

Fig. 46. *Penicillium digitatum*. 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 µm.

P. dipodomyicola (Frisvad, Filt. & Wicklow)
Frisvad, Int. Mod. Tax. Meth. Pen. Asp. Clas.:
275, 2000

In *Penicillium* subgenus *Penicillium* section *Penicillium*
series *Urticicolae*

Type: Herb. IMI 296935

Culture ex type: CBS 173.87 = IBT 21521 = IMI 296935,
ex external fur-lined cheek pouch of kangaroo rat (*Dipodomys spectabilis*), 6 km east of Portal, Arizona (T, Y)

Diagnostic features: Griseofulvin, cyclopiazonic acid,
patulin, broadly ellipsoidal smooth-walled conidia, short
phialides, dark brown reverse on CYA, dull green to dark
green conidia

Similar species: *P. dipodomyicola* has darker green conidia
and a darker brown reverse on CYA than *P. griseofulvum*

Description:

Conidiophores: Divergent biverticillate to terverticillate

Conidia: smooth-walled, broadly ellipsoidal, 2.5-3.5 x 2.2-
2.5 µm

Phialides: Cylindrical tapering to a distinct collulum, 4.5-
6.5 µm x 2.2-2.5 µm

Metulae: Cylindrical, 7.5-10 µm x 3.5-4 µm

Rami: Cylindrical, 15-25 µm x 3.5-4 µm

Stipes: Smooth-walled, 400-500 µm x 3-4 µm

Synnemata or fasciculation: Weakly fasciculate

Sclerotia: None

Colony texture: Velvety to weakly granular

Conidium colour on CYA: Dark (grey) green to dark green

Exudate droplets on CYA: Often exudates droplets, clear to
yellow to red

Reverse colour: Dark brown

Diffusible colour: None

Ehrlich reaction: Strong, violet

Odour and volatile metabolites: No data

Extrolites: 1) Patulin, 2) Griseofulvin, 3) Cyclopiazonic
acid

Growth on creatine: Poor

Acid and base production on creatine: No acid

Growth on UNO: Very good

Growth on nitrite: Weak

Abiotic factors:

Diam., 1 week, 25°C: CYA: 20-30 mm; MEA: 22-30 mm;
YES: 32-45 mm; CREA: 14-18 mm; Cz: 14-18 mm, OAT:
21-27 mm; CYAS: 24-28 mm; CzBS: 13-19 mm; CzP: 0
mm; UNO: 12-16 mm; DG18: 24-26 mm

Diam., 1 week: 15°C: 17-22 mm; 30°C: 17-21 mm; 37°C: 0
mm

CYA/CYAS: 1.1 [1.0-1.3]

CYA15°C/CYA 25°C: 0.7 [0.6-0.8]

CYA30°C/CYA 25°C: 0.7 [0.6-0.7]

CZBS/CZ: 1.1 [1-1.1]

CZP/CZ: 0

Distribution: Deserts of Western USA, New South Wales,
Australia, Slovakia

Ecology and habitats: Mounds and cheek pouches of
kangaroo rats, on rice, in mixed chicken feed, and in soil
under sagebrush

Biotechnological applications: None

Biodeterioration & phytopathology: Unknown

Mycotoxins and mycotoxins: Found on rice once and in
seeds from the desert

Typical cultures: IBT 16571 = CBS 110421, ex soil under
sagebrush, 16 km North of Rawlins, Wyoming, USA; IBT
19341 = CBS 110422 = FRR 3866, ex rice from Murrum-
didgee Irrigation Area fumigated with phosphine, Sydney,
N.S.W., Australia (identified as *P. waksmanii*); IBT 18044
= CBS 110423, ex soil under sagebrush, Rock Springs,
Wyoming; IBT 12706 = CBS 110424, ex kangaroo rat,
Sevilletta National Wildlife Refuge, Socorro County, New
Mexico, USA; IBT 10723 = CBS 110425 = NRRL A-
27015, ex kangaroo rat, Arizona, USA; IBT 16314 = CBS
110426, ex soil under sagebrush, 16 km North of Rawlins,
Wyoming, USA; IBT 4182 = CBS 110427 = NRRL A-
26936, ex kangaroo rat, Arizona, USA, IBT 4092 = IBT
10613 = NRRL A-27016; IBT 26223, ex chicken feed
mixture, Slovakia.

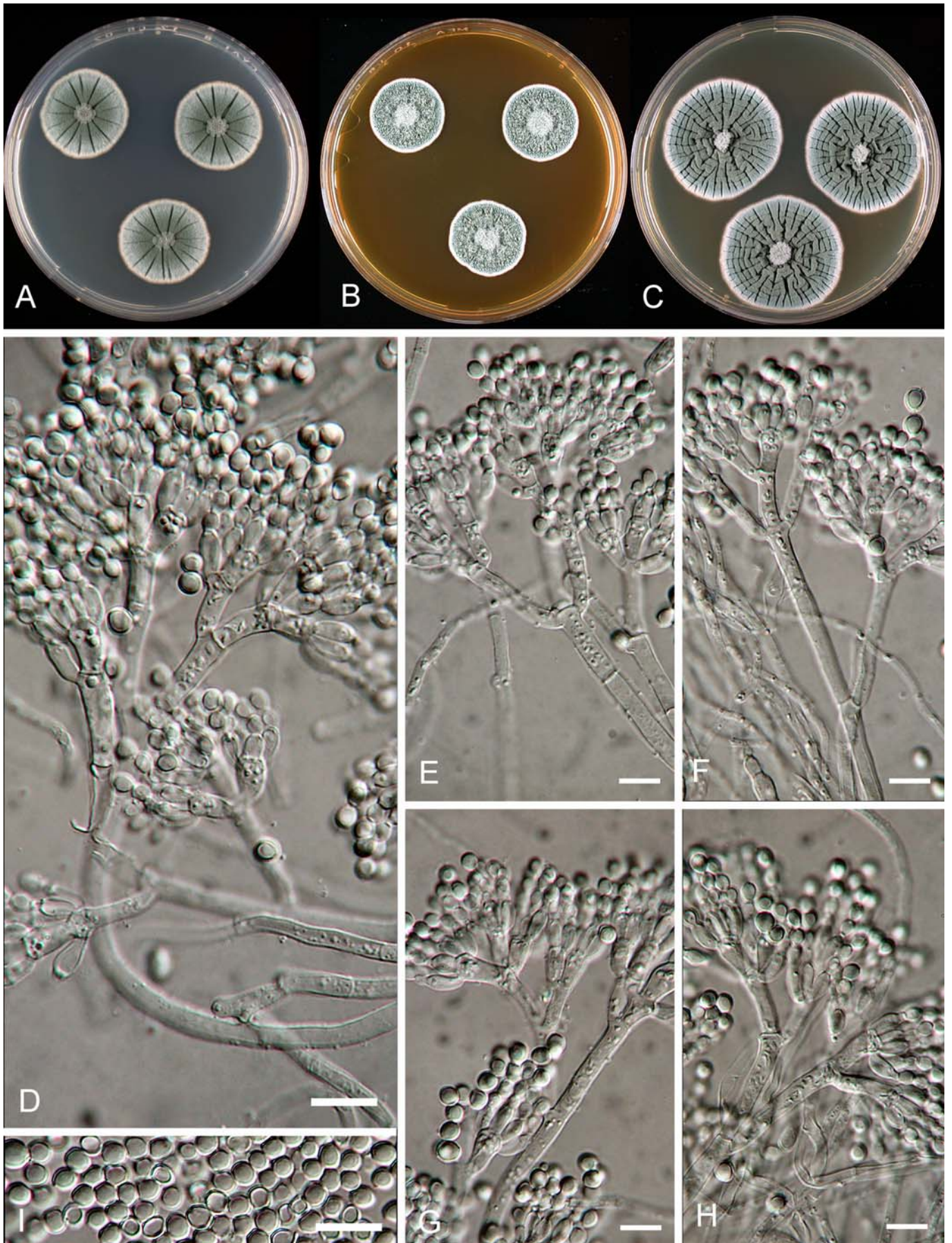


Fig. 47. *Penicillium dipodomyicola*. 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 µm.

P. dipodomyis (Frisvad, Filt. & Wicklow) Banke, Frisvad & S. Rosendahl, Int. Mod. Tax. Meth. Pen. Asp. Clas.: 271, 2000

In *Penicillium* subgenus *Penicillium* section *Chrysogena* series *Chrysogena*

Type: Herb. IMI 296926

Culture ex type: IBT 5333 = CBS 110412 = NRRL 13485 = NRRL A-26836 = IMI 296926, ex cheek pouch of kangaroo rat, 6 km east of Portal, Arizona (T)

Diagnostic features: Penicillin F & G, dipodazin, dark green smooth-walled conidia

Similar species: *P. dipodomyis* is more consistently terverticillate than *P. nalgiovense*.

Description:

Conidiophores: Bi-, terverticillate, both appressed and divergent rami born from aerial and subsurface hyphae, some stipes sinoid

Conidia: Smooth-walled, globose to subglobose, 2.5-4 µm x 2.3-3.5 µm

Phialides: Cylindrical, with short broad collula, 7-9 µm x 2.3-2.5 µm

Metulae: Cylindrical, 8-12 µm x 2.5-4 µm

Rami: Cylindrical, 15-22 µm x 3-4 µm

Stipes: Smooth to finely rough-walled, 200-300 µm x 3-4 µm

Synnemata or fasciculation: None

Sclerotia: None

Colony texture: Velutinous

Conidium colour on CYA: Dark green

Exudate droplets on CYA: Present, clear

Reverse colour on CYA: Cream coloured

Reverse colour on YES: Yellow to orange

Diffusible colour: None

Ehrlich reaction: None

Odour and volatile metabolites: Not tested

Extrolites: 1) Penicillin F and G, 2) Dipodazin

Growth on creatine: Poor

Acid and base production on creatine: No acid or acid under colony, no base

Growth on UNO: Very good

Growth on nitrite: Good (one isolate weak)

Abiotic factors:

Diam., 1 week, 25°C: CYA: 25-34 mm; MEA: 18-30 mm; YES: 28-45 mm; CREA: 13-18 mm; Cz: 13-20 mm, OAT: 20-26 mm; CYAS: 31-40 mm; CzBS: 13-18 mm; CzP: 0 mm; UNO: 11-19 mm; DG18: 26-34 mm

Diam., 1 week: 15°C: 17-21 mm; 30°C: 15-18 mm; 37°C: 0-4 mm

CYA/CYAS: 0.9 [0.8-1.0]

CYA15°C/CYA 25°C: 0.6 [0.6-0.7]

CYA30°C/CYA 25°C: 0.5 [0.4-0.6]

CZBS/CZ: 0.9 [0.8-1.0]

CZP/CZ: 0

Distribution: Western states of USA, Saudi Arabia

Ecology and habitats: Deserts, kangaroo rat mounds and cheek pouches, soil near salt lakes, leather harness

Biotechnological applications: None

Biodeterioration & phytopathology: May deteriorate leather

Mycotoxicoses and mycotoxins: None known

Typical cultures: IBT 21522 = CBS 170.87, ex kangaroo rat, Arizona, USA (Y); IBT 11425 = CBS 110415, ex harness, Saudi Arabia; IBT 12700 = CBS 110414, ex kangaroo rat, Sevilleta, New Mexico, USA; IBT 17759 = CBS 110413; ex barley, Star Valley, Wyoming, USA; IBT 20227 = CBS 112578, ex soil with 14% salt, Antelope Island, Salt Lake, Utah, USA; IBT 3353 = CBS 112570, ex soil, Walnut Crater, Arizona, USA; IBT 3356 = CBS 112316; seeds of an *Amaranthus* sp., Arizona, USA.

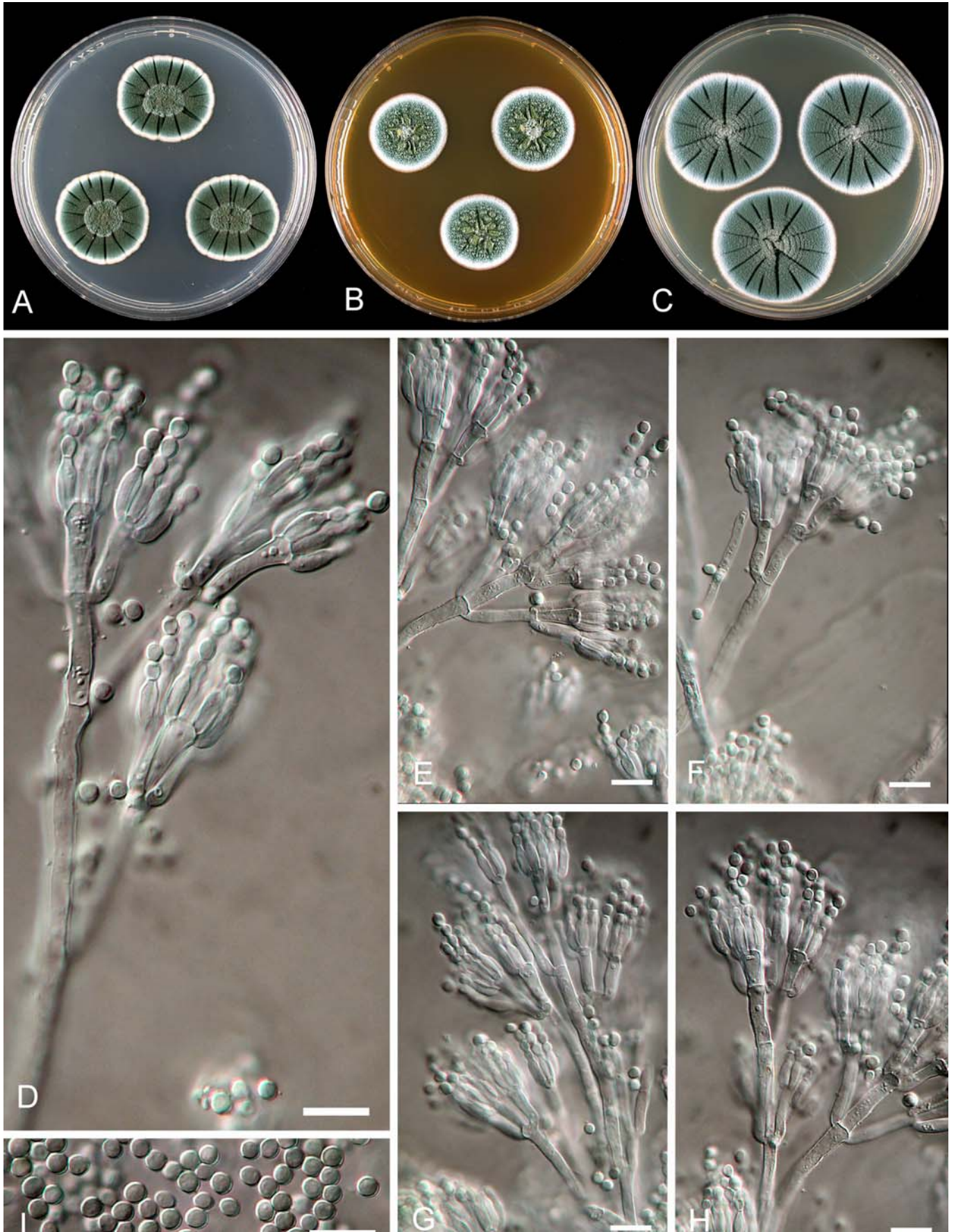


Fig. 48. *Penicillium dipodomyis*. 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 μ m.

P. discolor Frisvad & Samson, *Ant. Leeuwenhoek* 72: 120, 1997

In *Penicillium* subgenus *Penicillium* section *Viridicata* series *Solita*

Type: Herb. IMI 285513

Culture ex type: CBS 474.84 = IBT 21523 = IBT 5738 = IBT 14440 = IMI 285513 = FRR 2933, ex *Raphanus sativus*, Israel (Y, T)

Diagnostic features: Chaetoglobosin A, B, C, cyclophenol, cyclophenin, dark green rough-walled conidia, brilliant red diffusible colour on YES agar

Similar species: *P. echinulatum* and *P. cavernicola* differs from *P. discolor* by the brilliant red diffusible pigment produced by the latter species.

Description:

Conidiophores: Terverticillate, appressed elements, born from subsurface hyphae

Conidia: Rough-walled, globose to subglobose, 3.5-4.0 µm.

Phialides: Cylindrical tapering to a distinct collulum, 8-10 µm x 2-2.5 µm

Metulae: Cylindrical, 12-15 µm x 3-3.5 µm

Rami: Cylindrical, 12-20 µm x 3.2-4.2 µm

Stipes: Rough-walled, 200-250 µm x 3.5-4 µm

Synnemata or fasciculation: Fasciculate on MEA and OAT
Sclerotia: None

Colony texture on CYA: Velutinous to fasciculate

Conidium colour on CYA: Dark green

Exudate droplets on CYA: Clear

Reverse colour on CYA: Cream yellow

Reverse colour on YES: Orange turning into deep red with age

Diffusible colour: Brilliant red diffusible colour on YES

Ehrlich reaction: Weak, violet

Odour and volatile metabolites: 2-methyl-3-butene-2-ol, isobutanol, isopentanol, 3-octanone, 2-methyl-isoborneol, geosmin, isobutyl acetate (Larsen & Frisvad, 1995)

Extrolites: 1) Palitantin, 2) Cyclopeptin, dehydrocyclopeptin, cyclophenol, cyclophenin, viridicatol, viridicatin, 3) Chaetoglobosin A, B, C etc., 4) Daldinin D

Growth on creatine: Very good

Acid and base production on creatine: Good acid and base production

Growth on UNO: Very good

Growth on nitrite: Poor

Abiotic factors:

Diam., 1 week, 25°C: CYA: 21-36 mm; MEA: 20-33 mm; YES: 28-51 mm; CREA: 17-28 mm; Cz: 23-30 mm, OAT: 21-30 mm; CYAS: 27-38 mm; CzBS: 19-24 mm; CzP: 0 mm; UNO: 14-23 mm; DG18: 25-29 mm

Diam., CYA, 1 week: 5°C: 3-6 mm; 15°C: 24-30 mm; 30°C: 0-12 mm (thin colonies); 37°C: 0 mm

CYA/CYAS: 0.94 [0.7-1.1]

CYA15°C/CYA 25°C: 0.9 [0.8-1.2]

CYA30°C/CYA 25°C: 0.2 [0-0.3]

CZBS/CZ: 0.8 [0.7-1.0]

CZP/CZ: 0

Distribution: Denmark, the Netherlands, Belgium, Czech Republic, France, Germany, Italy, Georgia, North Carolina, Colorado, New Mexico, USA, Canada, Israel, Kenya, India, South Korea

Ecology and habitats: Hard cheese, blue cheese, acorns, walnuts, chestnuts, black walnuts, pecans, hazel nuts, radishes, onion, sunseed tubers, flower bulbs, apples

Biotechnological applications: None

Biodeterioration & phytopathology: Moulding natamycin treated cheeses

Mycotoxinoses and mycotoxins: Chaetoglobosin A, B and C could potentially be produced in vegetables, nuts and cheese, and have been found naturally occurring in chestnuts (Overy *et al.*, 2003).

