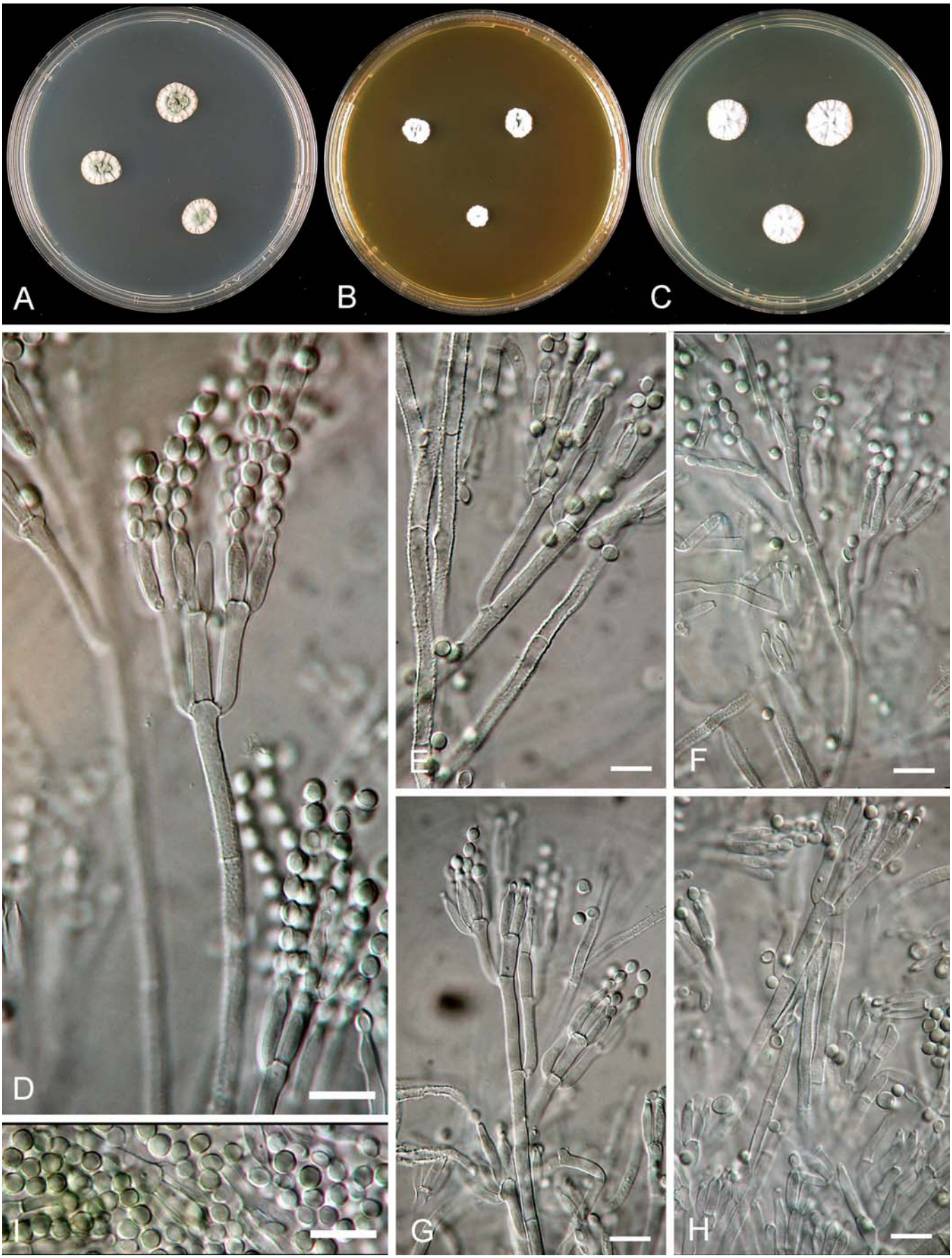

Fig. 66. *Penicillium nordicum*. 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 µm.

P. olsonii Bain. & Sartory, Ann. Mycol. 10: 398, 1912

In *Penicillium* subgenus *Penicillium* section *Coronata* series *Olsonii*

Type (neo): Herb. IMI 192502
Culture ex type: CBS 232.60 = IBT 23473 = IMI 192502 = FRR 432, ex root of *Picea* sp., Austria (**T**)

Diagnostic features: Ellipsoidal finely roughened conidia, multiramulate penicilli, verrucolone, ellipsoidal finely rough conidia

Similar species: *P. olsonii* grows much faster than *P. brevicompactum* and *P. bialowiezense* on CYA and YES.

Description:
Conidiophores: Long, multiramulate, appressed, terverticillate
Conidia: Finely roughened ellipsoidal, 3-4 µm x 2.5-3 µm
Phialides: Cylindrical with short collula, 9-12 µm x 2-3.2 µm
Metulae: Cylindrical but apically inflated, 10-12 µm x 2.5-4 µm
Rami: 8-18 µm x 4-5 µm
Stipes: 500-2000 µm x 4-6 µm, smooth-walled
Synnemata or fasciculation: None
Sclerotia: Occasionally large pale to light yellow sclerotia produced (IBT 20248)
Colony texture: Velutinous
Conidium colour on CYA: Greyish green to dull green
Exudate droplets on CYA: Clear to light yellow
Reverse colour: Cream to light yellow
Diffusible colour: None
Ehrlich reaction: Yellow reaction
Odour and volatile metabolites: 2-Butanone, isobutanol, isopentanol, 2-methyl-butanol, 2-heptanone, limonene, 2-nonanone (Larsen and Frisvad, 1995)
Extrolites: 1) Verrucolone, 2) Asperphenamate, 3) 2-(4-Hydroxyphenyl)-2-oxo acetaldehyde oxime, 4) Bis (2-ethylhexyl)phthalate, 5) Breviones
Growth on creatine: Weak
Acid and base production on creatine: No acid or just under colony
Growth on UNO: Very good
Growth on nitrite: Very good

Abiotic factors:
Diam., 1 week, 25°C: CYA: 26-40 mm; MEA: 19-36 mm; YES: 35-56; CREA: 13-17 mm; Cz: 20-24 mm, OAT: 17-33 mm: CYAS: 42-49; CzBS: 6-22; CzP: 0 mm; UNO: 7-20 mm; DG18: 32-49 mm
Diam., CYA, 1 week: 5°C: 2-5 mm, 15°C: 23-27 mm; 30°C: 0-2 mm; 37°C: 0 mm
CYA/CYAS: 0.8 [0.6-0.9], halotolerant
CYA15°C/CYA 25°C: 0.7 [0.7-0.8]
CYA30°C/CYA 25°C: 0.03 [0-0.05]
CZBS/CZ: 0.8 [0.3-1.0]
CZP/CZ: 0

Distribution: Denmark, Norway, Netherlands, Russia, Costa Rica, Puerto Rico, Ontario, Canada

Ecology and habitats: Very common in greenhouses, peat soil, tomatoes, rarely on barley and cod roe, tropical soil

Biotechnological applications: None

Biodeterioration & phytopathology: Can deteriorate tomatoes and other vegetables in greenhouses.

Mycotoxicoses and mycotoxins: Unknown

Typical cultures: IBT 21538 = CBS 833.88, ex cactus pot soil, Denmark (**Y**); IBT 20248 = CBS 112481 = CBS 312.97, ex forest soil, 2000 feet, Costa Rica; IBT 21925 = CBS 112567, ex sage; IBT 23269 = CBS 381.75, ex *Fragaria* sp., Netherlands; IBT 18096 = CBS 112883 = FRR 2377, wooden artefact from New Guinea, Australian Museum, Sydney; IBT 23032 = CBS 349.61 = FRR 433, ex rubber life-raft, Netherlands; IBT 23033 = CBS 626.72 = IHEM 4512 = IMI 167384 = LCP 72.2195 = VKM F-1127, ex soil close to Volga, Russia (*P. volgaense*); IBT 13065 = CBS 112884, ex chilli pepper imported to Denmark; CBS 193.88, ex peat moss soil, Denmark; CBS 266.97 = IBT 14335, ex barley, Denmark; CBS 298.97 = IBT 14812, ex cod roe, Denmark; CBS 299.97 = IBT 15736, ex cherry tomato, Denmark.

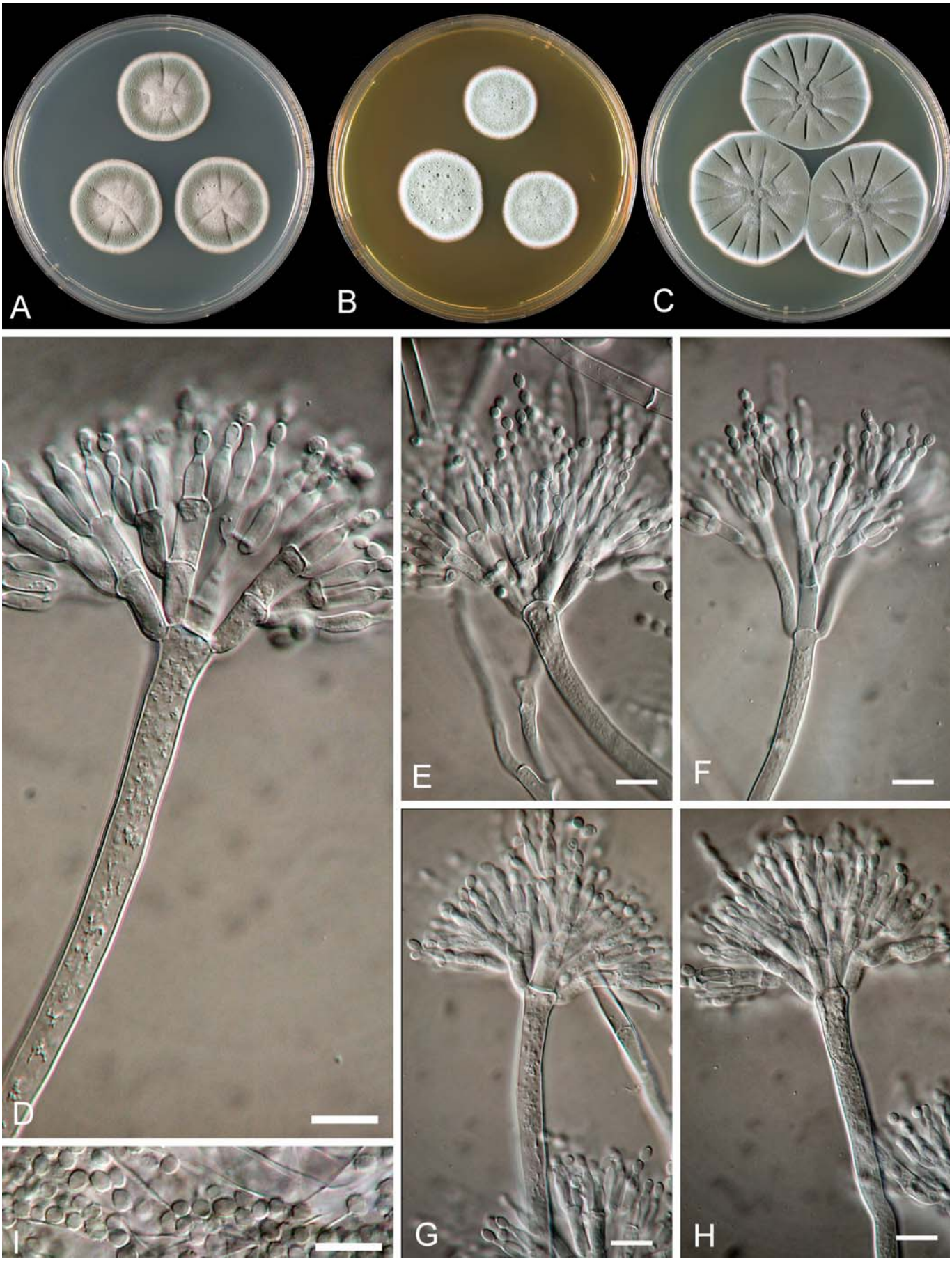

Fig. 67. *Penicillium olsonii.* 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 µm.

P. palitans Westling, Ark. Bot **11**: 83, 1911

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

Type: Herb. IMI 040215
Culture ex type: CBS 107.11 = IBT 23034 = IMI 040215 = ATCC 10477 = NRRL 2033 (**T**)

Diagnostic features: smooth-walled conidia, cyclopiazonic acid, fumigaclavine A & B; palitantin, dark green conidia, good growth on CREA

Similar species: *P. palitans* sporulates more heavily on YES and has greener conidia than *P. commune*. It is not crustose and grows more slowly than *P. crustosum*.

Description:
Conidiophores: Terverticillate, appressed elements, born from subsurface hyphae
Conidia: Smooth-walled, globose to subglobose, 3.5-4.5 µm.
Phialides: Cylindrical tapering to a distinct collulum, 9-12 µm x 2.5-3 µm
Metulae: Cylindrical, 10-15 µm x 3-4 µm
Rami: Cylindrical, 15-25 µm x 3-4 µm
Stipes: Rough-walled, 200-400 µm x 3-4 µm
Synnemata or fasciculation: None
Sclerotia: None
Colony texture: Velutinous
Conidium colour on CYA: Dark green to green
Exudate droplets on CYA: Present, clear to yellow
Reverse colour on CYA: Cream with a brown center
Reverse colour on YES: Yellow
Diffusible colour on CYA: None
Ehrlich reaction: Strong violet
Odour and volatile metabolites: No data
Extrolites: 1) Palitantin and frequentin, 2) Cyclopiazonic acid, 3) Fumigaclavine A & B
Growth on creatine: Very good
Acid and base production on creatine: Good acid production and subsequent base production
Growth on UNO: Very good
Growth on nitrite: Weak, occasionally good

Abiotic factors:
Diam., 1 week, 25°C: CYA: 15-31 mm; MEA: 17-27 mm; YES: 28-46 mm; CREA: 16-28 mm; Cz: 19-28 mm, OAT: 22-30 mm: CYAS: 27-38 mm; CzBS: 15-27 mm; CzP: 0-1 mm; UNO: 16-27 mm; DG18: 25-33 mm
Diam., CYA, 1 week: 5°C: 2-4 mm; 15°C: 21-30 mm; 30°C: 0-7 mm; 37°C: 0 mm
CYA/CYAS: 0.9 [0.7-1.1]
CYA15°C/CYA 25°C: 1.0 [0.9-1.1]
CYA30°C/CYA 25°C: 0.09 [0-0.2]
CZBS/CZ: 0.9 [0.6-1.2]
CZP/CZ: 0.01 [0-0.05]

Distribution: Denmark, Norway, Sweden, Russia, Japan, New Mexico (USA)

Ecology and habitats: Cheese, nuts, bread, liver pate

Biotechnological applications: None

Biodeterioration & phytopathology: May degrade cheese, but less common than *P. commune* on this substrate

Mycotoxicoses and mycotoxins: Cyclopiazonic acid and fumigaclavine may be formed in foods, but have not been found naturally occurring made by this species yet.

Typical cultures: IBT 6355 = CBS 491.84 = FRR 2948 = IMI 285507, ex mouldy liver pate; IBT 12714 = CBS 111834, ex kangaroo rat mound, Sevilletta, New Mexico; IBT 21540 = IBT 14740 = CBS 101031, Japan (**Y**); T327 = IBT 22531 = CBS 112207 = SUM 3170, Japan; IBT 14741, Japan; IBT 13514 = CBS 112203, ex wet barley, Denmark; T330 = IBT 13420 = CBS 112206 = VKM F-3088, Russia; T331 = IBT 13421 = CBS 112204 = VKM F-478, Russia; T332 = IBT 15975 = CBS 112205, ex mied pig feed, Stara Zagora, Bulgaria; IBT 18789 = CBS 112473, ex air in cake factory, Denmark; IBT 14757 = CBS 112474, ex wheat roll, Denmark.

