* Mycologia 81: 851. 1989.

Penicillium coprobium can be distinguished from *P. coprophilum* by the formation of sclerotia, dark green conidia, green phialides, an entire colony margin on MEA, a pale reverse on CYA and MEA, a black-currant-like aroma and the production of several specific secondary metabolites including patulin. In contrast *P. coprophilum* does not form sclerotia, produces dull green conidia and hyaline phialides, has a lobate colony margin on MEA, a dark brown reverse on CYA and MEA, a herb-like aroma on all substrates and produces other secondary metabolites, including griseofulvin, meleagin and oxaline (Frisvad & Filtenborg, 1989).

Penicillium coprophilum (Berk. & Curtis) Seifert & Samson *in* Adv. *Penicillium* and *Aspergillus* Syst.: 145. 1986.

In herbarium studies this name was found to be the oldest available for the distinct species so far known as *P. concentricum* Samson, Stolk & Hadlok (1976).

Penicillium cordubense Ramírez & Martínez *in* Mycopathologia 74: 164. 1981.

Penicillium cordubense is a typical *P. aurantiogriseum* Dierckx var. *aurantiogriseum*, producing viomellein, xanthomegnin and viridicatin.

Penicillium glandicola (Oud.) Seifert & Samson *in* Adv. *Penicillium* and *Aspergillus* Syst.: 147. 1986.

In herbarium studies this name was found to be the oldest available for the distinct species so far known as *P. granulatum* Bain. (see Seifert & Samson, 1986).

Penicillium glandicola (Oud.) Seifert & Samson var. ***confertum*** Frisvad & al. *in* Can. J. Bot. 65: 769. 1987.

This fungus has only been found once. It appears to be more distant from *P. glandicola* than indicated by Frisvad & al. (l.c.). Good growth at 37 °C, production of meleagrin and a compound related or similar to asteltoxin, thin sigmoid stipes, and widely divergent phialides indicate that this taxon deserves specific status as *P. confertum* (see above).

Penicillium glandicola (Oud.) Seifert & Samson var. ***glaucovenetum*** Frisvad apud Frisvad & Filtenborg *in* Mycologia 81: 854. 1989.

The variety *glaucovenetum* differs from var. *glandicola* by its more discrete synnemata, bluish green conidia, and smooth stipe walls.

Penicillium glandicola (Oud.) Seifert & Samson var. ***mononematosum*** Frisvad & al. *in* Can. J. Bot. 65: 767. 1987. (as var. *'mononematosa'*).

Since the description of this variety, several new isolates have been obtained of this taxon, including two isolates from salt marsh soil in Egypt. *Penicillium glandicola* var. *mononematosum* is related to *P. lanosum* and *P. chrysogenum*. It differs from these species by its broad rough stipes, its consistently good growth at 37 °C, and its production of viriditoxin, isochromantoxin, cyclopaldic acid, verrucologen, fumitremorgin A and C, and occasionally some of the Raistrick phenols (Frisvad, unpubl.). The variety has been raised to specific rank by Frisvad & al. (1989; see also below).

Penicillium granulatum Bain. var. ***globosum*** Bridge & al. ***in*** J. Gen. Microbiol. 135: 2958. 1989.

Distinction of this variety seems to have little justification. In the study by Bridge & al. (1989a) one of the strains of *P. granulatum* (= *P. glandicola*, IMI 297543) appears in both clusters (of *P. granulatum* var. *granulatum* and var. *globosum*). Varieties are supposed to be based on clear-cut, non-overlapping characters (Hawksworth & al., 1983).

****Penicillium griseofulvum*** Dierckx var. ***dipodomyicola*** Frisvad & al. ***in*** Can. J. Bot. 65: 767. 1987.

This variety differs consistently from var. *griseofulvum* by rather dark green conidia, a dark brown reverse on CYA, a higher proportion of simpler penicilli, and its inability to produce roquefortine C. The production of roquefortine C in var. *griseofulvum* is consistent.

****Penicillium hirsutum*** Dierckx var. ***albocoremium*** Frisvad apud Frisvad & Filtenborg ***in*** Mycologia 81: 855. 1989.

The variety *albocoremium* differs from var. *hirsutum* by the formation of white synnemata and the production of citrinin and meleagrin.