Typical cultures: IBT 15145 = CBS 278.97, ex dairy cooling device, Denmark; IBT 11512 = CBS 271.97, ex acorn, Kgs. Lyngby, Denmark; IBT 14472 = CBS 112557, ex wall of Lechuguilla Cave, Carlsbad, New Mexico, USA; IBT 16218 = IBT 16476 = CBS 112569; ex black walnut, North Carolina; IBT 3088 = CBS 112558 = ATCC 32002 = IBT 4229 = IBT 5730, ex weevil damaged pecan, Georgia, USA; IBT 13522 = CBS 112568, ex cereal, Kenya; T182 = IBT 19542 = CBS 112559, Czech Republic; IBT 16126 = CBS 284.97, ex black walnut, Colorado, USA; CBS 969.97, ex cheese, Germany; CBS 183.88 = IBT 3904 = IBT 4231 = IBT 5734 = IBT 5920, ex *Corylus avellana*; CBS 221.92 = IBT 14439, ex cheese, Netherlands; CBS 222.92, ex cheese, Netherlands; CBS 547.95, ex cheese surface, Italy; CBS 548.95, ex cheese surface, Netherlands; CBS 549.95, ex air in cheese plant, Belgium; CBS 550.95, ex cheese surface, Austria; CBS 551.95, ex cheese surface, France, IBT 4232 = IBT 5733 = ATCC 32000, ex weevil damaged pecans, IBT 5740, ex walnut, India; IBT 3086 = IBT 4224 = IBT 5744, ex *Helianthus tuberosus*, Denmark; IBT 3089 = IBT 4223 = IBT 5731, ex onion, Denmark; IBT 3179 = IBT 3769 = IBT 5736 = IBT 4237, ex onion, Denmark; IBT 3090, ex cheese, the Netherlands; IBT 3185 = IBT 4228 = IBT 5740, ex pecan nut; IBT 3187 = IBT 4220 = IBT 5735, ex walnut, Denmark; IBT 3557 = IBT 4227 = IBT 5737, ex apple, Kgs. Lyngby, Denmark; IBT 11699, ex walnut, France; IBT 11513, IBT 11626 & IBT 11511, all ex acorns, Denmark; IBT 11724 & IBT 11725, ex cheese, Denmark; IBT 13022, ex citrus fruits, Korea; IBT 15185, ex flower bulb, Denmark; IBT 15186, ex blue cheese, France; IBT 16126 = RMF 9950, ex black walnut, North Carolina, USA.

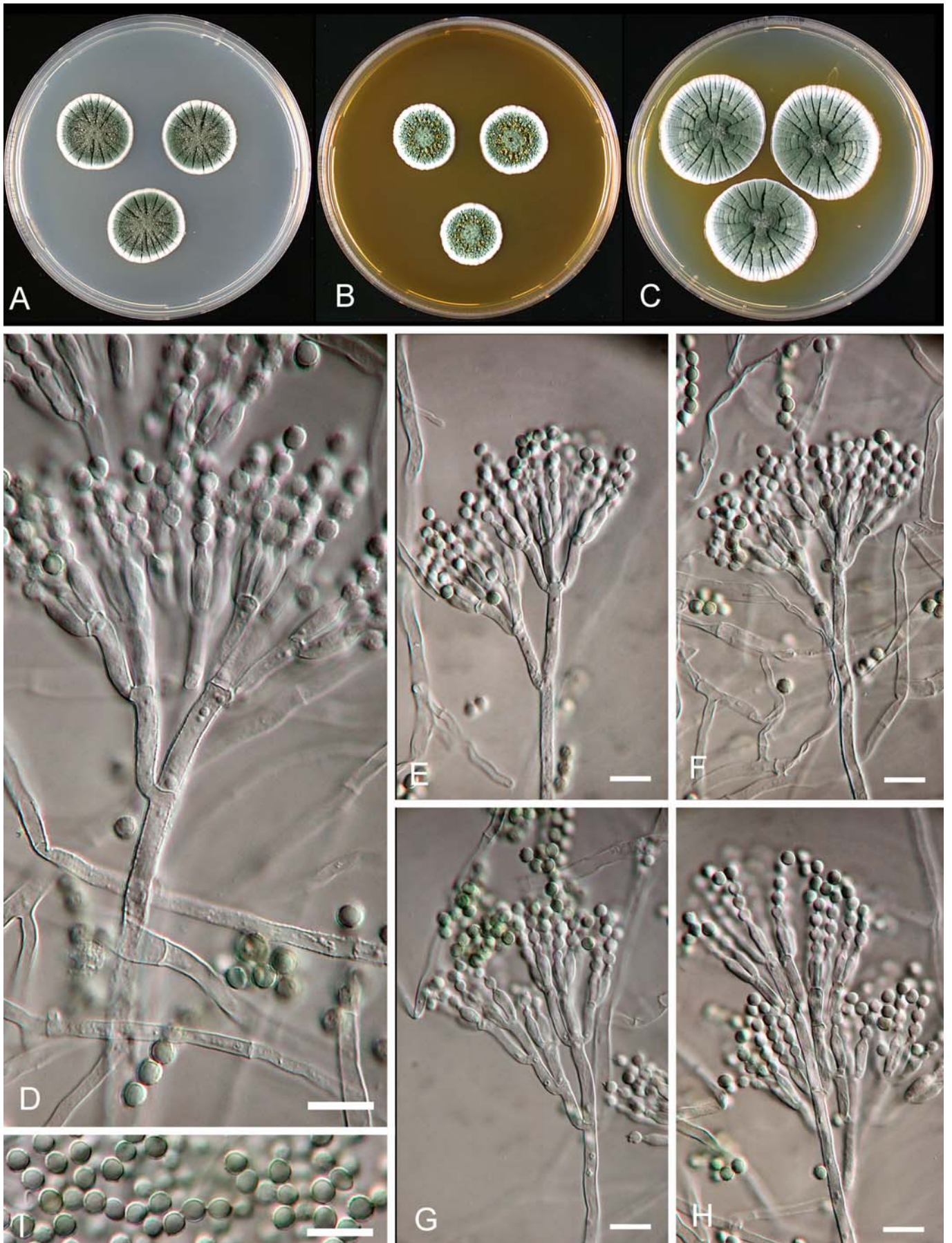


Fig. 49. *Penicillium discolor*. 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 μm.

P. echinulatum Fassatióvá, Acta Univ. Carol. Biol. 12: 326, 1977

In *Penicillium* subgenus *Penicillium* section *Viridicata* series *Solita*

Type: Herb. PRM 778523

Culture ex type: CBS 317.48 = IBT 6294 = IMI 040028 = ATCC 10434 = NRRL 1151 = FRR 1151 = IFO 7760 = MUCL 15615 = QM 7519, contaminant in a Petri dish, Ottawa, Canada (T)

Diagnostic features: Territrems, cyclopenins, dark green rough-walled conidia

Similar species: *P. echinulatum* differs from *P. solitum* by producing rough-walled conidia and from *P. discolor* by inability to produce a diffusible red pigment. *P. discolor* differs from *P. cavernicola* by the cream-coloured reverse on CYA, in contrast to the brown reverse of the latter species.

Description:

Conidiophores: Terverticillate, appressed elements, born from subsurface hyphae

Conidia: Rough-walled, globose to subglobose, 3.5-4.5 µm.

Phialides: Cylindrical tapering to a distinct collulum, 9-11 µm x 2.5-3.0 µm

Metulae: Cylindrical, 11-15 µm x 3-3.5 µm

Rami: Cylindrical, 12-20 µm x 3.5-4.2 µm

Stipes: Rough-walled, 250-500 µm x 3.5-4.2 µm

Synnemata or fasciculation: Weakly fasciculate

Sclerotia: None

Colony texture: Velutinous to weakly fasciculate

Conidium colour on CYA: Dark green

Exudate droplets on CYA: Present, clear

Reverse colour on CYA: Cream coloured

Reverse colour on YES: Yellow

Diffusible colour: None

Ehrlich reaction: None

Odour and volatile metabolites: Ethyl acetate, isobutanol, isopentanol, 3-octanone, geosmin (Larsen and Frisvad, 1995)

Extrolites: 1) Palitantin, 2) Territrems and arisugacins, 3)

Cyclopeptin, dehydrocyclopeptin, cyclopenin, cyclophenol, viridicatin, viridicatol

Growth on creatine: Very good

Acid and base production on creatine: Good acid production followed by base production

Growth on UNO: Very good

Growth on nitrite: Poor

Abiotic factors:

Diam., 1 week, 25°C: CYA: 20-40 mm; MEA: 18-35 mm; YES: 33-53 mm; CREA: 21-27 mm; Cz: 14-25 mm, OAT: 20-34 mm; CYAS: 32-39 mm; CzBS: 17-24 mm; CzP: 0 mm; UNO: 12-22 mm; DG18: 16-29 mm

Diam., CYA, 1 week: 5°C: 3-5 mm; 15°C: 25-31 mm; 30°C: 0-1 mm; 37°C: 0 mm

CYA/CYAS: 0.8 [0.6-1.0]

CYA15°C/CYA 25°C: 0.9 [0.8-1.3]

CYA30°C/CYA 25°C: 0.03 [0.03-0.05]

CZBS/CZ: 0.9 [0.8-1.0]

CZP/CZ: 0

Distribution: Denmark, Sweden, the Netherlands, Germany, France, Wyoming, Arizonut, USA, Canada, Thailand, Japan, South Africa

Ecology and habitats: Lipids, margarine, cheese, wood and wood products, lemon grass

Biotechnological applications: None

Biodeterioration & phytopathology: Has been found in wet mechanical pulp, and may be able to degrade paper.

Mycotoxinoses and mycotoxins: Territrems are tremorgenic mycotoxins, but these have not been found to occur naturally.

Typical cultures: IBT 21524 = IBT 12879 = CBS 101027, ex wash basin, Denmark (Y); IBT 7000 = CBS 268.97, ex goat cheese, Paris, France; IBT 3232 = CBS 337.59 = ATCC 18487 = FAT 1019 = FRR 637 = IFO 6233 = IMI 068236 = QM 7304, unrecorded source, Japan (*P. palitans* var. *echinoconidium*); IBT 3234 = CBS 112287 = FRR 1963, ex cheddar cheese, Orange Free State, South Africa; IBT 21568 = CBS 112288; ex wood shaving, Denmark; IBT 16296 = CBS 290.97, ex root, Wyoming, USA; IBT 22503 = CBS 112289, ex waste, Germany; IBT 21839 = CBS 112286, ex lemon grass, Thailand; CBS 255.55, ex wet mechanical pulp, Sweden; IBT 4105 = CBS 347.97, ex adult bee gut, Arizona, USA.

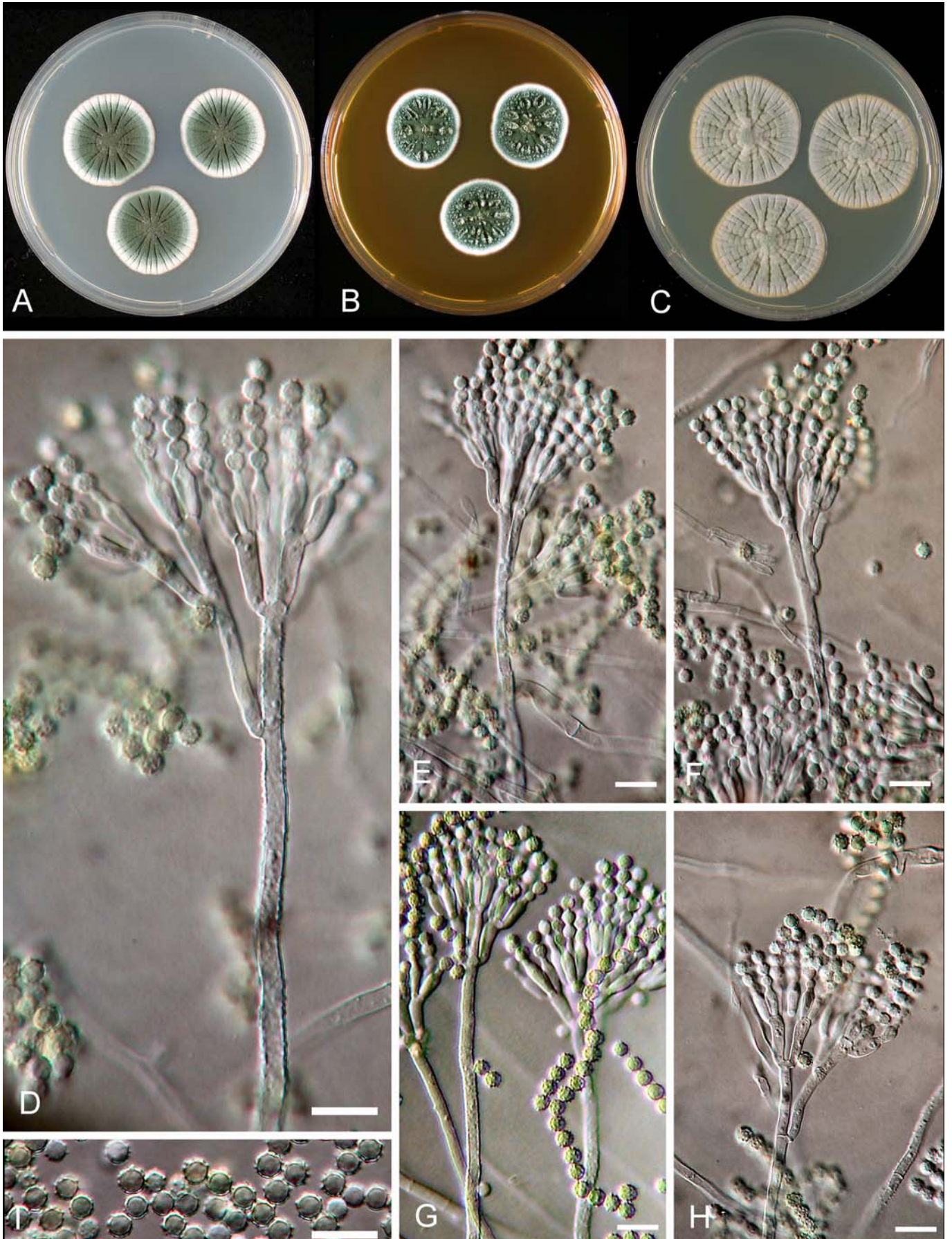


Fig. 50. *Penicillium echinulatum*. 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 μm.

P. expansum Link, Obs. Mycol. 1: 16, 1809

In *Penicillium* subgenus *Penicillium* section *Penicillium* series *Expansa*

Type (neo): Herb. CBS 325.48

Culture ex neotype: CBS 325.48 = IBT 3486 = IBT 5101 = IBT 5854 = IMI 039761ii = ATCC 7861 = ATUM 2891 = FRR 976 = MUCL 29192 = NRRL 976 = VKM F-275, ex *Malus sylvestris*, USA (T)

Diagnostic features: Expansolide, patulin, chaetoglobosins, roquefortine C, communesin A & B, ellipsoidal smooth-walled conidia, apple rot

Similar species: See *P. marinum*. *P. expansum* differs from *P. crustosum* by inability to produce conidial crusts.

Description:

Conidiophores: Terverticillate, appressed elements, born from subsurface and aerial hyphae

Conidia: Smooth-walled, ellipsoidal, 3-3.5 µm x 2.5-3 µm.

Phialides: Cylindrical tapering to a distinct collulum, 8-12 µm x 2.5-3.2 µm

Metulae: Cylindrical, 11-15 µm x 3-4 µm

Rami: Cylindrical, 15-25 µm x 3-4 µm

Stipes: Smooth walled, occasionally rough-walled at lower part of stipe, 200-500 µm x 3-4 µm

Synnemata or fasciculation: Capitulate synnemata produced in fresh strains or after cold storage on MEA or OAT

Sclerotia: None

Colony texture: Floccose to weakly fasciculate

Conidium colour on CYA: Blue green to green

Exudate droplets on CYA: Copious, clear

Reverse colour on CYA: Cream to yellow with brown center, orange brown or dark brown

Reverse colour on YES: Cream yellow or orange

Diffusible colour on CYA: Common, rosy brown

Ehrlich reaction: Strong, violet

Odour and volatile metabolites: Isobutanol, isopentanol, 1-methoxy-3-methyl-benzene, geosmin (Larsen and Frisvad, 1995; Mattheis and Roberts, 1992)

Extrolites: 1) Patulin, 2) Citrinin, 3) Chaetoglobosin A, B, C etc., 4) Communesin A and B, 5) Roquefortine C, 6) Expansolide A & B, 7) Fumaryl-d,l-alanine

Growth on creatine: Very good (poor in very few strains)

Acid and base production on creatine: Good acid production followed by base production

Growth on UNO: Good

Growth on nitrite: Weak

Abiotic factors:

Diam., 1 week, 25°C: CYA: 26-50 mm; MEA: 16-34 mm;

YES: 38-65 mm; CREA: 23-28 mm; Cz: 25-30 mm, OAT:

25-42 mm; CYAS: 23-41 mm; CzBS: 10-25 mm; CzP: 0 mm; UNO: 11-27 mm; DG18: 21-42 mm

Diam., CYA, 1 week: 5°C: 3-5 mm; 15°C: 26-34 mm; 30°C: 0-3 mm; 37°C: 0 mm

CYA/CYAS: 1.1 [0.7-1.6]

CYA15°C/CYA 25°C: 0.9 [0.8-1.3]

CYA30°C/CYA 25°C: 0.03 [0-0.09]

CZBS/CZ: 0.7 [0.4-0.8]

CZP/CZ: 0

Distribution: Denmark, United Kingdom, Sweden, Norway, the Netherlands, Belgium, Germany, France, Italy, Spain, Turkey, Czech Republic, Slovenia, Hungary, Moldavia, Russia, Israel, USA, Canada, Trinidad, Argentina, Ghana, Mozambique, Japan, Queensland and New South Wales, Australia, New Zealand. See also Domsch *et al.*, (1980)

Ecology and habitats: Apples, pears and other pomaceous fruits, cherries, peaches, plums and other stone fruits, tomatoes, papaya, *Albizia gummifera*, *Cydonia vulgaris*, *Dioscorea* spp., walnuts, acorns, pine cones, *Sorbus* endophyte, peanuts, dried meat, household waste, lumber, wall paper, indoor air, soil (see also Domsch *et al.*, 1980)

Biotechnological applications: None

Biodeterioration & phytopathology: Pathogen of pomaceous and other fruits

Mycotoxins and mycotoxins: Patulin, chaetoglobosin C, roquefortine C, citrinin and communesin A & B may be involved in mycotoxins, but it is only patulin that is regulated (especially in apple juice). Sugar beet waste, potato peel waste, fruit juices etc may have heavy growth of *P. expansum* and have resulted in toxicoses of domestic animals (Andersen *et al.*, 2004).

Typical cultures: IBT 21525 = CBS 481.84, ex *Brassica oleracea*, Denmark (Y); IBT 15598 = CBS 281.97, ex chilled food, Denmark; IBT 22804 = CBS 486.75, ex meat product, Germany; IBT 19300 = CBS 110402, ex lime quarry, Fakse, Denmark; IBT 13494 = VKM F-1971, Moldavia; IBT 15658 = CBS 110403 = FRR 4314, ex spoiled margarine, Sydney, Australia; Australia; IBT 16943 = CBS 110404, ex wheat, Hohenheim, Germany; T205 = IBT 15717 = CBS 110405, ex fungal mat on industrial cherry juice, Denmark; IBT 16705 = CBS 285.97, ex maize, Slovenia; CBS 150.45 = IMI 040227 = ATCC 10487 = NRRL 2021 = IFO 7734, culture contaminant (*P. resticulosum*).