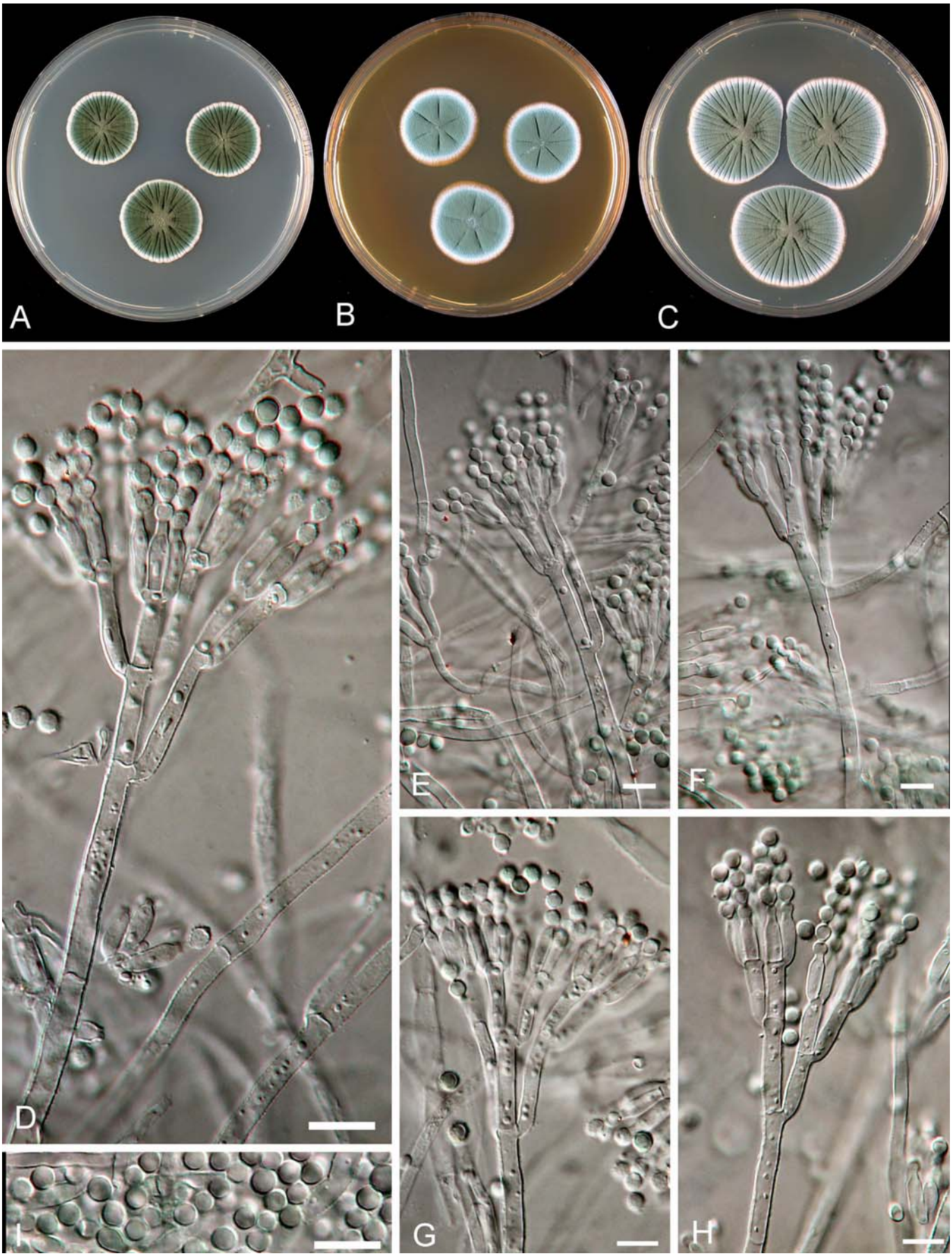

Fig. 68. *Penicillium palitans*. 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 µm.

P. paneum Frisvad, Microbiology, UK **142**: 546, 1996

In *Penicillium* subgenus *Penicillium* section *Roqueforti* series *Roqueforti*

Type: Herb. C 25000
Culture ex type: CBS 101032 = CBS 463.95 = IBT 21541 = IBT 12407 (**T, Y**) ex mouldy rye bread, Denmark

Diagnostic features: Marcfortines, patulin, globose smooth-walled conidia, growth on 0.5% acetic acid and 1% propionic acid (CzP)

Similar species: See *P. carneum*.

Description:
Conidiophores: Terverticillate, occasionally quarterverticillate, appressed elements, borne from subsurface hyphae
Conidia: smooth-walled, globose, 3.5-5 µm
Phialides: Cylindrical with short collula, 8-10 µm x 2.5-3.0 µm
Metulae: Cylindrical, 10-17 µm x 3-4 µm
Rami: Cylindrical, 17-33 µm x 3-4 µm
Stipes: Rough-walled, 100-250 µm x 4-5 µm
Synnemata or fasciculation: None
Sclerotia: None
Colony texture on CYA: Velutinous
Conidium colour on CYA: Blue green to green
Exudate droplets on CYA: Copious, clear
Reverse colour on CYA: Beige to brown
Reverse colour on YES: Cream beige often a pink to red water soluble pigment produced
Diffusible colour on CYA: None
Ehrlich reaction: None (weak violet reaction in one isolate)
Odour and volatile metabolites: Not examined
Extrolites: 1) Patulin, 2) Botryodiploidin, 3) Citreoisocoumarin, 4) Roquefortine C & D, 5) Marcfortine A, B & C
Growth on creatine: Very good
Acid and base production on creatine: None or weak acid at margin of colony
Growth on UNO: Very good
Growth on nitrite: Good growth

Abiotic factors:
Diam., 1 week, 25°C: CYA: 38-41 mm; MEA: 43-67 mm; YES: 52-71 mm; CREA: 14-30 mm; Cz: (9-)20-31 mm, OAT: 53-72 mm: CYAS: 20-28 mm; CzBS: 8-50 mm; CzP: 7-34 mm; UNO: 20-47 mm; DG18: 33-47 mm
Diam., CYA, 1 week: 5°C: 2-4 mm; 15°C: 27-36 mm; 30°C: 10-39 mm; 37°C: 0 mm
CYA/CYAS: 2.0 [1.4-2.6]
CYA15°C/CYA 25°C: 0.7 [0.6-0.9]
CYA30°C/CYA 25°C: 0.6 [0.2-0.8]
CZBS/CZ: 1.3 [0.9-1.4]
CZP/CZ: 0.7 [0.2-0.9]
High resistance to acid and good growth at high CO_2 levels.

Distribution: Denmark, Norway, Sweden, Canada

Ecology and habitats: Mouldy rye bread and bakers yeast, silage, cassava chips

Biotechnological applications: none

Biodeterioration & phytopathology: Deteriorates silage

Mycotoxicoses and mycotoxins: Botryodiploidin, patulin and roquefortine C may all be produced in silage.

Typical cultures: IBT 13321 = CBS 303.97, ex sweet carbonated water, Denmark; IBT 21729 = CBS 112296, ex cassava chips, Africa; IBT 21613 = CBS 112295, ex grass silage, Sweden; IBT 11839 = CBS 464.95, ex rye bread, Denmark; IBT 16402 = CBS 112294 = NRRL 1168, Ottawa, Canada; IBT 14356 = CBS 462.65, ex wine cork, Spain; IBT 19477 = IBT 3912 = CBS 167.91, ex grain, Sweden; IBT 21543 = CBS 479.84, ex mouldy bakers yeast, Denmark; IBT 21814 = CBS 112319, ex air, factory, Denmark; IBT 12392 = CBS 463.95, ex chocolate sauce, Norway; IBT 21736 = CBS 112320, ex cassava chips, Africa ; IBT 13929 = CBS 465.95, ex mouldy bakers yeast, Denmark.

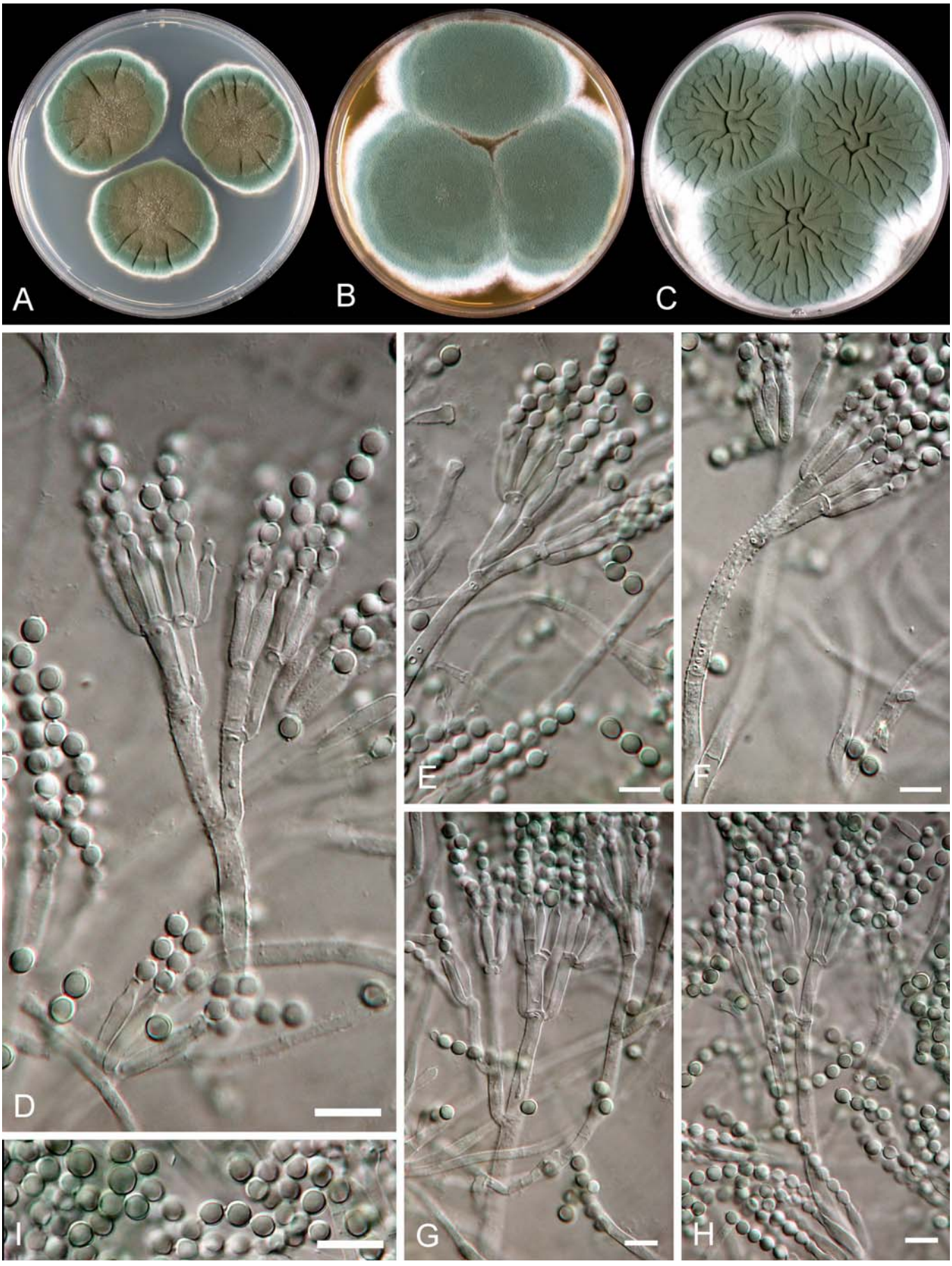

Fig. 69. *Penicillium paneum.* 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 µm.

P. persicinum L. Wang, H. Zhou, Frisvad & Samson, Ant. van Leeuwenhoek 86: 177. 2004

Provisionally in *Penicillium* subgenus *Penicillium* section *Chrysogena* series *Persicina*

Type: Herb. HMAS 80638-1-4
Culture ex type: CBS 111235 = IBT 24565 = AS 3.5891 = T505, ex soil, Qinghai, China

Diagnostic features: Griseofulvin, chrysogine, roquefortine C, cylindrical to ellipsoidal smooth-walled conidia, pink diffusible pigment on CYA and YES

Similar species: *P. persicinum* differs from *P. italicum* by production of a pink diffusing pigment on CYA and YES and growth at 37ºC.

Description:
Conidiophores: Terverticillate, occasionally quarterverticillate, appressed elements, borne from aerial hyphae
Conidia: smooth-walled, cylindrical and ellipsoidal, 3.5-4.5 µm x (1.5-) 2-3 (-3.5) µm
Phialides: Cylindrical with short collula, 7-11 µm x (2-) 2.5-3.5 (-4) µm
Metulae: Cylindrical, apically swollen up to 10 µm, 10-20 µm x 3.5-4.5(-5.4) µm
Rami: Cylindrical, 18-36 µm x 3.5-4.5 µm
Stipes: Rough-walled, 200-600 µm x 3.5-4.5 µm
Synnemata or fasciculation: None
Sclerotia: None
Colony texture: Velutinous
Conidium colour on CYA: Gnaphalium green
Exudate droplets on CYA: None
Reverse colour on CYA: Peach to coral red
Reverse on YES: Pinkish red
Diffusible colour on CYA: Peach to coral red
Ehrlich reaction: None
Odour and volatile metabolites: Not examined
Extrolites: 1) Griseofulvins, 2) Roquefortine C & D, 3) Chrysogine, 2-pyrovoylaminobezamide, 2-acetyl-qionazolin-4(3H)-one
Growth on creatine: Weak
Acid and base production on creatine: No acid
Growth on UNO: Good
Growth on nitrite: Weak

Abiotic factors:
Diam., 1 week, 25°C: CYA: 22-30 mm; MEA: 22-26 mm; YES: 24-33 mm; CREA: 13-18 mm; Cz: 27-29 mm, OAT: 23-30 mm: CYAS: 19-21mm; CzBS: 10-12 mm; CzP: 0 mm; UNO: 26-30 mm; DG18: 20-22 mm
Diam., CYA, 1 week: 5°C: 0 mm; 15°C: 13-18 mm; 30°C: 19-21 mm; 37°C: 8-9 mm
CYA/CYAS: 1.4 [1.3-1.5]
CYA15°C/CYA 25°C: 0.6 [0.5-0.6]
CYA30°C/CYA 25°C: 0.8 [0.7-0.9]
CZBS/CZ: 0.4
CZP/CZ: 0

Distribution: China

Ecology and habitats: Soil

Biotechnological applications: None

Biodeterioration & phytopathology: -

Mycotoxicoses and mycotoxins: Roquefortine C is produced.

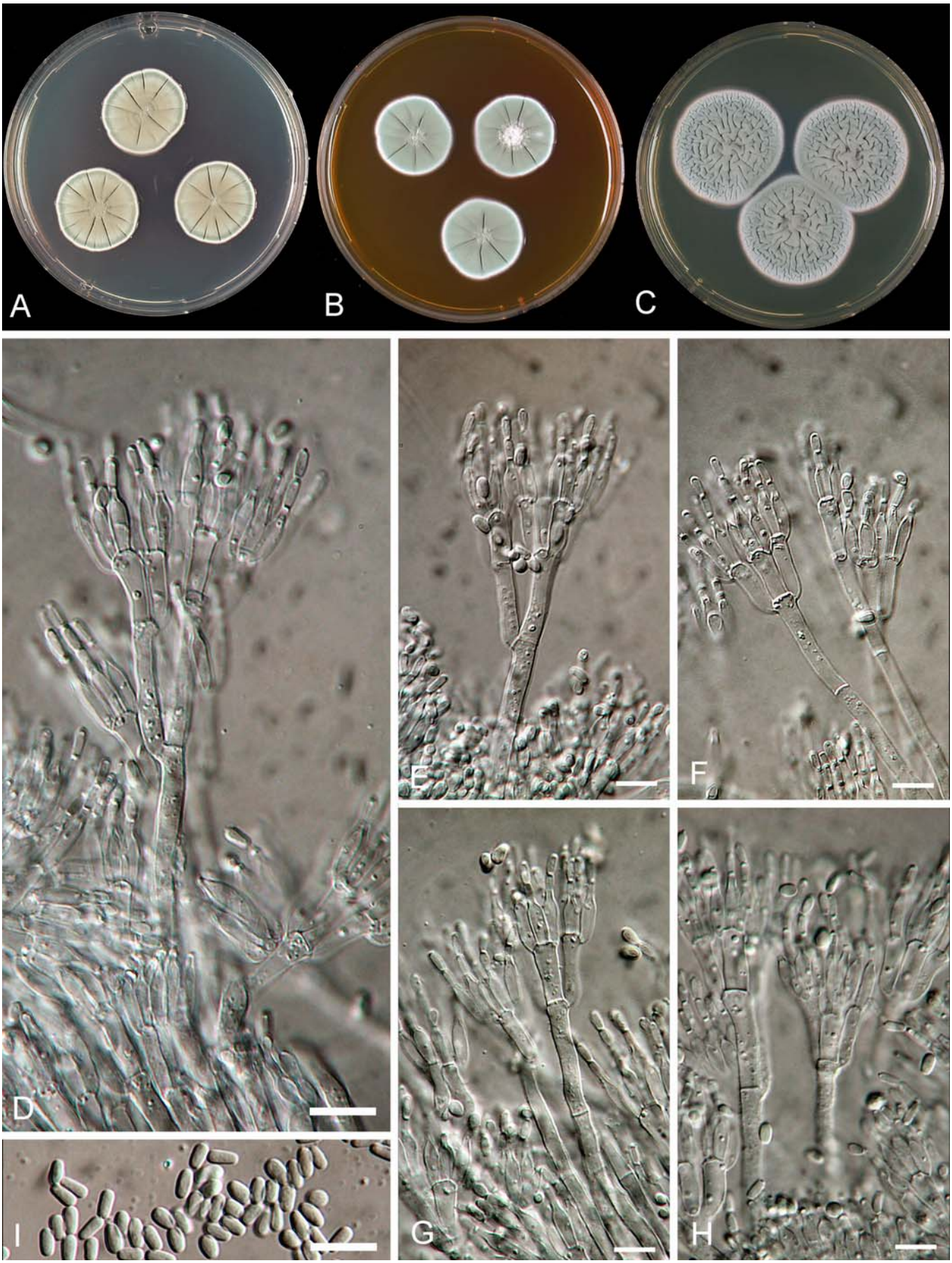

Fig. 70. *Penicillium persicinum.* 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 µm.

