IMI Descriptions of Fungi and Bacteria

Contents of Set 122 **1994**

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IMI DESCRIPTIONS OF FUNGI AND BACTERIA

The object of this series (formerly *CMI Descriptions of Pathogenic Fungi and Bacteria*, Sets 1–100 and *CMI Descriptions of Fungi and Bacteria*, Sets 101–102) is to provide, in convenient form, standardized, usually illustrated, descriptions of pathogens for use by plant pathologists and veterinary and medical mycologists. Besides a detailed description of the species, information is included on such subjects as the disease caused by the organism, its geographic distribution, physiologic specialization, transmission etc. Fungi of importance to other applied fields like biocontrol of insects and weeds, biodeterioration, biotechnology, industrial mycology etc. are also covered. References to key literature are also given. The information provided is based, wherever possible, on the *IMI Distribution Maps of Plant Diseases*, *the Review of Plant Pathology* (formerly *Review of Applied Mycology*) and the *Review of Medical and Veterinary Mycology*. The Descriptions are published in sets of 10, four sets being issued each year.

Mycopathologia **128**: 41–43, 1994.

IMI Descriptions of Fungi and Bacteria No. 1211

ACIDOVORAX AVENAE SUBSP. AVENAE

Acidovorax avenae subsp. **avenae** (Manns) Willems, Goor, Thielemans, Gillis, Kersters & De Ley, *International Journal of Systematic Bacteriology* **42**: 107–119, 1992.

Bacterium alboprecipitans (Rosen), Elliott, *Manual of Bacterial Plant Pathogens*, p. 89, Baillière, Tindall & Cox, London, 1930.

Bacterium avenae (Manns) Burgvits, *Fitopatogennye Bakterii* [Phytopathogenic Bacteria], p. 208, Akademiya Nauk SSSR, Moscow, 1935.

Bacterium rubrilineans (Lee, Purdy, Barnum & Martin) Elliott, *Manual of Bacterial Plant Pathogens*, p. 195, Baillière, Tindall & Cox, London, 1930.

Bacterium setariae Okabe, *Journal of the Society for Tropical Agriculture, Formosa* (*Taiwan*) **6**: 54–63, 1934.

Chlorobacter setariae (Okabe) Patel & Kulkarni, *Indian Phytopathology* **4**: 74–84, 1951.

Phytobacterium alboprecipitans (Rosen) Magrou & Prévot, *Comptes Rendus Hebdomadaires des Séances l'Académie des Sciences* **226**: 1229–1230, 1948.

Phytomonas alboprecipitans (Rosen) Bergey, Harrison, Breed, Hammer, Huntoon, *Bergey's Manual of Determinative Bacteriology*, 3rd edition, p. 277, Williams & Wilkins, Baltimore, 1930.

Phytomonas avenae (Manns) Bergey, Harrison, Breed, Hammer, Huntoon, *Bergey's Manual of Determinative Bacteriology*, 3rd edition, pp. 263–264, Williams & Wilkins, Baltimore, 1930.

Phytomonas rubrilineans Lee, Purdy, Barnum & Martin, *Red Stripe Disease. Phamphlet of the Experiment Station of the Haiwaiian Sugar Planters Association*, p. 72, 1925.

Phytomonas setariae (Okabe) Burkholder, *In* Bergey, Breed, Murray & Hitchens, *Bergey's Manual of Determinative Bacteriology*, 5th edition, p. 183, Williams & Wilkins, Baltimore, 1939.

Pseudomonas alboprecipitans Rosen, *Annals of the Missouri Botanical Garden* **9**: 333–402, 1922.

Pseudomonas avenae Manns *Bulletin of the Ohio Agricultural Experiment Station* **210**: 91–167, 1909.

Pseudomonas avenae subsp. *avenae* (Manns 1909) Hu, Young & Triggs, *International Journal of Systematic Bacteriology* **41**: 516–525, 1991.

Pseudomonas rubrilineans (Lee, Purdy, Barnum & Martin) Stapp, *In* Sorauer, *Handbuch der Pflanzenkrankheiten*, 5th edition, **Vol. 2**, p. 35, Paul Parey, Berlin, 1928.

Pseudomonas setariae (Okabe) Săvulescu, *Analele Academiei Române, Memoriile Sectinunii Stiintifice, Seria III*, **22**, Mem 4, 1–26, 1947.

Xanthomonas rubrilineans (Lee, Purdy, Barnum & Martin) Starr & Burkholder, *Phytopathology* **32**: 598–604, 1942.

Xanthomonas rubrilineans var. *indicus* Summanwar & Bhide, *Indian Journal of Sugarcane Research and Development* **6**: 65–68, 1962.

Aerobic, Gram-negative rods, motile with a single polar flagellum. Colonies are non-fluorescent on King's medium B (KB) and poly-β-hydroxybutyrate (PHB) granules are accumulated intracellularly when grown on a high carbon/low nitrogen media (e.g. Hayward, 1960). Colonies on YDC medium are white/cream with tan to brown centres, convex, smooth, 2–3 mm diameter after 3 days at 30 °C. Old colonies are sticky and adherent to the agar. Growth can occur at 41 °C but not at 4 °C, optimum temperature for growth 36 °C. Catalase, lipase (Tween 80), oxidase and urease positive; arginine dihydrolase negative. Nitrate reduced but no denitrification. Hypersensitive reaction on tobacco (*Nicotiana tabacum* L. cv. White Burley). Potato soft rot, and H_2S production are both negative and levan is not produced. Hydrolysis of gelatin variable and starch slight. Acid is produced from galactose, glucose, glycerol and mannitol, but not from lactose, maltose or sucrose. The following are used as sole carbon sources: β-alanine, 2-aminopentanoate, L-arabinose, 2,3-butylene glycol, citraconate, dextrin, ethanolamine, fucose, glucose, glutarate, lactate, L-leucine, levinulate, mannitol, propionate, D-sorbitol, succinate, D-tartrate and D-xylose; but not adonitol, benzoate, dulcitol, *p*-hydroxybenzoate, maltose, D-mannose, melezitose, inositol, L-threonine D-trehalose and tryptamine.

A member of the beta subdivision of the *Proteobacteria* (Woese *et al.*, 1984). Not assigned to any of the rRNA homology groups and placed within section V, a group containing taxa of unknown status whithin the genus *Pseudomonas* (Palleroni, 1984). However, the close relationship to rRNA homology group III pseudomonads was demonstrated by De Vos *et al.* (1985) and Hu *et al.* (1991), and this taxon was subsequently placed in the genus *Acidovorax* by Willems *et al.* (1992). The mol% G + C of the DNA is 67.8 - 69.8. The fatty acid profile is typical of Group 3a pseudomonads (Stead, 1992), the major hydroxy fatty acid being 3-hydroxydecanoic acid (10:0 3-OH), other 3-hydroxy acids are found in trace amounts and no 2-hydroxy acids are present. The major components are *cis*-9-hexadecenoic (16:1 *cis* 9; 41.4% (SD 3.8)), hexadecanoic (16:0; 31.9% (2.0)) and

cis-11-octadecenoic acids (18:1 *cis* 11; 15.5% (2.0)). Ubiquinones with eight isoprene units (Q-8) make up the major quinone composition, trace amounts of Q-7 and Q-9 are also detected.

Type strain: ATCC 19860; CFBP 2425; ICMP 3183; LMG 2117; NCPPB 1011.

HOSTS: *Agropyron intermedium*, *A. trichophorum*, *Avena sativa*, *Bromus catharticus*, *B. marginatus*, *Camellia sinensis* (may form a complex with *Pseudomonas syringae* pv. *theae*: **68**, 955), *Caryota mitis*, *Digitaria sanguinalis*, *Echinochloa crusgalli*, *Eleusine coracana*, *Euchlaena mexicana*, *Oryza sativa*, *Panicum hirsutum*, *P. miliaceum*, *Paspalum nutans*, *P. paniculatum*, *P. urvillei*, *Pennisetum americanum*, *Saccharum officinarum*, *Setaria italica*, *S. lutescens*, *S. viridis*, *Sorghum bicolor and Zea mays*.

DISEASE: Bacterial leaf blight of maize and sorghum, brown stripe of rice and red stripe of sugarcane. Symptoms in general consist of leaf streaks and stripes, which may extend into the sheaths. Occasionally a stalk rot develops. Symptoms are more severe on seedlings and immature plants. Discolouration of seeds can occur on rice. In fishtail palm (*Caryota mitis*), lesions are mainly at the leaf margin and brown/black with a chlorotic halo (Miller, 1992). In most cases conditions of high temperature and high relative humidity favour symptom development.

GEOGRAPHICAL DISTRIBUTION: Comoro Is., Egypt, Ethiopia, Ivory Coast, Kenya, Madagascar, Mauritius, Malawi, Mozambique, Niger, Nigeria, Reunion, Sierra Leone, South Africa, Sudan, Tanzania, Uganda, Zaire, Zimbabwe, Bangladesh, Burma, Bhutan, Cambodia, China, India, Indonesia, Iran, Iraq, Japan, Korea, Malaysia, Nepal, Okinawa, Pakistan, Philippines, Sri Lanka, Taiwan, Thailand, Vietnam, Australia, Fiji, Guam, Papua New Guinea, Tahiti, Italy, Portugal, Turkey, Mexico, USA (AL, AR, FL, GA, IL, HI, KS, LA, MT, NE, NY, PA, TX & VA), Barbados, Costa Rica, Cuba, Dominican Republic, El Salvador, Guadeloupe, Guatemala, Honduras, Jamaica, Martinique, Nicaragua, Panama, Puerto Rico, St. Kitts, Trinidad, Argentina, Brazil (Sao Paulo), Colombia, Guyana, Paraguay, Peru, Surinam, Uruguay, Venezuela (*CMI Map* 511 ed. 1, 1976 & *CMI Map* 39 ed. 5, 1987).

PHYSIOLOGICAL SPECIALIZATION: Although a number of studies report differences in physiological test results and distribution between strains these are not considered to be significant. In a recent study no differences were found in pathogenicity, host range and a number of physiological traits between strains (Ramundo & Claflin, 1990).

TRANSMISSION: The disease is largely thought to be seed borne. In rice, the bacterium is located between the glumes and the pericarp, or deeper in the seed (Shakya *et al.*, 1986). There is evidence to suggest that mature plants which survive infection in the seedling stage harbour latent infections. The bacterium can be found in 8-yr old rice seed samples stored at 5 °C (Shakya *et al.*, 1985). The bacterium is not thought to survive well in soil or in plant debris. Alternative hosts such as *Paspalum urvillei* (Vasey grass) in FL, USA have been noted as an inoculum reservoir in bacterial leaf blight of maize outbreaks (Shurtleff, 1973; **57**, 4929).