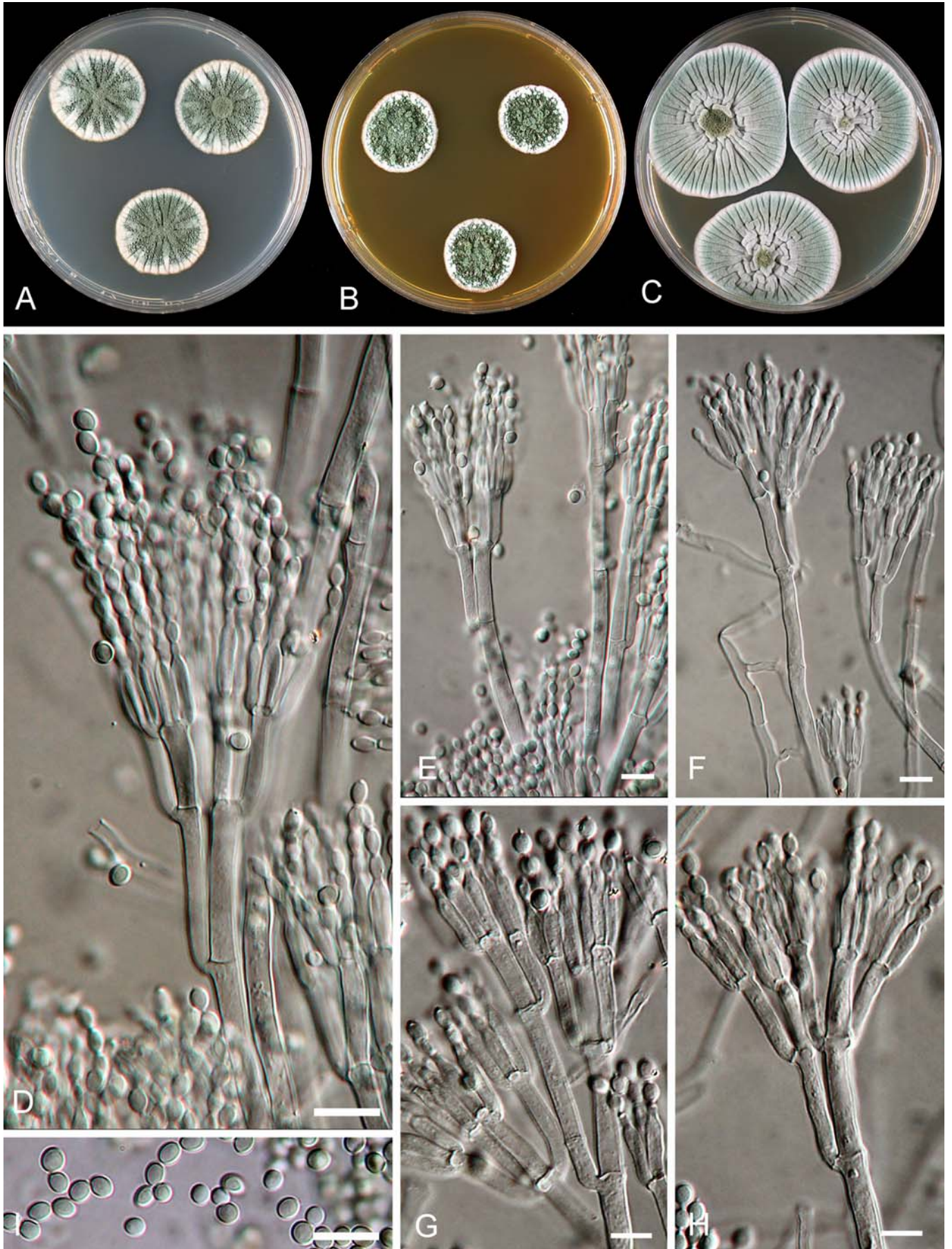


Fig. 51. *Penicillium expansum*. 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 μm.

P. flavigenum Frisvad & Samson, Mycol. Res.
101: 620, 1997

In *Penicillium* subgenus *Penicillium* section *Chrysogena* series *Chrysogena*

Type: Herb. CBS 419.89

Culture ex type: CBS 419.89 = CBS 190.88 = IBT 3091 = IBT 21526 = IBT 3780 = IBT 4727, ex wheat flour, Denmark (T)

Diagnostic features: Smooth-walled conidia, bright yellow droplets and reverse, diffusible pigment

Similar species: See *P. chrysogenum*.

Description:

Conidiophores: Terverticillate, both appressed and divergent rami born from aerial and subsurface hyphae

Conidia: Smooth-walled, globose to subglobose, 2.5-4 µm x 2.3-3.5 µm

Phialides: Cylindrical, with short broad collula, 7-9 µm x 2.3-2.5 µm

Metulae: Cylindrical, 8-12 µm x 2.5-4 µm

Rami: Cylindrical, 15-22 µm x 3-4 µm

Stipes: Smooth, 200-300 µm x 3-4 µm

Synnemata or fasciculation: None

Sclerotia: None

Colony texture: Velutinous to slightly floccose

Conidium colour on CYA: Blue green

Exudate droplets on CYA: Present, yellow

Reverse colour on CYA: Yellow

Reverse colour on YES: Yellow

Diffusible colour on CYA: Yellow

Ehrlich reaction: None

Odour and volatile metabolites: No data

Extrolites: 1) Penicillin F & G, 2) Xanthocillins, 3) Roquefortine C and meleagrins, 4) Penitrem A

Growth on creatine: Weak

Acid and base production on creatine: Acid under colony, no base

Growth on UNO: Very good

Growth on nitrite: Weak

Abiotic factors:

Diam., 1 week, 25°C: CYA: 22-31 mm; MEA: 24-36 mm; YES: 37-52 mm; CREA: 17-22 mm; Cz: 21-25 mm, OAT: 23-32 mm; CYAS: 23-39 mm; CzBS: 6-15 mm; CzP: 0 mm; UNO: 20-27 mm; DG18: 28-37 mm

Diam., 1 week: 15°C: 16-19 mm; 30°C: 15-21 mm; 37°C: 0-4 mm

CYA/CYAS: 0.9 [0.7-1.1]

CYA15°C/CYA 25°C: 0.7 [0.6-0.7]

CYA30°C/CYA 25°C: 0.7 [0.6-0.8]

CZBS/CZ: 0.4 [0.3-0.6]

CZP/CZ: 0

Distribution: Denmark, New Mexico, Arizona and Wyoming (USA), Canada, Tunisia

Ecology and habitats: Desert and cool desert soil, wheat, (nuts)

Biotechnological applications: none, but *P. flavigenum* is a potential producer of penicillin and xanthocillin X, both antibiotics

Biodeterioration & phytopathology: Unknown

Mycotoxins and mycotoxins: Penitrem A and roquefortine C may be potentially produced in cereals and nuts, but it is not known whether *P. flavigenum* can be a dominant species in cereals or nuts.

Typical cultures: IBT 16616 = CBS 110406, ex soil under *Chrysothamnus nauseosus*, Table Rock Road, Wyoming (Y); IBT 14060 = CBS 110407, ex hazel nut, Denmark; T209 = IBT 21794 = CBS 110408, ex saltern Slovenia; T210 = IBT 16864 = CBS 286.97, ex soil under *Atriplex gardneri*, New Mexico, USA; T211 = IBT 3230 = CBS 110409, ex mud from excavation, Tunisia; T212 = IBT 5908 = CBS 110410, ex soil under cactus, Marica Point, Grand canyon, Arizona, USA; IBT 11693 = CBS 110411, ex wheat, Canada; IBT 13687 = CBS 274.97, ex liquorice root, France; IBT 14531 = CBS 276.97, ex walls of Lecuguilla Cave, Carlsbad, New Mexico.

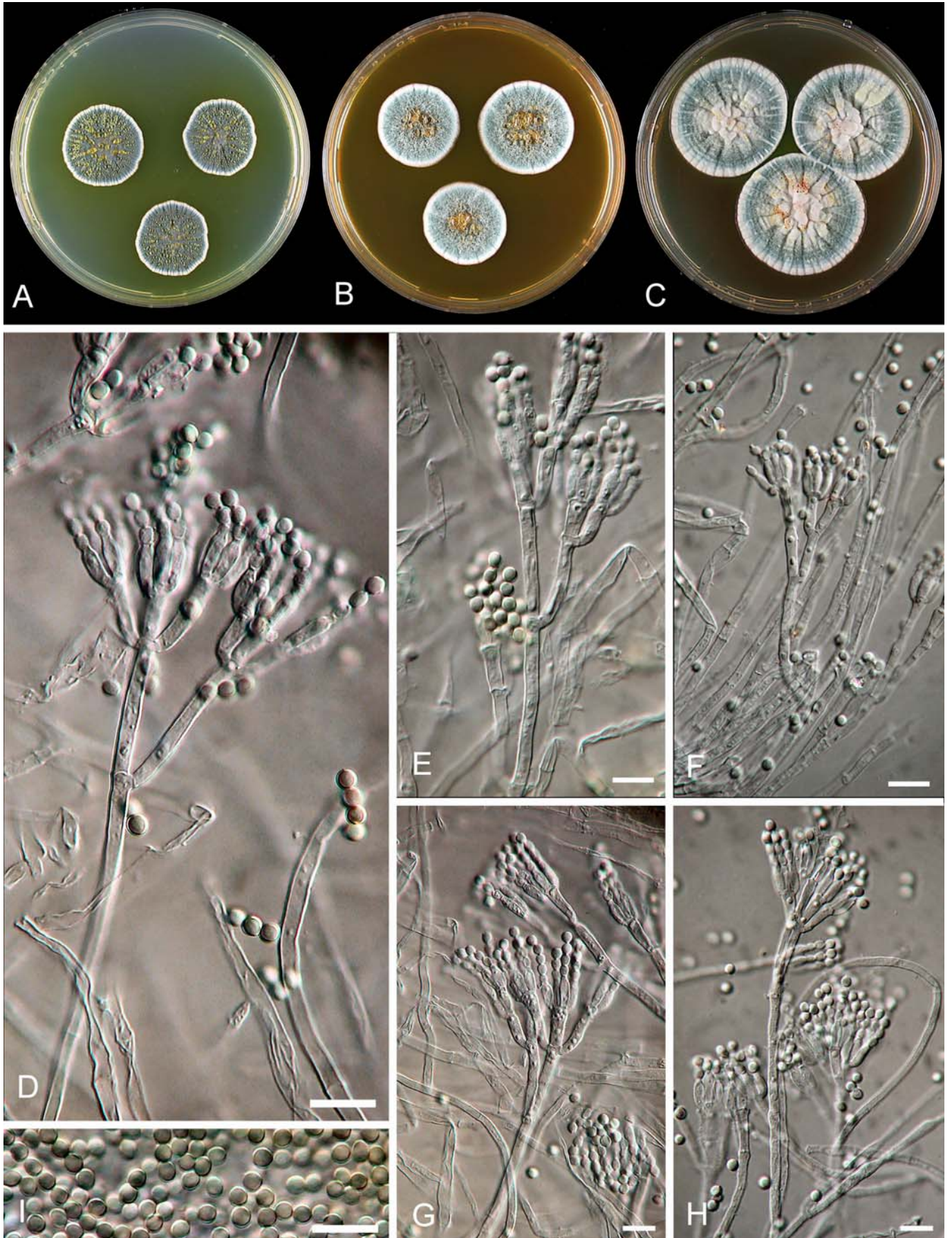


Fig. 52. *Penicillium flavigenum*. 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 μm.

***P. formosanum* Hsieh, Su & Tzean, Trans. Mycol. Soc. R.O.C. 2: 159, 1987**

In *Penicillium* subgenus *Penicillium* section *Penicillium* series *Claviformia*

Type: Herb. PPEH 10001

Culture ex type: IBT 21527 = IBT 19748 = CBS 211.92 = CBS 101028 = CCRC 32654, ex dungy soil, Hsihtou, Nantou County, Taiwan (T, Y)

Diagnostic features: Patulin, broadly ellipsoidal smooth-walled conidia, poor conidium production but yellow mycelium on CYA, poor growth on CREA and UNO, synnemata with yellow stipes, no growth at 30°C, very poor growth on CYAS

Similar species: *P. formosanum* is most closely related to *P. vulpinum* and *P. clavigerum*, but *P. formosanum* does not produce synnemata on CYA, while it produces yellow synnemata on MEA and OAT.

Description:

Conidiophores: Biverticillate or mostly terverticillate, appressed rami born from aerial and synnematal hyphae

Conidia: Smooth-walled, subglobose to broadly ellipsoidal, 2.8-4 µm x 2.4-3.5 µm

Phialides: Cylindrical, with short collula, 9-12 µm x 2.6-3.2 µm

Metulae: Cylindrical, 9-14 µm x 2.4-4.5 µm

Rami: Cylindrical, 10-25 µm x 3.2-4.5 µm

Stipes: Smooth, 100-300 µm x 3.5-4.5 µm

Synnemata or fasciculation: Yellow synnemata produced on OAT and MEA

Sclerotia: None

Colony texture: Weakly sulcate, fasciculate

Conidium colour on CYA: Few conidia, pale green (and light yellow mycelium)

Exudate droplets on CYA: Small exudates droplets, light yellow

Reverse colour on CYA: Light orange to yellow brown

Reverse colour on YES: Beige yellow

Diffusible colour on CYA: Light orange

Ehrlich reaction: None

Odour and volatile metabolites: Geosmin, ethyl acetate, citroenelle (Larsen and Frisvad, 1995)

Extrolites: 1) Patulin, 2) Asteltoxin

Growth on creatine: Weak

Acid and base production on creatine: No acid

Growth on UNO: Moderate

Growth on nitrite: Weak

Abiotic factors:

Diam., 1 week, 25°C: CYA: 18-42 mm; MEA: 9-15 mm (19-26 mm, Tzean et al., 1994); YES: 28-55 mm; CREA: 3-18 mm; Cz: 3-5 mm, OAT: 16-30 mm; CYAS: 3-5 mm;

CzBS: 0 mm; CzP: 0 mm; UNO: 4-6 mm; DG18: 17-19 mm

Diam., 1 week: 5°C: 0 mm; 15°C: 19-21 mm; 30°C: 0 mm; 37°C: 0 mm

CYA/CYAS: 15.5

CYA15°C/CYA 25°C: 0.8

CYA30°C/CYA 25°C: 0

CZBS/CZ: 0

CZP/CZ: 0

Distribution: Nantou County, Taiwan

Ecology and habitats: Probably a dung fungus

Biotechnological applications: None

Biodeterioration & phytopathology: Unknown

Mycotoxinoses and mycotoxins: Patulin production, but the species is not associated to foods

Typical cultures: No further strains known

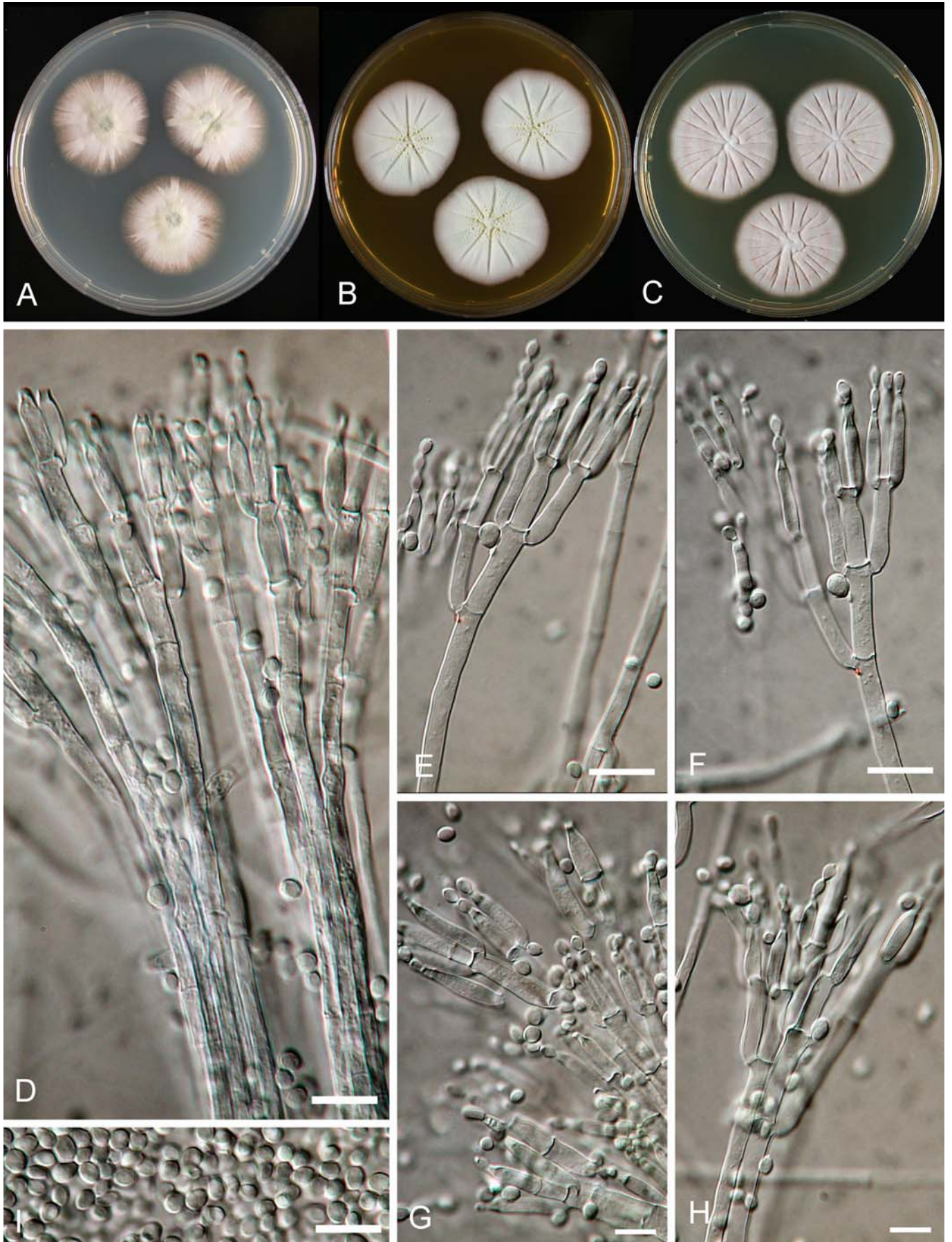


Fig. 53. *Penicillium formosanum*. 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 μ m.

***P. freii* Frisvad & Samson, sp. nov.**

In *Penicillium* subgenus *Penicillium* section *Viridicata* series *Viridicata*

Type: Herb. IMI 285513

Culture ex type: CBS 476.84 = IBT 5137 = IMI 285513, ex barley, Denmark (T)

Diagnostic features: Xanthomegnin, viomellein, vioxanthin, aurantiamine, blue green smooth-walled conidia, crustose, large clear exudates droplets

Similar species: See *P. aurantiogriseum*.

Description:

Conidiophores: Terverticillate, appressed elements, born from subsurface hyphae

Conidia: Smooth-walled, globose to subglobose, 2.6-3.4 μm .