****Penicillium hirsutum*** Diercks var. ***allii*** (Vincent & Pitt) Frisvad apud Frisvad & Filtenborg ***in*** Mycologia 81: 855. 1989.

This taxon was described as *P. allii* by Vincent & Pitt (1989). It, however, shares a number of similarities with other varieties of *P. hirsutum* (see above). Results from a numerical study of members of subgenus *Penicillium* also showed *P. hirsutum* var. *allii* to be a distinct taxon (Bridge & al., 1989a), but a possible link to other species was not discussed by these authors.

Penicillium hirsutum Diercks var. ***hordei*** (Stolk) Frisvad apud Frisvad & Filtenborg ***in*** Mycologia 81: 855. 1989.

Penicillium hordei Stolk has many characters in common with *P. hirsutum* var. *hirsutum* (Pitt, 1980; Frisvad & Filtenborg, 1983, 1989; Bridge & al., 1989a), but, like *P. allii* it has some distinctive diagnostic characters too. The most consistent solution is either to accept all the varieties of *P. aurantiogriseum* and *P. hirsutum* as such or to treat them all as species. Until more molecular data on DNA similarities are available we prefer to use the variety level in such cases, so we provisionally accept *P. hirsutum* var. *hordei.*

****Penicillium hirsutum*** Diercks var. ***venetum*** Frisvad apud Frisvad & Filtenborg ***in*** Mycologia 81: 855. 1989.

This variety differs from var. *hirsutum* by its dark blue-green conidia, slower growth rate, and production of viridicatins.

Penicillium hispalense Ramírez & Martínez ***in*** Mycopathologia 74: 169. 1981.

A dried type of *P. hispalense* was not prepared and the ex-type culture (IJFM 5940) is lost (Ramírez, pers. comm.). The 'polyverticillate' structure of the fungus was probably caused

by degeneration. The illustrations and description of *P. hispalense* suggests that this taxon is *P. hirsutum* Dierckx, but the exact status of the species remain in doubt.

Penicillium mali Gorlenko & Novobranova *in* Mikol. Fitopatol. 17: 464. 1983.

Penicillium mali is now regarded as a synonym of *P. solitum* (Pitt & Cruickshank, 1990; Stolk & al., 1990).

Penicillium mediolanense Dragoni & Cantoni *in* Ind. Aliment. 155: 281. 1979 (nom. inval., ICBN Art. 36; as *'P. mediolanensis'*).

Penicillium mediolanense was described without a Latin diagnosis and designation of holotype material by Dragoni & Cantoni (1979) and Dragoni & Marino (1979). The morphology of this species is identical with *P. verrucosum*. Its synonymy was further supported by the production of ochratoxin A and the restricted growth.

Penicillium melanochlorum (Samson & al.) Frisvad *in* Adv. Pen. Asp. Syst.: 330. 1985.

This taxon is now regarded a synonym of *P. solitum* (Pitt & Cruickshank, 1990; Stolk & al., 1990).

****Penicillium mononematosum*** (Frisvad & al.) Frisvad *in* Mycologia 81: 856. 1989.

This taxon is discussed above, under *P. glandicola* var. *monematosum*.

Penicillium nordicum Dragoni & Cantoni *in* Ind. Aliment. 155: 283. 1979 (nom. inval., ICBN Art. 36); ex Ramírez in Adv. *Penicillium* and *Aspergillus* Syst.: 139. 1986.

The type culture produces hyaline and atypically large conidia (comparable to those of *P. commune*) and seems to be a mutant. Because of its growth rates, reverse colours, reaction on creatine-sucrose agar and copious production of ochratoxin A and B, it is allocated to *P. verrucosum*.

Penicillium olivicolor Pitt *in* Gen. *Penicillium:* 368. 1980.

Penicillium olivicolor was introduced by Pitt (l.c.) as a name change for *P. ochraceum* Bain. apud Thom, because the latter name had already been used for *P. ochraceum* (Corda) Biourge, *P. ochraceum* (Boudier) Biourge, and *P. ochraceum* Raillo. Apart from its inability to produce green melanin complexes, the type isolate is an atypical *P. viridicatum* Westling (Pitt & Cruickshank, 1990).

****Penicillium roqueforti*** Thom var. ***carneum*** Frisvad apud Frisvad & Filtenborg *in* Mycologia 81: 857. 1989.

The variety *carneum* differs from var. *roqueforti* by its dark blue-green conidia, pale reverse on all substrates, and production of patulin. It never produces PR-toxin as var. *roqueforti* does.