NOTES: Synonomy has been demonstrated between *Pseudomonas avenae* [*Acidovorax avenae* subsp. *avenae*] and *Pseudomonas alboprecipitans* (Schaad *et al.*, 1975), and *Pseudomonas rubrilineans* (Ramundo & Claflin, 1990). Control can be achieved by use of disease free seed and resistant varieties. There is some evidence that use of bacteriocides can control the disease; Kasugamycin has been used to control brown stripe in rice (Kadota & Ohuchi, 1990; **64**, 4316; **68**, 5545) and streptocycline or copper sulphate used to control leaf blight in maize (Thind *et al.*, 1984).

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IMI Descriptions of Fungi and Bacteria No. 1211 (continued)

ACIDOVORAX AVENAE SUBSP. AVENAE

LITERATURE: De Vos, Goor, Gillis & De Ley, *International Journal of Systematic Bacteriology* **35**: 169–184, 1985; Hayward, *Nature* **186**: 405–406, 1960; Hu, Young & Triggs, *International Journal of Systematic Bacteriology* **41**: 516–525, 1991; Kadota & Ohuchi, *JARQ, Japan Agricultural Research Quarterly* **24**: 15–21, 1990; Miller, *Plant Pathology Circular* **No. 355**, 1992; Palleroni, In Krieg & Holt, *Bergey's Manual of Systematic Bacteriology*, **Vol. 1**, pp. 141–199, Williams & Wilkins, Baltimore, 1984; Ramundo & Claflin, *Journal of General Microbiology* **136**: 2029–2033, 1990; Schaad, Kado & Sumner, *International Journal of Systematic Bacteriology* **25**: 133–137, 1975; Shakya, Chung & Vinther, *Journal of Phytopathology* **116**: 92–96, 1986; Shakya, Vinther, Mathur, *Phytopathologische Zeitschrift* **114**: 256–259, 1985; Shurtleff (ed.), *Compendium of Corn Diseases*, APS Minnesota, USA, 1973; Stead, *International Journal of Systematic Bacteriology* **42**: 281–295, 1992; Thind, Randhawa & Soni, *Zeitschrift für Pflanzenkrankheiten und Pflanzenschutz* **91**: 424–430, 1984; Willems, Goor, Thielemans, Gillis, Kersters & De Ley, *International Journal of Systematic Bacteriology* **42**: 107–119, 1992; Woese, Weisburg, Paster, Hahn, Tanner, Krieg, Koops, Harms & Stackebrandt, *Systematic and Applied Microbiology* **5**: 327–336, 1984.

G.S. Saddler

[Numbers in brackets, e.g. (**62**, 5055), refer to abstracts in the Review of Plant Pathology]

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IMI Descriptions of Fungi and Bacteria No. 1212

ACIDOVORAX AVENAE SUBSP. CATTLEYAE

Acidovorax avenae subsp. **cattleyae** (Pavarino) Willems, Goor, Thielemans, Gillis, Kersters & De Ley, *International Journal of Systematic Bacteriology* **42**: 107–119, 1992.

Bacillus cattleyae (Pavarino) Stapp, *In* Sorauer, *Handbuch der Pflanzenkrankheiten*, 5th edition **Vol. 2**, p. 68, Paul Parey, Berlin, 1928.
Bacterium cattleyae Pavarino, *Atti della R. Accedemia nazionale dei Lincei. Rendiconti. Classe di scienze fisiche, matematiche e naturali* **20**: 233–237, 1911.
Phytobacterium cattleyae (Pavarino) Magrou & Prévot, *Comptes Rendus Hebdomadaires des Séances l'Académie des Sciences* **226**: 1229–1230, 1948.
Phytomonas căttleyae (Pavarino) Ark & Thomas, *Phytopathology* **36**: 695–698, 1946.
Pseudomonas cattleyae (Pavarino) Săvulescu, *Analele Academiei Române, Memoriile Sectinunii Stiintifice, Seria III*, **22**, Mem 4, 1–26, 1947.

The description of this taxon is largely dependant on the work of Ark & Thomas (1946). Aerobic, Gram-negative rods, motile with 1–2 polar flagella. Non-fluorescent on KB medium producing white/cream colonies on most media. No growth at 48 °C, optimum temperature for growth is between 25 and 35 °C. Catalase and urease positive; nitrate is reduced but no denitrification. Starch is hydrolyzed but not gelatin; nitrate is reduced to nitrite, no H_2S or indole produced. Hypersensitive reaction on tobacco (*Nicotiana tabacum* L. cv. White Burley). Acid is produced from arabinose, dulcitol, fructose, galactose, glucose, glycerol, lactose, mannitol, sucrose and xylose, but not from raffinose. The following are used as sole carbon sources: γ-aminobutyrate, L-arabinose, citraconate, citrate, ethanolamine, fucose, glucose, mannitol, ribose, sorbitol, D-tartrate and threonine; but not inositol, D-mannose, *m*-tartrate and D-xylose.

A member of the beta subdivision of the *Proteobacteria* (Woese *et al.*, 1984). Not assigned to any of the rRNA homology groups and placed within section V, a group containing taxa of unknown status whithin the genus *Pseudomonas* (Palleroni, 1984). However, the close relationship of the type strain (NCPPB 961) to rRNA homology group III pseudomonads and *Acidovorax* (*Pseudomonas*) *avenae* in particular was demonstrated by De Vos *et al.* (1985) and by Hu *et al.* (1991). This taxon was subsequently placed in the genus *Acidovorax* by Willems *et al.* (1992). The mol% G + C of the DNA is 68.6–68.9. The fatty acid profile is typical of Group 3a pseudomonads (Stead, 1992), the major hydroxy fatty acid being 3-hydroxydecanoic acid (10:0 3-OH), other 3-hydroxy acids are found in trace amounts and no 2-hydroxy acids are present. The major components are *cis*-9-hexadecenoic (16:1 *cis* 9; 40.6% (SD 0.3)), hexadecanoic (16:0; 34.9% (0.4)) and *cis*-11-octadecenoic acids (18:1 *cis* 11; 14.4% (0.6)). Ubiquinones with eight isoprene units (Q-8) make up the major quinone composition, trace amounts of Q-7 and Q-9 are also detected.

Type strain: CFBP 2429; ICMP 2826; LMG 2364; NCPPB 961; NRRL B835.

HOSTS: *Cattleya* spp., *Phalaenopsis* spp., and hybrids. The following have been reported: *Catasetum* Ecuador, *Cattleya harrisoniana*, *C. warneri*, *C.* Margaret Stewart × *Schomburgkia thomsoniana*, *Cypripedium* sp., *Dendrobium* sp., *D.* Joan Krishima, *D.* Sue Cornell, *Doritaenopsis* Clarelen, × *Epidendrum obrienianum*, *E. pamplonense* var. *variegatum*, *Epiphronites veitchii*, × *Ionopsis utricularioides*, *Miltonia* sp., *Oncidium ampliatum*, *O. lanceanum*, *O. luridum*, *O. warscewiczii*, *Ornithocephalus bicornis*, *Phalaenopsis amabilis*, *Renanthera* Brookie Chandler × *Phalaenopsis* Dos Pueblos, × *Rodricidium* Tahiti, *Rodriguezia secunda*, *Rhynchostylis gigantea*, *R. gigantea alba*, *R. retusa*, *Sophronitis carnus*, *Trichocentrum tigrinum* × *Oncidium lanceanum*, *Vanda* Alexander Bowman × *Vanda* Jennie Hashimoto, *Vanda* Bill Sutton, *Vanda coerulescens*, *Vanda parishii* × *Phalaenopsis lueddemanniana* and *Vanilla* sp.

DISEASE: Leaf spots. The bacteria are thought to enter the plant through the stomata; lesions initially appear water-soaked and will blacken with age; a considerable amount of exudate may also be observed. Lesions can occur on any part of the leaf, older spots may be surrounded by a light green or yellow halo. The disease can kill seedlings and, with certain varieties, mature plants, should the infection reach the growing point.

GEOGRAPHICAL DISTRIBUTION: Philippines, Taiwan, Italy, USA (FL, CA), possibly Portugal (**61**, 284).

PHYSIOLOGICAL SPECIALISATION: None known.

TRANSMISSION: Bacterial exudate from heavily infected plants may act as source of inoculum.

NOTE: A number of studies contain results obtained from strain ICMP 3992 which appears to be atypical for this subspecies, or was originally misidentified (De Vos *et al.*, 1985; Hu *et al.*, 1991). Control of the disease can be achieved by removal of diseased material and avoidance of overhead watering (Miller, 1990). Reduction of prolonged wetness on leaves, by increased air circulation or rinsing with a quarternary ammonium compound such as Physan, can also reduce symptoms (Frank, 1988).

LITERATURE: Ark & Thomas, *Phytopathology* **36**: 695–698, 1946; De Vos, Goor, Gillis & De Ley, *International Journal of Systematic Bacteriology* **35**: 169–184, 1985; Frank, *Orchid Digest* **52**: 66–67, 1988; Hu, Young & Triggs, *International Journal of Systematic Bacteriology* **41**: 516–525, 1991; Miller, *Plant Pathology Circular* **No. 330**, 1990; Palleroni, *In* Krieg & Holt, *Bergey's Manual of Systematic Bacteriology*, **Vol. 1**, pp. 141–199, Williams & Wilkins, Baltimore, 1984; Stead, *International Journal of Systematic Bacteriology* **42**: 281–295, 1992; Willems, Goor, Thielemans, Gillis, Kersters & De Ley, *International Journal of Systematic Bacteriology* **42**: 107–119, 1992; Woese, Weisburg, Paster, Hahn, Tanner, Krieg, Koops, Harms & Stackebrandt, *Systematic and Applied Microbiology* **5**: 327–336, 1984.

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IMI Descriptions of Fungi and Bacteria No. 1213

ACIDOVORAX AVENAE SUBSP. CITRULLI

Acidovorax avenae subsp. **citrulli** (Schaad, Sowell, Goth, Colwell & Webb) Willems, Goor, Thielemans, Gillis, Kersters & De Ley, *International Journal of Systematic Bacteriology* **42**: 107–119, 1992.

Pseudomonas avenae subsp. *citrulli* (Schaad, Sowell, Goth, Colwell & Webb) Hu, Young & Triggs, *International Journal of Systematic Bacteriology* **41**: 516–525, 1991.
Pseudomonas pseudoalcaligenes subsp. *citrulli* Schaad, Sowell, Goth, Colwell & Webb, *International Journal of Systematic Bacteriology* **28**: 117–125, 1978.