Phialides: Cylindrical tapering to a distinct collulum, 7-9 μm x 2.2-2.8 μm

Metulae: Cylindrical, 9.5-14 μm x 3.2-4.2 μm

Rami: Cylindrical, 15-25 μm x 3.2-4.2 μm

Stipes: Smooth or finely rough walled, 100-650 μm x 3-4 μm

Synnemata or fasciculation: Weakly fasciculate

Sclerotia: None

Colony texture: Velutinous to granular, crustose

Conidium colour on CYA: Blue green

Exudate droplets on CYA: Copious, clear

Reverse colour on CYA: Cream to yellow rarely brownish rose

Reverse colour on YES: Strongly yellow

Diffusible colour on CYA: If present, red brown

Ehrlich reaction: Pink reaction

Odour and volatile metabolites: Isobutanol, isopentanol, 3-octanone (Larsen and Friavad, 1995)

Extrolites: 1) Penicillic acid, 2) Xanthomegnin, viomellein and vioxanthin, 3) Aurantiamine, 4) Cyclopeptin, dehydrocyclopeptin, cyclopenin, cyclophenol, 3-methoxyviridicatin, viridicatol

Growth on creatine: Weak

Acid and base production on creatine: Strong acid production, no base

Growth on UNO: Weak

Growth on nitrite: Very weak

RT agar: Strong reaction and dark brown halo

Abiotic factors:

Diam., 1 week, 25°C: CYA: 15-27 mm; MEA: 15-33 mm; YES: 25-40 mm; CREA: 11-23 mm; Cz: 13-24 mm, OAT: 16-32 mm; CYAS: 33-38 mm; CzBS: 15-23 mm; CzP: 0 mm; UNO: 6-11 mm; DG18: 12-23 mm

Diam., CYA, 1 week: 15°C: 17-23 mm; 30°C: 0 mm; 37°C: 0 mm

CYA/CYAS: 0.6 [0.5-0.9]

CYA15°C/CYA 25°C: 0.8 [0.7-1.1]

CYA30°C/CYA 25°C: 0

CZBS/CZ: 1.1 [0.7-1.3]

CZP/CZ: 0

Distribution: Denmark, Sweden, Norway, United Kingdom, Bulgaria, Ontario, Winnipeg, Canada, South Africa

Ecology and habitats: Cereals, mostly barley, wheat, rye and oats.

Biotechnological applications: None

Biodeterioration & phytopathology: Deteriorates cereals and barley especially at low temperature

Mycotoxins and mycotoxins: Involved in viomellein production (natural occurrence) in cereals (Hald *et al.*, 1983, misidentified as *P. crustosum*)

Typical cultures: IBT 11273 = CBS 794.95, ex chicken feed, Denmark; IBT 11310 = CBS 796.95, ex feed, Norway (Y); IBT 15065 = CBS 112022, ex barley, Pudria, Bulgaria; T218 = IBT 4363 = CBS 112290, ex wheat, United Kingdom; IBT 11996 = CBS 101486 = CSIR 1876, ex barley, South Africa; IBT 16693 = CBS 112293, ex pigfeed, Bulgaria; T221 = IBT 10107 = CBS 112292, ex barley, Denmark; T222 = IBT 11662 = CBS 112291, ex wheat, Canada; CBS 183.89, ex barley, Denmark; CBS 225.90 = IBT 5132, ex barley, Denmark.

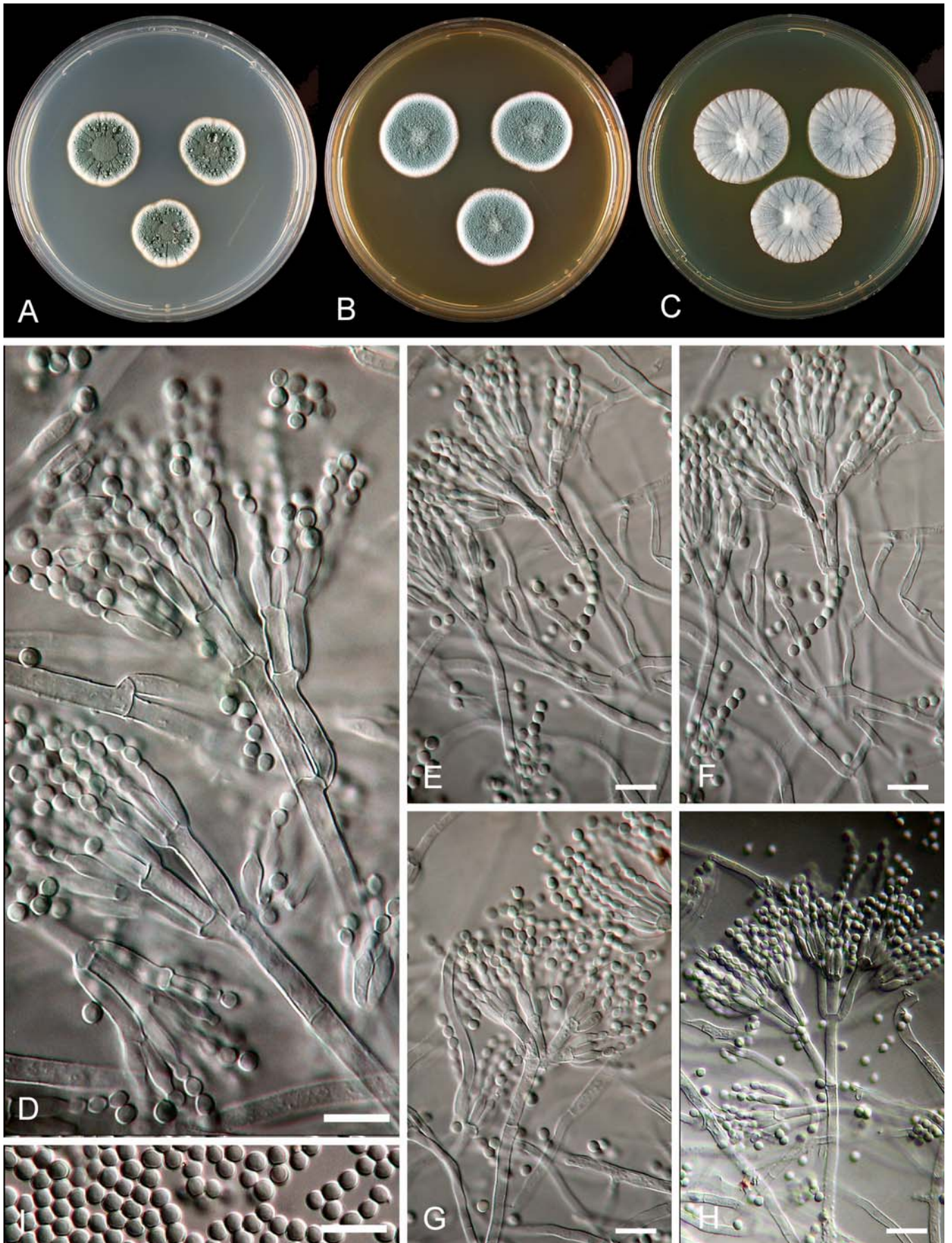


Fig. 54. *Penicillium freii*. 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 μm.

P. gladioli McCulloch & Thom, Science, N.Y.
67: 217, 1928

In *Penicillium* subgenus *Penicillium* section *Penicillium*
series *Gladioli*

Type: Herb. IMI 034911

Culture ex type: CBS 332.48 = IBT 14772 = IMI 034911 =
NRRL 939 = ATCC 10448 = FRR 339 = LCP 89.202 =
MUCL 29174 = QM 1955, ex corm of *Gladiolus* sp. from
Netherlands imported to Columbia, USA (T)

Diagnostic features: Gladiolic acid, patulin, glyanthrypine,
smooth-walled conidia, sclerotia produced, gladiolus rot

Similar species: This species superficially resembles
Eupenicillium crustaceum, but differs from that species by
having rough walled stipes (Stolk and Samson, 1983)

Description:

Conidiophores: Terverticillate, appressed elements, occa-
sionally with one or two lower branches

Conidia: Smooth-walled, subglobose, 2.6-3.4 µm.

Phialides: Cylindrical with short collula, 7.5-10 µm x 2.0-
2.5 µm

Metulae: Cylindrical, 10-15 µm x 2.5-3.5 µm

Rami: Cylindrical, 15-25 µm x 2.5-3.5 µm

Stipes: Rough walled, 200-900 µm x 2.5-4 µm

Synnemata or fasciculation: Weakly fasciculate

Sclerotia: Abundant in fresh isolates, especially on OAT
and MEA, hard, 150-300 (-600) µm, composed of thick
walled cells (8-12 µm). Sclerotium colour cream to light
pinkish tan

Colony texture: Floccose to slightly fasciculate

Conidium colour on CYA: Bluish grey green

Exudate droplets on CYA: Copious, clear

Reverse colour on CYA: Cream to light yellow or orange

Reverse colour on YES: Cream yellow

Diffusible colour on CYA: None

Ehrlich reaction: None

Odour and volatile metabolites: Not examined

Extrolites: 1) Gladiolic acid and dihydro-gladiolic acid, 2)
Atrovenetins, 3) Glyanthrypine (Patulin in CBS 815.70)
Growth on creatine: moderate (very good in CBS 815.70)
Acid and base production on creatine: Moderate acid
production
Growth on UNO: Weak
Growth on nitrite: Weak

Abiotic factors:

Diam., 1 week, 25°C: CYA: 27-41 mm; MEA: 21-38 mm;
YES: 30-52 mm; CREA: 12-27 mm; Cz: 18-26 mm, OAT:
25-41 mm; CYAS: 41-43 mm; CzBS: 22-24 mm; CzP: 0
mm; UNO: 4-23 mm; DG18: 27-30 mm

Diam., CYA, 1 week: 5°C: 2-4 mm; 15°C: 17-23 mm;
30°C: 0 mm; 37°C: 0 mm

CYA/CYAS: 0.8 [0.7-0.9]

CYA15°C/CYA 25°C: 0.8 [0.7-0.9]

CYA30°C/CYA 25°C: 0

CZBS/CZ: 1.0 [0.9-1.2]

CZP/CZ: 0

Distribution: UK, Netherlands, USA, India

Ecology and habitats: *Gladiolus* corms is the only habitat
known

Biotechnological applications: None

Biodeterioration & phytopathology: Pathogenic to
Gladiolus corms, but the last isolation of *P. gladioli* is from
India in 1970. The species may be extinct, maybe because
of changed fungicide treatment plans.

Mycotoxins and mycotoxins: Patulin is produced, but
P. gladioli is only known from *Gladiolus* bulbs.

Typical cultures: IBT 14699 = CBS 214.28, ex *Gladiolus*
sp., USA; IBT 14773 = CBS 278.47 = ATCC 9437 = DSM
2436 = IFO 5766 = IMI 038567ii = NCTC 3994 = NRRL
938 = QM 6756, ex corm of *Gladiolus* sp., UK; IBT 21528
= IBT 14769 = CBS 815.70 = CBS 101029 = IMI 140809 =
FRR 1548, ex corm of *Gladiolus*, India (Y).

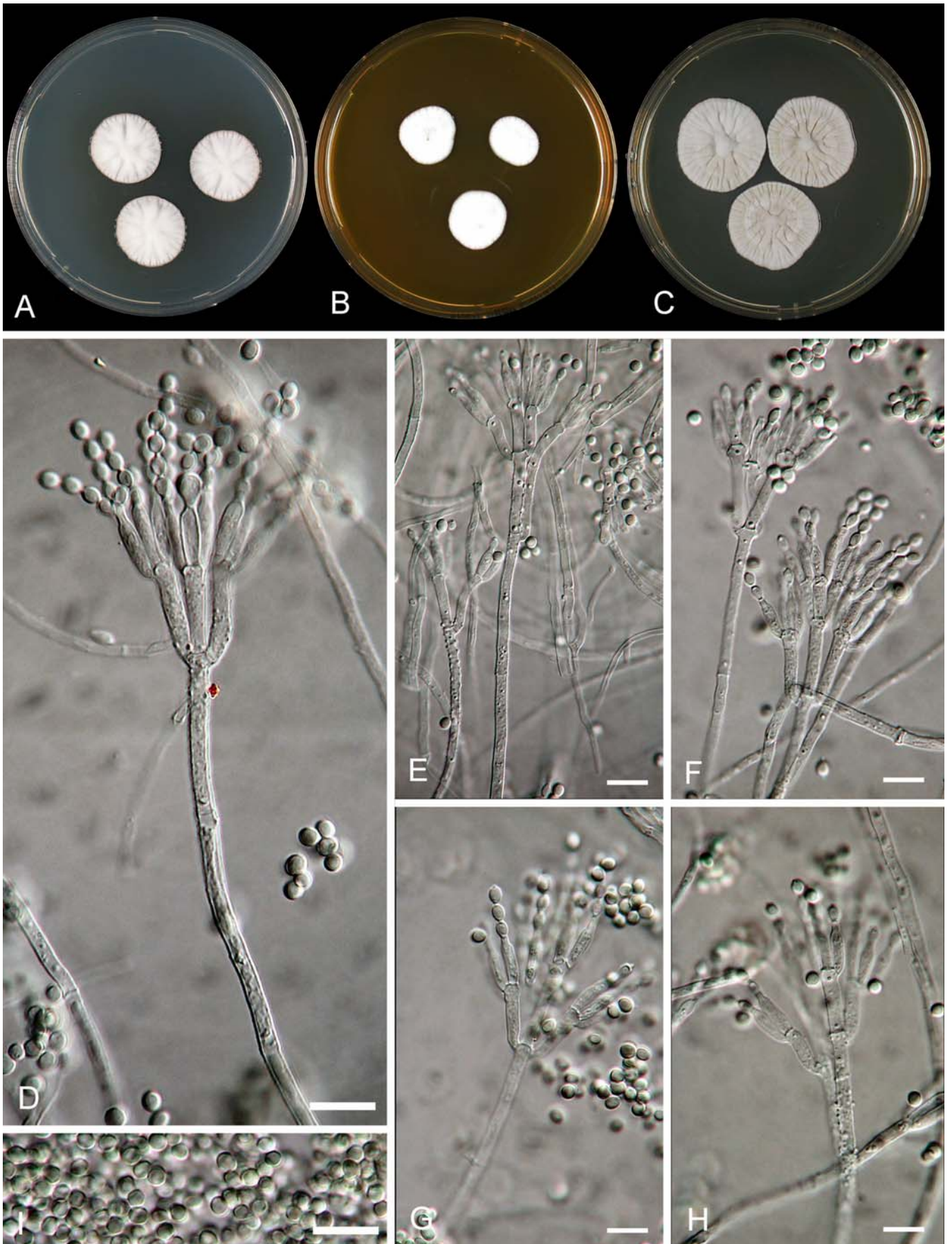


Fig. 55. *Penicillium gladioli*. 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 µm.

P. glandicola (Oud.) Seifert & Samson, Adv. Pen. Asp. Syst.: 147, 1985

In *Penicillium* subgenus *Penicillium* section *Penicillium* series *Claviformia*

Type: Netherlands, Valkenburg, Jul. 1901, Rick in herb. Oudemans (L)

Culture ex epitype: CBS 498.75 = IBT 21529 = IMI 154241, ex mouldy wine cork, Portugal (**epiT**, **Y**)

Diagnostic features: Patulin, patulidin, roquefortine C, meleagrins, penitrem A, ellipsoidal smooth-walled conidia, extremely tuberculate stipes

Similar species: *P. glandicola* resembles *P. concentricum*, but does not produce capitulate synnemata and very rough-walled stipes.

Description:

Conidiophores: Terverticillate, appressed elements, born from subsurface hyphae

Conidia: Smooth-walled, ellipsoidal, 3-3.5 μm x 2.2-2.8 μm .

Phialides: Cylindrical tapering to a distinct collulum, 8-11 μm x 2.2-3 μm

Metulae: Cylindrical, 8-14 μm x 3.5-4.5 μm (occasionally apically inflated)

Rami: Cylindrical, 12-20 μm x 3.5-4.2 μm

Stipes: Tuberculate walls, 100-200 μm x 3.5-4.5 μm

Synnemata or fasciculation: Strongly fasciculate, small feathery synnemata (1-3 mm)

Sclerotia: None

Colony texture: Strongly fasciculate

Conidium colour on CYA: Glaucous green to dull green

Exudate droplets on CYA: Present, clear to pale yellow

Reverse colour on CYA: yellow to orange or red brown

Reverse colour on MEA: Orange to orange red

Reverse colour on YES: Bright orange red

Diffusible colour: Yellow to red brown

Ehrlich reaction: None (few strains yellow reaction, however)

Odour and volatile metabolites: Isobutanol, 2-pentanone, isopentanol, β and γ -elemene, ethyl acetate, ethylisopentanoate, 4-heptanone, styrene, 1,8-cineol (Larsen and Frisvad, 1995)

Extrolites: 1) Patulin, 2) Patulidin, 3) Roquefortine C & D, glandicolin A / B, meleagrins, 4) Penitrem A

Growth on creatine: Very good

Acid and base production on creatine: Weak acid (mostly under colony)

Growth on UNO: Very good

Growth on nitrite: Weak

Abiotic factors:

Diam., 1 week, 25°C: CYA: 15-32 mm; MEA: 7-17 mm; YES: 22-40(-52) mm; CREA: 12-10 mm; Cz: 13-25 mm, OAT: 21-40 mm; CYAS: 19-25 mm; CzBS: 9-13 mm; CzP: 0 mm; UNO: 5-9 mm; DG18: 14-21 mm

Diam., CYA, 1 week: 5°C: 2-5 mm, 15°C: 17-23 mm; 30°C: 0 mm; 37°C: 0 mm

CYA/CYAS: 0.9 [0.8-1.0]

CYA15°C/CYA 25°C: 0.8 [0.6-1.0]

CYA30°C/CYA 25°C: 0.05 [0-0.3]

CZBS/CZ: 0.5 [0.2-0.8]

CZP/CZ: 0

Distribution: Germany, Switzerland, Portugal, Illinois & South Carolina (USA), Malaysia. Domsch *et al.* (1980) list Peru, Japan, Egypt, Israel, Syria and Australia

Ecology and habitats: Oak trees and acorns, wine corks, dungy soil, forest soil and low pH soils (see also Domsch *et al.*, 1980)

Biotechnological applications: None

Biodeterioration & phytopathology: The volatiles and mycotoxins of *P. glandicola* may be present in wine corks and give bad taste (and traces of mycotoxins) to wine.

Mycotoxicoses and mycotoxins: Patulin, penitrem A, roquefortine C may be produced in silage, as *P. glandicola* (often called *P. granulatum*) has been reported from that source.