P. polonicum K. Zaleski, Bull. Int. Acad. Pol. Sci. Lett., Sér. B **1927**: 445, 1927

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

Type: Herb. CBS 222.28
Culture ex type: CBS 222.28 = IBT 12821 = IMI 291194 = MUCL 29204 = NRRL 995, ex soil, Poland (**T**)

Diagnostic features: Penicillic acid, puberuline / verrucofortine, verrucosidin, cyclopenin, cyclopenol, smooth-walled conidia,

Similar species: *P. polonicum* grows faster than *P. aurantiogriseum* and other species in series *Viridicata* with blue green conidia on CYA and YES, sporulates better on YES and grow better on CREA. *P. polonicum* has blue green conidia in contrast to the pure green conidia of *P. melanoconidium* and *P. viridicatum*.

Description:
Conidiophores terverticillate, few biverticillate and quarterverticillate from subsurface hyphae
Conidia: Smooth-walled, globose to subglobose, 3-4 x 2.5-3.5 µm
Phialides: Flask-shaped tapering to a distinct collulum, 7.5 - 10 µm x 2.5-2.8 µm
Metulae: Cylindrical, 10-13 µm x 2.8-3.5 µm
Rami: Cylindrical, 15-25 µm x 3-3.5 µm
Stipes: 180-400 µm x 3-4 µm, walls smooth to finely roughened
Synnemata or fasciculation: None
Sclerotia: None
Colony texture: Velutinous
Conidium colour on CYA: Blue green
Exudate droplets on CYA: Present, clear
Reverse colour on CYA: Pale to cream or yellow brown to red brown
Reverse colour on YES: Yellow (strong sporulation)
Diffusible colour: None or beige brown to red brown
Ehrlich reaction: Weak, violet
Odour and volatile metabolites: gamma-elemene, ethyl acetate, 3-octanone, 2-methyl-isoborneol (Larsen & Frisvad, 1995)
Extrolites: 1) Penicillic acid, 2) Verrucosidin, 3) Puberuline and verrucofortine, 4) Cyclopeptin, dehydrocyclopeptin, Cyclopenol, cyclopenin, viridicatol, 3-methoxyviridicatin, 5) Anacine, 6) Aspterric acid, 7) Methyl-4-(2-(2R)-hydroxyl-3-butynyloxy) benzoate, 8) Nephrotoxic glycopeptides
Growth on creatine: Moderate to good, colony often with a yellow center
Acid and base production on creatine: Very good, no base
Growth on UNO: Weak
Growth on nitrite: Weak
RT: Strong reaction, dark brown halo and reverse

Abiotic factors:
Diam., 1 week, 25°C: CYA: 24-43 mm; MEA: 28-40 mm; YES: 36-54 mm; CREA: 10-27 mm; Cz: 22-38 mm, OAT: 24-36 mm: CYAS: 36-49 mm; CzBS: 22-30 mm; CzP: 0 mm; UNO: 8-15 mm; DG18: 30-36 mm
Diam., 1 week: 5°C: 2-5 mm, 15°C: 27-30 mm; 30°C: 10-15 mm; 37°C: 0 mm
CYA/CYAS: 0.8 [0.7-1.0], halotolerant
CYA15°C/CYA 25°C: 0.9 [0.7-1.0]
CYA30°C/CYA 25°C: 0.4 [0.2-0.4]
CZBS/CZ: 0.9 [0.8-1.0]
CZP/CZ: 0

Distribution: Denmark, Sweden, United Kingdom, Germany, Netherlands, Spain, Italy, BC, Canada, Kenya, Taiwan

Ecology and habitats: Wheat, barley, rye, oats, rice, corn, peanuts, dried meat, onions, vegetable field soil

Biotechnological applications: None

Biodeterioration & phytopathology: Deteriorate cereals

Mycotoxicoses and mycotoxins: This species produce penicillic acid, verrucosidin and nephrotoxic glycopeptides (see also *P. aurantiogriseum*). It may play a role in Balkan Endemic Nephropathy.

Typical cultures: IBT 14318 = CBS 110332 = NRRL 952; T334 = IBT 21542 = IBT 11245 = CBS 793.95 (**Y**), ex *Hordeum vulgare*, Denmark; IBT 14320 = CBS 101479 = IMI 321304, Vratsa, Bulgaria; IBT 22439 = CBS 112490, ex cassava chips, Africa; IBT 15982 = CBS 112561, ex mixed pig feed, Bulgaria; IBT 11383 = CBS 639.95, ex mixed cereal feed, Denmark; IBT 18382 = CBS 112560 = CCRC 32637, ex rhizosphere of garlic, Taichung, Taiwan; IBT 6285 = CBS 690.77 = IJFM 3752 = IMI 291200, ex air, Spain (*P. glaucocoeruleum, nomen nudum*); IBT 14609 = CBS 112020 = ATCC 15683, ex peanuts, USA (reported as aflatoxin producer); CBS 278.30 = ATCC 10421 = IFO 7723 = IMI 040218 = NRRL 2035 = QM 6867 = IBT 11782, ex dried flowers of *Humulus lupulus*, United Kingdom (*P. carneolutescens*); CBS 111.43 = ATCC 10467 = FRR 2027 = IFO 8142 = IMI 040211 = MUCL 15618 = NRRL 2027 = VKM F-310 = IBT 6156 = IBT 4349; CBS 316.48 = ATCC 10433 = FRR 1899 = IFO 5847 = IMI 040236ii = NRRL 1899 = QM 684 = IBT 12820; CBS 692.77 = IJFM 3751 = IMI 291195, ex air, Spain (*P. ochraceoviride, nomen nudum*); CBS 475.84 = FRR 2934 = IMI 285514; CBS 222.90 = IBT 3448, ex *Allium* sp., Denmark; CBS 224.90 = IBT 3522, ex *Triticum aestivum*, Denmark; CBS 228.90 = IBT 3447 = PREM 47750 = ATCC 64541, South Africa; CBS 654.95 = IBT 5131; CBS 793.95 = IBT 11245, ex *Hordeum vulgare*, Denmark; CBS 101478 = IBT 12826 = NRRL 6316, USA; CBS 101487 = IBT 14321, ex wheat, United Kingdom, IBT 11410 = NRRL 3608, IBT 5157 = NRRL 5570, IBT 12822 = NRRL 6314, IBT 12827 = NRRL 2029, IBT 12828 = NRRL 6315.

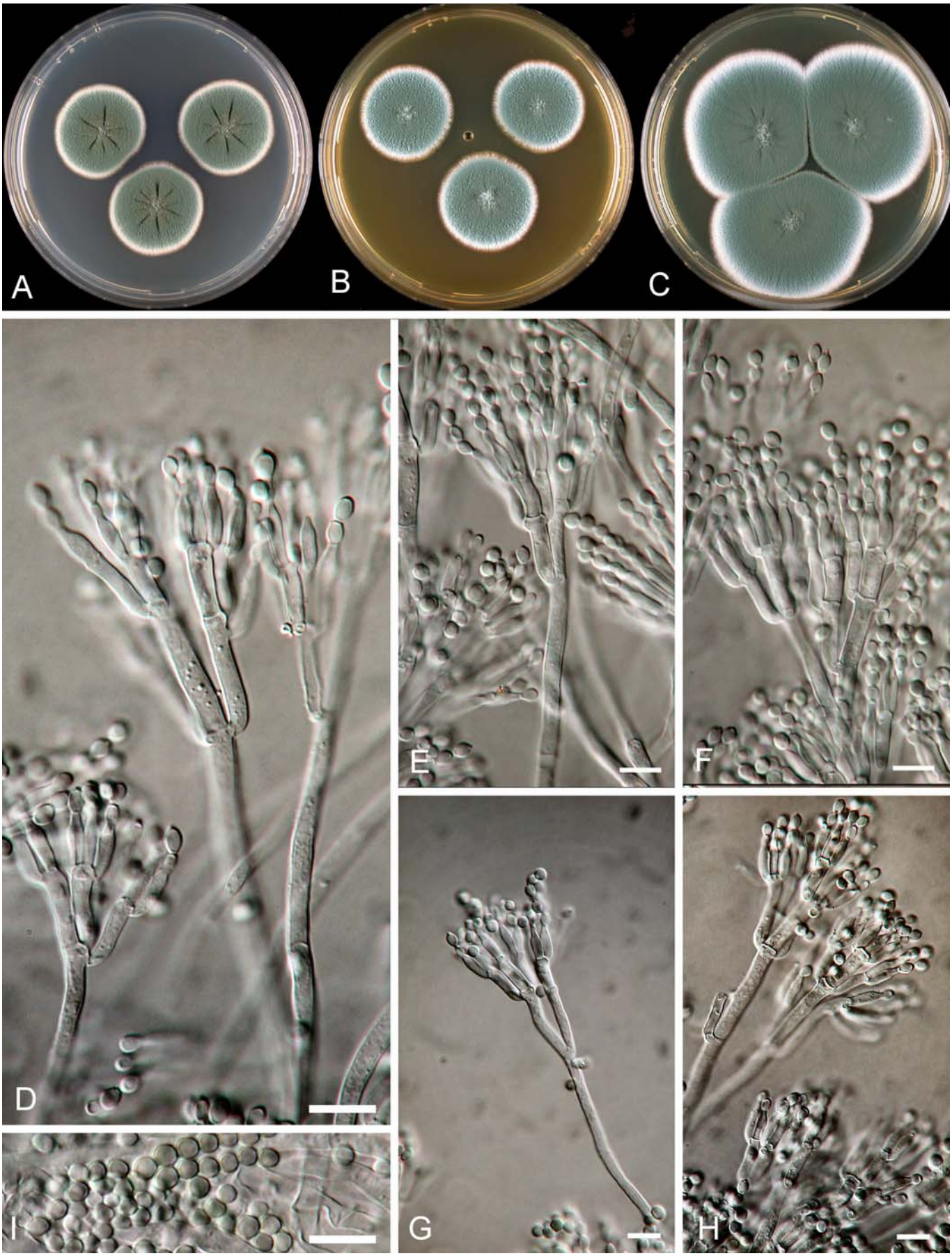

Fig. 71. *Penicillium polonicum*. 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 µm.

P. radicicola Overy and Frisvad, Syst. Appl. Microbiol., **26**: 633, 2003

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

Type: Herb. C 60161
Culture ex type: CBS 112430 = IBT 10696 (**T, Y**), ex *Armoracia rusticana* root, Denmark

Diagnostic features: Smooth-walled conidia, poor sporulation but fasciculate colonies on MEA, no sporulation on YES agar, orange reverse on CYA, production of citrinin, meleagrin, penicillic acid, and terrestric acid

Similar species: See *P. albocoremium*.

Description:
Conidiophores terverticillate, few quarterverticillate from subsurface hyphae
Conidia: Smooth-walled, globose to subglobose, 2.8-4 µm
Phialides: Flask-shaped tapering to a distinct collulum, 7.8 - 11.2 µm x 2.6-3.5 µm
Metulae: Cylindrical, 10-17 µm x 2.5-4.8 µm
Rami: Cylindrical, 12-27 µm x 2.6-4.8 µm
Stipes: 150-2000 µm x 3-4 µm, walls smooth to finely roughened
Fasciculation: Weakly fasciculate
Sclerotia: None
Colony texture: Floccose to weakly fasciculate
Conidium colour on CYA: Greyish green to dull green
Exudate droplets on CYA: Present, clear
Reverse colour on CYA: Deep orange to Persian orange
Reverse colour on YES: Deep to butter yellow
Diffusible colour on CYA: None
Ehrlich reaction: Weak violet reaction
Odour and volatile metabolites: isobutanol, isopentanol, γ-muurolene? (Larsen & Frisvad, 1995)
Extrolites: 1) Citrinin, 2) penicillic acid, 3) Terrestric acid 4) Roquefortine C & D, meleagrin, 5) Cyclopeptin, dehydrocyclopeptin, cyclopenin, cyclopenol, viridicatol, 3-methoxyviridicatin, 6) Chrysogine
Growth on creatine: Weak to moderate
Acid and base production on creatine: Good acid production
Growth on UNO: Weak
Growth on nitrite: Weak

Abiotic factors:
Diam., 1 week, 25°C: CYA: 29-41 mm; MEA: 17-37 mm; YES: 37-50 mm; CREA: 15-27 mm; Cz: 17-30 mm, OAT: 28-40 mm: CYAS: 29-37 mm; CzBS: 11-24 mm; CzP: 0 mm; UNO: 10-15 mm; DG18: 22-36 mm
Diam., 1 week: 5°C: 2-5 mm, 15°C: 27-34 mm; 30°C: 1-10 mm; 37°C: 0 mm
CYA/CYAS: 0.8 [0.7-1.0], halotolerant
CYA15°C/CYA 25°C: 1.2 [0.7-1.0], psychrotolerant
CYA30°C/CYA 25°C: 0.1 [0.1]
CZBS/CZ: 0.9 [0.8-1.0]
CZP/CZ: 0

Distribution: Denmark, United Kingdom, Iceland

Ecology and habitats: Carrots, potatoes, onions and taproot plants, (snake dung)

Biotechnological applications: none

Biodeterioration & phytopathology: May cause a rot in vegetable roots and flower bulbs

Mycotoxicoses and mycotoxins: It is not known whether this species can produce citrinin, penicillic acid, terrestic acid or roquefortine C in carrots, onions or potatoes

Typical cultures: IBT 10693 = CBS 112429, ex *Apium graveolens*, Denmark; IBT 18894 = CBS 112576, ex butter cake, Denmark; IBT 3491 = CBS 112428, ex *Solanum tuberosum*, Denmark; IBT 22526 = CBS 109554, ex *Allium cepae*, Denmark; IBT 22520 = CBS 112427, ex *Allium cepae*, Denmark; IBT 22522 = CBS 112426, ex *Allium cepae*, Denmark; IBT 3489 = CBS 112425, ex carrot, Denmark; IBT 10695, ex *Colchicum* sp.; IBT 10698 = IMI 293206, ex carrot; IBT 10699, ex *Apium graveolens*; IBT 11646 & IBT 11647, ex carrot, Denmark; IBT 11649, ex *Allium fistulosum*, Denmark; IBT 15242, ex *Pastinaca sativa,* Denmark; IBT 18856, ex snake dung, United Kingdom; IBT 22536, ex soil, Iceland.

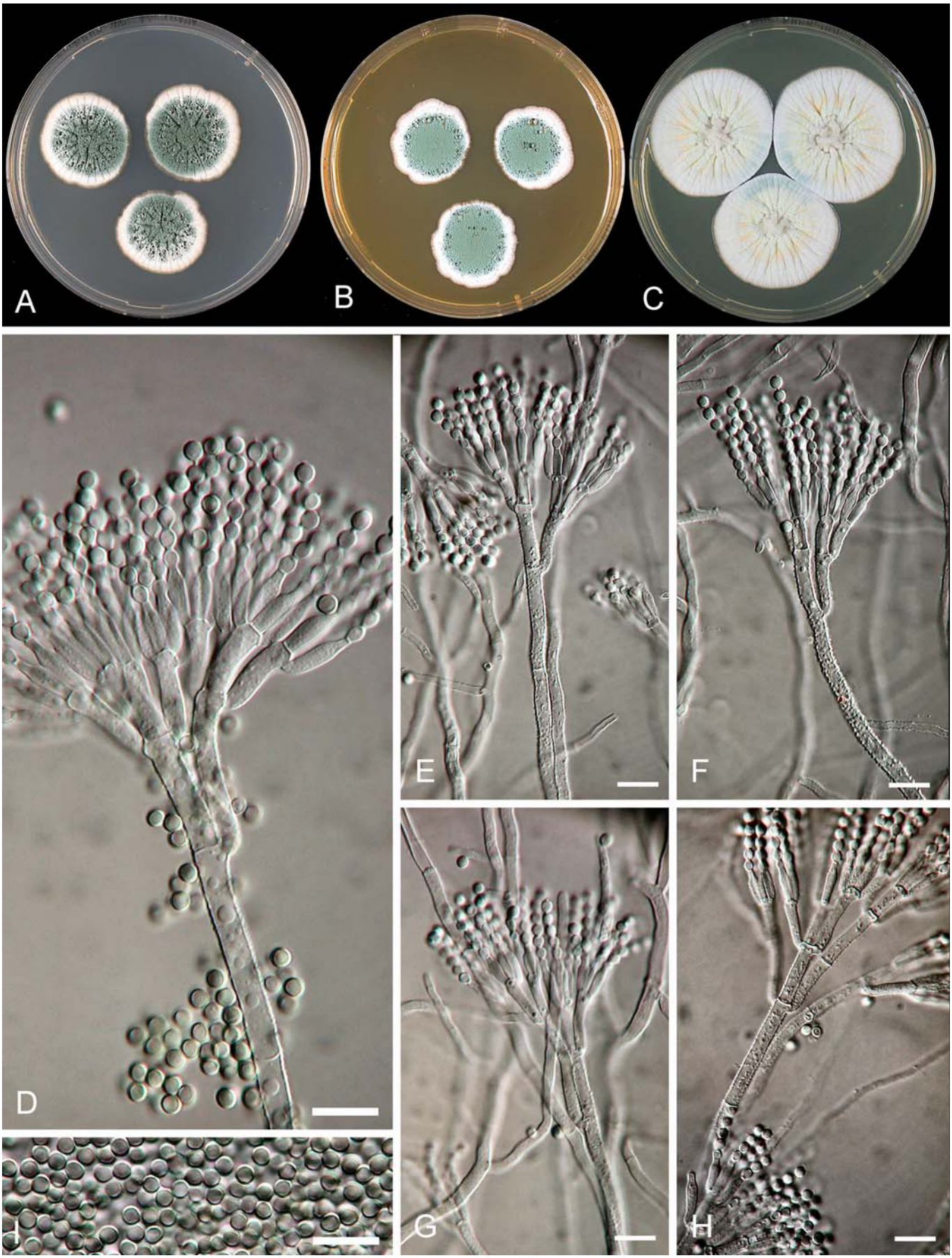

Fig. 72. *Penicillium radicicola.* 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 µm.