Aerobic, Gram-negative rods, motile with a single polar flagella. Colonies are non-fluorescent on King's medium B (KB) and PHB granules are accumulated intracellularly by some strains, but not all. Colonies are white/cream on most media. Growth occurs at 41 °C but not at 4 °C. Catalase, oxidase, lipase (Tween 80) and urease positive; arginine dihydrolase is negative and gelatin hydrolysis is weak and strain dependant. In the original description (Schaad *et al.*, 1978) nitrate is not reduced and there is no hypersensitive response on tobacco, which is at odds with recent work by Hu *et al.* (1991) in which the same strain, the type ATCC 29625, reduced nitrate and was tobacco HR positive. The work of Latin & Rane (1990) and Somodi *et al.* (1991) also suggests that some strains are tobacco HR positive. The following are used as sole carbon sources: β-alanine, α-aminopentanoate, citrate, ethanol, ethanolamine, fructose, glutarate, lactate, L-leucine, levinulate, *n*-propanol, D-serine, succinate and D-xylose; but not adonitol, benzoate, cellobiose, dextrin, dulcitol, erythritol, inositol, inulin, lactose, maltose, mannose, melezitose, raffinose, rhamnose, ribose, salicin, sorbitol, sucrose, D-tartrate and trehalose. In the original description glucose and arabinose are not used as a carbon source, in contrast to work by Willems *et al.* (1992) in which the same strain produced growth on these substrates. Growth on arabinose was also detected in the work of Hu *et al.* (1991).

A member of the beta subdivision of the *Proteobacteria* (Woese *et al.*, 1984). Assigned to rRNA homology group I within the genus *Pseudomonas* (Palleroni, 1984), however, this was largely due to the fact that *Pseudomonas pseudoalcaligenes* was assigned to this group and phenotypically this taxon was indistinguishable from the species, hence the original name *Pseudomonas pseudoalcaligenes* subsp. *citrulli*. However, the close relationship of this taxon to rRNA homology group III pseudomonads and *Acidovorax* (*Pseudomonas*) *avenae* in particular was demonstrated by De Vos *et al.* (1985) and Hu *et al.* (1991). It was subsequently placed in the genus *Acidovorax* by Willems *et al.* (1992). The mol% G + C of the DNA is 67.2–68.4. The fatty acid profile is typical of Group 3a pseudomonads (Stead, 1992), the major hydroxy fatty acid being 3-hydroxydecanoic acid (10:0 3-OH), other 3-hydroxy acids are found in trace amounts and no 2-hydroxy acids are present. The major components are hexadecenoic (16:1 *cis* 9; 42.1% (SD 0.5)), hexadecanoic (16:0; 33.1 (2.5)) and octadecenoic acids (18:1 *cis* 11; 9.1 (1.8)). In contrast to other phytopathogens within the genus *Acidovorax* substantial amounts of pentadecanoic acid (15:0) are found in some strains, in particular those isolated from watermelon fruit blotch lesions (Somodi *et al.*, 1991).

Type strain: ATCC 29625; ICMP7500; LMG 5376.

HOSTS: *Citrullus lanatus* is the natural host. *Cucumis melo* (**61**, 1997) has also been noted and other members of the *Cucurbitaceae* can produce symptoms following inoculation.

DISEASE: Two distinct symptoms have been observed: (1) leaf spots, forming water-soaked lesions on the cotyledons of seedlings; (2) watermelon fruit blotch, forming large, firm, water-soaked lesions with irregular margins on fruit. As lesions age on fruit the periderm can crack and bacterial ooze is produced. The pathogen is thought to enter the fruit through stomata; immature fruits in particular are infected (Frankle *et al.*, 1993).

GEOGRAPHICAL DISTRIBUTION: Australia, Guam, Tinian, (possibly Malaysia and Indonesia, IMI records), USA (AR, DE, FL, GA, IW, IN, MD, NC, SC).

PHYSIOLOGIC SPECIALISATION: The situation is as yet unclear and there are documented differences between the type strain and watermelon fruit blotch strains in particular. Some of these discrepancies can, at least in part, be explained by the use of different experimental techniques and methods. However, the type strain appears to cause seedling blight alone, no symptoms being observed on fruits, and may be tobacco HR negative,

whilst watermelon fruit blotch strains are tobacco HR positive (Frankle *et al.*, 1993). For the purposes of this description both populations have been considered together as one taxon.

TRANSMISSION: The spread of seedling blight appears to be seed borne (Sowell & Schaad, 1979). No information on the spread of watermelon fruit blotch exists at present, though dissemination by infected seed seems likely.

NOTES: Reduction of severity maybe achieved by use of seed treatments such as streptomycin or sodium hypochlorite (Sowell & Schaad, 1979). In addition some cultivars appear to be more resistant than others, although none are totally immune (Hopkins *et al.*, 1993).

LITERATURE: De Vos, Goor, Gillis & De Ley *International Journal of Systematic Bacteriology* **35**: 169–184, 1985; Frankle, Hopkins & Stall, *Plant Disease* **7**: 1090–1092, 1993; Hopkins, Thompson & Elstrom, *HortScience* **28**: 122–123, 1993; Hu, Young & Triggs, *International Journal of Systematic Bacteriology* **41**: 516–525, 1991; Latin & Rane, *Plant Disease* **74**: 331; 1990; Stead, *International Journal of Systematic Bacteriology* **42**: 281–295, 1992; Palleroni, *In* Krieg & Holt, *Bergey's Manual of Systematic Bacteriology*, **Vol. 1**, pp. 141–199, Williams & Wilkins, Baltimore, 1984; Schaad, Sowell, Goth, Colwell & Webb, *International Journal of Systematic Bacteriology* **28**: 117–125, 1978; Somodi, Jones, Hopkins, Stall, Kucharek, Hodge & Watterson, *Plant Disease* **75**: 1053–1056, 1991; Sowell & Schaad, *Plant Disease Reporter* **63**: 437–441, 1979; Willems, Goor, Thielemans, Gillis, Kersters & De Ley, *International Journal of Systematic Bacteriology* **42**: 107–119, 1992; Woese, Weisburg, Paster, Hahn, Tanner, Krieg, Koops, Harms & Stackebrandt, *Systematic and Applied Microbiology* **5**: 327–336, 1984.

G.S. Saddler

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ACIDOVORAX KONJACI

Acidovorax konjaci (Goto) Willems, Goor, Thielemans, Gillis, Kersters & De Ley, *International Journal of Systematic Bacteriology* **42**: 107–119, 1992.

Pseudomonas pseudoalcaligenes subsp. *konjaci* Goto, *International Journal of Systematic Bacteriology* **33**: 539–545, 1983.

Possible synonyms:

Bacterium conjac (Uyeda) Elliott, *Manual of Bacterial Plant Pathogens*, pp. 121–122, Baillire, Tindall & Cox, London, 1930.

Phytomonas conjac (Uyeda) Magrou, *In* Hauduroy, Ehringer, Urbain, Guillot & Magrou, *Dictionnaire des Bactéries Pathogènes*, 1st edition, p. 347, Masson, Paris, 1937.

Pseudomonas conjac Uyeda, *Botanical Magazine, Tokyo* **24**: 177–182, 1910.

Xanthomonas conjac (Uyeda) Burkholder, *In* Breed, Murray & Hitchens, *Bergey's Manual of Determinative Bacteriology*, 6th edition, p. 171, Baillière, Tindall & Cox, London, Baltimore, 1948.

Aerobic, Gram-negative rods motile with a single polar flagellum. Colonies are non-fluorescent on KB medium, producing a water-soluble brown pigmentation; PHB granules are accumulated intracellularly. Growth can occur at 41 °C but may be weak or delayed, no growth at 4 °C. Catalase, Lipase (Tween 80), oxidase and urease positive, nitrate is reduced, but there is no denitrification and milk is peptonised. Arginine dihydrolase, levan production, starch and gelatin hydrolysis are all negative. Growth in 3% NaCl, but only very poorly in 4%, potato rot negative. Hypersensitive reaction on tobacco (*Nicotiana tabacum* L. cv. White Burley) and watermelon. The following can be used a sole carbon sources: β-alanine, γ-aminobutyrate, *n*-caprate, ethanol, ethanolamine, D-fructose, fumarate, glutarate, lactate, mannitol, melibiose, *n*-propanol, ribose, succinate and L-tartrate; but not adonitol, 2-aminopentanoate, L-arabinose, 2,3,-butylene glycol, cellobiose, dextrin, dulcitol, erythritol, galactitol, glucitol, D-gluconate, D-glucose, inositol, inulin, lactose, maltose, D-mannose, melezitose, raffinose, L-rhamnose, ribitol, salicin, D-sorbitol, starch, sucrose, D-tartrate, trehalose and xylose.

A member of the beta subdivision of the *Proteobacteria* (Woese *et al.*, 1984). Not assigned to any of the rRNA homology groups within the genus *Pseudomonas* (Palleroni, 1984). However, the close relationship to rRNA homology group III, and *Acidovorax* (*Pseudomonas*) *avenae* in particular, was demonstrated by Hu *et al.* (1991). The taxon was subsequently placed in the genus *Acidovorax* by Willems *et al.* (1992). The mol% G + C of the DNA is 67.7–68.4. The fatty acid profile is typical of Group 3a pseudomonads (Stead, 1992), the major hydroxy fatty acid being 3-hydroxydecanoic acid (10:0 3-OH), no other hydroxy acids present. The major components are *cis*-9-hexadecenoic (16:1 *cis* 9; 43.9% (SD 0.3)), hexadecanoic (16:0; 28.3% (1.5)) and *cis*-11-octadecanoic acids (18:1 *cis* 11; 18.3% (1.4)).

Type strain: ATCC 33996; ICMP 7733; LMG 5691.

HOST: *Amorphophallus konjac* (konjac or konnyaku).

DISEASE: Bacterial leaf blight of the konjac plant; leaf spot and leaf blight. Under severe conditions petioles are infected and wilting of plants and rotting of roots may ensue.

GEOGRAPHICAL DISTRIBUTION: Japan.

PHYSIOLOGIC SPECIALIZATION: None known.

TRANSMISSION: The bacteria can survive on infected plant material for more than a year and the corm can harbour infection for six months. Plant debris or previously infected corms are the most likely infection sources (Hayashi, 1989). Secondary dissemination occurs through the action of wind and rain (Hayashi, 1991).