Typical cultures: IBT 6592 = CBS 333.48 = ATCC 10450 = FRR 2036 = IMI 040220 = MUCL 15621 = NRRL 2036 = QM 6868, ex soil, Illinois, USA (*P. granulatum*); IBT 14689 = CBS 111222, Switzerland; IBT 20584 = CBS 111221, growing on wood, Switzerland; IBT 4168 = CBS 111219 = IMI 296059, ex air in caves, workshop, Notts, UK; IBT 3291 = CBS 111218 = IMI 297593, ex soil in *Fagus-Prunus* forest, Switzerland; IBT 16918 = CBS 294.97 = CBS 111220, ex boiled cork, Portugal; IBT 13697 = CBS 112317 = VKM F-1277 (as *P. divergens*), Russia; IBT 3287 = CBS 494.75, ex colon of a deer, Germany; CBS 308.63, ex salami sausage, Netherlands; IBT 6778 = IBT 3290 = CBS 192.88 = IMI 321513, ex soil under *Quercus* sp., Columbia, South Carolina, USA; NRRL 985 = FRR 985 = IMI 092224 (*P. schneegii*); IBT 3288 = NRRL 3480, ex soil, USA; IBT 12298 = WSF 5122, ex soil, Wisconsin, USA; FRR 1386, ex wine corks, Portugal, imported to Sydney, Australia

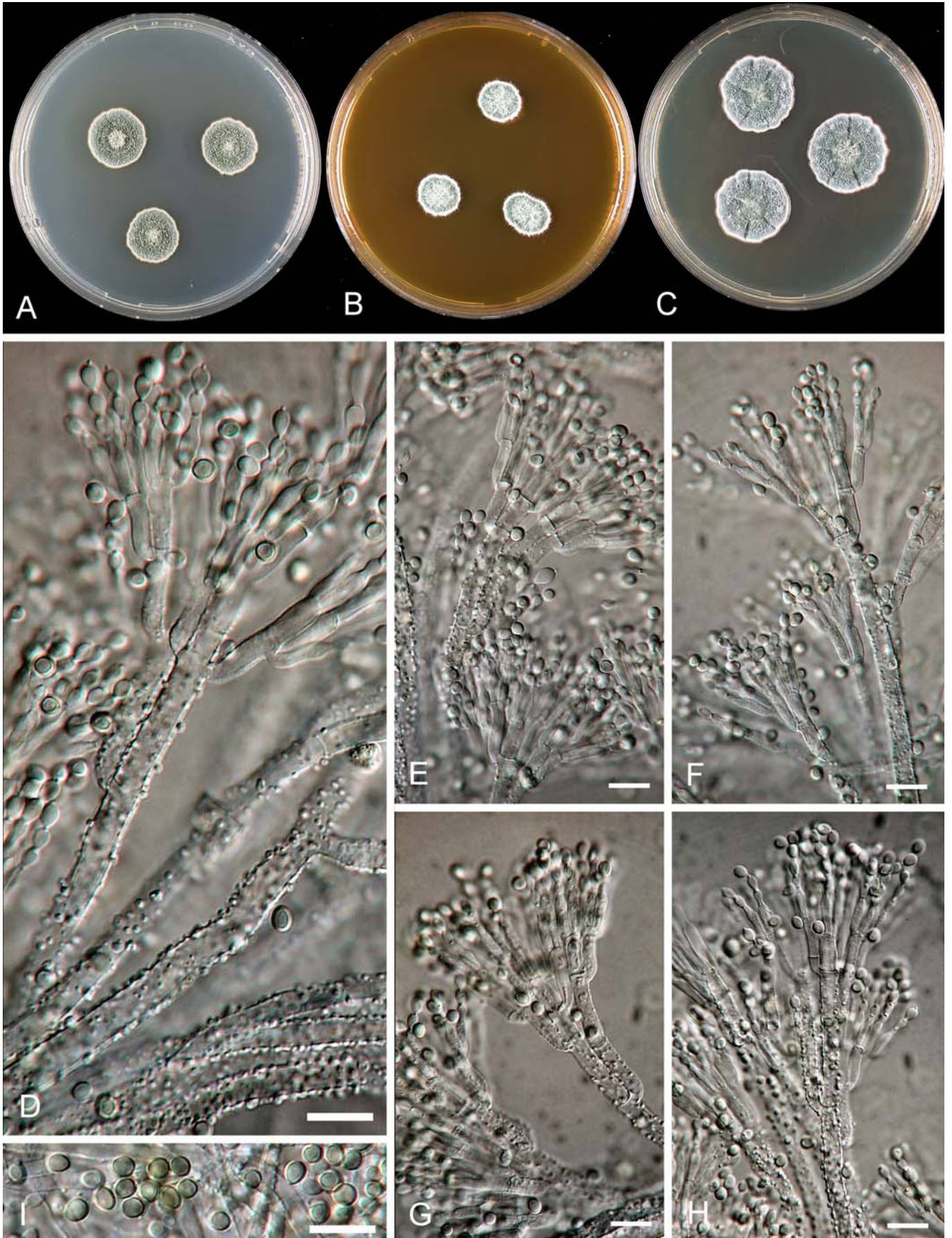


Fig. 56. *Penicillium glandicola*. 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 μm .

P. griseofulvum Dierckx, Ann. Soc. Scient. Brux.
25: 88, 1901

In *Penicillium* subgenus *Penicillium* section *Penicillium*
series *Urticicolae*

Type: Herb. IMI 075832

Culture ex type: Type: CBS 185.27 = IBT 6740 = ATCC
11885 = IMI 075832 = ATHUM 2893 = CECT 2605 =
DSM 896 = IFO 7640 = IFO 7641 = LCP 79.3245 = MUCL
28643 = NRRL 2152 = NRRL 2300 = QM 6902 = VKM F-
286, Belgium (T)

Diagnostic features: Griseofulvin, cyclopiazonic acid,
patulin, roquefortine C, cyclopiamide, cyclopiamine,
ellipsoidal smooth-walled conidia, very short phialides, grey
conidia with only small element of green, very branched
conidiophores

Similar species: *P. dipodomycicola* has a dark brown reverse
and green conidia on CYA in contrast to *P. griseofulvum*.

Description:

Conidiophores: Divergent, undulate or sinuate, terverticil-
late to quinterverticillate

Conidia: Smooth-walled, broadly ellipsoidal, 2.5-3.5 x 2.2-
2.5 µm

Phialides: Flask-shaped tapering to a distinct collulum, 4.5-
6.5 µm x 2.2-2.5 µm

Metulae: Cylindrical, 7.5-10 µm x 3.5-4 µm

Rami: Cylindrical, 15-25 µm x 3.5-4 µm

Stipes: Smooth-walled, 400-500 µm x 3-4 µm

Synnemata or fasciculation: Weakly fasciculate

Sclerotia: None

Colony texture: Velutinous to fasciculate

Conidium colour on CYA: Grey to grey green

Exudate droplets on CYA: Present, clear to yellow

Reverse colour: Cream, beige or brown

Diffusible colour: Weak pinkish brown

Ehrlich reaction: Violet

Odour and volatile metabolites: Ethylene, ethyl acetate,
ethyl isobutanoate, isobutyl acetate, ethyl butanoate, ethyl
2-methyl-butanoate, ethyl isopentanoate, ethyl propanoate,
propyl acetate, butyl acetate, isopropyl butanoate, 2-methyl-
butyl acetate, isopentyl acetate, pentyl acetate, ethyl hexa-
noate, ethyl heptanoate (Larsen and Frisvad, 1995)

Extrolites: 1) Patulin, isopatulin, desoxypatulic acid, 2)
Griseofulvin, 3) Fulvic acid, 4) Triacetic acid lactone, 5)
Cyclopiazonic acid, 6) Mycelianamide, 7) Roquefortine C
and D, 8) Cyclopiamine, 9) Cyclopiamide, 10) Chano-
clavine I, elymoclavine,

Growth on creatine: Weak

Acid and base production on creatine: No acid

Growth on UNO: Weak

Growth on nitrite: Weak

Abiotic factors:

Diam., 1 week, 25°C: CYA: 19-32 mm; MEA: 14-32 mm;
YES: 28-46 mm; CREA: 11-22 mm; Cz: 15-22 mm, OAT:
15-27 mm; CYAS: 17-23 mm; CzBS: 7-19 mm; CzP: 0
mm; UNO: 9-22 mm; DG18: 22-27 mm

Diam., 1 week: 5°C: 2-4 mm; 15°C: 18-21 mm; 30°C: 17-
22 mm; 37°C: 0 mm

CYA/CYAS: 1.5 [1.3-1.7]

CYA15°C/CYA 25°C: 0.7 [0.6-0.8]

CYA30°C/CYA 25°C: 0.7 [0.7-0.8]

CZBS/CZ: 0.8 [0.4-1.2]

CZP/CZ: 0

Distribution: Denmark, Greenland, Norway, Netherlands,
Belgium, Germany, British Isles, United Kingdom, France,
Spain, Czech Republic, Russia, Iran, Israel, Alaska, New
Mexico, Wyoming, Colorado, California (USA), Peru,
Brazil, Mozambique, Somalia, South Africa, Pakistan,
India, Australia

Ecology and habitats: Rice and other cereals, cherries,
animal feed, dungy soil, deteriorating plants, grassland and
cool desert soil. See also Domsch *et al.* (1980).

Biotechnological applications: Production of griseofulvin

Biodeterioration & phytopathology: Degradation of malt

Mycotoxinoses and mycotoxins: There are indications of
mycotoxicosis when *P. griseofulvum* has grown in cereal
based animal feeds (Domsch *et al.*, 1980). Patulin, cyclopi-
azonic acid, roquefortine C and probably other metabolites
of *P. griseofulvum* are all toxic.

Typical cultures: IBT 21530 = CBS 485.84, ex *Hordeum*
vulgare, Denmark (Y); IBT 14319 = CBS 110420 = IMI
351308, ex maize seed, Vratsa, Bulgaria; IBT 11633 = CBS
110419, ex wheat, Canada; IBT 13695 = CBS 110418 =
VKM F-758, Russia; IBT 16399 = CBS 110417, ex cereal
grain in field, Denmark; IBT 15163 = CBS 110416, ex
malting barley, South Africa; IBT 21778 = IBT 18077 =
CBS 112297 = RMF 3098A, ex soil in Pawnee National
Grassland, Colorado, USA; IBT 17756 = CBS 295.97, ex
soil with rabbit dung, New Mexico, USA; CBS 124.14 =
FRR 992 = IMI 092273 = MUCL 29201 = NRRL 992 =
VKM F-320, ex soil, Scotland (*P. flexuosum*); CBS 384.48
= ATCC 10120 = FRR 989 = IMI 039809 = VKM F-374,
ex dead stem of *Urticaceae* (*P. urticae*), CBS 315.63 = LCP
79.3237, ex grain elevator, South Africa; CBS 746.70, ex
soil, Italy; CBS 472.75, ex stored cereals, Yugoslavia; CBS
493.75, ex contents of a deer colon, Germany; CBS 100233,
ex soil, Nepal; NRRL 994 = FRR 994 = ATCC 9260 = IMI
028808 (*P. patulum*).

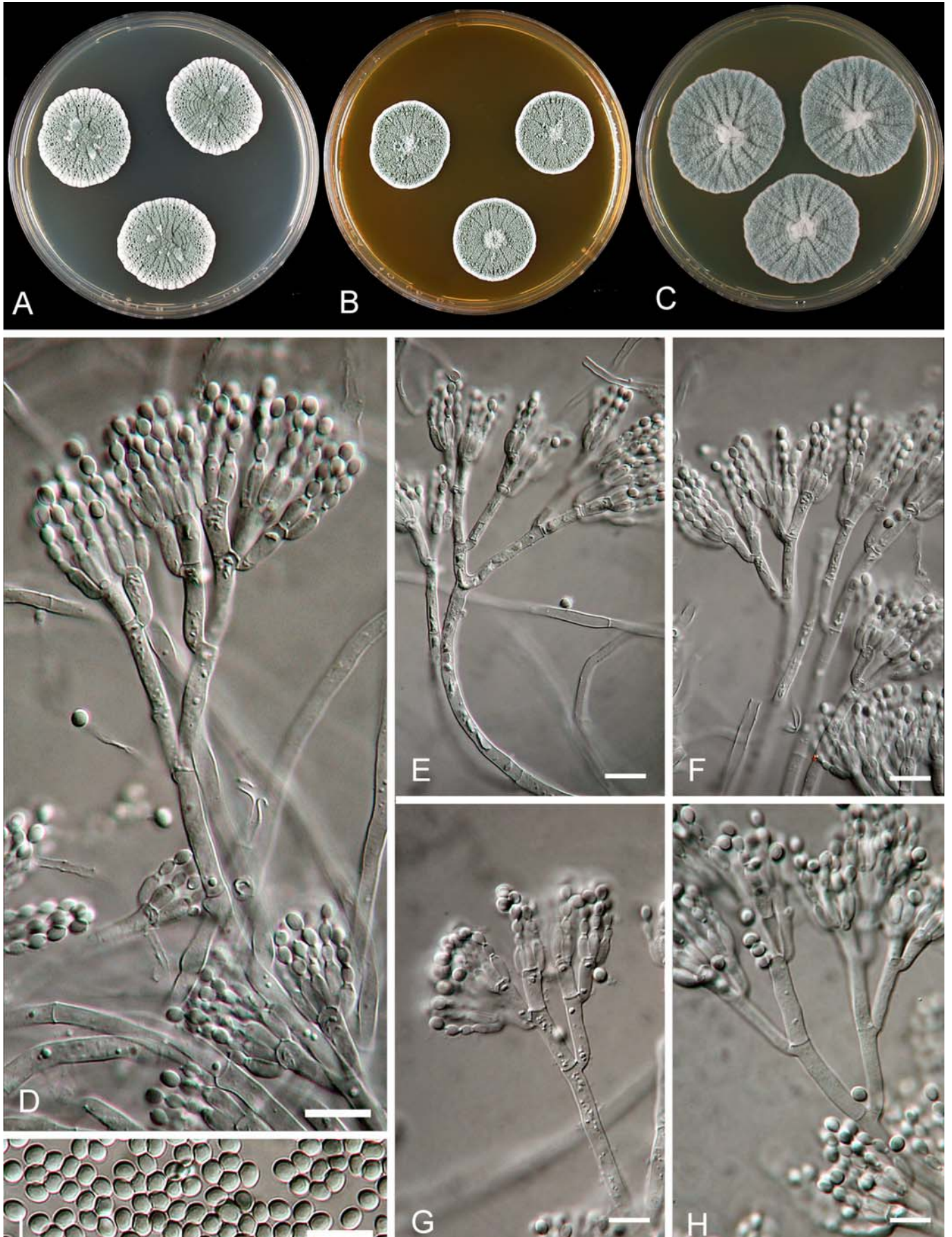


Fig. 57. *Penicillium griseofulvum*. 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 μm.

P. hirsutum Dierckx, Ann. Soc. Scient. Brux. 25: 89, 1901

In *Penicillium* subgenus *Penicillium* section *Viridicata* series *Corymbifera*

Type: Herb. IMI 040213

Culture ex type: CBS 135.41 = IBT 21531 = IBT 10628 = IMI 040213 = ATCC 10429 = FRR 2032 = IFO 6092 = MUCL 15622 = NRRL 2032, ex aphid, Netherlands (T,Y)

Diagnostic features: Compactin, daldinin D, smooth-walled conidia, yellow synnemata

Similar species: *P. hirsutum* produce yellow synnemata in contrast to *P. radicolata*, *P. albocoremium* and *P. tulipae*.

Description:

Conidiophores: Terverticillate, appressed elements, born from subsurface hyphae

Conidia: Smooth-walled, globose to subglobose, 2.2-3.8 µm

Phialides: Cylindrical tapering to a distinct collulum, 8-12 µm x 2.4-3.2 µm

Metulae: Cylindrical, 7.5-13 µm x 3.2-4 µm

Rami: Cylindrical, 16-27 µm x 3.2-4 µm

Stipes: Rough-walled, 100-500 µm x 3.2-4 µm

Synnemata or fasciculation: Yellow synnemata produced, especially on OAT and MEA

Sclerotia: None

Colony texture: Velutinous to fasciculate

Conidium colour on CYA: Green

Exudate droplets on CYA: Yellow to dark orange or red brown

Reverse colour on CYA: Yellow to orange brown

Reverse colour on YES: Cream yellow to curry yellow

Diffusible colour on CYA: Yellow brown to brown

Ehrlich reaction: Red to violet

Odour and volatile metabolites: Isobutanol, isopentanol (Larsen & Frisvad, 1995)

Extrolites: 1) Terrestrial acid, 2) Daldinin D, 2) Compactins, 3) Roquefortine C & D, meleagrins

Growth on creatine: Moderate to good

Acid and base production on creatine: Acid production, no base production

Growth on UNO: Moderate to good

Growth on nitrite: Weak

Abiotic factors:

Diam., 1 week, 25°C: CYA: 19-43 mm; MEA: 22-45 mm; YES: 41-54 mm; CREA: 23-36 mm; Cz: 25-41 mm, OAT: 26-43 mm; CYAS: 28-42 mm; CzBS: 29-38 mm; CzP: 0 mm; UNO: 13-20 mm; DG18: 28-38 mm

Diam., CYA, 1 week: 5°C: 2-4 mm; 15°C: 32-36 mm; 30°C: 2-9 mm; 37°C: 0 mm

CYA/CYAS: 0.9 [0.5-1.1]

CYA15°C/CYA 25°C: 1.0 [0.8-1.0(-1.9)]

CYA30°C/CYA 25°C: 0.09 [0.05-0.3]

CZBS/CZ: 1.0 [0.9-1.1]

CZP/CZ: 0

Distribution: Netherlands, Czech Republic, Illinois (USA), Korea, Taiwan. See also Domsch *et al.* (1980) under *P. verrucosum* var. *corymbiferum*, but this taxon may also include *P. allii*, *P. venetum*, *P. radicolata*, *P. albocoremium* and *P. tulipae*.

Ecology and habitats: Greenhouses, horse radish, tulip bulbs, aphids, butter.

Biotechnological applications: None

Biodeterioration & phytopathology: May degrade flower bulbs and vegetable roots

Mycotoxins and mycotoxins: It is not known whether roquefortine C will be produced in vegetable roots.

Typical cultures: IBT 12398 = CBS 349.75, ex bulb of *Tulipa* sp., Netherlands; IBT 10623 = CBS 110101 = CCF 1445, ex rotten apple, Prague, Czech Republic; IBT 10624 = CBS 110100 = NRRL 999, ex horse radish roots, Illinois, USA; IBT 19340 = CBS 110099 = FRR 3642 = PPEH 25001, Taiwan; IBT 13033 = CBS 437.92, ex *Tulipa* sp., Korea; IBT 18379 = CBS 110098 = CCRC 32022, ex butter, Taipei City, Taiwan; IBT 22221 = CBS 112318, ex chestnut, Denmark.