P. roqueforti Thom, Bull. Bur. Anim. Ind. US Dept. Agric. **82**: 35, 1906

In *Penicillium* subgenus *Penicillium* section *Roqueforti* series *Roqueforti*

Type: Herb. IMI 024313
Culture ex type: CBS 221.30 = IBT 6754 = IMI 024313 = ATCC 10110 = ATCC 1129 = CECT 2905 = IFO 5459 = NCTC 588 = NRRL 849 = QM 1937 (**T**), ex French Roquefort cheese, USA

Diagnostic features: PR-toxin, roquefortine C, globose smooth-walled conidia, good growth on media with 0.5% acetic acid or 1% propionic acid, black green reverse on CYA and YES

Similar species: *P. roqueforti* differs from *P. paneum* and *P. carneum* by produing a dark greenish black reverse on CYA and YES.

Description:
Conidiophores: Terverticillate, occasionally quarterverticillate, appressed elements, borne from subsurface hyphae
Conidia: smooth-walled, globose, 3.5-5 µm
Phialides: Cylindrical with short collula, 8-10 µm x 2.5-3.0 µm
Metulae: Cylindrical, 10-17 µm x 3-4 µm
Rami: Cylindrical, 17-33 µm x 3-4 µm
Stipes: Rough-walled, 100-250 µm x 4-5 µm
Synnemata or fasciculation: None
Sclerotia: Occasionally rudimentary sclerotia
Colony texture on CYA: Velutinous
Conidium colour on CYA: Green
Exudate droplets: None
Reverse colour on CYA: Blackish green
Reverse colour on YES: Blackish green
Diffusible colour on CYA: None
Ehrlich reaction: Violet (yellow in few old strains)
Odour and volatile metabolites: Isobutanol, isopentanol, 2-methyl-butanol, isobutyl acetate, 1-octene, 3-octanone, β-myrcene, p-cymene, limonene, linalool, eremophilene, aristolochene, patchoulene isomer, β-elemene? (Larsen & Frisvad, 1995)
Extrolites: 1) Citreoisocoumarin, 2) Mycophenolic acids, 3) PR-toxins, 4) roquefortine C & D, 5) Isofumigaclavine A & B, α-amino isobutyric acid peptides
Growth on creatine: Very good
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: (17-) 40-77 mm; MEA: 26-43 mm; YES: 38-71 mm; CREA: 12-44 mm; Cz: 15-46 mm, OAT: 34-61 mm: CYAS: 26-43 mm; CzBS: 28-41 mm; CzP: 13-25 mm; UNO: 16-48 mm; DG18: 37-48 mm
Diam., CYA, 1 week: 5°C: 2-4 mm; 15°C: 28-38 mm; 30°C: (0-) 6-11 mm; 37°C: 0 mm
CYA/CYAS: 1.3 [0.6-1.6]
CYA15°C/CYA 25°C: 0.8 [0.4-1.7]
CYA30°C/CYA 25°C: 0.2 [0-0.2]
CZBS/CZ: 1.2 [0.9-1.9]
CZP/CZ: 0.7 [0.4-1.3]
High resistance to acid and good growth at high CO_2 levels.

Distribution: Denmark, France, Netherlands, Belgium, Germany, Sweden, Norway, United Kingdom, Ireland, Czech Republic, Italy, Spain, Portugal, Turkey, USA, Canada

Ecology and habitats: Blue mould cheeses, silage, rye bread, mould bakers yeast, forest soil, wood

Biotechnological applications: Production of blue cheese

Biodeterioration & phytopathology: Deterioration of silage

Mycotoxicoses and mycotoxins: PR-toxin, roquefortine C and isofumigaclavine A & B. Mycophenolic acid is immunosuppressive and may thus cause secondary (indirect) mycotoxicosis.

Typical cultures: IBT 21543 = CBS 479.84, ex mouldy bakers yeast, Denmark (**Y**); IBT 19479 = CBS 253.56, ex Roquefort cheese, France; IBT 19475 = CBS 135.67 = MUCL 8491, ex blue cheese, Germany; IBT 19480 = CBS 265.55 = IBT 16401 = NRRL 858 (light reverse), ex Gorgonzola cheese, Italy; IBT 19476 = CBS 498.73 = ATCC 24720 = FRR 1480 = IMI 174718 = IMI 291199 = VKM F-1748 (light reverse), ex fruit of *Malus sylvestris*, Russia (*P. conservandi*); IBT 19481 = CBS 234.38 = IMI 291202, ex blue Cheshire cheese, United Kingdom; IBT 16407 = CBS 112579 = NRRL 1165 (light reverse), ex waste sulphite liquor, Ottawa, Canada; IBT 5308 = IBT 3915 = CBS 112571 = IMI 300728 (slow growing)(received as *P. mali*); IBT 5309 = IBT 3905 = IMI 298084, ex soil in *Salix-Populus* forest, South Wisconsin; IBT 16404 = NRRL 852, Grove City, Pennsylvania; IBT 16408 = NRRL 853, State College of Washington, USA; IBT 16405 = NRRL 857 (*P. gorgonzolae* Weideman), IBT 16403 = NRRL 851, Waycross, Georgia; IBT 19482 = CBS 257.55, ex blue cheese, Denmark.

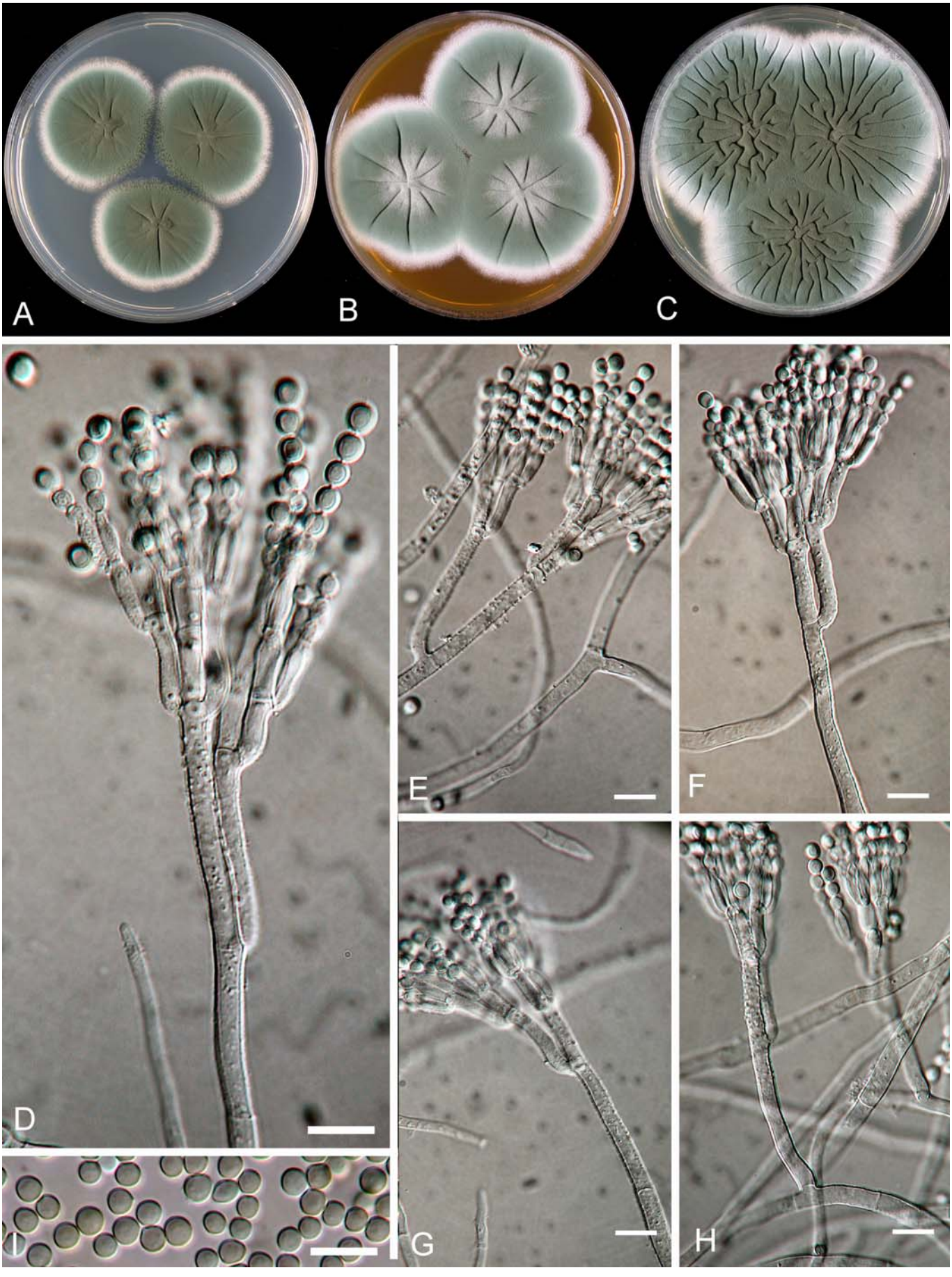

Fig. 73. *Penicillium roqueforti.* 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 µm.

P. sclerotigenum Yamamoto, Scient. Rep. Hyogo Univ. Agric., Agric. Biol. Ser. 2, **1**: 69, 1955

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

Type: Herb. IMI 068616
Culture ex type: CBS 349.59 = CBS 101033 = IBT 14346 = IBT 21544 = IMI 068616 = ATCC 18488 = IFO 6167 = NRRL 3461 = QM 7779 (**T, Y**), ex rotting tuber of *Dioscorea batatas*, Japan

Diagnostic features: Griseofulvin, sclerotigenin, patulin, gregatins, ellipsoidal smooth-walled conidia, high growth rates on all media

Similar species: *P. sclerotigenum* differs from *P. expansum* by poor growth on CREA, many biverticillate penicilli and production of sclerotia.

Description:
Conidiophores: Biverticillate and terverticillate, appressed elements, borne from surface hyphae
Conidia: smooth-walled, ellipsoidal, 4-5 µm x 2.5-3.5 µm
Phialides: Cylindrical with short collula, 8-12 µm x 2.5-3.0 µm
Metulae: Cylindrical, 13-22 µm x 3-4 µm, can be apically swollen
Rami: Cylindrical, 17-25 µm x 3-4 µm
Stipes: Rough-walled, 200-600 µm x 3-4 µm
Synnemata or fasciculation: None
Sclerotia: 150-300 µm, pseudoparenchymatous
Colony texture: Velutinous
Conidium colour on CYA: Dull green
Exudate droplets on CYA: None
Reverse colour on CYA: Light brown with a darker brown center
Diffusible colour on CYA: None
Ehrlich reaction: None
Odour and volatile metabolites: Not examined
Extrolites: 1) Patulin, 2) Griseofulvin, 3) Gregatins, 4) Sclerotigenin, 5) Roquefortine C & D
Growth on creatine: Weak
Acid and base production on creatine: No acid or some acid, no base
Growth on UNO: Very good
Growth on nitrite: Very good

Abiotic factors:
Diam., 1 week, 25°C: CYA: 40-62 mm; MEA: 16-70 mm; YES: 53-80 mm; CREA: 33-45 mm; Cz: 33-48 mm, OAT: 46-67 mm: CYAS: 22-34 mm; CzBS: 0-17 mm; CzP: 0 mm; UNO: 19-34 mm; DG18: 30-51 mm
Diam., CYA, 1 week: 5°C: 0-1 mm; 15°C: 23-35 mm; 30°C: 16-29 mm; 37°C: 0 mm
CYA/CYAS: 2.0 [1.5-2.6]
CYA15°C/CYA 25°C: 0.6 [0.5-0.7]
CYA30°C/CYA 25°C: 0.4 [0.3-0.5]
CZBS/CZ: 0.3 [0-0.5]
CZP/CZ: 0

Distribution: Philippines, Japan, Taiwan, Russia, Jamaica.

Ecology and habitats: Yam tubers and yams products

Biotechnological applications: None

Biodeterioration & phytopathology: Pathogenic on yams

Mycotoxicoses and mycotoxins: Patulin, roquefortine C may be produced in yams, but this has not been examined.

Typical cultures: IBT 15061 = CBS 307.97 = IMI 361520, ex blue yams flour, Philippines; IBT 13938 = CBS 306.97 = IMI 267703, ex *Dioscorea cayennensis*, Jamaica; IBT 13826 = CBS 112566 = VKM F-2398, Russia.

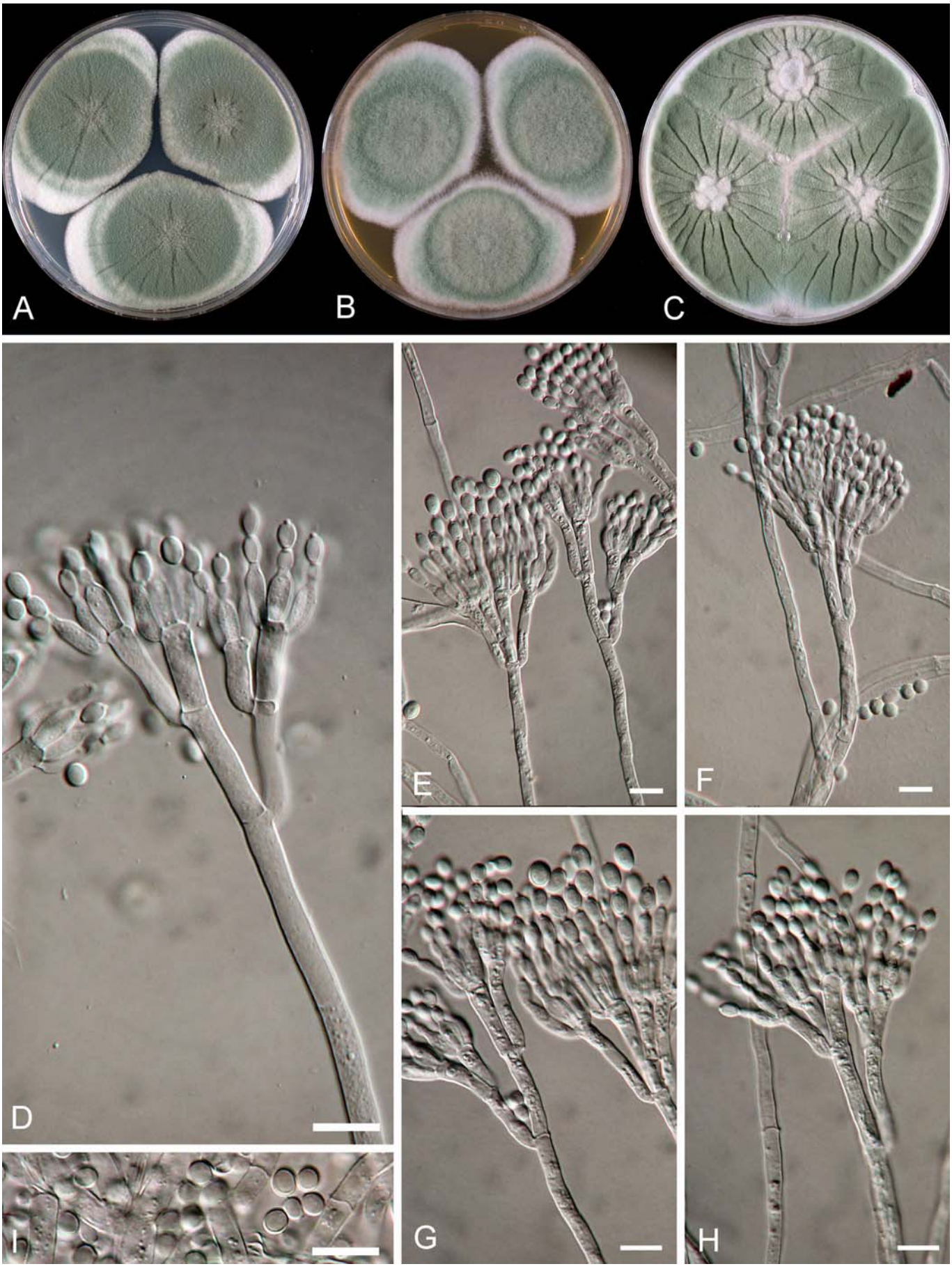

Fig. 74. *Penicillium sclerotigenum*. 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 µm.