NOTES: Goto (1983) considered the disease identical to that described by Uyeda in 1910. However, Uyeda's epithet lost its standing in nomenclature when excluded from the Approved Lists and from the ISPP List (Bradbury, 1986). Partial control of the disease may involve the use of more resistant varieties such as *A. konjac* cv. Akagioodama, in combination with mulching with green oats or rice straw (Hayashi *et al.*, 1988). Isolation of the causative organism can be achieved by the use of a selective isolation medium (Hayashi, 1987).

LITERATURE: Bradbury, *Guide to Plant Pathogenic Bacteria*, p. 145, CAB-IMI, Kew, 1986; Goto, *International Journal of Systematic Bacteriology* **33**: 539–545, 1983; Hayashi, *Annals of the Phytopathological Society of Japan* **53**: 489–494, 1987; 55: 609–614, 1989 & 57: 345–350, 1991; Hayashi, Suwa & Nakazato, *Gunma Journal of Agricultural Research, A (General)* **No. 5**: 49–54, 1988; Hu, Young, Triggs, *International Journal of Systematic Bacteriology* **41**: 516–525, 1991; Palleroni, *In* Krieg & Holt, *Bergey's Manual of Systematic Bacteriology*, **Vol. 1**, pp. 141–199, Williams & Wilkins, Baltimore, 1984; Stead, *International Journal of Systematic Bacteriology* **42**: 281–295, 1992; Uyeda, *Botanical Magazine, Tokyo* **24**: 177–182, 1910; Willems, Goor, Thielemans, Gillis, Kersters & De Ley, *International Journal of Systematic Bacteriology* **42**: 107–119, 1992; Woese, Weisburg, Paster, Hahn, Tanner, Krieg, Koops, Harms & Stackebrandt, *Systematic and Applied Microbiology* **5**: 327–336, 1984.

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IMI Descriptions of Fungi and Bacteria No. 1215

BURKHOLDERIA CARYOPHYLLI

Burkholderia caryophylli (ex Burkholder) Yabuuchi, Kosako, Oyaizu, Yano, Hotta, Hashimoto, Ezaki & Arakawa, *Microbiology and Immunology* **36**: 1251–1275, 1992 (Effective publication). Yabuuchi, Kosako, Oyaizu, Yano, Hotta, Hashimoto, Ezaki & Arakawa, *International Journal of Systematic Bacteriology* **43**: 398, 1993 (Valid publication).

Phytomonas caryophylli Burkholder, *Phytopathology* **32**: 141–149, 1942.
Pseudomonas caryophylli (Burkholder) Starr & Burkholder, *Phytopathology* **32**: 598–604, 1942.

Aerobic, Gram-negative rods, motile with several polar flagella. Non-fluorescent on KB medium, PHB granules are accumulated intracellularly. Growth can occur at 41 °C but not at 4 °C, with optimum growth between 30–33 °C. Arginine dihydrolase, catalase, oxidase and polygalacturonase are all positive; lipase (Tween 80) is positive for most strains and urease and levan production are negative. No growth in the presence of 3% NaCl (w/v) or at pH4, 8 or 9. Nitrate is reduced and denitrification occurs, there is no hydrolysis of gelatin or starch. Acid is produced from sucrose. The following are utilized as sole carbon source: α-amyline, D-arabinose, 2,3-butylene glycol, cellobiose, D-galactose, glucose, *m*-hydroxybenzoate, inositol, mannitol, D-mannose, melibiose, L-rhamnose, D-ribose, saccharate, sorbitol, sucrose, *meso*-tartrate, trehalose and D-xylose; but not adonitol, β-alanine, benzoate, citraconate, dulcitol, erythritol, lactose, levulinate, mesaconate, ornithine, *n*-propanol, D-tartrate, L-threonine and tryptamine.

A member of the beta subdivision of the *Proteobacteria* (Woese *et al.*, 1984). Assigned to rRNA homology group II within the pseudomonads (Palleroni, 1984). The complete 16S rRNA sequence for the type strain (ATCC 25418) has been deposited with EMBL/GenBank, accession number X67039 (Li *et al.*, 1993). Assigned to the genus *Burkholderia* with several other phytopathogenic Group II organisms by Yabuuchi *et al.* (1992). The mol% G + C of the DNA is 64.6. The fatty acid profile is typical of Group 2a pseudomonads (Stead, 1992), with a variety of 3-hydroxy, 2-hydroxy and cyclopropane acids present, in particular the detection of 2-hydroxydecanoic acid (16:0 2-OH) appears significant. The major components are *cis*-9-hexadecenoic (16:1 *cis* 9; 14.1 (SD 0.9)), hexadecanoic (16:0; 21.7 (1.8)) and *cis*-11-octadecenoic acids (18:1 *cis* 11; 41.8 (1.9)). Ubiquinones with eight isoprene (Q-8) units make up the major quinone composition, trace amounts of Q-7 and Q-9 are also detected.

Type strain: ATCC 25418; CFBP 2429; ICMP 512; LMG 2155; NCPPB 2151.

HOSTS: *Dianthus caryophyllus*, and *D. allwoodii* and *D. barbatus* by inoculation. *Gysophila paniculata* (**71**, 5902), *Helianthus annuus* (**71**, 7223) and *Limonium sinuatum* (**63**, 3401; **68**, 3811).

DISEASE: Bacterial wilt and stem cracking; a systemic vascular disease. Vascular tissues fracture as a result of invasion, resulting in a generalised wilt of the plant with roots disintegrating.

GEOGRAPHICAL DISTRIBUTION: (*CMI Map* 411, ed. 2, 1976) China, Japan, Taiwan, Denmark, France, Germany, Hungary, Italy, Netherlands, Norway, Poland, Sweden, Yugoslavia, USA (IL, IN, IA, MA, MO, NY, PA, WA), Argentina, Brazil (SE).

PHYSIOLOGIC SPECIALIZATION: None known.

TRANSMISSION: The main source of infection is by the movement of infected cuttings taken from mother plants with latent infections. Infection can also occur from contaminated tools and water.

NOTES: The paper by Yabuuchi *et al.* (1992) in which the genus *Burkholderia* was established did not include the type strain of *Pseudomonas caryophylli*. The type strain was included in a subsequent study (Urakami *et al.*, 1994) in which the generic assignment of this species was reaffirmed. *B. caryophylli* is an EPPO A2 quarantine pest, it also has quarantine significance for JUNAC. Control is achieved by the use of disease free cuttings; rooting beds and soil should be fumigated. An immunofluorescence staining procedure exists for the detection of latent infections (Muratore *et al.*, 1986). In a test of 126 varieties of *Dianthus caryophyllus* all were found to be suseptible to disease (**71**, 3737). For additional information see 'Data Sheets on Quarantine Pests' (1992).

LITERATURE: Li, Dorsch, Del Dot, Sly, Stackebrandt & Hayward, *Journal of Applied Bacteriology* **74**: 324–

329, 1993; Muratore, Mazzucchi, Gasperini & Fiori, *Bulletin OEPP/EPPO Bulletin* **16**: 1–12, 1986; Palleroni, *In* Krieg & Holt, *Bergey's Manual of Systematic Bacteriology*, **Vol. 1**, pp. 141–199, Williams & Wilkins, Baltimore, 1984; Stead, *International Journal of Systematic Bacteriology* **42:** 281–295, 1992; Woese, Weisburg, Paster, Hahn, Tanner, Krieg, Koops, Harms & Stackebrandt, *Systematic and Applied Microbiology* **5**: 327–336, 1984; Yabuuchi, Kosako, Oyaizu, Yano, Hotta, Hashimoto, Ezaki & Arakawa, *Microbiology and Immunology* **36**: 1251–1275, 1992. Data sheets on quarantine pests: *Quarantine Pests for Europe*, pp. 772–775, CAB International, Wallingford, 1992.

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IMI Descriptions of Fungi and Bacteria No. 1216

BURKHOLDERIA CEPACIA

Burkholderia cepacia (ex Burkholder) Yabuuchi, Kosako, Oyaizu, Yano, Hotta, Hashimoto, Ezaki & Arakawa, *Microbiology and Immunology* **36**: 1251–1275, 1992 (Effective publication). Yabuuchi, Kosako, Oyaizu, Yano, Hotta, Hashimoto, Ezaki & Arakawa, *International Journal of Systematic Bacteriology* **43**: 398, 1993 (Valid Publication).

Pseudomonas cepacia (ex Burkholder, *Phytopathology* **40:** 115–117, 1950) Palleroni & Holmes, *International Journal of Systematic Bacteriology* **31**: 479–481, 1981.
Pseudomonas kingii Jonsson, *International Journal of Systematic Bacteriology* **20**: 255–257, 1970.
Pseudomonas multivorans Stanier, Palleroni & Doudoroff, *Journal of General Microbiology* **43:** 159–271, 1966.

Aerobic, Gram-negative rods, motile with a polar tuft of flagella. Non-fluorescent, producing a yellowish or greenish pigment on a variety of media; PHB is accumulated intracellularly. Most strains grow at 41 °C but not 4 °C, optimum temperature for growth is 30 to 35 °C. Growth in the presence of 3% NaCl (w/v) is weak; growth occurs at pH 4 & 8 but not at pH 9. Catalase, lipase (Tween 80), oxidase and urease positive, nitrate is reduced to nitrite, but there is no denitrification; arginine dihydrolase negative, starch is not hydrolyzed, gelatin liquefaction and levan production are strain dependant. The following are used as sole carbon sources: adonitol, α-amylamine, D-arabinose, benzoate, 2,3-butylene glycol, cellobiose, citraconate, D-fucose, D-galactose, glucose, *m*-hydroxybenzoate, inositol, lactose, levulinate, mannitol, D-mannose, mucate, DL-ornithine, *n*-propanol, ribose, saccharate, sebacate, sorbitol, sucrose, *meso*-tartrate, L-threonine, trehalose and tryptamine; but not erythritol, mesaconate and D-tartrate. Growth on L-rhamnose and D-xylose is strain dependant.

B. cepacia can be differentiated from *B. gladioli* pv. *alliicola*, also an onion pathogen, using the following tests: (*B. cepacia* positive and *B. gladioli* pv. *alliicola*, negative) growth on δ-aminovalerate, α-amylamine, butylamine, 2,3-butylene glycol, *m*-hydroxybenzoate, levulinate, putrescine and tryptamine, and (*B. cepacia*, negative and *B. gladioli* pv. *alliicola*, positive) for growth on mesaconate and D-tartrate.