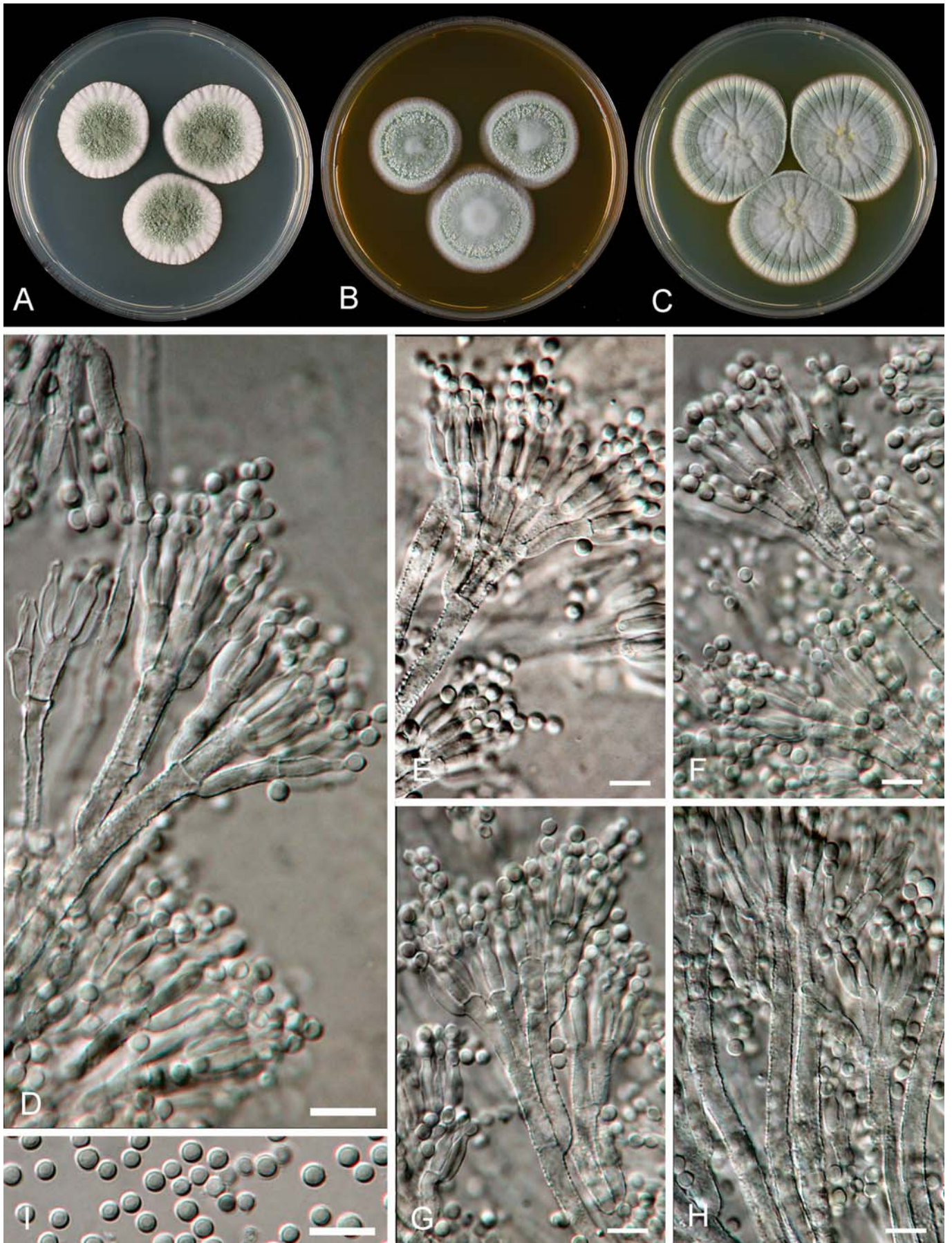


Fig. 58. *Penicillium hirsutum*. 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 µm.

P. hordei Stolk, Ant. van Leeuwenhoek **35**: 270, 1969

In *Penicillium* subgenus *Penicillium* section *Viridicata* series *Corymbifera*

Type: Herb. CBS 701.68

Culture ex type: CBS 701.68 = IBT 17804 = IBT 6980 = IMI 151748 = ATCC 22053 = CECT 2290 = FRR 815 = MUCL 39559, ex *Hordeum vulgare*, Denmark (T)

Diagnostic features: Rough-walled conidia, yellow mycelium and synnemata, roquefortine C, terrestrial acid

Similar species: *P. hordei* differs from *P. hirsutum* and other members of series *Corymbifera* by its finely roughened conidia.

Description:

Conidiophores: Terverticillate, appressed or slightly divergent elements, born from subsurface and aerial hyphae

Conidia: Finely rough-walled, globose to subglobose, 2-3 μm

Phialides: Cylindrical tapering to a distinct collulum, 7-10 μm x 2-2.5 μm

Metulae: Cylindrical, 7.5-10 μm x 2.2-3.5 μm

Rami: Cylindrical, 16-27 μm x 3.2-4 μm

Stipes: Finely rough and smooth-walled, 75-1000 μm x 2.2-3 μm

Synnemata or fasciculation: Yellow synnemata, especially on MEA and OAT

Sclerotia: None

Colony texture: Floccose to fasciculate

Conidium colour on CYA: Green (artemisia to lily green)

Mycelium colour: yellow

Exudate droplets on CYA: Present, yellow to red brown droplets

Reverse colour on CYA: Yellow brown to reddish brown

Reverse colour on YES: Yellow

Diffusible colour on CYA: Yellow brown

Ehrlich reaction: Light violet

Odour and volatile metabolites: Isobutanol, isopentanol (Larsen & Frisvad, 1995)

Extrolites: 1) Terrestrial acid, carolic acid, carlosic acid, 2) Roquefortine C

Growth on creatine: Moderate to good

Acid and base production on creatine: Moderate to good acid production

Growth on UNO: Moderate to good

Growth on nitrite: Weak

Abiotic factors:

Diam., 1 week, 25°C: CYA: 27-41 mm; MEA: 23-35 mm; YES: 27-45 mm; CREA: 19-25 mm; Cz: 21-29 mm, OAT: 27-33 mm; CYAS: 37-40 mm; CzBS: 17-24 mm; CzP: 0-2 mm; UNO: 8-18 mm; DG18: 29-34 mm

Diam., CYA, 1 week: 5°C: 2-4 mm; 15°C: 19-31 mm; 30°C: 10-17 mm; 37°C: 0 mm

CYA/CYAS: 0.8 [0.7-1.0]

CYA15°C/CYA 25°C: 0.9 [0.7-1.0]

CYA30°C/CYA 25°C: 0.4 [0.3-0.5]

CZBS/CZ: 0.7 [0.5-0.9]

CZP/CZ: 0.02 [0-0.05]

Distribution: Denmark, Sweden, Netherlands, Germany, United Kingdom

Ecology and habitats: Barley, wheat, wheat field soils

Biotechnological applications: None

Biodeterioration & phytopathology: Cereal decomposition

Mycotoxins and mycotoxins: Roquefortine C is a potential mycotoxin in cereals

Typical cultures: IBT 21532 = IBT 4505 = CBS 560.90, ex *Hordeum vulgare*, Denmark (Y); IBT 3084 = CBS 473.84, ex *Lycopersicon esculentum*, Denmark; IBT 15999 = CBS 110097, ex cereal, Denmark; IBT 16374 = CBS 110122, ex wasted barley kernel, Denmark; IBT 4900 = CBS 559.90, ex fern in greenhouse, Netherlands; IBT 23023 = CBS 704.68, ex *Hordeum vulgare*, Netherlands; IBT 23024 = CBS 788.70 = IMI 197487, ex cereal, United Kingdom; IBT 11204 = CBS 112440, ex *Hordeum vulgare*, Denmark; IBT 6470 = CBS 558.90, ex wheat field soil, Denmark; IBT 6766 = 557.90, ex *Hordeum vulgare*, Denmark; IBT 3513 = CBS 220.90, ex *Hordeum vulgare*, Denmark; CBS 813.70, ex straw in soil, Denmark; CBS 703.68, ex *Hordeum vulgare*, Denmark; CBS 702.68 = IMI 197486 = FRR 1743, ex grain of *Hordeum vulgare*, Denmark.

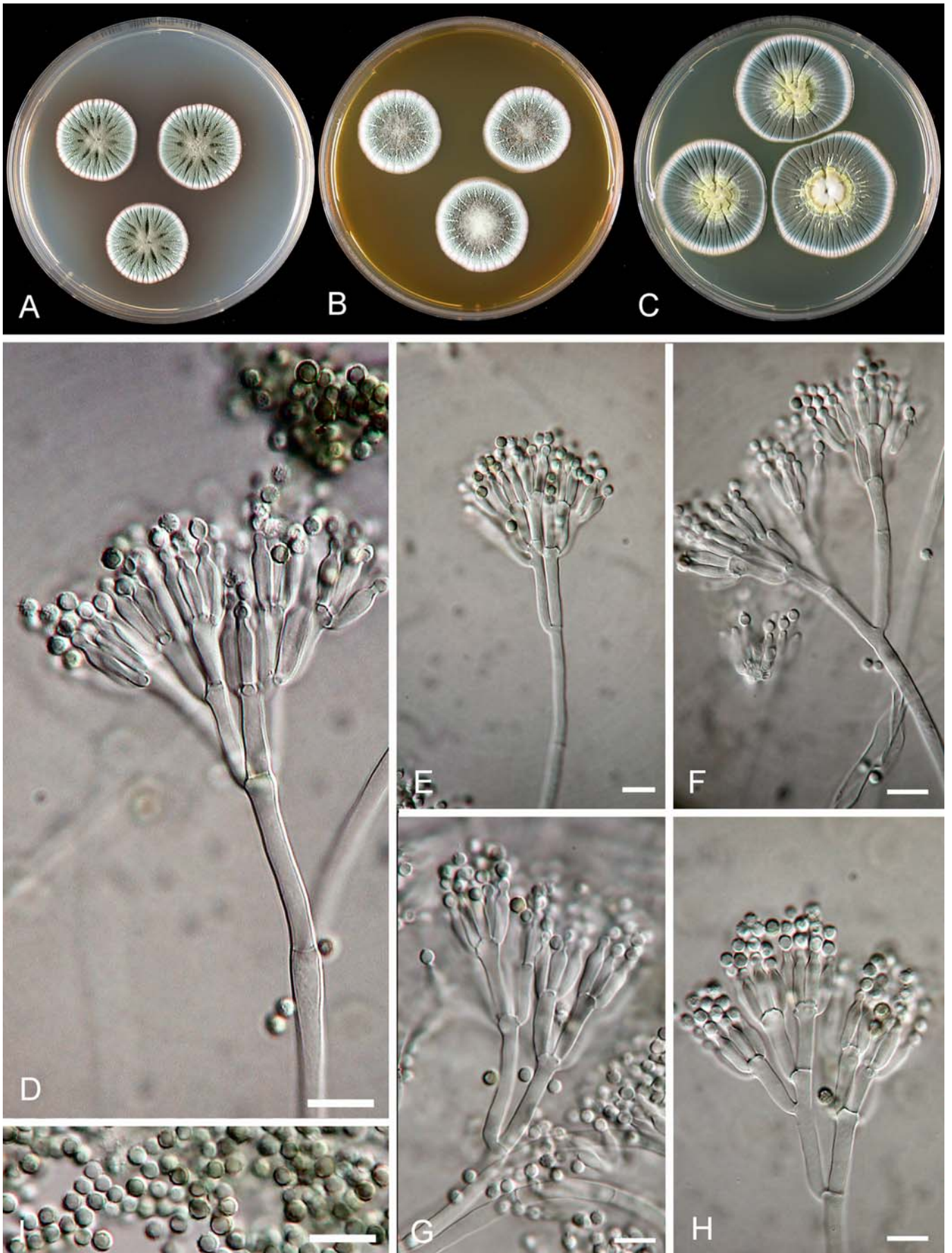


Fig. 59. *Penicillium hordei*. 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 μm .

P. italicum Wehmer, Hedwigia **33**: 211, 1894

In *Penicillium* subgenus *Penicillium* section *Penicillium* series *Italica*

Type (neo): CBS 339.48

Culture ex type: CBS 339.48 = IBT 23029 = IMI 039760 = ATCC 10454 = FRR 983 = NRRL 983, ex citrus fruit, Riverside, California, USA (T)

Diagnostic features: cylindrical to ellipsoidal smooth-walled conidia, poor growth and no acid production on CREA, crustose on YES, deoxybrevianamide E

Similar species: *P. italicum* grows much faster than *P. ulaiense* and is more colourful.

Description:

Conidiophores: Terverticillate, appressed elements, born from subsurface hyphae

Conidia: Smooth-walled, ellipsoidal to cylindrical, 3.5-5 µm x 2.2-3.5 µm

Phialides: Cylindrical tapering to a distinct collulum, 8-15 µm x 2.5-4.5 µm

Metulae: Cylindrical, 14-20 µm x 3.5-4 µm

Rami: Cylindrical, 12-20 µm x 3.2-4.5 µm

Stipes: Smooth-walled, 100-300 µm x 3-5 µm

Synnemata or fasciculation: Fasciculate in the colony margins

Sclerotia: Reported in fresh isolates, colourless to light brown, 200-500 µm (Raper and Thom, 1949)

Colony texture: Velutinous to fasciculate, crustose

Conidium colour on CYA: Grey green

Exudate droplets on CYA: None or small clear droplets

Reverse colour on CYA: Pale, brownish orange or red brown

Reverse colour on YES: Red brown

Diffusible colour on CYA: None

Ehrlich reaction: None

Odour and volatile metabolites: Ethyl acetate, isopentanol, linalool, isobutanol, 1-octene, ethyl butanoate, ethyl 2-methyl-butanoate, 1-nonene, styrene, citronellene? (Larsen & Frisvad, 1995)

Extrolites: 1) Italinic and italicic acid, 2) 2,5-dihydro-4-methoxy-2H-pyran-2-one & verrucolone, 3) deoxybrevianamide E, 4) formylxanthocillin X, 5) dehydrofulvic acid,

PI-3 & PI-4, 6) 4-methoxy-6-n-propenyl-2-pyrone, 7) 5-hydroxymethyl-2-furic acid, 7) Abscisic acid

Growth on creatine: Weak

Acid and base production on creatine: No acid

Growth on UNO: Very good

Growth on nitrite: Weak

Abiotic factors:

Diam., 1 week, 25°C: CYA: 26-50 mm; MEA: 22-47 mm; YES: 31-71 mm; CREA: 6-12 mm; Cz: 19-34 mm, OAT: 24-38 mm; CYAS: 3-17 mm; CzBS: 14-32 mm; CzP: 0 mm; UNO: 5-19 mm; DG18: 23-48 mm

Diam., CYA, 1 week: 5°C: 2-4 mm; 15°C: 17-34 mm; 30°C: 0-12 mm; 37°C: 0 mm

CYA/CYAS: 5.4 [2.2-11]

CYA15°C/CYA 25°C: 0.7 [0.6-0.8]

CYA30°C/CYA 25°C: 0.1 [0-0.2]

CZBS/CZ: 0.8 [0.4-0.9]

CZP/CZ: 0

Distribution: Italy, Spain, Portugal, (imported to Denmark, Germany, Netherlands, Australia etc.), Turkey, Israel, Egypt, Libya, Cyprus, Ghana, Zambia, Zimbabwe, South Africa, India, Australia, New Zealand

Ecology and habitats: Citrus fruits and debris in soil. See also Domsch *et al.* (1980)

Biotechnological applications: None

Biodeterioration & phytopathology: *P. italicum* is pathogenic to citrus fruits.

Mycotoxins and mycotoxins: The toxicity of the many extrolites produced by *P. italicum* is unknown.

Typical cultures: IBT 21533 = CBS 489.84, ex *Raphanus sativus*, Denmark (Y); IBT 23026 = CBS 495.75, ex soil, Uttar Pradesh, India; IBT 23028 = CBS 490.75, ex fruit of *Citrus* sp., Israel; IBT 23030 = CBS 278.58 = DSM 2428, ex fruit of *Citrus sinensis*, Netherlands; IBT 18097 = CBS 112437 = FRR 1312, ex fruit of *Citrus limon*, Sydney, N.S.W., Australia; IBT 15661 = CBS 112480, ex food product, Turkey; IBT 12955, ex mouldy fruit of *Citrus sinensis*, Denmark; CBS 719.73 = DSM 2417, ex *Citrus* sp., Israel (*P. italicum* var. *avellaneum*).

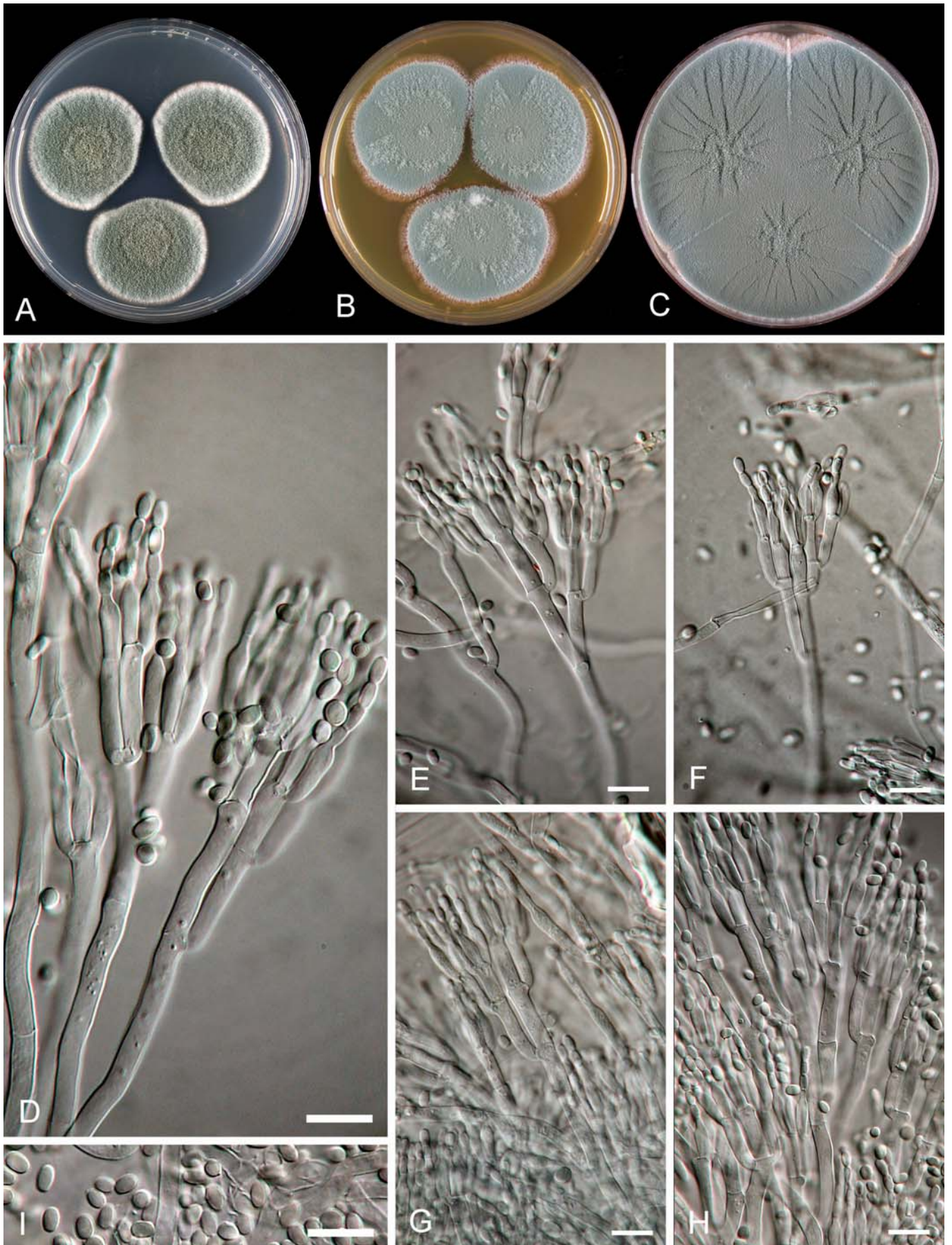


Fig. 60. *Penicillium italicum*. 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 µm.

P. marinum Frisvad & Samson, **sp. nov.**

In *Penicillium* subgenus *Penicillium* section *Penicillium* series *Expansa*

Type: Herb. CBS 109550

Culture ex type: CBS 109550 = IBT 14360, ex sandy soil, Japan (**T, Y**)

Diagnostic features: Expansolide, patulin, penostatins, subglobose smooth-walled conidia

Similar species: *P. expansum* is growing much faster than *P. marinum*. *P. marinum* cannot produce an apple rot like *P. expansum*.