P. solitum Westling, Ark. Bot. **11**: 65, 1911

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

Type: Herb. CBS 424.89
Culture ex type: CBS 424.89 = CBS 288.36 = IBT 3948 = FRR 937 = IFO 7765 = IMI 039810 = IMI 092225 = ATCC 9923 = MUCL 28668 = MUCL 29173 = NRRL 937, Norway (**T**)

Diagnostic features: Compactin, cyclopenin, cyclopenol, dark green smooth to slightly rough-walled conidia, rough stipes, yellow orange reverse on YES agar

Similar species: *P. solitum* differs from *P. cavernicola*, *P. echinulatum* and *P. discolor* by having smooth to slightly rough-walled conidia, in contrast to the conspicuously rough-walled conidia of the other species with dark green conidia in series *Solita*. *P. solitum* differs from *P. palitans* by darker green conidia and a more orange reverse on YES.

Description:
Conidiophores: Terverticillate, appressed elements, born from subsurface hyphae
Conidia: Smooth to slightly 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, 12-18 µm x 3.5-4.2 µm
Stipes: Rough-walled, 200-400 µm x 3.5-4.2 µm
Synnemata or fasciculation: None
Sclerotia: None
Colony texture on CYA: Velutinous
Conidium colour on CYA: Dark blue green to green
Exudate droplets on CYA: Often present, clear to light yellow (rarely brown)
Reverse colour on CYA: Cream to light beige
Reverse colour on YES: Yellow to orange
Diffusible colour: None
Ehrlich reaction: None
Odour and volatile metabolites: Isobutanol, isopentanol, 2-methyl-isoborneol (Larsen & Frisvad, 1995)
Extrolites: 1) Palitantin, 2) Compactins and solistatin, 3) Cyclopeptin, dehydrocyclopeptin, cyclopenin, cyclopenol., viridicatol, viridicatin
Growth on creatine: Good to very good
Acid and base production on creatine: Under colony or good, base production poor or delayed
Growth on UNO: Very good
Growth on nitrite: Weak

Abiotic factors:
Diam., 1 week, 25°C: CYA: 16-34 mm; MEA: 14-26 mm; YES: 25-39 mm; CREA: 6-22 mm; Cz: 12-27 mm, OAT: 17-29 mm: CYAS: 30-38 mm; CzBS: 5-23 mm; CzP: 0 mm; UNO: 7-24 mm; DG18: 27-32 mm
Diam., CYA, 1 week: 5°C: 3-5 mm; 15°C: 18-30 mm; 30°C: 0 mm; 37°C: 0 mm
CYA/CYAS: 0.8 [0.7-0.9], halotolerant
CYA15°C/CYA 25°C: 0.9 [0.7-1.1]
CYA30°C/CYA 25°C: 0
CZBS/CZ: 0.9 [0.3-1.4]
CZP/CZ: 0

Distribution: Denmark, Greenland, Svalbard, Norway, Sweden, United Kingdom, Netherlands, Germany, France, Russia, USA, BC, Canada

Ecology and habitats: Refrigerated dry meat, cheese, apples, pears, nuts

Biotechnological applications: Used for production of compactin, a cholesterol lowering agent. Compactin also has an antifungal effect. Present on naturally fermented lamb meat on Faroe Islands, but not used deliberately.

Biodeterioration & phytopathology: An important apple rotting organism (Frisvad, 1981; Pitt *et al*, 1991; Sanderson and Spotts, 1995). It may cause spoilage of cheese (Hocking and Faedo, 1992; Lund *et al*., 1995)

Mycotoxicoses and mycotoxins: Unkown

Typical cultures: IBT 21545 = CBS 147.86, ex fruit of *Malus sylvestris*, Denmark (**Y**); IBT 21838 = CBS 109828, ex mouldy cheese, Denmark; IBT 22505 = CBS 109827, ex waste, Germany; IBT 23267 = CBS 500.73 = VKM F-1751 = ATCC 24727 = IMI 287746, ex *Malus sylvestris*, Russia (*P. mali*); IBT 3950 = IBT 23182 = CBS 487.75 = IMI 291192, ex meat product, Germany (*P. verrucosum* var. *melanochlorum* & *P. melanochlorum*); IBT 23035 = CBS 146.86, ex fruit of *Malus sylvestris*, Denmark; IBT 22583 = CBS 112019, ex wheat bread, Italy; IBT 14859 = CBS 112053, ex Manchego cheese, Spain; CBS 488.75 = IMI 291196, ex meat product, Germany; CBS 489.75 = IMI 291198, ex meat product, Germany; CBS 470.84 = IMI 285509 = FRR 2928, ex tuber of *Helianthus tuberosus*, Denmark; CBS 140.86, ex surface of *Malus sylvestris*, Denmark; CBS 141.86, ex air, Denmark; CBS 142.86, ex mouse nest, Denmark; CBS 143.86, ex mouldy salami, Denmark; CBS 143.86, ex mouldy salami, Denmark; CBS 144.86, ex soil, Sweden; CBS 145.86, ex mouldy peas, Denmark; CBS 422.89 = CBS 423.89 = FRR 955 = IMI 134650 = MUCL 29088 = MUCL 29183 = NRRL 954 = NRRL 955, ex fruit, Norway (*P. majusculum*); CBS 109275 = IBT 19846, ex French cheese, CBS 109276 = IBT 19803, ex French cheese.

Fig. 75. *Penicillium solitum.* 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 µm.

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

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

Type: Herb. CBS 111225
Culture ex type: CBS 111225 = IBT 5891, ex thyme, Greece (**T**)

Diagnostic features: Green rough-walled conidia, verrucolone, alantrypinone, fumiquinazoline F, halotolerant and psychrotolerant

Similar species: *P. thymicola* differs from *P. verrucosum* and *P. nordicum* by rough-walled conidia and a yellow reverse on CYA.

Description:
Conidiophores: Terverticillate, appressed elements, born from subsurface hyphae
Conidia: Rough-walled, globose to subglobose, 2.6-3.2 µm.
Phialides: Cylindrical tapering to a distinct collulum, 7-9 µm x 2.5-3.0 µm
Metulae: Cylindrical, 8-14 µm x 3.2-4.4 µm
Rami: Cylindrical, 10-20 µm x 3.5-4.5 µm
Stipes: Rough-walled, 200-500 µm x 3.5-4.2 µm
Synnemata or fasciculation: none
Sclerotia: None
Colony texture: Velutinous
Conidium colour on CYA: Green
Exudate droplets on CYA: None or yellow droplets
Reverse colour on CYA: Yellow
Reverse colour in YES: Yellow to orange
Diffusible colour: None
Ehrlich reaction: Yellow green
Odour and volatile metabolites: 2-methyl-isoborneol (Larsen *et al*., 2001)
Extrolites: 1) Verrucolone & PC-2, 2) Daldinine D, 3) Fumiquinazoline F, 4) Alantrypinone and serantrypinone, 5) Anacine
Growth on creatine: Weak
Acid and base production on creatine: acid under colony, no base
Growth on UNO: Good
Growth on nitrite: Good

Abiotic factors:
Diam., 1 week, 25°C: CYA: 9-20 mm; MEA: 8-17 mm; YES: 15-26 mm; CREA: 5-13 mm; Cz: 7-12 mm, OAT: 8-13 mm: CYAS: 24-30 mm; CzBS: 2-10 mm; CzP: 0 mm; UNO: 6-11 mm; DG18: 18-21 mm
Diam., CYA, 1 week: 15°C: 19-24 mm; 30°C: 2-6 mm; 37°C: 0 mm
CYA/CYAS: 0.6 [0.4-0.7], halotolerant
CYA15°C/CYA 25°C: 1.4 [1.0-2.3], psychrotolerant
CYA30°C/CYA 25°C: 0
CZBS/CZ: 0.6 [0.3-1.0]
CZP/CZ: 0

Distribution: Czech Republic, Greece, Sudan, Wyoming (USA)

Ecology and habitats: Thyme and other herbs, sorghum, soil under cottonwood

Biotechnological applications: None

Biodeterioration & phytopathology: Unknown

Mycotoxicoses and mycotoxins: The toxicity of the extrolites of *P. thymicola* is unknown.

Typical cultures: IBT 21560 = CBS 111226, ex air of archive, Moravia, Czech Republic, Czech Republic (**Y**); IBT 5254 = CBS 111227, ex sorghum, Sudan; IBT 5812 = CBS 111224; herb, Greece; IBT 16332 = CBS 111223, ex soil under *Populus angustifolia* in creek, Arlington, Wyoming, USA.

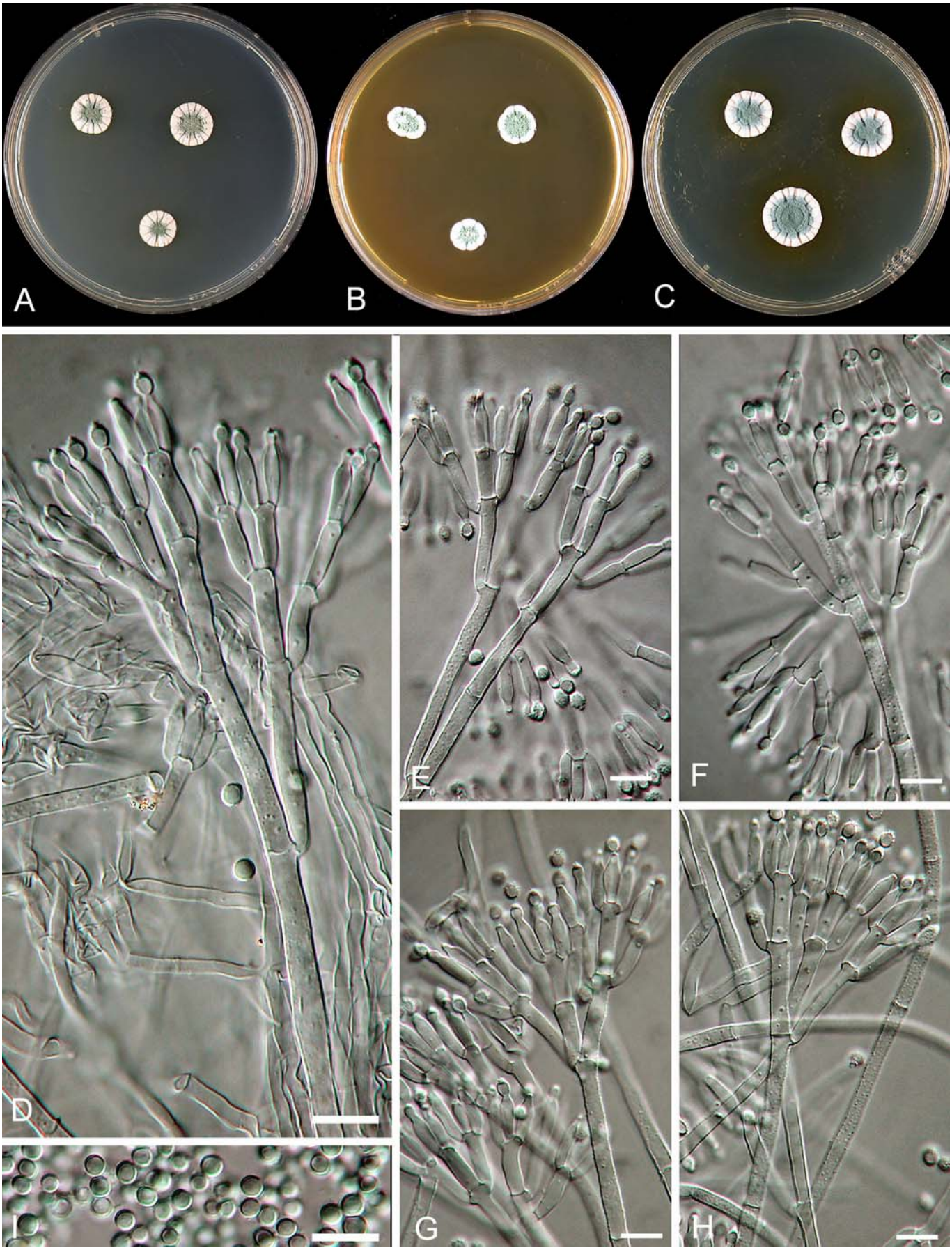

Fig. 76. *Penicillium thymicola.* 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 µm.

P. tricolor Frisvad, Seifert, Samson & Mills, Can. J. Bot. **72**: 937, 1994

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

Type: Herb. DAOM 216240
Culture ex type: CBS 635.93 = IBT 12493 = DAOM 216240, ex *Triticum aestivum*, Saskatchewan, Canada (**T**)

Diagnostic features: Terrestric acid, xanthomegnin, viomellein, vioxanthin, smooth-walled conidia, rough walled stipes, grey (green) conidia, yellow brown reverse on CYA and YES

Similar species: *P. tricolor* differs from other members of series *Viridicata* by producing grey green condia and a brown reverse on YES.

Description:
Conidiophores: Terverticillate, appressed elements, born from subsurface and aerial hyphae
Conidia: Smooth-walled, globose to subglobose, 2.6-3.4 µm.
Phialides: Flask-shapes 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: Rough walled, 100-450 µm x 3-4 µm
Synnemata or fasciculation: None or very weak fasciculation
Sclerotia: None
Colony texture on CYA: Velutinous
Conidium colour on CYA: Grey green
Exudate droplets on CYA: Copious, brown
Reverse colour on CYA: Dark yellow brown
Reverse colour on YES: Yellow brown
Diffusible colour on CYA: light yellow brown
Ehrlich reaction: None
Odour and volatile metabolites: Isobutanol, isopentanol, 1-octene-3-ol, 3-octanone, 3-octanol, isobutyl acetate, 1-octene, styrene, γ-hexalactone (Larsen and Frisvad, 1995)
Extrolites: 1) Terrestric acid, 2) Xanthomegnin, viomellein and vioxanthin, 3) Asteltoxin, 4) Puberuline and verrucofortine
Growth on creatine: Weak
Acid and base production on creatine: Good acid production, no base
Growth on UNO: Weak
Growth on nitrite: Weak

Abiotic factors:
Diam., 1 week, 25°C: CYA: 20-32 mm; MEA: 24-33 mm; YES: 30-40 mm; CREA: 20-28 mm; Cz: 22-30 mm, OAT: 23-30 mm: CYAS: 24-27 mm; CzBS: 21-25 mm; CzP: 0 mm; UNO: 13-16 mm; DG18: 19-23 mm
Diam., CYA, 1 week: 5°C: 2-4 mm, 15°C: 4-15 mm; 30°C: 0 mm; 37°C: 0 mm
CYA/CYAS: 1.2 [1.0-1.3]
CYA15°C/CYA 25°C: 0.4 [0.1-0.5]
CYA30°C/CYA 25°C: 0
CZBS/CZ: 0.8 [0.7-1.0]
CZP/CZ: 0

Distribution: Saskatchewan and Manitoba (Canada)

Ecology and habitats: Wheat and barley

Biotechnological applications: None

Biodeterioration & phytopathology: Unknown

Mycotoxicoses and mycotoxins: Xanthomegnin, viomellein, vioxanthin and asteltoxin, but the species seems to be rare in cereals

Typical cultures: IBT 21547 = IBT 11663 = CBS 637.93 = IMI 357306, ex *Triticum aestivum*, Saskatchewan, Canada (**Y**); IBT 12471 = CBS 636.93 = DAOM 216241, ex *Triticum aestivum*, Saskatchewan, Canada; IBT 12494 = CBS 101488 = IMI 357307 = DAOM 216242, ex *Triticum aestivum*, Manitoba, Canada.