A member of the beta subdivision of the *Proteobacteria* (Woese *et al.*, 1984). Assigned to rRNA homology group II within the pseudomonads (Palleroni, 1984). Assigned to the genus *Burkholderia* with several other phytopathogenic Group II organisms by Yabuuchi *et al.* (1992). The complete 16S rRNA sequence for the type strain (ATCC 25416) has been deposited with EMBL/GenBank, accession number M22518 (Dewhirst *et al.*, 1989) and the 23S rRNA sequence for strain (ATCC 17759) has accession number X16368 (Hopfl *et al.*, 1989). The mol% G + C of the DNA is 66.6. The fatty acid profile is typical of Group 2a organisms (Stead, 1992), with a variety of 3-hydroxy, 2-hydroxy and cyclopropane acids present, in particular the detection of 2-hydroxydecanoic acid (16:0 2-OH) appears significant. The major components are *cis*-9-hexadecenoic (16:1 *cis* 9; 14.9% (SD 5.8)), hexadecanoic (16:0; 22.4% (4.6)), *cis*-9,10-methylene hexadecanoic acid (17:0 cyclo; 9.1% (4.6)) and *cis*-11-octadecenoic acids (18:1 *cis* 11; 28.6% (6.5)). Ubiquinones with eight isoprene (Q-8) units make up the major quinone composition, trace amounts of Q-7 and Q-9 are also detected.

Type strain: ATCC 25416; CFBP 2227; ICMP 5796; LMG 1222; NCPPB 2993; NCTC 10743.

HOSTS: Common host is *Allium cepa*, but can also cause disease in *Allium sativum*. Also identified as causing disease in *Lycopersicon esculentum* (**63**, 3168), a cavity disease of a cultivated mushroom (*Agaricus bitorquis*) (**72**, 5605) and a leaf spot on the a number of orchids including *Cymbidium spp.*, *Dendrobium* sp. and *Paphiopedilum* spp. (**66**, 4326). The bacterium can also be found in soil, in clinical material, in disinfectant solutions and as an opportunistic pathogen of man and animals. It is gaining in significance as a major pathogen for sufferers of cystic fibrosis (Isles *et al.*, 1984; McKevitt & Woods, 1984; Thomassen *et al.*, 1985).

DISEASE: Onion slippery skin; this is a rot of bulb scales, usually occurring at or near maturity, sometimes in storage. The bacterium does not appear to be strongly invasive, attacking plants that are damaged or weakened. Bacteria are thought to gain entry through the neck or leaf blades as the foliage falls over and the epidermis breaks, at maturity (**64**, 5550).

GEOGRAPHICAL DISTRIBUTION: Worldwide.

PHYSIOLOGIC SPECIALIZATION: There is some evidence to suggest that the species can be divided into a number of biotypes (Mukwaya & Welch, 1989) and that plant pathogenic strains and strains isolated from the

clinical environment may make up two distinct populations (Bevivino *et al.*, 1994), though reports are conflicting (Yohalem & Lorbeer, 1994).

TRANSMISSION: Appears to be a soilborne wound pathogen.

NOTES: The name *Pseudomonas cepacia* was accidentally omitted from the Approved List and was revived by Palleroni & Holmes (1981). See (**52**, 945) for synonymy with *P. kingii* and (**49**, 3092; **52**, 574) for synonymy with *P. multivorans*. Monoclonal antibodies can be used for the detection of the pathogen (Takahashi *et al.*, 1990) and a selective isolation medium can also be used for recovery from soil and other material (Hagedorn *et al.*, 1987). In the field there is some evidence that furrow irrigation reduces the effect of disease symptoms (**69**, 833).

LITERATURE: Bevivino, Tabacchioni, Chiarini, Carusi, Del Gallo & Visca, *Microbiology* **140**: 1069–1077, 1994; Dewhirst, Paster & Bright, *International Journal of Systematic Bacteriology* **39**: 258–266, 1989; Hagedorn, Gould, Bardinelli & Gustavson, *Applied and Environmental Microbiology* **53**: 2265–2268, 1987; Hopfl, Ludwig, Schleifer & Larsen, *European Journal of Biochemistry* **185**: 355–364, 1989; Isles, Maclusky, Corey, Gold, Prober, Fleming & Levison, *Journal of Pediatrics* **104**: 206–210, 1984; McKevitt & Woods, *Journal of Clinical Microbiology* 19: 291–293, 1984; Mukwaya & Welch, *Journal of Clinical Microbiology* **27**: 2640–2646, 1989; Palleroni, *In* Krieg & Holt, *Bergey's Manual of Systematic Bacteriology*, **Vol. 1**, pp. 141–199, Williams & Wilkins, Baltimore, 1984; Palleroni & Holmes, *International Journal of Systematic Bacteriology* **31**: 479–481, 1981; Stead, *International Journal of Systematic Bacteriology* **42**: 281–295, 1992; Takahashi, Tsuchiya, Shohara & Suzui, *Annals of the Phytopathological Society of Japan* **56**: 229–234, 1990; Thomassen, Demko, Klinger & Stren, *American Review of Respiratory Disease* **113:** 791–796, 1985; Woese, Weisburg, Paster, Hahn, Tanner, Krieg, Koops, Harms & Stackebrandt, *Systematic and Applied Microbiology* **5:** 327–336, 1984; Yabuuchi, Kosako, Oyaizu, Yano, Hotta, Hashimoto, Ezaki & Arakawa *Microbiology and Immunology* **36**: 1251–1275, 1992; Yohalem & Lorbeer, *Antonie van Leeuwenhoek* **65**: 111–131, 1994.

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IMI Descriptions of Fungi and Bacteria No. 1217

BURKHOLDERIA GLADIOLI PV. ALLIICOLA

Burkholderia gladioli pv. **alliicola** (Burkholder) Yabuuchi, Kosako, Oyaizu, Yano, Hotta, Hashimoto, Ezaki & Arakawa, *Microbiology and Immunology* **36**: 1251–1275, 1992.

Phytomonas alliicola Burkholder, *Phytopathology* **32**: 141–149, 1942.
Pseudomonas alliicola (Burkholder) Starr & Burkholder, *Phytopathology* **32**: 598–604, 1942.
Pseudomonas gladioli pv. *alliicola* (Burkholder) Young, Dye & Wilkie, *In* Young, Dye, Bradbury, Panagopoulos & Robbs, *New Zealand Journal of Agricultural Research* **21**: 153–177, 1978.

The majority of physiological characteristics are the same as *Burkholderia gladioli* pv. *gladioli* (sheet 1218). Aerobic, Gram-negative rods, motile with a polar flagellar tuft. Non-fluorescent, white/cream colonies which produce a yellowish diffusible pigment on most media, PHB is accumulated intracellularly. Growth at 41 °C but not at 4 °C. No growth in the presence of 3% NaCl (w/v); growth occurs at pH 4 & 8 but not at pH 9. Catalase, lecithinase (egg yolk), lipase (Tween 80), oxidase and urease positive; arginine dihydrolase, nitrate and denitrification negative. Levan is produced, gelatin is hydrolyzed weakly, starch is not hydrolysed. The following are used as sole carbon sources: adonitol, D-arabinose, benzoate, cellobiose, citraconate, D-fucose, D-galactose, D-glucose, inositol, lactose, D-mannitol, D-mannose, mesaconate, mucate, ornithine, D-ribose, saccharate, D-sorbitol, D-tartrate, *meso*-tartrate, L-threonine and D-xylose; but not α-amyline, 2,3-butylene glycol, erythritol, *m*-hydroxybenzoate, levulinate, L-rhamnose and sucrose.

B. gladioli pv. *allicola* can be differentiated from pv. *gladioli*, by pathogenicity testing. Early work by Ballard *et al.* (1970) suggests that pv. *alliicola* and pv. *gladioli* are indistinguishable using physiological testing. However, recent work by Urakami *et al.* (1994) detected minor physiological differences between the pathotypes of these pathovars which may be of value in confirming pathovar membership. The interpretation of results from these tests should be viewed with caution and only used in conjunction with pathogenicity testing. The following tests showed pv. *alliicola* positive and pv. *gladioli* negative for growth on citraconic acid and glycine; and pv. *alliicola* negative and pv. *gladioli* positive for growth on acetamide, DL-citrulline, *m*-hydroxybenzoic acid, sarcosine and tryptamine.

B. gladioli pv. *allicola* can be differentiated from *B. cepacia*, also an onion pathogen, using the following tests; (*B. gladioli* pv. *alliicola* is positive and *B. cepacia* is negative) for growth on mesaconate, nicotinic acid and D-tartrate. (*B. gladioli* pv. *alliicola* is negative and *B. cepacia* is positive) growth on δ-aminovalerate, α-amylamine, benzylamine, butylamine, 2,3-butylene glycol, *m*-hydroxybenzoate, levulinate, putrescine, sucrose and tryptamine.

A member of the beta subdivision of the *Proteobacteria* (Stackebrandt *et al.*, 1988; Woese *et al.*, 1984). Assigned to rRNA homology group II within the pseudomonads (Palleroni, 1984). Assigned to the genus *Burkholderia* with several other phytopathogenic Group II organisms by Yabuuchi *et al.* (1992). The mol% G + C of the DNA is 68.3. The fatty acid profile is typical of Group 2a organisms (Stead, 1992), with a variety of 3-hydroxy, 2-hydroxy and cyclopropane acids present, in particular the detection of 2-hydroxydecanoic acid (16:0 2-OH) appears significant. The major components are *cis*-9-hexadecenoic (16:1 *cis* 9; 8.4% (SD 4.7)), hexadecanoic (16:0; 24.0% (1.9)), *cis*-9,10-methylene hexadecanoic acid (17:0 cyclo; 14.6% (3.8)), *cis*-11,12-methylene octadecanoic acid (19:0 cyclo 11–12; 12.1% (5.8)) and *cis*-11-octadecenoic acids (18:1 *cis* 11; 20.0% (7.0)). Ubiquinones with eight isoprene (Q-8) units make up the major quinone composition, trace amounts of Q-7 and Q-9 are also detected.

Pathotype strain: ATCC 19302; CFBP 2422; ICMP 2804; LMG 2121; NCPPB 947.

HOSTS: *Allium cepa*, *Tulipa* spp. (**72**, 7970).

DISEASE: Mainly a storage rot of onion, usually of the inner scales of the bulbs. The outsides may appear healthy at first, but later the whole bulb may soften and large numbers of bacteria are then to be seen. Dry necrotic spots of leaves may also occur (**55**, 5445).

GEOGRAPHICAL DISTRIBUTION: Egypt, India (UP), Indonesia, Japan, Thailand, Australia, New Zealand, Bulgaria, England, Hungary, Spain, USSR, USA (IA, MA, NY, WA and possibly ID, IN, MD, OH).