Penicillium solitum Westling var. ***crustosum*** (Thom) Bridge & al. *in* J. gen. Microbiol. 135: 2957. 1989.

Even though *P. solitum* Westling and *P. crustosum* Thom have some characters in common such as the ability to produce a restricted rot in apples, cyclopenin production and rough conidiophore stipes, the differences are very significant. *Penicillium solitum* produces compactin and related compounds, while *P. crustosum* produces penitrem A, roquefortine C, and terrestric acid. Furthermore *P. solitum* grows more slowly, has hydrophilic dark green conidia and does not form conidial crusts. *Penicillium crustosum* grows fast, produces grey-green highly hydrophobic conidia, and typical conidial crusts. With Pitt & Cruickshank (1990) and Stolk & al. (1990) we consider the two species as distinct species (also compare Frisvad & al., 1990c).

Penicillium vulpinum (Cooke & Massee) Seifert & Samson *in* Adv. *Penicillium* and *Aspergillus* Syst.: 144. 1986.

In herbarium studies this name was found to be the oldest available for a distinct species so far known as *P. claviforme* Bain. (Seifert & Samson, 1986).

Penicillium subgenus Biverticillium

Penicillium aurantioflammiferum Ramírez & al. *in* Mycopathologia 72: 28. 1980.

This species is in all respects a typical *P. islandicum* Sopp.

Penicillium coalescens Quintanilla *in* Mycopathologia 84: 115. 1983.

This species resembles *P. dendriticum* Pitt and *P. pseudostromaticum* Hodges & al., but, based on differences in conidial shape, growth rates and colony colours, the species is distinct (see also Samson & al., 1989).

Penicillium dendriticum Pitt *in* Gen. *Penicillium:* 413. 1980.

This species is distinct both morphologically and chemically (Samson & al., 1989).

Penicillium eberhardtii Yokoyama apud Kobayashi & Yokoyama *in* Bull. natn. Sci. Mus., Tokyo, Ser. B, 7: 20. 1981 (nom. inval., ICBN Art 36).

This name was introduced without Latin description and based on cultural studies of isolates obtained from immature tissues of *Dendrosphaera eberhardtii* Pat. The conidiophores are described and illustrated as biverticillate penicilli and therefore this anamorph should be placed in subgenus *Biverticillium*. We have not examined the isolates and a more detailed examination is required to identify its correct taxonomic status.

Penicillium erythromellis Hocking apud Pitt *in* Gen. *Penicillium:* 459. 1980.

This is a distinct species producing great amounts of carbohydrate and red exudate droplets.

Penicillium gaditanum Ramírez & Martínez *in* Mycopathologia 74: 165. 1981.

Penicillium gaditanum is a synonym of *P. minioluteum* (van Reenen-Hoekstra & al., 1990).

Penicillium ilerdanum Ramírez & al. *in* Mycopathologia 72: 32. 1980.

Because of its good growth at 37 °C (better than at 25 °C), characteristic conical conidial heads, profile of secondary metabolites, vesiculate stipes and metulae and conidial form, this species is inseparable from *P. piceum* Raper & Fennell.

****Penicillium loliense*** Pitt *in* Gen. *Penicillium:* 450. (1980).

Penicillium loliense resembles *P. proteolyticum* Kamyschko, but differs from it by more roughened conidia and slower growth rate at 37 °C.

****Penicillium oblatum*** Pitt & Hocking *in* Mycologia 77: 819 (1985).

Penicillium oblatum is a good species, characterized by simple to two- stage-branched penicilli of the *Biverticillium* type and acerose phialides and therefore, in contrast with Pitt & Hocking (1985), we accommodate it in subgenus *Biverticillium.*

****Penicillium palmae*** Samson & al. *in* Stud. Mycol. 31: 135 (1989).

This species is very distinctive. It is somewhat related to *P. isariiforme* Stolk & Meyer, but the latter grows much faster and has longer synnemata. Furthermore, *P. palmae* produces mitorubrins, while *P. isariiforme* produces secalonic acid D and citreoviridin (Samson & al., 1989).