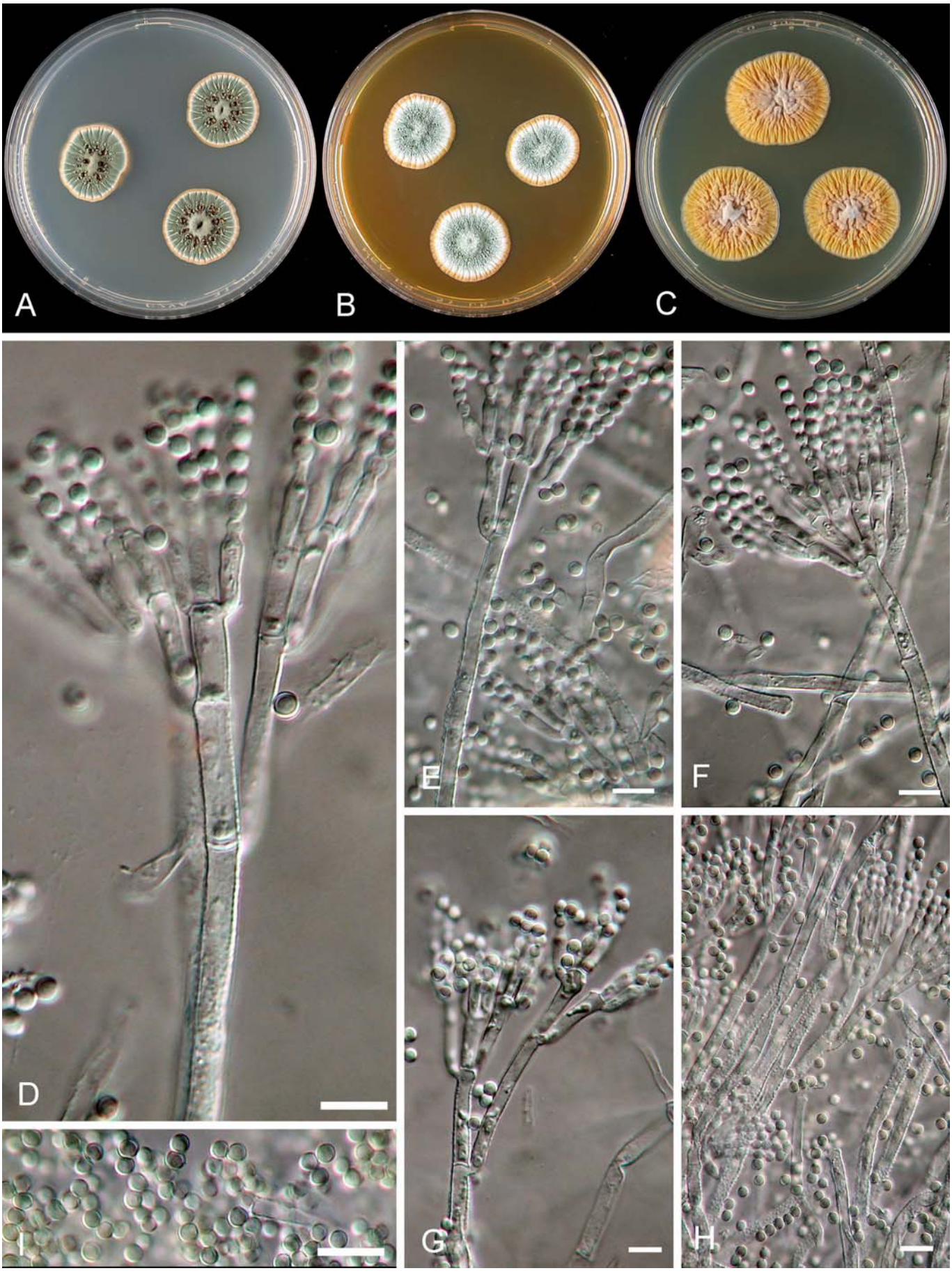

Fig. 77. *Penicillium tricolor.* 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 µm.

P. tulipae Overy & Frisvad, Syst. Appl. Microbiol. **26**: 634, 2003

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

Type: Herb. C 60162
Culture ex type: CBS 109555 = CBS 187.88 = IBT 3458, ex *Tulipa* sp., Denmark (**T, Y**)

Diagnostic features: Terrestric acid, penitrem A, meleagrin, neoxaline, smooth-walled conidia, fast growing on all substrates, melon yellow to orange reverse on CYA

Similar species: *P. tulipae* differs from *P. albocoremium* and *P. radicicola* by base production following acid production on CREA and better sporulation on YES agar.

Description:
Conidiophores terverticillate, few quarterverticillate from subsurface hyphae
Conidia: Smooth-walled, globose to subglobose, 2.8-4.5 µm
Phialides: Flask-shaped tapering to a distinct collulum, 7.4 - 12.9 µm x 2.2-3.8 µm
Metulae: Cylindrical, 8.8-15.3 µm x 2.5-4.8 µm
Rami: Cylindrical, 10.6-24.9 µm x 2.6-5.1 µm
Stipes: 150-2000 µm x 3.5-4.5 µm, walls smooth to finely roughened
Synnemata or fasciculation: Loose fasciculation
Sclerotia: None
Colony texture on CYA: Velutinous to slightly floccose
Conidium colour on CYA: Greyish green to dull green
Exudate droplets on CYA: Present, clear to yellow or yellow brown
Reverse colour on CYA: Melon yellow to orange
Reverse colour on YES: Deep yellow to yellowish orange
Diffusible colour on CYA: None
Ehrlich reaction: Weak to moderate, violet
Odour and volatile metabolites: No data
Extrolites: 1) Terrestric acid, 2) Penicillic acid (rare), 3) Chrysogine, 4) Roquefortine C, meleagrin, neoxaline, 5) Penitrem A
Growth on creatine: weak to moderate
Acid and base production on creatine: Good acid production
Growth on UNO: weak
Growth on nitrite: weak

Abiotic factors:
Diam., 1 week, 25°C: CYA: 39-48 mm; MEA: 26-40 mm; YES: 48-54 mm; CREA: 24-30 mm; Cz: 30-40 mm, OAT: 33-59 mm: CYAS: 30-40 mm; CzBS: 18-27 mm; CzP: 0 mm; UNO: 11-15 mm; DG18: 32-38 mm
Diam., 1 week: 5°C: 2-5 mm, 15°C: 28-37 mm; 30°C: 2-9 mm; 37°C: 0 mm
CYA/CYAS: 1.1 [1.0-1.3]
CYA15°C/CYA 25°C: 0.80 [0.7-0.9]
CYA30°C/CYA 25°C: 0.2 [0.1-0.2]
CZBS/CZ: 0.7 [0.6-0.9]
CZP/CZ: 0

Distribution: Denmark, the Netherlands, Korea, Germany

Ecology and habitats: *Tulipa*, *Lilium,* and *Chrysanthemum* bulbs, *Apium graveolens*, *Glycyrrhiza* sp., *Brassica oleracea*, *Helianthus tuberosus*

Biotechnological applications: None

Biodeterioration & phytopathology: Pathogenic to tulips and *Lilium*

Mycotoxicoses and mycotoxins: The natural occurrence of penitrem A, roquefortine C and penicillic acid may be produced in *Beta vulgaris*, *Helianthus tuberosus* etc. has yet to be determined.

Typical cultures: IBT 23036 = CBS 734.74, ex bulb of *Lilium* sp., Netherlands; IBT 10676 = CBS 111217, ex leave of *Tulipa* sp., Denmark; IBT 10687 = CBS 109552, ex agricultural soil, Germany; IBT 10631 = CBS 112431, ex *Glycyrrhiza* sp., Thailand; IBT 10691 = CBS 112432, ex *Apium graveolens*, Denmark; IBT 6173 = CBS 112433, ex *Helianthus tuberosus*, Denmark; IBT 6174, ex *Beta vulgaris*, Denmark; IBT 10632, ex *Beta vulgaris*, Denmark; IBT 10671, IBT 10675, IBT 10678, IBT 10680, IBT 15852, IBT 17812, ex *Tulipa* sp., Denmark; IBT 10674 & IBT 10686, ex *Brassica oleracea* ssp. *gemmifera*, Denmark; IBT 13024 = CBS 406.92, IBT 13025 = CBS 408.92, IBT 13029 = CBS 407.92, ex *Tulipa* sp., Korea; IBT 11648, ex *Apium graveolens*, Denmark; IBT 10681, ex *Chrysanthemum* sp., Denmark.

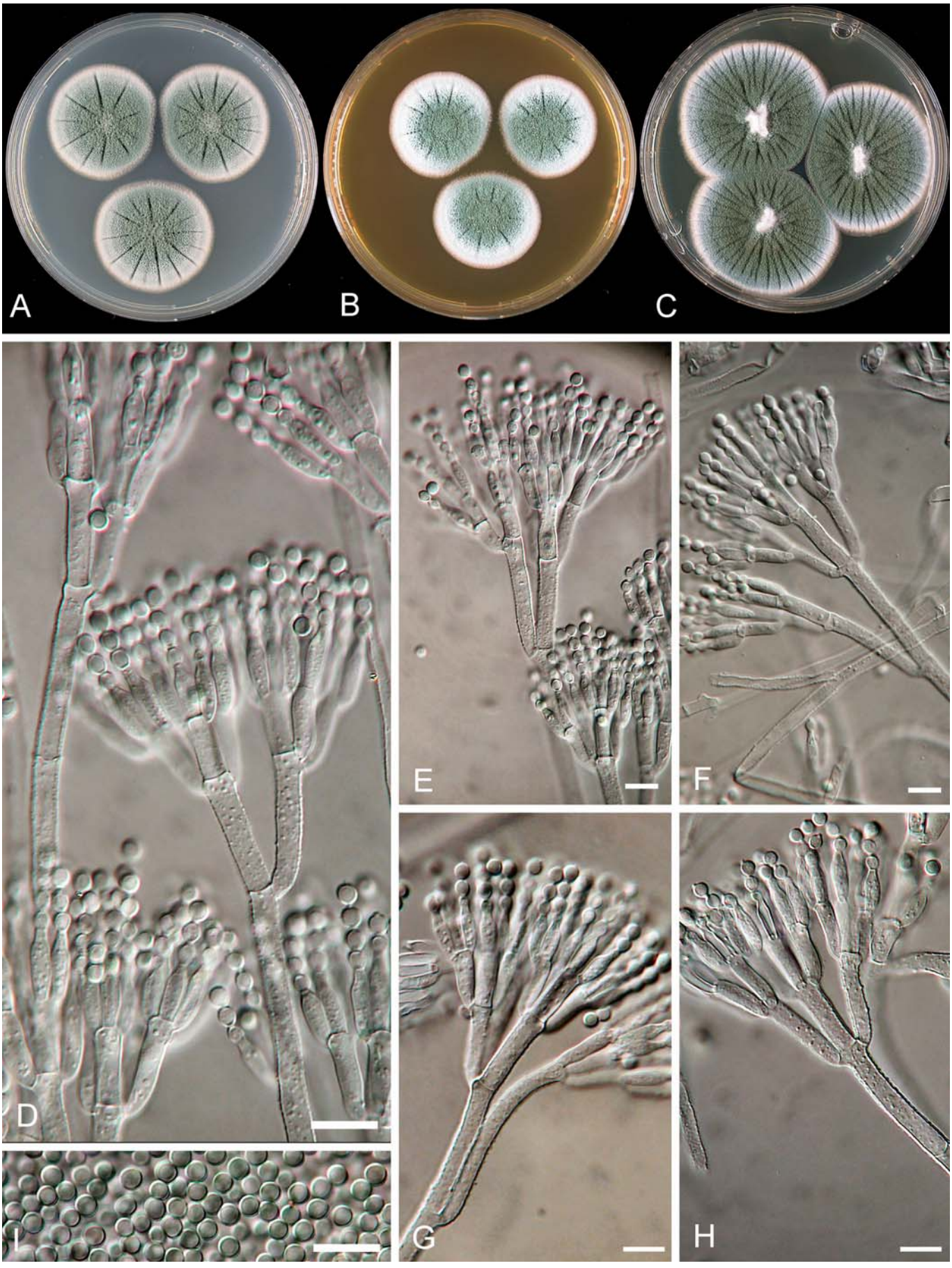

Fig. 78. *Penicillium tulipae*. 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 µm.

P. ulaiense Hsieh, Su & Tzean, Trans. Mycol. Soc. R.O.C. **2**: 161, 1987

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

Type: Herb. PPEH 29001.87
Culture ex type: CBS 210.92 = IBT 18387 = IBT 23037 = CBS 261.94 = CCRC 32655, ex skin of decaying orange, Ulai, Taipei County, Taiwan (**T**)

Diagnostic features: Ellipsoidal to long cylindrical smooth-walled conidia, slow growth rate, neither growth nor acid on CREA, synnemata on MEA, very poor growth on CYAS

Similar species: *P. ulaiense* differs from *P. italicum* by much slower growth rates on all media and pale reverse colours on all media.

Description:
Conidiophores: Terverticillate, appressed elements, sinoid, born from surface hyphae
Conidia: Smooth-walled, cylindrical and ellipsoidal, 4.5-9.5 µm x 2.2-3.5 µm
Phialides: Cylindrical tapering to a short collulum, 9-15 µm x 3-4 µm
Metulae: Cylindrical, 10-15 µm x 3.5-4.5 µm
Rami: Cylindrical, 17-22 µm x 3.2-4 µm
Stipes: Smooth and rough walled, 50-250 µm x 4-5 µm
Synnemata or fasciculation: Synnematous, fasciculate
Sclerotia: None
Colony texture: Velutinous to strongly fasciculate, crustose
Conidium colour on CYA: Dull green to greyish green
Exudate droplets on CYA: Present, clear or none
Reverse colour on CYA: Pale to cream
Reverse colour on YES: Cream yellow to brown
Diffusible colour on CYA: None
Ehrlich reaction: None
Odour and volatile metabolites: None
Extrolites: 1) Deoxybrevianamide E and 12,13-dehydrodeoxybrevianamide E
Growth on creatine: Weak
Acid and base production on creatine: None
Growth on UNO: Weak
Growth on nitrite: Weak (one strain good growth)

Abiotic factors:
Diam., 1 week, 25°C: CYA: 13-26 mm; MEA: 13-23 mm; YES: 24-33 mm; CREA: 4-6 mm; Cz: 8-16 mm, OAT: 16-20 mm: CYAS: 0-13 mm; CzBS: 0-7 mm; CzP: 0 mm; UNO: 1-7 mm; DG18: 19-25 mm
Diam., CYA, 1 week: 5°C: 2-4 mm; 15°C: 4-17 mm; 30°C: 0 mm; 37°C: 0 mm
CYA/CYAS: ≥6.6 [2-11]
CYA15°C/CYA 25°C: 0.7 [0.5-1.1]
CYA30°C/CYA 25°C: 0
CZBS/CZ: 0.2 [0-0.6]
CZP/CZ: 0

Distribution: Denmark, USA, South Africa, Taiwan

Ecology and habitats: Citrus fruits

Biotechnological applications: None

Biodeterioration & phytopathology: *P. ulaiense* produces rot in fungicide treated citrus fruits, the so-called whisker mould (Holmes *et al*., 1994)

Mycotoxicoses and mycotoxins: None known

Typical cultures: IBT 23027 = CBS 136.41 = DSM 2734, ex *Citrus medica limoneum*, South Africa; IBT 21548 = IBT 23038 = CBS 262.94, ex grapefruit cv. Marsh, California, USA (**Y**); IBT 13258 = CBS 314.97, ex apricot, Denmark; IBT 13078 = CBS 322.92, ex lemon, Denmark**.**

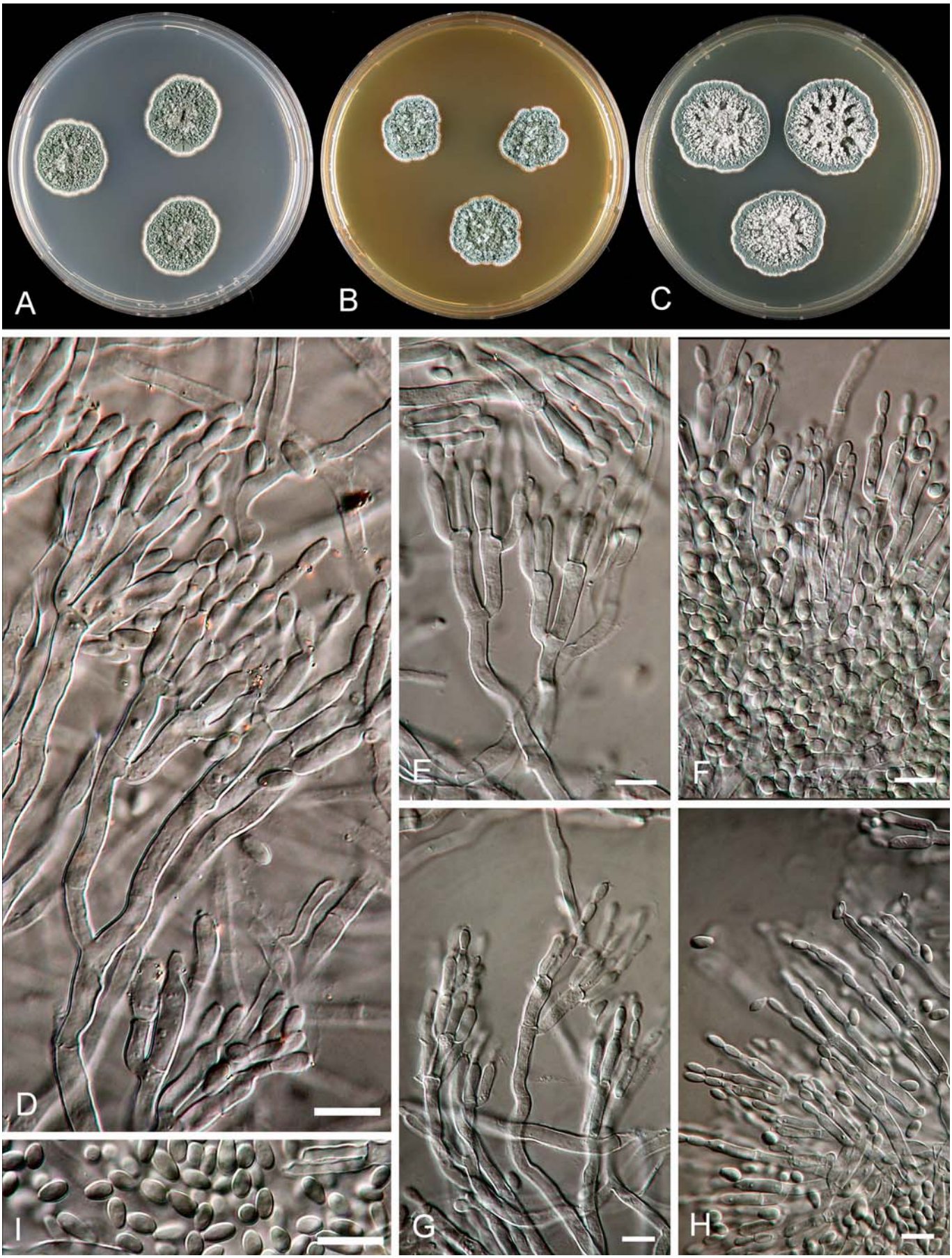

Fig. 79. *Penicillium ulaiense*. 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 µm.