PHYSIOLOGIC SPECIALIZATION: None known.

TRANSMISSION: Soil borne, has been isolated from rice seed, although the significance of this finding is unclear (**72**, 6712).

NOTES: The paper by Yabuuchi *et al.* (1992) in which the genus *Burkholderia* was established did not include the pathotype strain of *Pseudomonas gladioli* pv. *allicola*. The pathotype strain was included in a subsequent study (Urakami *et al.* 1994) in which the generic assignement of this species/pathovar was reaffirmed. There is some evidence to suggest that overhead watering during the field-curing period can increase the incidence of disease (Wright *et al.*, 1993).

LITERATURE: Ballard, Palleroni, Doudoroff, Stanier & Mandel, *Journal of General Microbiology* **60**: 199–214, 1970; Palleroni, *In* Krieg & Holt, *Bergey's Manual of Systematic Bacteriology*, **Vol. 1**, pp. 141–199, Williams & Wilkins, Baltimore, 1984; Stackebrandt, Murray & Trüper, *International Journal of Systematic Bacteriology* **38**: 321–325, 1988; Stead, *International Journal of Systematic Bacteriology* **42**: 281–295, 1992; Urakami, Ito-Yoshida, Araki, Kijima, Suzuki & Komagata, *International Journal of Systematic Bacteriology* **44**: 235–245, 1994; Woese, Weisburg, Paster, Hahn, Tanner, Krieg, Koops, Harms & Stackebrandt, *Systematic and Applied Microbiology* **5**: 327–336, 1984; Wright, Hale & Fullerton, *New Zealand Journal of Crop and Horticultural Science* **21**: 161–164, 1993; Yabuuchi, Kosako, Oyaizu, Yano, Hotta, Hashimoto, Ezaki & Arakawa, *Microbiology and Immunology*.**36**: 1251–1275, 1992.

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IMI Descriptions of Fungi and Bacteria No. 1218

BURKHOLDERIA GLADIOLI PV. GLADIOLI

Burkholderia gladioli pv. **gladioli** (Severini) Yabuuchi, Kosako, Oyaizu, Yano, Hotta, Hashimoto, Ezaki & Arakawa, *Microbiology and Immunology* **36**: 1251–1275, 1992.

Bacterium gladioli (Severini) Elliott, *Manual of Bacterial Plant Pathogens*, p. 132, Baillière, Tindall & Cox, London, 1930.
Phytomonas gladioli (Severini) Magrou, *In* Hauduroy, Ehringer, Urbain, Guillot & Magrou, *Dictionnaire des Bactéries Pathogènes*, 1st edition, p. 356, Masson, Paris, 1937.
Bacterium marginatum McCulloch, *Science*, **54**: 115–116, 1921.
Chlorobacter marginatus (McCulloch) Patel & Kulkarni, *Indian Phytopathology* **4**: 74–84, 1951, as '*marginatum*'.
Phytomonas marginata (McCulloch) Bergey, Harrison, Breed, Hammer, Huntoon, *Bergey's Manual of Determinative Bacteriology*, 1st edition, p. 188, Williams & Wilkins, Baltimore, 1923.
Pseudomonas gladioli Severini, *Annali di Botanica* **11**: 413–424, 1913.
Pseudomonas marginata (McCulloch) Stapp, *In* Sorauer, *Handbuch der Pflanzenkrankheiten*, 5th edition **Vol. 2**, p. 56, Paul Parey, Berlin, 1928.

The majority of physiological characteristics are the same as *Burkholderia gladioli* pv. *allicola* (sheet 1217). Aerobic, Gram-negative rods, motile with a polar flagellar tuft. Non-fluorescent, white/cream colonies which produce a yellowish diffusible pigment on most media, PHB is accumulated intracellularly. Growth at 41 °C but not at 4 °C. No growth in the presence of 3% NaCl (w/v); growth occurs at pH 4 & 8 but not at pH 9. Catalase, lecithinase (egg yolk), lipase (Tween 80), oxidase and urease positive; arginine dihydrolase, nitrate and denitrification negative. Levan is produced, gelatin is hydrolyzed weakly, starch is not hydrolysed. The following are used as sole carbon sources: adonitol, D-arabinose, benzoate, cellobiose, citraconate, D-fucose, D-galactose, D-glucose, *m*-hydroxybenzoate, inositol, lactose, D-mannitol, D-mannose, mesaconate, mucate, ornithine, D-ribose, saccharate, D-sorbitol, D-tartrate, meso-tartrate, L-threonine and D-xylose; but not α-amyline, 2,3-butylene glycol, erythritol, levulinate, L-rhamnose and sucrose.

B. gladioli pv. *gladioli* can be differentiated from pv. *alliicola*, by pathogenicity testing. Early work by Ballard *et al.* (1970) suggests that pv. *gladioli* and pv. *allicola* are indistinguishable using physiological testing. However, recent work by Urakami *et al.* (1994) detected minor physiological differences between the pathotypes of these pathovars which may be of value in confirming pathovar membership. The interpretation of results from these tests should be viewed with caution and only used in conjunction with pathogenicity testing. The following tests showed pv. *gladioli* positive and pv. *alliicola* negative for growth on acetamide, DL-citrulline, m-hydroxybenzoic acid, sarcosine and tryptamine; and pv. *gladioli* positive and pv. *alliicola* negative for growth on citraconic acid and glycine.

A member of the beta subdivision of the *Proteobacteria* (Stackebrandt *et al.*, 1988; Woese *et al.*, 1984). Assigned to rRNA homology group II within the pseudomonads (Palleroni, 1984). Assigned to the genus *Burkholderia* with several other phytopathogenic Group II organisms by Yabuuchi *et al.* (1992). The complete 16S rRNA sequence for the type strain (ATCC 10248) has been deposited with EMBL/GenBank, accession number X67038 (Li *et al.*, 1993). The mol% G + C of the DNA is 67.9. The fatty acid profile is typical of Group 2a pseudomonads (Stead, 1992), with a variety of 3-hydroxy, 2-hydroxy and cyclopropane acids present, in particular the detection of 2-hydroxydecanoic acid (16:0 2-OH) appears significant. The major components are *cis*-9-hexadecenoic (16:1 *cis* 9; 11.4% (SD 3.2)), hexadecanoic (16:0; 23.1% (2.3)), *cis*-9,10-methylene hexadecanoic acid (17:0 cyclo; 13.0% (3.3)), *cis*-11,12-methylene octadecanoic acid (19:0 cyclo 11–12; 8.5% (2.5)) and *cis*-11-octadecenoic acids (18:1 *cis* 11; 25.0% (4.8)). Ubiquinones with eight isoprene (Q-8) units make up the major quinone composition, trace amounts of Q-7 and Q-9 are also detected.

Pathotype strain: ATCC 10248; CFBP 2427; ICMP 3950; LMG 2216; NCPPB 1891.

HOSTS: *Crocus spp.*, *Freesia hybrida*, *F. refracta*, *Gladiolus colvillei*, *G. hortulanus*, *Iris* spp., *Ixia maculata* and *Tigridia pavonia*. In addition the same organism has been reported to infect various ferns, including *Asplenium nidus*, *Platycerium bifurcatum*, *Pteris cretica*, *P. ensiformis*, *Adiantum* sp., *Cyrtomium falcatum*, *Davallia fejeensis*, *Pelleae rotundifolia* (**63**, 3386; **64**, 216). Orchids of the genus *Dendrobium* are also thought to be susceptible (**63**, 5459).

DISEASE: Rot of stem bases and corms of gladioli; leaf spots and blight of ferns. Leaves begin dying at the tip, initially spots are reddish in colour becoming enlarged and circular and darkening to dark brown to black.

Yellow or orange sunken spots develop on the corm. Severity of the disease may be enhanced by the actions of the root knot nematode, *Meloidogyne javanica* (**53,** 3055), bulb mites and possibly grub and wireworm injury. Young tissue appears to be the most susceptible.

GEOGRAPHICAL DISTRIBUTION: South Africa, Zimbabwe, China, Japan, Thailand, Australia (NT, NSW, Qd., S. Aust., Tas., WA, Vict.), New Caledonia, Belgium, Czechoslovakia, Finland, Germany, Italy, Netherlands, Romania, USA (widespread), Canada (Ont., BC), Argentina.

PHYSIOLOGIC SPECIALIZATION: None known.

TRANSMISSION: By the movement of infected corms.

NOTES: The paper by Yabuuchi *et al.* (1992) in which the genus *Burkholderia* was established did not include the pathotype strain of *Pseudomonas gladioli* pv. *gladioli*. The pathotype strain was included in a subsequent study (Urakami *et al.* 1994) in which the generic assignment of this species/pathovar was reaffirmed. Control of the disease may be achieved by crop rotation, disease-free corms and chemical treatment (**53**, 3054; **54**, 890).

LITERATURE: Ballard, Palleroni, Doudoroff, Stanier & Mandel, *Journal of General Microbiology* **60**: 199–214, 1970; Li, Dorsch, Del Dot, Sly, Stackebrandt & Hayward, *Journal of Applied Bacteriology* **74**: 324–329, 1993; Palleroni, *In* Krieg & Holt, *Bergey's Manual of Systematic Bacteriology*, **Vol. 1**, pp. 141–199, Williams & Wilkins, Baltimore, 1984; Stackebrandt, Murray & Trüper, *International Journal of Systematic Bacteriology* **38**: 321–325, 1988; Stead, *International Journal of Systematic Bacteriology* **42**: 281–295, 1992; Urakami, Ito-Yoshida, Araki, Kijima, Suzuki & Komagata, *International Journal of Systematic Bacteriology* **44**: 235–245, 1994; Woese, Weisburg, Paster, Hahn, Tanner, Krieg, Koops, Harms & Stackebrandt, *Systematic and Applied Microbiology* **5**: 327–336, 1984; Yabuuchi, Kosako, Oyaizu, Yano, Hotta, Hashimoto, Ezaki & Arakawa, *Microbiology and Immunology* **36**: 1251–1275, 1992.

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IMI Descriptions of Fungi and Bacteria No. 1219

BURKHOLDERIA GLUMAE

Burkholderia glumae (Kurita & Tabei) Urakami, Ito-Yoshida, Araki, Kijima, Suzuki & Komagata, *International Journal of Systematic Bacteriology* **44**: 235–245, 1994.

Pseudomonas glumae Kurita & Tabei, *Annals of the Phytopathological Society of Japan* **33**: 111, 1967, (Japanese abstract only).