Description:

Conidiophores: Terverticillate, with divergent rami born from aerial and subsurface hyphae

Conidia: Smooth-walled, globose to subglobose, 2.5-3.2 µm

Phialides: Cylindrical, with short broad collula, 8-12 µm x 2.2-3.5 µm

Metulae: Cylindrical, 10-16 µm x 2.5-4 µm

Rami: Cylindrical, 15-22 µm x 3-4 µm

Stipes: Smooth, 200-400 µm x 3-4 µm

Synnemata or fasciculation: None

Sclerotia: None

Colony texture: Velutinous to lanose

Conidium colour on CYA: Blue green to green on CYA,

Exudate droplets on CYA: Present, clear to yellow or orange

Reverse colour on CYA: Brown to dark brown

Reverse colour on YES: Cream yellow

Diffusible colour on CYA: None

Ehrlich reaction: Strong reaction

Odour and volatile metabolites: Unknown

Extrolites: 1) Patulin, 2) 3,5-dimethyl-6-hydroxyphthalide, 3) Expansolide, 4) Penostatins, 5) Aurantioclavine and

communesins, 6) Roquefortine C, 7) Chaetoglobosins and penochalasin

Growth on creatine: Good growth

Acid and base production on creatine: Acid under colony and often around colony

Growth on UNO: Good

Growth on nitrite: Good (except two of the mutants)

Abiotic factors:

Diam., 1 week, 25°C: CYA: 17-27 mm; MEA: 8-16 mm; YES: 23-40 mm; CREA: 14-18 mm; Cz: 11-17 mm, OAT: 17-25 mm; CYAS: 17-24 mm; CzBS: 4-13 mm; CzP: 0 mm; UNO: 6-12 mm; DG18: 15-23 mm

Diam., 1 week: 15°C: 17-24 mm; 30°C: 0 mm; 37°C: 0 mm

CYA/CYAS: 1.0 [0.8-1.2]

CYA15°C/CYA 25°C: 1.1 [1.0-1.3], psychrotolerant

CYA30°C/CYA 25°C: 0

CZBS/CZ: 0.5 [0.3-0.8]

CZP/CZ: 0

Distribution: Tunisia, Japan

Ecology and habitats: Marine species found on an *Enteromorpha* sp. and in coastal sand.

Biotechnological applications: Potential production of penostatins and communesins

Biodeterioration & phytopathology: Unknown

Mycotoxins and mycotoxins: Patulin and communesins, but the species has not been found on foods or feeds

Typical cultures: IBT 16712 = CBS 109549, ex sandy soil, Tunisia

Mutant strains of CBS 109549: IBT 16715 = CBS 109548;

IBT 16713 = CBS 109547; IBT 16714 = CBS 109546;

IBT16716 = CBS 109545.



Fig. 61. *Penicillium marinum*. 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 µm.

P. melanoconidium (Frisvad) Frisvad & Samson,
comb. nov.

In *Penicillium* subgenus *Penicillium* section *Viridicata*
series *Viridicata*

Type: Herb. IMI 321503

Culture ex type: IBT 3444 = IMI 321503, ex wheat,
Denmark (T)

Diagnostic features: Penicillic acid, sclerotigenin, verrucosidin, oxaline, dark green smooth-walled conidia, curry yellow reverse on CYA,

Similar species: *P. melanoconidium* has much darker green conidia than *P. viridicatum*. It differs from *P. polonicum* by its dark green rather than blue green conidia. The distinctive black brown halo produced by most members of series *Viridicata* is not produced by *P. melanoconidium*.

Description:

Conidiophores: Terverticillate, appressed elements, born from subsurface hyphae

Conidia: Smooth-walled, globose to subglobose, 2.5-3.5 μm .

Phialides: Cylindrical tapering to a distinct collulum, 7.5-9 μm x 2.2-2.8 μm

Metulae: Cylindrical, 9.5-14 μm x 3.2-4.2 μm

Rami: Cylindrical, 15-23 μm x 3.2-4.2 μm

Stipes: Rough walled, 100-500 μm x 3-4 μm

Synnemata or fasciculation: Not observed

Sclerotia: None

Colony texture: Velutinous

Conidium colour on CYA: Dark green

Exudate droplets on CYA: Present, clear

Reverse colour on CYA: Curry yellow

Reverse colour on YES: Yellow (strong sporulation on YES)

Diffusible colour: None

Ehrlich reaction: Pink

Odour and volatile metabolites: Isobutanol, isopentanol (Larsen & Frisvad, 1995)

Extrolites: 1) Penicillic acid, 2) Verrucosidin, 3) Xanthomegnin, viomellein and vioxanthin, 4) Penitrem A, 5)

Roquefortine C, meleagrins, oxaline, 6) Sclerotigenin

Growth on creatine: Weak

Acid and base production on creatine: Good acid production, no base

Growth on UNO: Weak

Growth on nitrite: Weak

RT: No black brown halo

Abiotic factors:

Diam., 1 week, 25°C: CYA: 17-27 mm; MEA: 18-36 mm; YES: 31-46 mm; CREA: 16-24 mm; Cz: 22-25 mm, OAT: 22-32 mm; CYAS: 34-40 mm; CzBS: 16-22 mm; CzP: 0 mm; UNO: 10-11 mm; DG18: 26-30 mm

Diam., CYA, 1 week: 5°C: 2-4 mm; 15°C: 18-23 mm; 30°C: 13-18 mm; 37°C: 0 mm

CYA/CYAS: 0.7 [0.6-0.7]

CYA15°C/CYA 25°C: 0.9 [0.8-1.0]

CYA30°C/CYA 25°C: 0.6 [0.6-0.8]

CZBS/CZ: 0.8 [0.7-0.9]

CZP/CZ: 0

Distribution: Denmark, United Kingdom, Canada, Washington (USA)

Ecology and habitats: Barley, wheat, rye, oats, rice

Biotechnological applications: None

Biodeterioration & phytopathology: May deteriorate cereals

Mycotoxins and mycotoxins: Penicillic acid, verrucosidin, xanthomegnin, viomellein, vioxanthin may be produced in cereals

Typical cultures: IBT 3435x = CBS 109542, ex cereal, Denmark; IBT 21534 = IBT 11406 = CBS 641.95, ex mixed cereal feeds for birds, Denmark (Y); IBT 10031 = CBS 640.95, ex *Panicum miliaceum* imported to Denmark; IBT 3443 = CBS 218.90, ex *Hordeum vulgare*, Denmark; IBT 3445 = CBS 653.95, ex cereal, Denmark; IBT 22052 = CBS 109604 = PIL 333a, ex cereal, United Kingdom; IBT 15983 = CBS 109606, ex mixed pig feed, Bulgaria; IBT 6672 = CBS 109603 = NRRL 958, Pullman, Washington; IBT 15448 = CBS 109605; CBS 219.90 = IBT 3702, ex *Triticum aestivum*, United Kingdom; CBS 186.88, ex *Hordeum vulgare*, Denmark; ATCC 64627, ex wheat, Denmark; NRRL 13628, ex wheat, Denmark; IMI 351502, ex barley, Denmark.

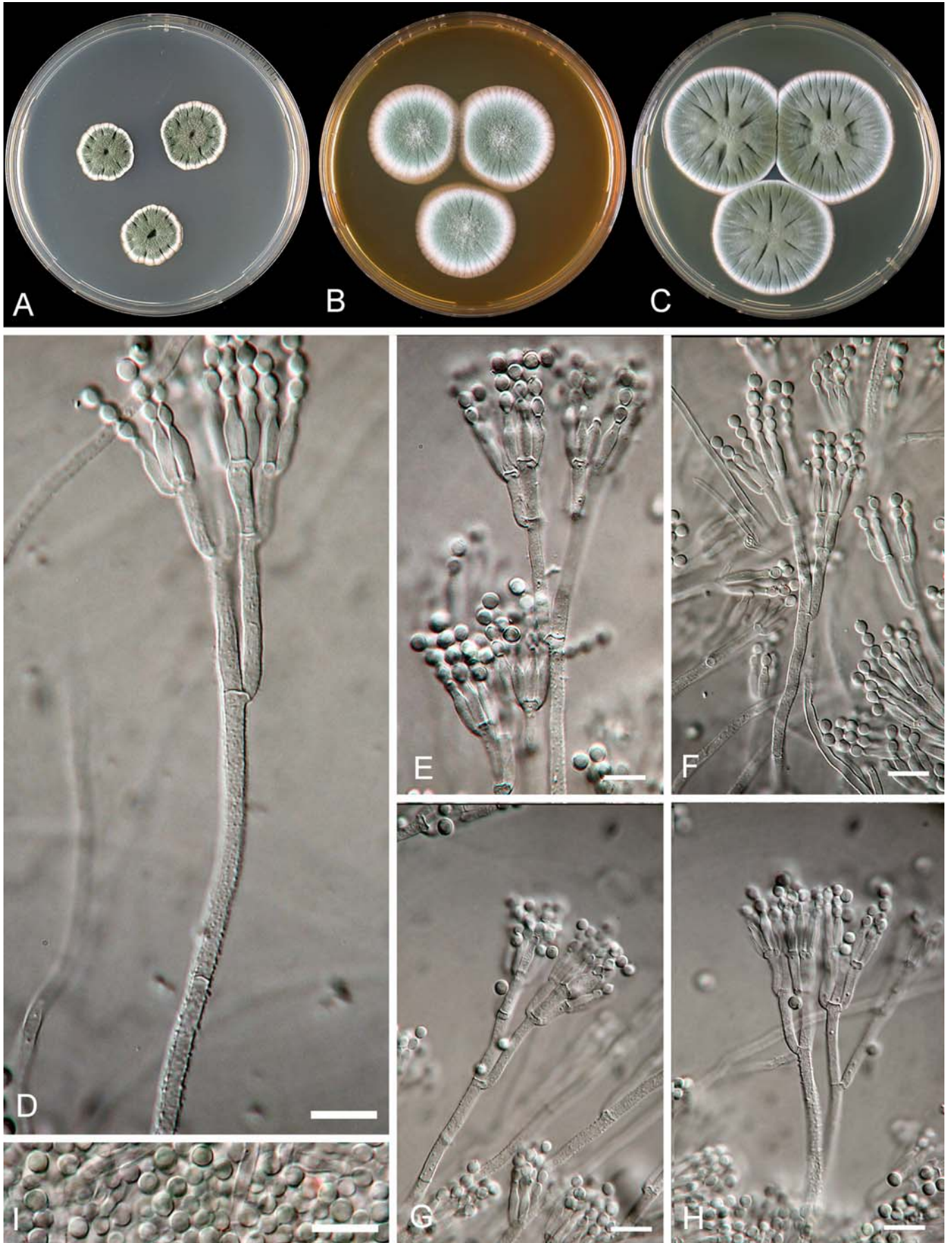


Fig. 62. *Penicillium melanoconidium*. 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 μ m.

P. mononematosum (Frisvad, Filt. & Wicklow)
Frisvad, Mycologia **81**: 857, 1989

In *Penicillium* subgenus *Penicillium* section *Chrysogena* series *Mononematosum*

Type: Herb. IMI 296925

Culture ex type: CBS 172.87 = IBT 3072 = IBT 5518 = IBT 21535 = IMI 296925 = NRRL 13482 = NRRL A-26709, ex burrow system of *Dipodomys spectabilis*, 6 km east of Portal, Arizona (**T, Y**)

Diagnostic features: Fumitremorgins, verrucologen, cyclopaldic acid, divergent structures and often 2 rami, smooth-walled conidia, very good growth at 30°C

Similar species: See *P. confertum*

Description:

Conidiophores: Terverticillate to quaterverticillate, appressed and divergent elements, born from subsurface hyphae

Conidia: Smooth-walled, subglobose to broadly ellipsoidal, 3.2-3.7 µm x 2.5-3.2 µm

Phialides: Flask shaped with a distinct broad collulum, 7.5-10 µm x 2.5-3.2 µm

Metulae: Cylindrical, 10-15 µm x 3-4 µm

Rami: Cylindrical, 15-25 µm x 3-4 µm

Stipes: Broad smooth-walled 200-500 µm x 3-4.5 µm

Synnemata or fasciculation: None

Sclerotia: None

Colony texture: Velutinous

Conidium colour on CYA: Blue green to green

Exudate droplets on CYA: Copious, clear

Reverse colour: Beige to greyish cream

Diffusible colour: None

Ehrlich reaction: None

Odour and volatile metabolites: Not examined

Extrolites: 1) Cyclopaldic acid, 2) Isochromantoxins, 3) fumitremorgins and verrucologen, 4) Viriditoxin

Growth on creatine: Weak to moderate

Acid and base production on creatine: Moderate acid production

Growth on UNO: Weak

Growth on nitrite: Weak

Abiotic factors:

Diam., 1 week, 25°C: CYA: 19-34 mm; MEA: 13-35 mm; YES: 25-58 mm; CREA: 17-25 mm; Cz: 12-26 mm, OAT: 27-33 mm; CYAS: 20-38 mm; CzBS: 14-24 mm; CzP: 0 mm; UNO: 2-27 mm; DG18: 18-39 mm

Diam., CYA, 1 week: 5°C: 2-3 mm; 15°C: 18-24 mm; 30°C: 26-33 mm; 37°C: 0 mm

CYA/CYAS: 1.0 [0.7-1.4]

CYA15°C/CYA 25°C: 0.7 [0.6-0.8]

CYA30°C/CYA 25°C: 0.9 [0.8-1.2]

CZBS/CZ: 1.0 [0.6-1.3]

CZP/CZ: 0

Distribution: France, Arizona and New Mexico (USA), Egypt (type II)

Ecology and habitats: Cheek pouches and mounds of kangaroo rats, seeds of *Amaranthus* sp., Rocky Mountain desert soil, salt marsh soil (type II)

Biotechnological applications: None

Biodeterioration & phytopathology: Unknown

Mycotoxins and mycotoxins: Fumitremorgin A, B, verrucologen, isochromantoxin are toxic, but *P. mononematosum* has not been found to produce the mycotoxins in any food or feed samples.

Typical cultures: T118 = IBT 20392 = RMF 9577; IBT 6071 = CBS 112104 = NRRL A-26710 = NRRL 13483 = IMI 296932, ex cheek pouch of banner-tailed kangaroo rat, 6 km east of Portal, Arizona, USA; NRRL 13484, ex cheek pouch of banner-tailed kangaroo rat, 6 km east of Portal, Arizona, USA; IBT 12628 = CBS 112102, ex wine cork, Portugal; IBT 12410 = CBS 112103, ex kangaroo rat mound, Sevilleta, New Mexico, USA; IBT 11891 = CBS 112105, squash, France; IBT 11682 = CBS 112106, Jerusalem artichoke, Denmark; IBT 5510 = CBS 112107, ex soil, Walnut Crater, Arizona, USA; IBT 5507 = IBT 4391 = CBS 112434 = IBT 4308 = CBS 112575 = CBS 112435 {type II}, ex salt marsh soil, Egypt; T291 = IBT 5509 = CBS 109616 (type II), ex salt marsh soil, Egypt.

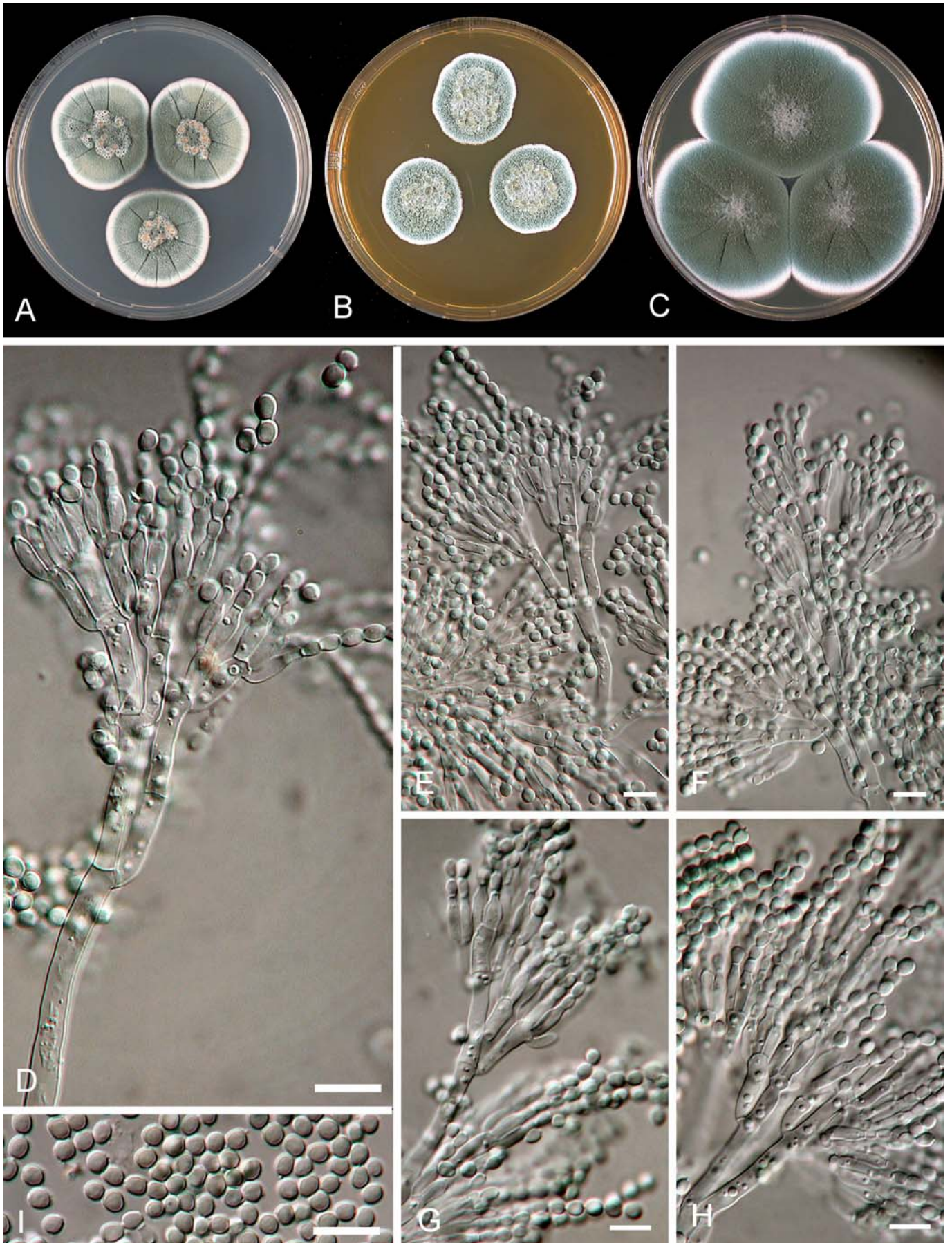


Fig. 63. *Penicillium mononematosum*. 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 μm.

P. nalgiovensis Laxa, Zentbl. Bakt. ParasitKde.,
Abt. II **86**: 162, 1932

In *Penicillium* subgenus *Penicillium* section *Chrysogena*
series *Chrysogena*

Type: Herb. CBS 352.48

Culture ex type: CBS 352.48 = CBS 101030 = IBT 21536
= IBT 3800 = IMI 039804 = ATCC 10472 = CCF 1728 =
CCRC 31671 = DSM 897 = FRR 911 = IFO 8112 = MUCL
31194 = NRRL 911 = QM 7600, ex Ellischauer cheese,
Czech Republic (**T,Y**)

Diagnostic features: Penicillin F & G, nalgiovensin,
smooth-walled conidia, orange reverse on YES, divergent
structures, dark green conidia in fresh isolates

Similar species: See *P. dipodomyis*.