P. venetum (Frisvad) Frisvad, Int. Mod. Tax. Meth. Pen. Asp. Clas.: 275, 2000

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

Type: Herb. IMI 321520
Culture ex type: IBT 10661 = IMI 321520, ex *Armoracia rusticana*, Kgs. Lyngby, Denmark

Diagnostic features: Smooth-walled conidia, yellow brown exudates droplets and diffusible pigment,

Similar species: *P. venetum* produce conidia that are blue rather than blue green and yellow brown exudate droplets and diffusible pigment distinguishing it from *P. albocoremium, P. hirsutum, P. hordei, P. radicicola*, 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: weakly fasciculate
Sclerotia: None
Colony texture: Velutinous to weakly fasciculate
Conidium colour on CYA: Blue green
Exudate droplets on CYA: Copious, yellow to red brown
Reverse colour: Yellow and dark yellow brown center
Diffusible colour: Yellow brown to dark ochre
Ehrlich reaction: None
Odour and volatile metabolites: Isobutanol, 3-octanone, 1,8-cineol, isopentanol, 3-heptanone, limonene (Larsen and Frisvad, 1995)
Extrolites: 1) Terrestric acid, 2) Atrovenetins, 3) Roquefortine C, 4) Cyclopeptin, dehydrocyclopeptin, cyclopenin, cyclopenol, viridicatol, 3-methoxyviridicatin
Growth on creatine: Weak to moderate
Acid and base production on creatine: Acid under colony, no base
Growth on UNO: Weak
Growth on nitrite: Weak

Abiotic factors:
Diam., 1 week, 25°C: CYA: 18-34 mm; MEA: 17-34 mm; YES: 34-47 mm; CREA: 15-24 mm; Cz: 15-26 mm, OAT: 23-34 mm: CYAS: 30-37 mm; CzBS: 14-23 mm; CzP: 0 mm; UNO: 14-21 mm; DG18: 19-31 mm
Diam., CYA, 1 week: 5°C: 2-4 mm; 15°C: 26-33 mm; 30°C: 2-7 mm; 37°C: 0 mm
CYA/CYAS: 0.8 [0.7-1.0]
CYA15°C/CYA 25°C: 1.1 [0.8-1.3]
CYA30°C/CYA 25°C: 0.2 [0.1-0.3]
CZBS/CZ: 0.9 [0.9-1.0]
CZP/CZ: 0

Distribution: Denmark, the Netherlands, United Kingdom, Canada, Korea, Montana (USA), Transvaal (South Africa), Thailand

Ecology and habitats: *Iris* spp., *Asparagus*, *Ornithogalum* spp., *Hyacinthus* spp., *Armoracea* spp.

Biotechnological applications: None

Biodeterioration & phytopathology: Can cause a destructive rot in flower bulbs, pathogenic to *Iris* and *Ornithogalum*.

Mycotoxicoses and mycotoxins: Roquefortine C is produced, but *P. venetum* is rare on foods.

Typical cultures: IBT 21549 = CBS 405.92, ex *Iris* sp., Korea (**Y**); IBT 23039 = CBS 201.57 = ATCC 16025 = CECT 2812 = IMI 019759 = MUCL 19012 = QM 840, ex bulb of *Hyacinthus* sp., United Kingdom; IBT 23040 = CBS 253.96, ex *Asparagus*; IBT 16215 = IBT 16127 = CBS 110096, Canada; IBT 22111, ex *Hyacinthus* sp., Denmark; IBT 15191 = CBS 110095, ex flower bulb, Denmark; IBT 16308 = CBS 110094, ex metal polluted soil, pH 2.5-3.5, under moss, Glengarry Creek, Montana, USA; IBT 23814 = CBS 112441, ex *Asparagus*; CBS 502.75 = IMI 068414, ex *Ornithogalum* sp., Transvaal, South Africa; CBS 402.92, ex *Iris* sp., Korea; CBS 403.92, ex *Iris* sp., Korea; CBS 404.92, ex *Iris* sp., Korea; IBT 4662 = IMI 321519, ex Liquirice root, Thailand, IBT 24614, ex Hyacinth flower, Denmark.

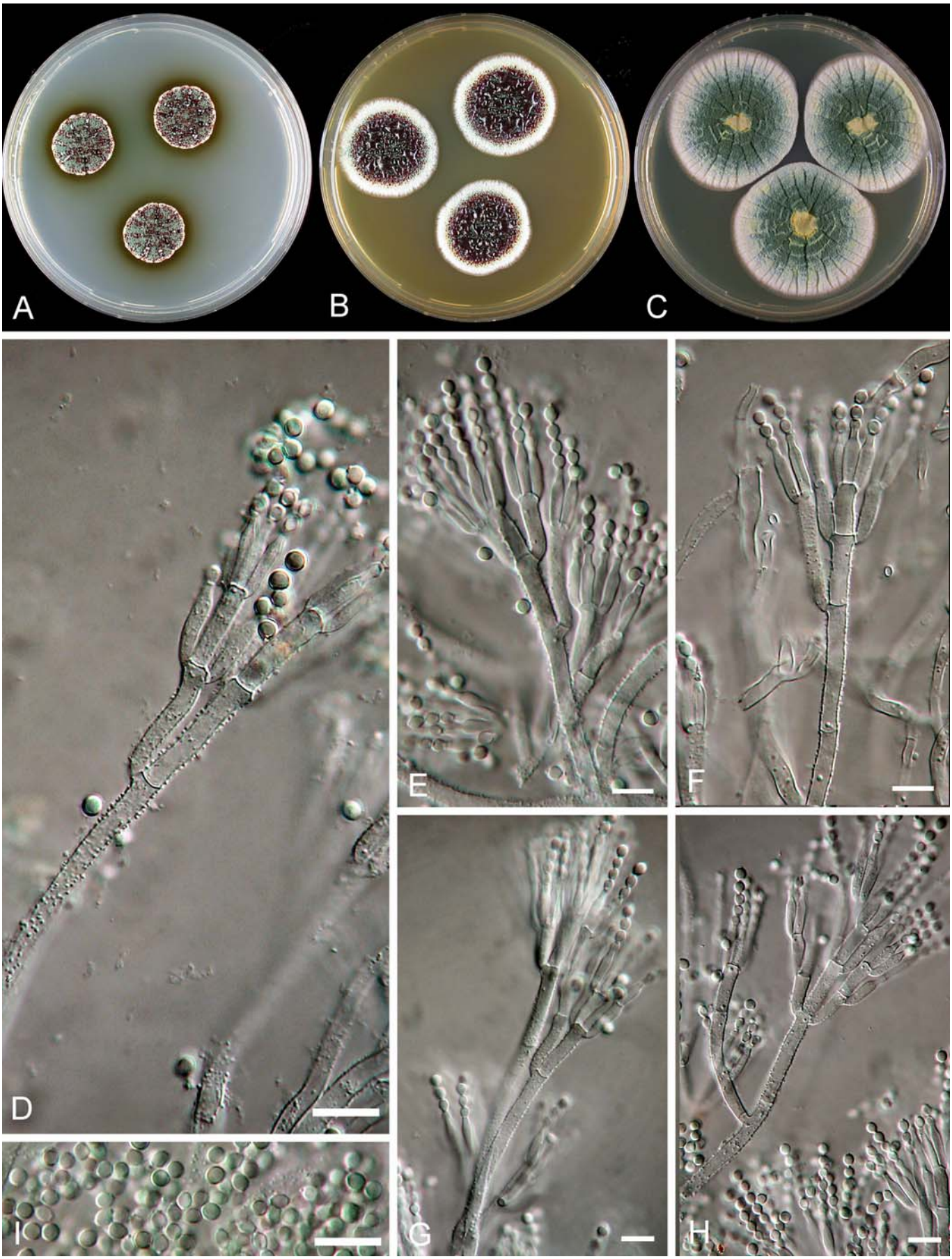

Fig. 80. *Penicillium venetum.* 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 µm.

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

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

Type: Herb. IMI 200310
Culture ex type: CBS 603.74 = ATCC 48957 =ATHUM 2897 = CECT 2906 = FRR 965 = IBT 4733 = IBT 12809 = IMI 200310 = MUCL 28674 = MUCL 29089 = MUCL 29186 = NRRL 965 (**T**)

Diagnostic features: Ochratoxin A, citrinin, verrucolone, verrucins, smooth-walled conidia, red brown reverse on YES, slow growing on all media, no growth at 30°C

Similar species: *P. verrucosum* has a red-brown to terracotta reverse on YES agar distinguishing it from *P. nordicum* and *P. thymicola*.

Description:
Conidiophores: Terverticillate, appressed elements, born from surface or subsurface hyphae
Conidia: Rough-walled, globose to subglobose, 2.6-3.2 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 on CYA: Velutinous to floccose to weakly fasciculate
Conidium colour on CYA: Green
Exudate droplets on CYA: Copious, clear
Reverse colour on CYA: Cream yellow, often with brown center
Reverse colour on YES: Red brown (terracotta)
Diffusible colour on CYA: None
Ehrlich reaction: None
Odour and volatile metabolites: 2-pentanone, 2-butanone, isobutanol, isopentanol, 3-octanone (Larsen & Frisvad, 1995)
Extrolites: 1) Verrucolone = arabenoic acid, 2) Ochratoxin A, 3) Citrinin, 4) Verrucin A & B
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: (9-) 11-24 mm; MEA: (7-) 10-22 mm; YES: (14-) 24-32 mm; CREA: 12-15 mm; Cz: 11-16 mm, OAT: 10-14 mm: CYAS: 21-27 mm; CzBS: 3-8 mm; CzP: 0 mm; UNO: 9-13 mm; DG18: 25-31 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: 0.7 [0.6-0.9], halotolerant
CYA15°C/CYA 25°C: 1.1 [1.0-1.2], psychrotolerant
CYA30°C/CYA 25°C: 0
CZBS/CZ: 0.5 [0.3-0.9]
CZP/CZ: 0

Distribution: Norway, Denmark, Sweden, United Kingdom, Germany, Poland, Netherlands, Belgium, Switzerland, France, Portugal, Italy, Canada, USA, Russia; most common in cold temperate regions

Ecology and habitats: barley, oats, rye, wheat, cheese (Lund and Frisvad, 2003; Staub, 1930)

Biotechnological applications: None

Biodeterioration & phytopathology: Deteriorate cereals and produce brown spots on cheese (Staub, 1930)

Mycotoxicoses and mycotoxins: Porcine mould nephrosis is cause primarily by *P. verrucosum* in Northern temperate regions (Lund and Frisvad, 2003). *P. verrucosum* was a possible candidate to be involved in Balkan endemic nephropathy. However, because *P. nordicum* is much more prevalent in the Balkan countries and grows on dried meat products, this species may play a contributing role to Balkan Endemic Nephropathy in combination with other species in series *Viridicata*.

Typical cultures: IBT 21550 = CBS 223.71, ex white bean, Ontario, Canada (**Y**); IBT 5088 = CBS 321.90, ex *Triticum aestivum*, United Kingdom; IBT 5061 = CBS 226.90, ex Hordeum vulgare, Denmark; IBT 21573 = CBS 112485, ex *Hordeum vulgare*, Denmark; IBT 22025 = CBS 112577 = VTT D98495, ex *Hordeum vulgare*, Finland; IBT 22112 = CBS 112486, ex wheat, United Kingdom; IBT 22682 = CBS 112488, ex soil in spruce forest, 4 km east of Zelenogorsk, Russia; IBT 22699 = CBS 111026, ex wheat, Sweden; CBS 302.48 = IBT 3434 = IBT 4738 = IBT 6731 = ATCC 10422 = IFO 8109 = IMI 039766 = NRRL 844 = QM 7499, ex Swiss cheese (*P. casei*); CBS 222.71, Canada; CBS 224.71 & CBS 225.71 & CBS 226.71G, ex unshelled nut of *Arachis hypogea*, Canada; IBT 14257 = CBS 226.71A, and CBS 227.71B-E, ex toxic white beans, Ontario, Canada; CBS 226.71F, ex poultry feed, Saskatchewan, Canada; CBS 221.90 = IBT 5007, ex *Hordeum vulgare*, Denmark; CBS 321.90, ex *Triticum aestivum*, United Kingdom; CBS 815.96, ex rye, Gotland, Sweden.

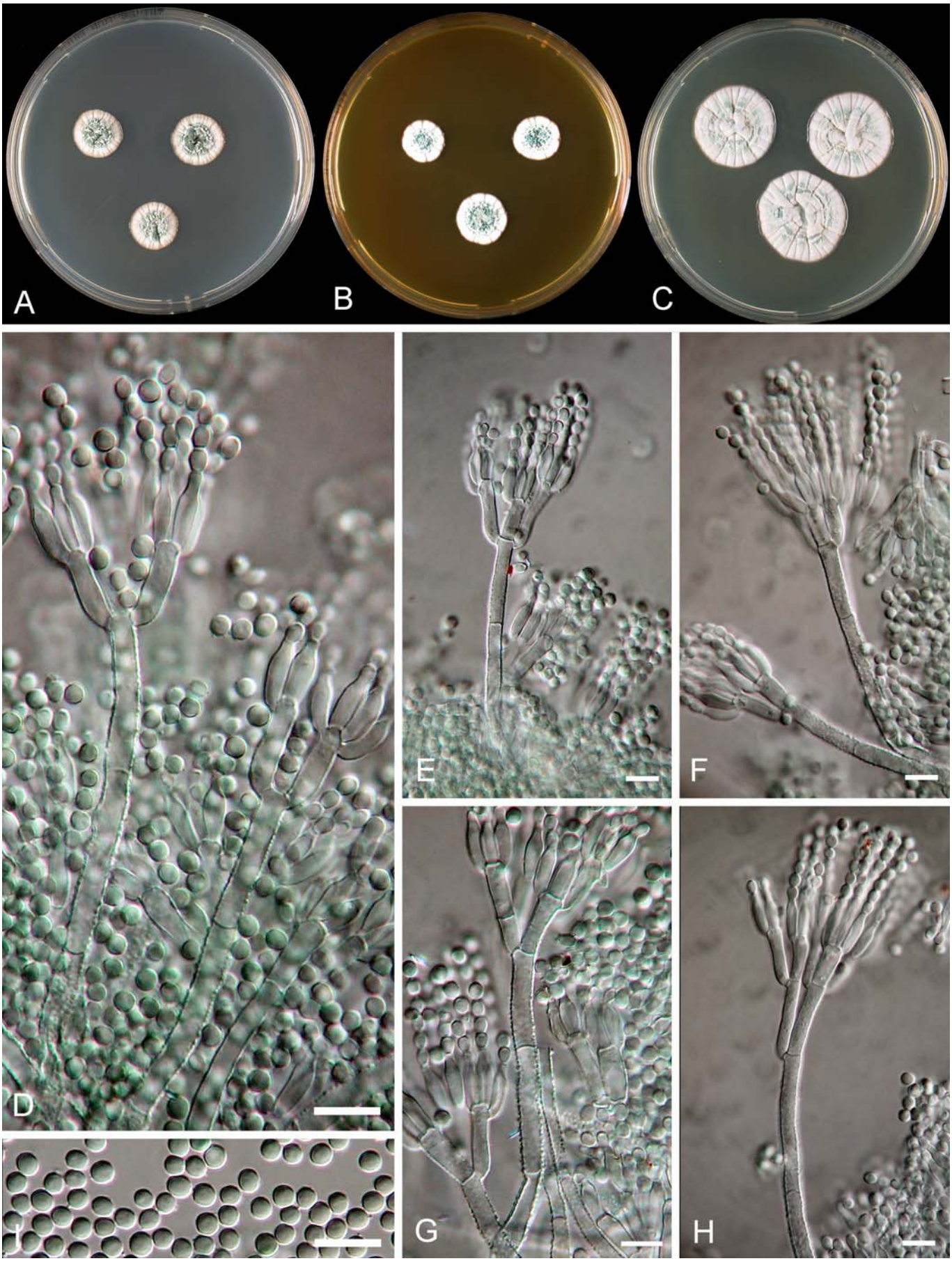

Fig. 81. *Penicillium verrucosum*. 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 µm.

P. viridicatum Westling, Ark. Bot. **11**: 88, 1911

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

Type (neo): Herb. IMI 039758
Culture ex type: CBS 390.48 = IBT 23041 = IMI 039758ii = ATCC 10515 = IFO 7736 = FRR 963 = NRRL 963 = IBT 4674 = IBT 3455 = IBT 5151 = QM 7683, ex air, Washington DC, USA (**T**)

Diagnostic features: Xanthomegnin, viomellein, vioxanthin, brevianamide A, viridic acid, penicillic acid, finely rough-walled conidia, yellow green to pure green conidia

Similar species: *P. viridicatum* has pure green conidia distinguishing it from all other species in series *Viridicata*, except *P. melanoconidium,* which, however, has dark green conidia. P. viridicatum produce acid on CREA and a bright yellow reverse on YES in contrast to *P. verrucosum* and *P. nordicum*.