Aerobic, Gram-negative rods motile with a polar flagellar tuft. Non-fluorescent, PHB is accumulated intracellularly. Growth at 41 °C but not at 4 °C, optimum 30 °C. Growth in the presence of 3% NaCl (w/v); growth is weak at pH 8 and there is no growth at pH 4 or 9. Catalase, lecithinase (egg yolk), lipase (Tween 80) and urease positive; arginine dihydrolase, oxidase and polygacturonase negative. Gelatin is liquefied; levan is not produced, nitrate is not reduced and aesculin, arbutin and starch are not hydrolysed. Acid is produced from arabinose, fructose, galactose, glucose, glycerol, mannitol, mannose, sorbitol and xylose. Lactose and raffinose were variable. No acid from dextrin, inulin, maltose, rhamnose, salicin, or sucrose. The following are used as sole carbon sources: adonitol, L-arabinose, cellobiose, D-galactose, glucose, inositol, levulinate, mannitol, D-mannose, *n*-propanol, sorbitol, *meso*-tartrate, L-threonine, tryptamine and D-xylose; but not α-amylamine, 2,3-butylene glycol, citraconate, erythritol, *m*-hydroxybenzoate, DL-ornithine, L-rhamnose, sucrose and D-tartrate. Growth on lactose is strain dependant.

A member of the beta subdivision of the *Proteobacteria* (Woese *et al.*, 1984). Not assigned to any of the rRNA homology groups and placed within section V, a group containing taxa of unknown status whithin the genus *Pseudomonas* (Palleroni, 1984). However, the close relationship to rRNA homology group II pseudomonads was demonstrated by De Vos *et al.* (1985) and this taxon was subsequently placed in the genus *Burkholderia* by Urakami *et al.* (1994). The mol% G + C of the DNA is 68.2. The fatty acid profile is heterogeneous and members of the species were recovered in Groups 2a and 2b of the pseudomonads (Stead, 1992). Subgroup A includes the pathotype NCPPB 2981, and ICMP 3728 & 3729, whilst B, includes NCPPB 2391 & 3591. Subgroup A has a variety of 3-hydroxy, 2-hydroxy and cyclopropane acids present, in particular the detection of 2-hydroxydecanoic acid (16:0 2-OH) appears significant. The major components are *cis*-9-hexadecenoic (16:1 *cis* 9; 15.5% (SD 3.4)), hexadecanoic (16:0; 19.9% (1.1)), 9,10-methylene hexadecanoic acid (17:0 cyclo; 3.0% (2.6)), *cis*-11,12-methylene octadecanoic acid (19:0 cyclo 11–12; 2.4% (1.5)) and *cis*-11-octadecenoic acids (18:1 *cis* 11; 38.7% (2.9)). Subgroup B also has a variety of 3-hydroxy, 2-hydroxy and cyclopropane acids, however, the presence of significant amounts of 3-hydroxydecanoic acid (10:0 3-OH), 3-hydroxydodecanoic acid (12:0 3-OH) and substantial amount of 3-hydroxytetradecanoic acid (14:0 3-OH; 18.6% (1.0)) are unique within Group 2. The major components are *cis*-9-hexadecenoic (16:1 *cis* 9; 6.2% (1.9)), hexadecanoic (16:0; 16.4% (0.6)), 9,10-methylene hexadecanoic acid (17:0 cyclo; 8.7% (1.3)), *cis*-11,12-methylene octadecanoic acid (19:0 cyclo 11–12; 5.9% (2.0)) and *cis*-11-octadecenoic acids (18:1 *cis* 11; 24.1% (1.9)). Ubiquinones with eight isoprene (Q-8) units make up the major quinone composition, trace amounts of Q-7 and Q-9 are also detected.

Type strain: ATCC 33617; CFBP 2039; ICMP 3655; LMG 2196; NCPPB 2981.

HOSTS: *Oryza sativa*. *Andropogon virginicus*, *Arundinella hirta*, *Beckmannia syzigachne*, *Chloris gayana*, *Coix lacryma-jobi*, *Eleusine coracana*, *E. indica*, *Eragrotis curvula*, *E. multicaulis*, *Lolium multiflorum*, *Panicum coloratum*, *P. dichotomiflorum*, *P. maximum*, *Paspalum distichum*, *P. dilatatum*, *Pennisetum alopecuroides*, *Phleum pratense*, *Phragmites communis* and *Setaria viridis* var. *minor* have all been recognised as new hosts (**68**, 4324).

DISEASE: Bacterial grain and seedling rot of rice. The grains rot in the pannicles after 'heading'. Severely diseased pannicles may form infection foci for disease dissemination (Tsushima & Naito, 1991). The bacteria are thought to enter through the stoma on the inner surface of the rice husk and then multiply in the intercellular space of parenchyma (**69**, 1652). There is some evidence to suggest that degradative enzymes (**72**, 6749) and toxin production may also have a role in phytopathogenicity (**69**, 2349).

GEOGRAPHICAL DISTRIBUTION: Sri Lanka (**69**, 4949), China, Japan, Taiwan (**63**, 3360), Colombia (**70**, 2670), Latin America in general (**69**, 1080; **70**, 827).

PHYSIOLOGIC SPECIALIZATION: The evidence of the fatty acid data outlined above would suggest that

differences between strains exist. No systematic evidence has yet been put forward to formalise this heterogeneity amongst strains.

TRANSMISSION: Latent infection of rice seeds (**70**, 7648).

NOTES: A selective medium has been designed to aid recovery from natural specimens (Tsushima *et al.*, 1986). In addition, a culture medium incorporating bromothymol blue can be used to differentiate between rice pathogens including the nonfluorescent pseudomonads; *Burkholderia glumae* and *Acidovorax avenae* subsp. *avenae* (Zeigler & Alvarez, 1989). Treatment with oxolinic acid appears to offer promise as a control strategy (**73**, 2855–2857 & 2859). There is evidence to suggest that some varieties are more resistant to the disease, though none are immune (**70**, 342) and protocols are being developed for biological control (**71**, 4717; **72**, 2087). An immunofluorescent antibody technique has been used effectively for pathogen detection in plant material (**73**, 2858).

LITERATURE: De Vos, Goor, Gillis & De Ley, *International Journal of Systematic Bacteriology* **35**: 169–184, 1985; Palleroni, *In* Krieg & Holt, *Bergey's Manual of Systematic Bacteriology*, **Vol. 1**, pp. 141–199, Williams & Wilkins, Baltimore, 1984; Stead, *International Journal of Systematic Bacteriology* **42**: 281–295, 1992; Tsushima & Naito, *Annals of the Phytopathological Society of Japan* **57**: 180–187, 1991; Tsushima, Wakimoto & Mogi, *Annals of the Phytopathological Society of Japan* **52**: 253–259, 1986; Urakami, Ito-Yoshida, Araki, Kijima, Suzuki & Komagata, *International Journal of Systematic Bacteriology* **44**: 235–245, 1994; Woese, Weisburg, Paster, Hahn, Tanner, Krieg, Koops, Harms, Stackebrandt, *Systematic and Applied Microbiology* **5**: 327–336, 1984; Zeigler & Alvarez, *International Rice Research Newsletter* **14**: 27–28, 1989.

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IMI Descriptions of Fungi and Bacteria No. 1220

BURKHOLDERIA SOLANACEARUM

Burkholderia solanacearum (Smith) Yabuuchi, Kosako, Oyaizu, Yano, Hotta, Hashimoto, Ezaki & Arakawa, *Microbiology and Immunology* **36**: 1251–1275, 1992 (Effective publication). Yabuuchi, Kosako, Oyaizu, Yano, Hotta, Hashimoto, Ezaki & Arakawa, *International Journal of Systematic Bacteriology* **43**: 398, 1993 (Valid Publication).

Bacillus musae Rorer, *Phytopathology* **1**: 45–49, 1911.
Bacillus musarum Zeman, *Revista de la Facultad Agronomía Universidad Nacionel de la Plata* **14**: 17–30, 1921.
Bacillus nicotianae Uyeda, *Zentralblatt für Bakteriologie, Parasitenkunde, Infectionskrankheiten und Hygiene. Abteilung II* **13**: 327–329, 1904.
Bacillus sesami Malkoff, *Zentralblatt für Bakteriologie, Parasitenkunde, Infectionskrankheiten und Hygiene. Abteilung II* **16**: 664–666, 1906.
Bacillus solanacearum Smith, *Bulletin, Division of Vegetable Physiology and Pathology, USDA* **No. 12**: 1–28, 1896.
Bacterium solanacearum (Smith) Chester, *Annual Report of the Delaware University Agricultural Experiment Station* **9**: 20–145, 1897.
Bacterium solanacearum var. *asiatica* (Smith) Magrou, In Hauduroy, Ehringer, Urbain, Guillot & Magrou, *Dictionnaire des Bactéries Pathogènes*, 1st edition, p. 414, Masson, Paris, 1937.
Bacterium solanacearum var. *asiaticum* Smith, *Bacteria in Relation to Plant Disease* **Vol. 3**: p. 282, Carnegie Institute, Washington, 1914.
Chromobacterium nicotianae (Uyeda) Krasil'nikov, *Opredelitel' Bakterii i Aktinomitsetov*. [Guide to Bacteria and Actinomycetes] p. 495, Akademiya Nauk, Moscow, 1949.
Erwinia nicotianae (Uyeda) Bergey, Harrison, Breed, Hammer & Huntoon, *Bergey's Manual of Determinative Bacteriology*, 1st edition, p. 172, Williams & Wilkins, Baltimore, 1923, as '*nicotiana*'.
Erwinia solanacearum (Smith) Holland, *In* Winslow, Broadhurst, Buchanan, Krumwiede, Rogers & Smith, *Journal of Bacteriology* **5**: 222, 1920.
Phytobacterium solanacearum (Smith) Patel & Kulkarni, *Indian Phytopathology* **4**: 74–84, 1951.
Phytomonas ricini Archibald, *Tropical Agriculture Trinidad* **4**: 124–125, 1927.
Phytomonas solanacearum (Smith) Bergey, Harrison, Breed, Hammer & Huntoon, *Bergey's Manual of Determinative Bacteriology*, 1st edition, p. 186, Williams & Wilkins, Baltimore, 1923, as '*solanaceara*'.
Phytomonas solanacearum var. *asiatica* (Smith) Stapp, *In* Sorauer, *Handbuch der Pflanzenkrankheiten*, 5th edition **Vol. 2**: pp. 414, Paul Parey, Berlin, 1928.
Pseudomonas batatae Cheng & Faan, *Acta Phytophylacica Sinica* **1**: 243–253, 1962, as cited by Cheng & Faan, *Acta Phytopathologica Sinica* **6**: 127–130, 1963.
Pseudomonas ricini (Archibald) Robbs, *Escola Nacional de Agronomia Rio de Janeiro* **13**: 265–282, 1954.
Pseudomonas solanacearum (Smith) Smith, *Bacteria in Relation to Plant Disease* **Vol. 3**: p. 178, Carnegie Institute, Washington, 1914.
Pseudomonas solanacearum var. *asiatica* (Smith) Stapp, *In Sorauer, Handbuch der Pflanzenkrankheiten*, 5th edition **Vol. 2**: pp. 253, Paul Parey, Berlin, 1928.
Xanthomonas solanacearum (Smith) Dowson, *Transactions of the British Mycological Society* **26**: 4–14, 1943.
Xanthomonas solanacearum var. *asiatica* (Smith) Elliott, *Manual of Bacterial Plant Pathogens*, 2nd. edition, p. 142, Chronica Botanica, Waltham, 1951.