****Penicillium panamense*** Samson & al. *in* Stud. Mycol. 31: 136 (1989).

Penicillium panamense is characterized by conspicuous synnemata in yellow and orange colours, apiculate conidia, and a strongly coloured basal mycelium (red and yellow). These characters set it apart from *P. vulpinum* (Cooke & Massee) Seifert & Samson, to which isolates of *P. panamense* were first allocated. Both species are strictly synnematous and do not produce mononematous conidiophores in culture.

****Penicillium pittii*** Quintanilla *in* Mycopathologia 91: 75 (1985).

This taxon resembles *P. rubrum* Stoll and *P. minioluteum* sensu Pitt, and a more detailed study is needed to elucidate its taxonomic position.

****Penicillium primulinum*** Pitt *in* Gen. *Penicillium:* 455 (1980).

Penicillium primulinum was introduced for *P. diversum* Raper & Fennell var. *aureum* Raper & Fennell, especially because its very characteristic arrangement of the metulae. A second isolate, included in this taxon by Pitt (1980), ATCC 24100, is however a typical *P. marneffei* Segretain (Samson & Frisvad, in prep.).

****Penicillium rademiricii*** Quintanilla *in* Mycopathologia 91: 72 (1985).

By its poor growth on Czapek agar and its morphology and growth rates this taxon is reminiscent of *P. diversum,* but this identity could not be confirmed by the profiles of secondary metabolites in the two species (van Reenen-Hoekstra & al., 1990).

Penicillium resinae Qi & Kong *in* Acta mycol. Sin. 1: 103. 1982.

This is a synonym of *P. asperosporum* G. Smith and duplicates the latter species in all respects.

Penicillium sabulosum Pitt & Hocking *in* Mycologia 77: 818 (1985).

This is a good species and resembles *P. diversum* Raper & Fennell and *P. tardum* Thom. Because of the unique combination of characters, this species should also be keyed out in subgenus *Furcatum*.

Penicillium samsonii Quintanilla *in* Mycopathologia 91: 69 (1985).

Penicillium samsonii is a synonym of *P. minioluteum* Dierxck (van Reenen- Hoekstra & al., 1990).

Penicillium siamense Manoch & Ramírez *in* Mycopathologia 101: 32 (1988).

Penicillium siamense appears to be a good species, but it has metabolites in common with *P. diversum*. It differs from this species by its better growth on all media.

Penicillium zacinthae Ramírez & Martínez *in* Mycopathologia 74: 167 (1981).

This species is considered to be a synonym of *P. allahabadense* Mehrotra & Kumar (van Reenen-Hoekstra & al., 1990).

Paecilomyces pascuus Pitt & Hocking *in* Mycologia 77: 822. 1985; as *'P. pascua'*).

Paecilomyces pascuus belongs to *Penicillium* subgenus *Biverticillium* because of its penicillus structure and the phialide shape. Consequently, we propose the combination: ***Penicillium pascuum*** (Pitt & Hocking) Frisvad, Stolk & Samson, *c o m b. n o v.* for it.

Penicillium pascuum resembles *P. dendriticum* Pitt, but we have not observed synnema production even after exposure to light, and isolates of *P. pascuum* produce only a few, if any, red or yellow pigments, in contrast to *P. dendriticum*.

Penicillium subgenus Geosmithia

Penicillium turris-painense Ramírez *in* Mycopathologia 91: 93 (1985) (as *'P. turris-painensis'*).

This taxon is indistinguishable from *P. namyslowskii* Zaleski in all respects.

Geosmithia viridis Pitt & Hocking in Mycologia 77: 822 (1985) (as *'G. virida'*).

Stolk & Samson (1985) did not recognize *Geosmithia* Pitt as a genus, but considered it as a subgenus of *Penicillium*, because it is difficult to use the morphological characters of species belonging to this group to separate it from the other subgenera with the variable structures e.g. monoverticillate versus biverticillate penicilli, flask-shaped versus acerose phialides, *Eupenicillium* versus *Talaromyces* teleomorphs. If *Geosmithia* was accepted, then separate genera for the subgenera *Biverticillium* and *Aspergilloides* should also be proposed.

Since we reject *Geosmithia* as genus, we propose ***Penicillium viride*** (Pitt & Hocking) Frisvad, Samson & Stolk, *c o m b. n o v. Penicillium viride* produces a diffusible red pigment in MEA after prolonged incubation at low temperatures, a character not observed in other species in subgenus *Geosmithia*.