Description:
Conidiophores: Terverticillate, appressed elements, born from subsurface and aerial hyphae
Conidia: Finely rough-walled, globose to subglobose, 2.6-3.4 µm.
Phialides: Flask-shapes 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: Rough walled, 200-450 µm x 3-4 µm
Synnemata or fasciculation: weakly fasciculate
Sclerotia: None
Colony texture on CYA: Velutionous to weakly fasciculate
Conidium colour on CYA: Green
Exudate droplets on CYA: clear to yellow droplets
Reverse colour: Yellow to orange brown
Diffusible colour: None or orange brown
Ehrlich reaction: Weak, yellow, pink or brown
Odour and volatile metabolites: 3-octanone, 3-heptanone, 1-octen-3-ol, 3-octanol (Larsen & Frisvad, 1995)
Extrolites: 1) Penicillic acid, 2) Xanthomegnin, viomellein and vioxanthin, 3) Brevianamide A, 4) Viridic acid, 5) Viridamine
Growth on creatine: Weak
Acid and base production on creatine: Good acid production, no base
Growth on UNO: Weak to moderate
Growth on nitrite: Weak

Abiotic factors:
Diam., 1 week, 25°C: CYA: 19-35 mm; MEA: 25-34 mm; YES: (16-) 25-40 mm; CREA: 17-24 mm; Cz: 19-27 mm, OAT: 21-32 mm: CYAS: 33-40 mm; CzBS: 16-25 mm; CzP: 0 mm; UNO: 9-18 mm; DG18: 22-33 mm
Diam., CYA, 1 week: 5°C: 2-4 mm, 15°C: 21-24 mm; 30°C: 6-18 mm; 37°C: 0 mm
CYA/CYAS: 0.8 [0.7-0.9], halotolerant
CYA15°C/CYA 25°C: 0.8 [0.7-0.9]
CYA30°C/CYA 25°C: 0.5 [0.2-0.6]
CZBS/CZ: 0.9 [0.8-1.1]
CZP/CZ: 0

Distribution: Denmark, Sweden, Great Britain, France, Bulgaria, Ohio, Michigan, Texas, Kansas, Indiana, Washington DC, Pennsylvania, Wisconsin, Montana, Arizona (USA), Canada, Ethiopia, Taiwan

Ecology and habitats: Corn, wheat, barley, beans, peas

Biotechnological applications: None

Biodeterioration & phytopathology: Deteriorates cereals

Mycotoxicoses and mycotoxins: Xanthomegnin, viomellein, vioxanthin, and viridic acid are mycotoxins that can be potentially produced by *P. viridicatum* in cereals.

Typical cultures: IBT 21551 = IBT 15053 = CBS 101034 (**Y**), ex beans, Bulgaria; IBT 14246 = CBS 109826 = IMI 351305, ex cereal, Bulgaria; IBT 16939 = CBS 109823, ex *Triticum aestivum*, Germany; IBT 5145 = CBS 109825 = NRRL A-26909, ex mound of kangaroo rat, 8 km east of Portal, Arizona, USA; IBT 12824 = CBS 109824 = NRRL 3600, ex wheat, Pennsylvania, USA; IBT 12817 = NRRL 3586, ex wheat flour, Michigan, USA; IBT 18375 = CBS 112052 = CCRC 32632, ex corn seed, Alien, Kaosiung County, Taiwan; CBS 101473 = IBT 11636, ex *Hordeum vulgare*, Denmark; CBS 101474 = NRRL 5569 = FRR 1636 = IBT 5193, ex corn, Kansas, USA; CBS 101475 =IBT 5192, ex piece of a branch, Ethiopia; CBS 101476 = IBT 11664, ex field pea, Denmark; CBS 101477 = IBT 14245 = IMI 351306, ex cereal, Bulgaria; IBT 12823 = NRRL 2028 = NRRL 959, ex cultivated soil, Woburn, Bedford, UK (*P. olivinoviride*), IBT 5292 = NRRL 961, Buenos Aires, Argentina (as *P. olivinoviride*), IBT 12814 = CBS 356.48 = IMI 039823 = FRR 871 = NRRL 871 = ATCC 10474 = IBT 12814 = CBS 246.32 = IMI 092264 = IFO 5760 = MUCL 29155, ex corn, France (*P. ochraceum* and *P. olivicolor*), IBT 5289 = NRRL 870 = FRR 870 = ATCC 10112, ex diseased corn kernels, Cleveland, Ohio, USA (as *P. ochraceum*); IBT 5145 = NRRL A-26909, ex mound of *Dipodomys spectabilis*, 6 east of Portal, Arizona, USA; IBT 12818 = NRRL A-15402, ex wheat flour, Texas, USA; IBT 12825 = NRRL A-18563, ex wheat, Michigan; IBT 12829 = NRRL 869, ex ex diseased corn kernels, Cleveland, Ohio, USA (as *P. ochraceum*).

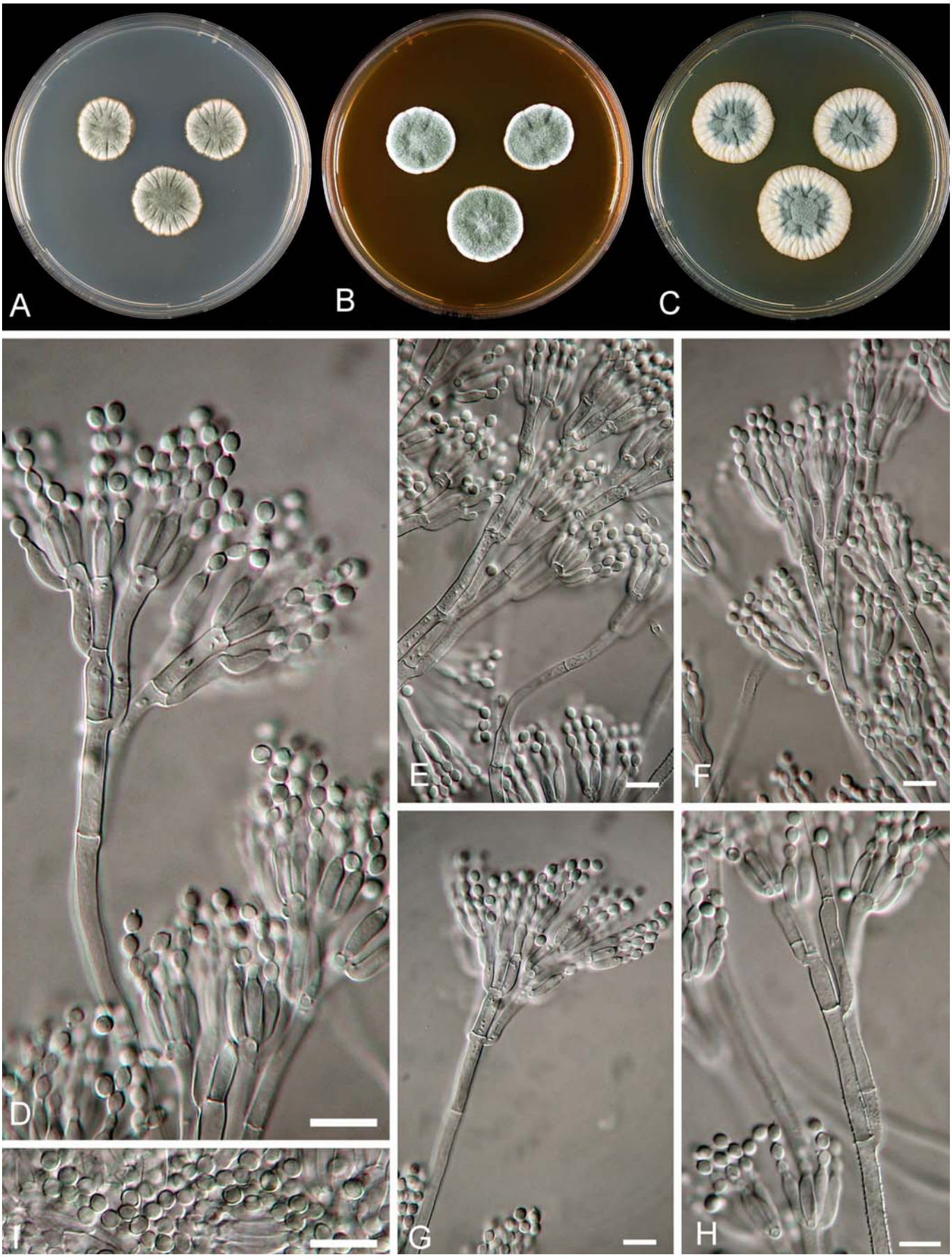

Fig. 82. *Penicillium viridiactum.* 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 µm.

P. vulpinum (Cooke & Massee) Seifert & Samson, Adv. Pen. Asp. Syst.: 144, 1985

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

Type: "on dung", *s. coll*., in herb Cooke (K)
Epitype: Herb. CBS 126.23 (proposed here)
Culture ex epitype: CBS 126.23 = ATCC 10426 = IMI 040237 = NRRL 2031 = VKM F-257 (*P. claviforme*) (**epiT**)

Diagnostic features: Patulin, roquefortine C, meleagrin, oxaline, broadly ellipsoidal smooth-walled conidia, long synnemata with pink stipes

Similar species: *P. vulpinum* has capitulate synnemata with pink stipes in contrast to *P. clavigerum*, which has acicular synnemata without a differentiated capitulum.

Description:
Conidiophores: Terverticillate, sinoid, appressed elements, but divergent rami born on synnemata
Conidia: Smooth-walled, ellipsoidal, 4-4.5 µm x 3-3.5 µm.
Phialides: Cylindrical tapering to a sort collulum, 8-11 µm x 2.2-3 µm
Metulae: Cylindrical, 9-12 µm x 2-3 µm (occasionally apically inflated)
Rami: Cylindrical, 10-27 µm x 3-4 µm
Stipes: Smooth walls, 100-200 µm x 2.5-3.5 µm
Synnemata or fasciculation: Long conspicous capitulate synnemata (2-5 mm)
Sclerotia: None
Colony texture on CYA: Coremiform
Conidium colour on CYA: Greenish grey
Exudate droplets on CYA: Clear
Reverse colour on CYA: Cream to reddish brown
Reverse on YES: Cream yellow to beige
Diffusible colour on CYA: None
Ehrlich reaction: None, yellow or weak violet reacvtion in few stsrains
Odour and volatile metabolites: 1-methoxy-3-methyl-benzene, 1,8-cineol, 1,3-octadiene (2 isomers), beta-bisabolene?, 1,3,6-octatriene and two isomers, 6-methyl-5-heptene-2-one, 2-methyl-phenol, 1-hexene, 1-heptene, 1-octene, sabinene, beta-myrcene, limonene, alfa-terpinene, 2-methyl-phenol, 2-methyl-isoborneol, ethyl acetate, isobutanol, isopentanol, isobutyl acetate (Larsen & Frisvad, 1995)
Extrolites: 1) Asterric acid, 2) Patulin, 3) Pachybasin, 4) lichexanthone, 5) Cyclopeptin, dehydrocyclopeptin, cyclopenin, cyclopenol, viriudicatin, viridicatol, 6) Roquefortine C / D, meleagrin, oxaline 7) Cyclopiamin
Growth on creatine: Very good
Acid and base production on creatine: moderate acid
Growth on UNO: Weak to good
Growth on nitrite: Weak

Abiotic factors:
Diam., 1 week, 25°C: CYA: 17-43 mm; MEA: 12-33 mm; YES: 26-48 mm; CREA: 11-23 mm; Cz: 11-22 mm, OAT: 19-38 mm: CYAS: 18-33 mm; CzBS: 0-5 mm; CzP: 0 mm; UNO: 10-18 mm; DG18: 10-19 mm
Diam., CYA, 1 week: 5°C: 2-3 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: Denmark, Netherlands, British Isles, United Kingdom, Poland, Germany, Austria, Czech Republic, Russia, Turkey, Cyprus, Israel, Syria, India, Taiwan, USA, Canada, Guinea, Colombia, Chile, Australia

Ecology and habitats: Dung, insects, soil (see Domsch *et al*., 1980, as *P. claviforme*)

Biotechnological applications: None

Biodeterioration & phytopathology: Unknown

Mycotoxicoses and mycotoxins: Patulin, roquefortine C

Typical cultures: IBT 21552 = IBT 11932 = CBS 309.97 = CBS 101133 (**Y**), melon, Denmark; CBS 305.63 = IBT 10605 = IBT 3228 = IBT 10605 = MUCL 3132, ex greenhouse soil, Belgium; IBT 3099 = CBS 488.84 = IMI 285528, *Hordeum vulgare*, Denmark; IBT 10606 = IBT 3227 = CBS 308.97 = CBS 218.89 = ATCC 58612 = IMI 293198, insect, Denmark; IBT 19370 = CBS 110772 = IMI 300363, ex soil, Meghalaya, India; IBT 6311 = CBS 110773, United Kingdom; IBT 23042 = CBS 344.54, owl pellet?, Netherlands; IBT 23392 = CBS 112442, ex ant farm; CBS 305.65, ex insect, Amsterdam, Netherlands; CBS 295.65, ex soil, Savelsbos, Netherlands; NRRL 1001 (*Coremium silvaticum*); NRRL 2149, Germany; NRRL 1002.

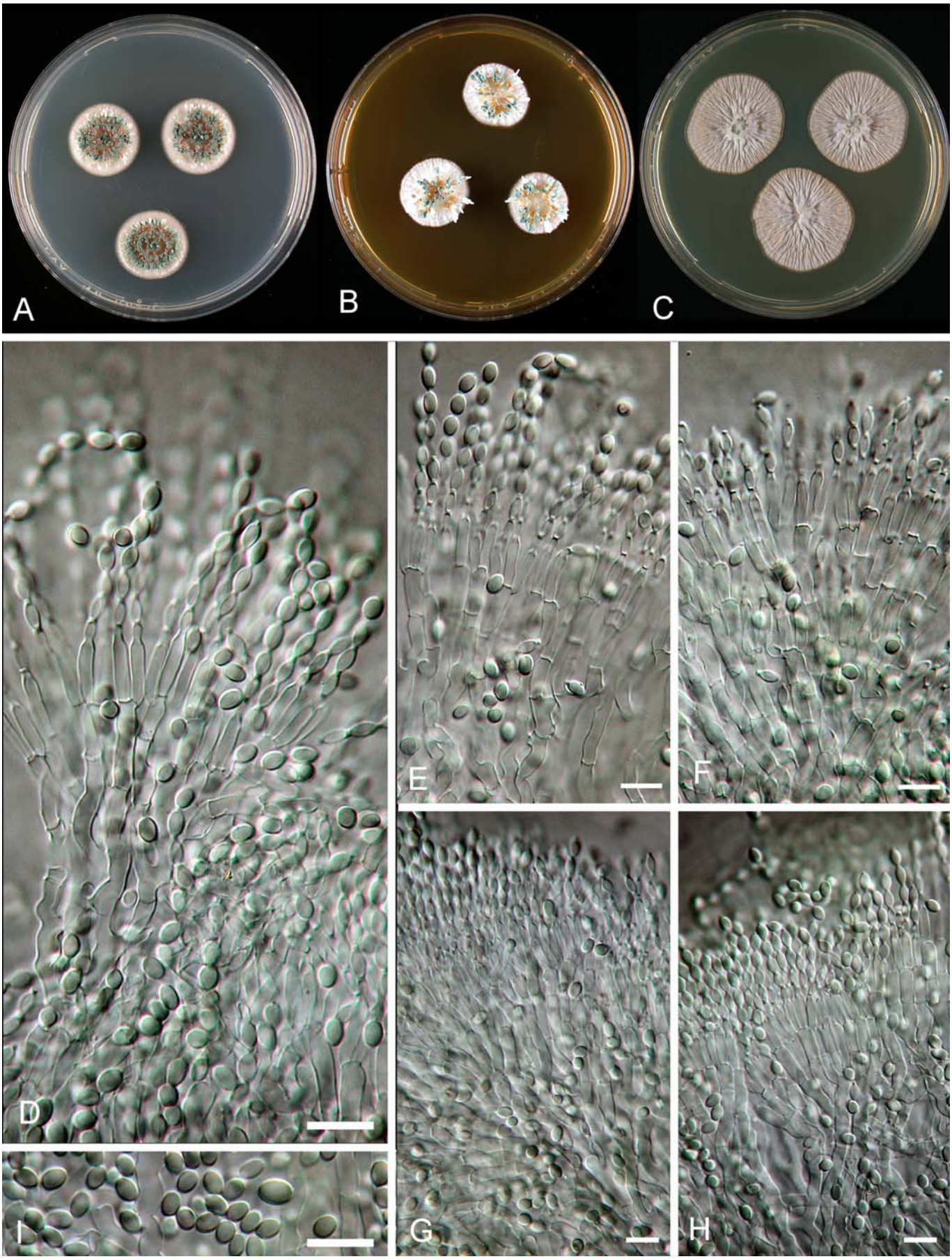

Fig. 83. *Penicillium vulpinum*. 7-day old colonies on A. CYA, B. MEA, C. YES, D-H. Conidiophores. I. Conidia. White bar = 10 µm.

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