Aerobic, Gram-negative rods, motile with a polar flagellar tuft. Non-fluorescent, some strains produce a brown diffusible pigment, PHB is accumulated intracellularly. No growth at 4 °C or 41 °C. No growth in the presence of 3% NaCl (w/v); Growth is weak at pH 8 with no growth at pH 4 or 9. Catalase and oxidase positive, most strains produce tyrosinase, but not those isolated from *Musaceae*, arginine dihydrolase, lecithinase (egg yolk) and lipase (Tween 80) negative. Levan is not produced; aesculin, gelatin and starch are not hydrolysed; nitrate is reduced and denitrification is strain dependant. Acid is produced from fructose, glucose, glycerol and sucrose but not from amygdalin, dextrin, erythritol, inulin, melibiose, α-methyl-D-glucoside, raffinose or salicin. The following are utilized a sole carbon sources: acetate, aconitate, L-alanine, D-alanine, γ-aminobutyrate, asparagine, L-aspartate, benzoate, butyrate, citrate, fumarate, gluconate, D-glucose, L-glutamate, glycerol, L-histidine, β-hydroxybutyrate, isobutyrate, α-ketoglutarate, L-malate, mucate, L-proline, propionate, pyruvate, saccharate, succinate, sucrose, and trehalose; but not adipate, adonitol, α-amylamine, L-arabinose, 2,3-butylene glycol, cellobiose, citraconate, erythritol, glutarate, glycine, histamine, *m*-hydroxybenzoate, inulin, 2-ketogluconate,

lactose, maleate, malonate, mesaconate, maltose, raffinose, L-rhamnose, salicin D-tartrate, tryptamine, L-tryptophane, D-tryptophane, L-valine and D-xylose.

A member of the beta subdivision of the *Proteobacteria* (Woese *et al.*, 1984; Stackebrandt *et al.*, 1988). Assigned to rRNA homology group II within the pseudomonads (Palleroni, 1984), and subsequently placed in the genus *Burkholderia* by Urakami *et al.* (1994). The complete 16S rRNA sequence for the type strain (ATCC 11696), a biovar 1 strain, has been deposited with EMBL/GenBank, accession number X67036. Biovar 2 (ACH 0158), biovar 3 (ACH 0171) and biovar 4 (ACH 092) strains have been given the accession numbers X67035, X67041 & X67040, respectively (Li *et al.*, 1993). Separately, other workers have deposited a complete 16S rRNA sequence for the type strain and is accessed under S55002 & S55011 (Yabuuchi *et al.*, 1992). Partial 16S rRNA sequences for other B. solanacearum strains are also available through EMBL/GenBank X70344-X70346, X70350 (Seal *et al.*, 1993). The mol% G + C of the DNA is 66.6. The fatty acid profile is typical of Group 2c organisms (Stead, 1992), with a variety of 3-hydroxy, 2-hydroxy and cyclopropane acids present; no 2-hydroxydecanoic acid (16:0 2-OH) was detected. The major components are *cis*-9-hexadecenoic (16:1 *cis* 9; 28.8% (SD 1.5)), hexadecanoic (16:0; 25.1% (1.38)) and *cis*-11-octadecenoic acids (18:1 *cis* 11; 19.9% (1.6)). Ubiquinones with eight isoprene (Q-8) units make up the major quinone composition, trace amounts of Q-7 and Q-9 are also detected.

Type strain: ATCC 11696; CFBP 2047; ICMP 5712; LMG 2299; NCPPB 325.

HOSTS: The host range is one of the widest of all the phytopathogenic bacteria. The most susceptible plant family, in terms of numbers of species affected is the *Solanaceae*; over fifty other plant families contain susceptible species. The most economically significant hosts are listed here. For a more complete listing see Kelman (1953), Bradbury (1986) and Hayward & Hartman (1994). *Arachis hypogaea*, *Capsicum* spp., *Gossypium hirsutum*, *Ipomoea batatus*, *Lycopersicon esculentum*, *Manihot esculenta*, *Musa* spp., *Nicotiana* spp., *Solanum melongena*, *Solanum tuberosum and Zingiber officinale*.

DISEASE: Bacterial wilt. Infection is systemic, producing a wilt of parts or the whole plant. Vascular system may become discoloured, bacterial ooze can be produced and plants may be stunted and chlorotic.

GEOGRAPHICAL DISTRIBUTION: Widespread in tropical, subtropical and warm temperate regions of the world (see Data Sheets on Quarantine Pests, 1992).

PHYSIOLOGIC SPECIALISATION: The species is heterogeneous and has been divided into four biovars (biotypes) according to acid production from three disaccharides and three sugar alcohols (Hayward, 1964). An additional biovar, biovar 5, has been subsequently proposed for strains isolated from mulberry (He *et al.*, 1982). In addition, a previously undescribed phenotype has been distinguished within biovar 2 (**69**, 6131), generally referred to as biovar N2; these strains originate in the Amazon basin and tend to be metabolically more versatile than biovar 2 *sensu strictu* (Hayward *et al.*, 1991; Gillings & Fahy, 1992). In addition, the species has also been divided into three races on the basis of pathogenicity (Buddenhagen *et al.*, 1962). More recently 30 RFLP groups have been distinguished within the species and form two genetically distinct divisions with origins in Austalasia and the Americas (Cook *et al.*, 1989, 1991). See Gillings & Fahy (1993) for a tabulated account of how the various infraspecific classifications relate to each other.

TRANSMISSION: A variety of modes of transmission exist which are host dependant. Infected planting material and true seed is responsible for the spread of bacterial wilt of banana, ginger, groundnut, potato and tomato, whilst transport of latently infected in seedlings (stawberry) and the actions of insect (Moko disease of banana) and weather (tobacco) have all been implicated. For a review see Kelman *et al.* (1994).

NOTES: *B. solanacearum* is an EPPO A2 quarantine pest, it also has quarantine significance for APPPC and IAPSC. A number of techniques are of value in the detection of the pathogen in plant material (Seal & Elphinstone, 1994). Up to date information on research into taxonomy, epidemiology, control of this pathogen can be found in Hayward & Hartman (1994) and 'Data Sheets on Quarantine Pests' (1992).

LITERATURE: Bradbury, *Guide to Plant Pathogenic Bacteria*, CAB-IMI, Kew, 1986; Buddenhagen, Sequeira & Kelman, *Phytopathology* **52**: 726, 1962; Cook, Barlow & Sequeira, *Molecular Plant-Microbe Interactions* **2**: 113–121, 1989; Cook, Barlow & Sequeira, *In* Hennecke & Verma, *Advances in Molecular Genetics of Plant-Microbe Interactions* **1**: pp. 103–108, 1991; Gillings & Fahy, *Plant Pathology* **42**: 744–753, 1992; Gillings & Fahy, In Hartman & Hayward, *Bacterial Wilt*, pp. 85–96, ACIAR, Canberra, 1993; Hartman & Hayward, *Bacterial Wilt*, pp. 85–96, ACIAR, Canberra, 1993; Hayward, *Journal of Applied Bacteriology* **27**: 265–277, 1964; Hayward & Hartman, *Bacterial Wilt: The Disease and its Causative Agent, Pseudomonas solanacearum*, CAB International, Wallingford, 1994; Hayward, Sequeira, French, El-Nashaar & Nydegger, *Proceedings of the XV Meeting Asocia-*

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IMI Descriptions of Fungi and Bacteria No. 1220 (continued)

BURKHOLDERIA SOLANACEARUM

sion Latinoamerica de la Papa, March 10–17 1991, Lima, Peru (Abstract), 1991; He, Sequeira, Kelman, *Phytopathology* **72**: 936, 1982; Kelman, *North Carolina Agricultural Experiment Station Technical Bulletin* **99**: 1–194, 1953; Kelman, Hartman & Hayward, *In* Hayward & Hartman, *Bacterial Wilt: The Disease and its Causative Agent, Pseudomonas solanacearum*, CAB International, Wallingford, 1994; Li, Dorsch, Del Dot, Sly, Stackebrandt & Hayward, *Journal of Applied Bacteriology* **74**: 324–329, 1993; Palleroni, *In* Krieg & Holt, *Bergey's Manual of Systematic Bacteriology*, **Vol. 1**, pp. 141–199, Williams & Wilkins, Baltimore, 1984; Seal & Elphinstone, *In* Hayward & Hartman, *Bacterial Wilt: The Disease and its Causative Agent, Pseudomonas solanacearum*, CAB International, Wallingford, 1994; Seal, Jackson, Young & Daniels, *Journal of General Microbiology* **139:** 1587–1594, 1993; Stackebrandt, Murray & Trüper, *International Journal of Systematic Bacteriology* **38**: 321–325, 1988; Stead, *International Journal of Systematic Bacteriology* **42**: 281–295, 1992; Urakami, Ito-Yoshida, Araki, Kijima, Suzuki & Komagata, *International Journal of Systematic Bacteriology* **44:** 235–245, 1994; Woese, Weisburg, Paster, Hahn, Tanner, Krieg, Koops, Harms, Stackebrandt, *Systematic and Applied Microbiology* **5**: 327–336, 1984; Yabuuchi, Kosako, Oyaizu, Yano, Hotta, Hashimoto, Ezaki & Arakawa *Microbiology and Immunology* **36**: 1251–1275, 1992. Data sheets on quarantine pests: *Quarantine Pests for* Europe, pp. 776–783, CAB International, Wallingford, 1992; Quarantine procedure, *Bulletin OEPP/EPPO Bulletin* **20**: 255–262, 1990.

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