Table III. List of *Penicillium* nomina nuda which appeared in collection catalogues and patents since 1977.

Nomina nuda	Culture number	Identity (mycotoxins)
P. allorensis Swanson	ATCC 20399	*P. rugulosum* Thom (rugulosin)
P. barcinonense Ramírez & Martínez	CBS 330.79	*P. corylophilum* Dierckx
P. betaolens Ramírez & Martínez	CBS 331.79	*P. simplicissimum* (= *P. janthinellum*)
P. citrinum var. *pseudopaxilli* Martínez & Ramírez	CBS 688.77	*P. citrinum* Thom, chemotype II (citrinin and terrein)
P. fungistaticum P.C. Misra	ATCC 18089	*P. capsulatum* Raper & Fennell
P. glaucocoeruleum Ferrer-Ortega & Ramírez	CBS 692.77	*P. aurantiogriseum* (penicillic acid, verrucosidin, cyclopenin)
P. janthinellum var. *kuensanii* Kinoshita & al.	ATCC 13154	*P. simplicissimum*
P. mariaecrucis var. *fulvescens* Quintanilla	ATCC 48476	*P. mariaecrucis* (xanthomegnin, viomellein)
P. ochraceoviride Ferrer-Ortega & Ramírez	CBS 690.77	*P. aurantiogriseum* (penicillic acid)
P. pimprinum A. Subramanian & Thirumalachar	CBS 373.75	*T. emersonii* Stolk
P. pinsaporum Ramírez & Martínez	IMI 265388A	*P. rugulosum* (rugulosin)
P. piperis Ramírez & Gonzales	CBS 406.73	*P. argillaceum* Stolk & al.
P. poonense A. Subramanian & Thirumalachar	CBS 204.75	*T. emersonii*
P. rinesinum Swanson	ATCC 20398	*P. variabile* Sopp (rugulosin)
P. restrictum var. *kuensanii* Kinoshita & al.	ATCC 13155	*P. restrictum*
P. verrucosum var. *cyclopium* strain *ananas-olens*	IJFM 3865	*P. chrysogenum* Thom

GENUS TALAROMYCES

Talaromyces assiutensis Samson & Abdel-Fattah *in* Persoonia 9: 501. 1978
Anamorph: *Penicillium assiutense* Samson & Abdel-Fattah.
This is a distinct species, described and illustrated by Samson & Abdel-Fattah (1978).

Talaromyces derxii Takada & Udagawa *in* Mycotaxon 31: 418. 1988.
Anamorph: *Penicillium derxii* Takada & Udagawa.
This distinct heterothallic species resembles *T. bacillisporus* Swift, by its dark green reverse, but differs from it by echinulate ascospores and the anamorph. Until now it is the only heterothallic teleomorph with a *Penicillium* anamorph.

Talaromyces gossypii Pitt *in* Gen. *Penicillium:* 500. 1980.
Anamorph: *Penicillium gossypii* Pitt.
This species is inseparable from *T. assiutensis* (Frisvad & al., 1990b).

Talaromyces macrosporus (Stolk & Samson) Frisvad & al. *in* Antonie van Leeuwenhoek 57: 186. 1990.
Anamorph: *Penicillium macrosporum* Frisvad & al.
The species was introduced to raise *T. flavus* (Kloecker) Stolk & Samson var. *macrosporus* Stolk & Samson to specific rank, because of the distinct profile of secondary meta-

bolites and larger ascospores which possess a higher heat-resistance (see Frisvad & al., 1990b).

Talaromyces mimosinus Hocking apud Pitt *in* Gen. *Penicillium:* 507. 1980.

Talaromyces mimosinus is a distinct species because of its ascospores which are ornamented with distinct sinuous flanges.

Penicillium vonarxii Frisvad & Samson in Antonie van Leeuwenhoek 57: 186. 1990.

This name was proposed because no name was available for the anamorph of *T. luteus* (Zukal) C.R. Benjamin as *P. luteum* Zukal was described inclusive of the teleomorph.

Further nomina nuda in Penicillium

A number of epithets appear in culture collection catalogues and patents and to our knowledge they have never been validly published. We have reidentified most of these isolates and they are listed in Table III. They produce many yet unidentified secondary metabolites and some of these secondary metabolites may have interesting biotechnological applications.

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