Description:

Conidiophores: Bi-, ter- and quarterverticillate both divergent
metulae and rami born from aerial and subsurface
hyphae

Conidia: Smooth-walled, globose to subglobose to broadly
ellipsoidal, 3-4 µm x 2.3-3.5 µm

Phialides: Flask-shaped, with short wide collula, 8-10 µm x
2-2.5 µm

Metulae: Cylindrical, 7-15 µm x 2.5-3 µm

Rami: Cylindrical, 15-20 µm x 3-4 µm

Stipes: 200-300 µm x 3-4 µm

Synnemata or fasciculation: None

Sclerotia: None

Colony texture: Velutinous

Conidium colour on CYA: Dark green (occasionally white)

Exudate droplets on CYA: clear

Reverse colour on CYA: cream to yellow to orange to dark
orange brown

Reverse colour on YES: Bright yellow to orange

Diffusible colour: yellow brown in CBS 352.48 and IBT
13039

Ehrlich reaction: None

Odour and volatile metabolites: Ethyl acetate, isobutanol,
styrene, 3-octanone

Extrolites: 1) Nalgiovensin, nalgiofaxin, 2) Diaporthis, 3)

Penicillin F & G, 4) Dipodazin

Growth on creatine: Weak

Acid and base production on creatine: No acid

Growth on UNO: Very good

Growth on nitrite: Very good

Abiotic factors:

Diam., 1 week, 25°C: CYA: 18-34 mm; MEA: 9-27 mm;
YES: 28-45 mm; CREA: 14-20 mm; Cz: 13-27 mm, OAT:
14-25 mm; CYAS: 31-42 mm; CzBS: 6-25 mm (0 mm in
one isolate); CzP: 0 mm; UNO: 13-17 mm; DG18: 25-35
mm

Diam., CYA, 1 week: 5°C: 1-4 mm; 15°C: 14-25 mm;
30°C: 5-16 mm (1 mm in one isolate); 37°C: 0 mm

CYA/CYAS: 0.8 [0.6-0.9]

CYA15°C/CYA 25°C: 0.7 [0.6-0.8]

CYA30°C/CYA 25°C: 0.4 [0.05-0.6]

CZBS/CZ: 0.6 [0-0.9]

CZP/CZ: 0

Distribution: Svalbard (Norway), Denmark, Germany,
Italy, Canada

Ecology and habitats: Cheese, salami, desert sand

Biotechnological applications: Fermentation of salami
(Hungary, Germany, Italy, Spain)

Biodeterioration & phytopathology: Unknown

Mycotoxins and mycotoxins: The toxicity of nalgioven-
sin, nalgiofaxin, dipodazin and diaporthis are unknown.

Typical cultures: IBT 13039 = CBS 109607, ex cheese,
Crete, Greece; IBT 15040 = CBS 297.97 = CBS 258.94, ex
sandy soil, California, USA; IBT 13042 = CBS 109608, ex
salami; IBT 12108, ex cheese, Denmark; IBT 11965 = CBS
109610 = FRR 3284, ex salami, Germany; IBT 12383 =
CBS 318.92, ex salami; IBT 23346 = CBS 112438, ex ice,
Svalbard, Norway; IBT 22527 = CBS 112439, ex salami;
IBT 11970 = Sp 1785, ex salami, Germany; IBT 12640 =
CBS 315.92, ex salami, Denmark; IBT 12372 = CBS
316.92, ex salami, Denmark; IBT 12648 = CBS 317.92, ex
salami, Denmark; IBT 12383 = CBS 318.92, ex salami,
Denmark; IBT 12561 = CBS 319.92, ex salami, Denmark,
CBS 390.92, ex salami; IBT 12420 = CBS 321.92, ex
salami, Denmark; CBS 257.94, ex sandy soil, California.

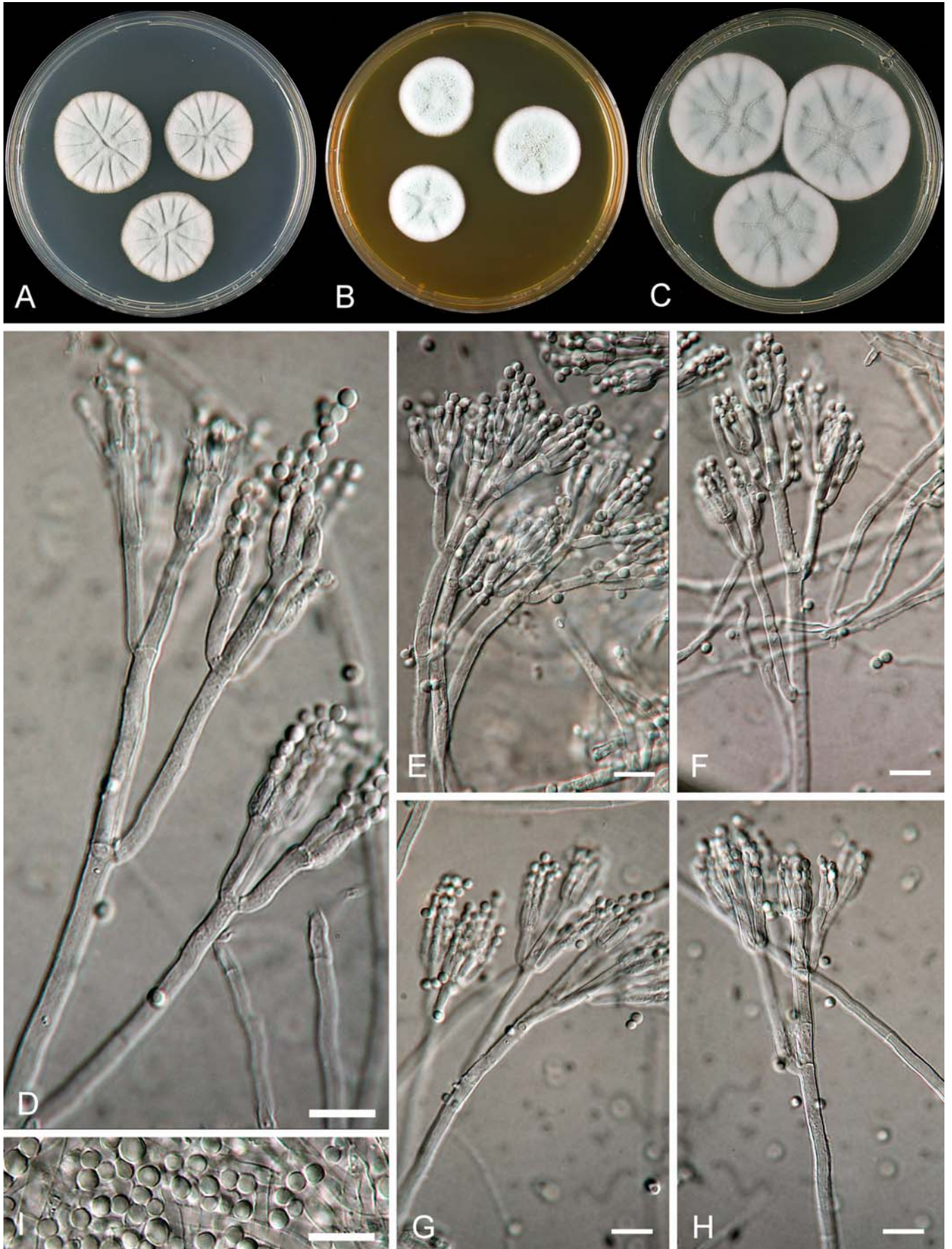


Fig. 64. *Penicillium nalgiovense*. 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 μm.

P. neoechinulatum (Frisvad, Filt. & Wicklow)
Frisvad & Samson, **comb. nov.**

In *Penicillium* subgenus *Penicillium* section *Viridicata* series *Viridicata*

Type: Herb. IMI 296937

Culture ex type: CBS 169.87 = CBS 101135 = IBT 3493 = IBT 21537 = IMI 296937 = NRRL 13486 = NRRL A-27178, ex cheek pouch of *Dipodomys spectabilis*, 8 km east of Portal, Arizona, USA (**T, Y**)

Diagnostic features: rough-walled conidia, weak growth on CREA, penicillic acid, cyclopenin, cyclophenol

Similar species: Other members of series *Viridicata* have smooth to very finely roughened conidia.

Description:

Conidiophores: Terverticillate, appressed elements, born from subsurface and aerial hyphae

Conidia: Rough-walled, globose to subglobose, 2.6-3.4 µm.

Phialides: Cylindrical tapering to a distinct collulum, 7-9 µm x 2.2-2.8 µm

Metulae: Cylindrical apically swollen, 9.5-13 µm x 3.2-4.2 µm

Rami: Cylindrical, 15-25 µm x 3.2-4.2 µm

Stipes: Finely roughened and smooth walls, 100-550 µm x 3-4 µm

Synnemata or fasciculation: Weakly fasciculate

Sclerotia: None

Colony texture: Floccose to weakly fasciculate

Conidium colour on CYA: Blue green

Exudate droplets on CYA: Copious, clear

Reverse colour on CYA: Yellow, orange to red brown

Reverse colour on YES: Yellow

Diffusible colour: Pink, orange or red brown

Ehrlich reaction: Strong, red violet

Odour and volatile metabolites: Not examined

Extrolites: 1) Penicillic acid, 2) Aurantiamine, 3)

Cyclopeptin, dehydrocyclopeptin, cyclophenin, cyclophenol, viridicatol, 3-methoxyviridicatin

Growth on creatine: Weak

Acid and base production on creatine: Strong acid production

Growth on UNO: Weak

Growth on nitrite: Weak

RT: Blackish brown halo

Abiotic factors:

Diam., 1 week, 25°C: CYA: 24-35 mm; MEA: 24-34 mm; YES: 26-43 mm; CREA: 14-23 mm; Cz: 22-27 mm, OAT: 22-32 mm; CYAS: 32-38 mm; CzBS: 15-26 mm; CzP: 0 mm; UNO: 8-12 mm; DG18: 20-27 mm

Diam., CYA, 1 week: 5°C: 2-4 mm, 15°C: 24-28 mm; 30°C: 13-17 mm; 37°C: 0 mm

CYA/CYAS: 1.0 [0.8-1.1]

CYA15°C/CYA 25°C: 0.8 [0.8-0.9]

CYA30°C/CYA 25°C: 0.4 [0.4-0.5]

CZBS/CZ: 0.9 [0.7-1.1]

CZP/CZ: 0

Distribution: Arizona (USA)

Ecology and habitats: Mounds and cheek pouches of kangaroo rats

Biotechnological applications: None

Biodeterioration & phytopathology: Unknown

Mycotoxins and mycotoxins: Penicillic acid produced, but *P. neoechinulatum* has not been found in foods.

Typical cultures: IBT 23266 = IBT 5583 = CBS 101472 = NRRL A-26679 = IMI 321490; IBT 5603 = CBS 101468 = NRRL A-26677; IBT 5600 = CBS 110342 = NRRL A-26680; IBT 5414 = CBS 110341 = NRRL A-27001; IBT 5595 = CBS 110343 = NRRL A-26842; IBT 5424 = CBS 110339 = NRRL A-27003; IBT 5582 = CBS 110340 = NRRL A-26859; CBS 101469 = IBT 5591 = NRRL A-27147; CBS 101470 = IBT 5590 = NRRL A-27151; CBS 101471 = IBT 5587 = NRRL A-26838; all strains are from mounds or cheek pouches of kangaroo rats, live trapped 6 km east of Portal, Arizona, USA.

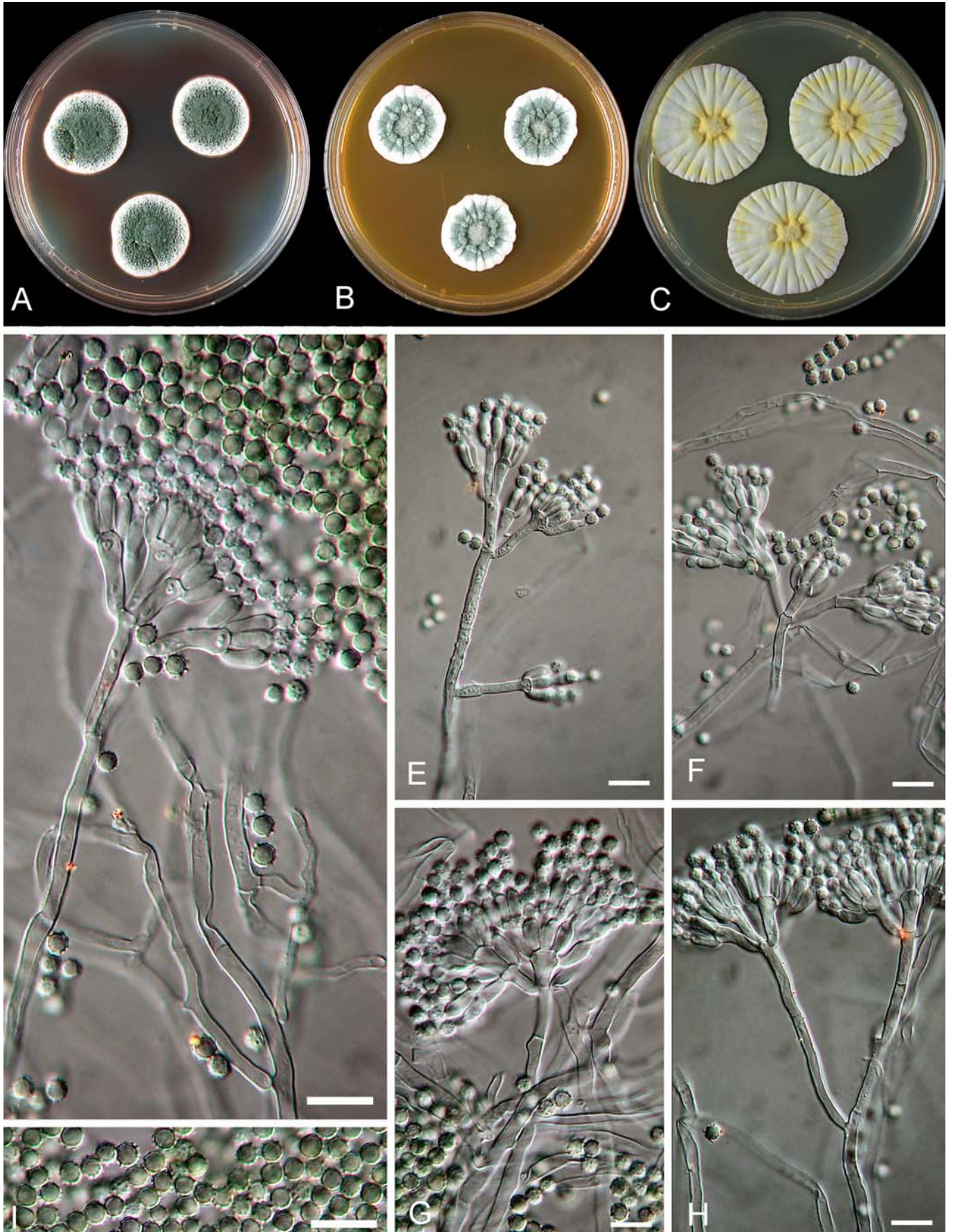


Fig. 65. *Penicillium neoechimulatum*. 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 μ m.

P. nordicum Dragoni & Cantoni ex Ramírez,
Adv. Pen. Asp. Syst.: 139, 1985

In *Penicillium* subgenus *Penicillium* section *Viridicata*
series *Verrucosa*

Type: ATCC 44219

Culture ex type: IBT 13307 = ATCC 44219, ex salami,
Italy (T)

Diagnostic features: smooth-walled conidia, ochratoxin A,
verrucolone, anacine, good growth on UNO and nitrite,
poor growth and no acid production of CREA, rough
conidiophore stipes

Similar species: *P. verrucosum* is the most similar and
closely related species, but *P. nordicum* has a cream yellow
reverse on YES in contrast to the red brown to terracotta
reverse of *P. verrucosum*.

Description:

Conidiophores: Terverticillate, appressed elements, born
from surface or subsurface hyphae

Conidia: Rough-walled, globose to subglobose, 2.6-3.4 µm.

Phialides: Cylindrical tapering to a distinct collulum, 7-9
µm x 2.2-2.8 µm

Metulae: Cylindrical, 8-13 µm x 3-4 µm

Rami: Cylindrical, 12-22 µm x 3-4 µm

Stipes: Rough walled, 200-450 µm x 3-4 µm

Synnemata or fasciculation: Weakly fasciculate

Sclerotia: None

Colony texture: Velutinous to floccose, often weakly
fasciculate

Conidium colour on CYA: Green

Exudate droplets on CYA: Copious, clear to light yellow

Reverse colour on CYA: Cream often with brown center

Reverse colour on YES: Cream yellow

Diffusible colour on CYA: None

Ehrlich reaction: Yellow green reaction

Odour and volatile metabolites: As in *P. verrucosum*

Extrolites: 1) Verrucolone, 2) Ochratoxin A & B, 3) ana-
cine, 4) sclerotigenin, 5) lumpidin (only fish roe type), 6)
Viridic acid

Growth on creatine: Weak

Acid and base production on creatine: None

Growth on UNO: Very good

Growth on nitrite: Very good

Abiotic factors:

Diam., 1 week, 25°C: CYA: 8-21 mm; MEA: 6-16 mm;
YES: 14-36 mm; CREA: 6-12 mm; Cz: 10-17 mm, OAT: 9-
19 mm; CYAS: 14-30 mm; CzBS: 4-10 mm; CzP: 0 mm;
UNO: 9-14 mm; DG18: 21-26 mm

Diam., CYA, 1 week: 5°C: 2-4 mm, 15°C: 8-21 mm; 30°C:
0 mm; 37°C: 0 mm

CYA/CYAS: 0.8 [0.4-1.0]

CYA15°C/CYA 25°C: 1.0 [0.6-1.2]

CYA30°C/CYA 25°C: 0

CZBS/CZ: 0.5 [0.3-0.7]

CZP/CZ: 0

Distribution: Greenland, Svalbard (Norway), Denmark,
Italy, Spain, Japan, Australia, Indonesia

Ecology and habitats: Refrigerated dry meat (salami, ham,
chicken), salted fish, fish roe, cheese and jam

Biotechnological applications: None

Biodeterioration & phytopathology: Degrading meat
products

Mycotoxinoses and mycotoxins: Ochratoxin A is produced
by all strains and can also be produced in meat products
(Spotti *et al.*, 2001). It may play a more prominent role in
Balkan Endemic Nephropathy than hitherto believed.

Typical cultures: IBT 5105 = CBS 112573 = NRRL 5547
= FRR 1642, ex salami, Italy; IBT 6728 = CBS 110770, ex
salami, Germany (Y); IBT 6734 = CBS 483.84, ex cheese,
Denmark; IBT 14172 = CBS 606.68, ex chicken meat,
Germany; IBT 12797 = CBS 112565 = NRRL A-19175, ex
sausage, Italy; IBT 14745 = CBS 110769, ex cheese, Spain;
IBT 12802 = CBS 110771 = NRRL 6061 = NRRL A-
19166, ex sausage, Italy; IBT 22949 = CBS 112321 = FRR
5205, ex wheat, southern part of Western Australia; ATCC
44220, ex salami, Italy (*P. mediolanense*); NRRL 5573 =
FRR 1641, ex salami, Italy; Fish roe type: IBT 6573 = CBS
109541, ex roe of *Lumpus*; IBT 12806 = CBS 109536 =
NRRL 1161, ex air in meat packing plant, Canada; IBT
13943 = CBS 109535, ex Serano ham, Spain; IBT 13958 =
CBS 109539, ex Spanish ham; IBT 22528 = CBS 109538,
ex fish roe, Denmark; IBT 22532 = CBS 109537, ex jam,
Japan.