Nocardia dassonvillei, a Macroscopic Replica of *Streptomyces griseus*

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SUMMARY

Twenty-six strains of *Nocardia dassonvillei* (Brocq-Rousseu) Liégard & Landrieu from the soil and from infections of man and animals are described, and a pattern of characteristics for their identification and differentiation from *N. asteroides*, *N. brasiliensis*, *N. caviae*, *N. madurae* and *N. pelletieri* is presented. Strains of *N. dassonvillei* resembled strains of *Streptomyces griseus* (Krainky) Waksman & Henrici in the macroscopic appearance of their growth and in many of the physiological properties examined.

INTRODUCTION

The strains of nocardias and streptomycetes examined by Becker, Lechevalier, Gordon & Lechevalier (1964) for the form of diaminopimelic acid (DAP) in hydrolysates of whole organisms included a small group isolated from pulmonary infections of animals in the Chicago Zoological Park. The strains of this group macroscopically resembled strains of *Streptomyces griseus*, and two strains had the same pattern of physiological characteristics as *S. griseus*. Only two properties, at that time, separated the others from *S. griseus*. Later Becker *et al.* (1964) reported that the two strains had the *LL*-form of DAP and the other strains the *meso*-form. Determination of the form of DAP was therefore added to our observations of those nocardias and streptomycetes in our collection of whose specific identity we were uncertain.

Strains from other sources were encountered with the three correlating properties that distinguished them from *Streptomyces griseus*, and only one more property was found to widen the separation between the two taxa. Because the strain bearing the oldest name among those with the *meso*-form of DAP was *Nocardia dassonvillei* (Brocq-Rousseu, 1907) Liégard & Landrieu (1911), we assigned this name to the group. A pattern of characteristics for the recognition of strains of *N. dassonvillei* is given here and contrasted with the properties of *S. griseus* and those of five other species of *Nocardia*.

METHODS

Organisms. The strains presented in Table 1 were compared with those listed by Gordon & Horan (1968) and by Gordon (1966).

Tests. The strains were examined according to the procedures described by Gordon (1966, 1967), and for the the form of diaminopimelic acid (Becker *et al.* 1964).

RESULTS

Smears of the 26 cultures of *Nocardia dassonvillei*, grown on glycerol agar for 5 days and stained by a modified Ziehl-Neelsen method, showed long filaments. Approximately half the smears also contained rods of varying lengths and a few coccoid bodies. The cultures were not acid-fast.

Table 1. *Strains identified as Nocardia dassonvillei*

Strain no.	Name when received, source, strain name or number
509	* <i>Nocardia dassonvillei</i> (Brocq-Rousseu) Liégard & Landrieu; P. Thibault, Inst. Pasteur, Paris
N3255	<i>Nocardia madurae</i> ; (NCTC 3255)
575	<i>Nocardia</i> sp.; C. W. Emmons, Nat. Inst. of Health, Bethesda, Md. (A 826); G. Altmann (1344, ulcerating lesion on leg of patient with elephantiasis)
639, 711, 714-718	<i>Nocardia</i> sp.; E. B. Tilden, Chicago Zoological Park, Brookfield, Ill. (lung lesion of a sitatunga; P 2, lung of a penguin; 6, 9, 10, 11, 12, lung of a kangaroo)
1288	<i>Nocardia</i> sp.; C. W. Emmons (10,006, nasal washings)
1289	<i>Nocardia</i> sp.; N. F. Conant, Duke Univ.; H. A. Campana (Malloch, chronic ulcer following bite of a dog)
1322-1330	<i>Nocardia</i> spp.; M. P. Lechevalier, Rutgers Univ. (G 1, G 2, H 1, J 2, J 3, L 10, L 13, 11-36, soil; Cross Fil., bovine streptothricosis)
N434	<i>Streptomyces listeri</i> (Erikson) Waksman & Henrici; NCTC; (434, human)
1236	<i>Streptomyces</i> sp.; C. W. Emmons (B-2031, pulmonary lymph node)
1250	† <i>Streptomyces</i> sp.; D. Taplin, Univ. of Miami (Babcock, case of erosive plantar disease)
794	Unidentified isolation; H. Cohen, Kaiser Foundation Hosp., Los Angeles, Calif. (Robinson, pleural biopsy)
1213	Unidentified isolation; G. Ryvarden, Kaiserin Elizabeth Hospital, Vienna (venous blood of patient with malignant lymphoma)

* ATCC 23218; NCTC 10488.

† ATCC 23219; NCTC 10489.

Under the conditions of the examination, the 26 strains formed loosely or densely filamentous colonies; colonies with smooth margins were not observed. Aerial hyphae were not produced by four of the cultures and in the remaining cultures varied from sparse to abundant. These hyphae were short and straight, or long and branching, straight or coiled (Pl. 1). Sporulation was abundant. The colonies of a few strains displayed many purple-coloured crystals identified by Gerber (1966) as crystals of iodinin.

Cultures grown on 'yeast dextrose (glucose) agar' were macroscopically abundant, coarsely wrinkled or flat. The growth was yellowish, greenish yellow or reddish brown, and produced a yellowish, greenish yellow or brown soluble pigment. The aerial hyphae formed by some cultures were not visible to the unaided eye but on other cultures showed as a sparse coating or a few whitish patches; still other cultures were thickly covered with greyish aerial hyphae. The resemblance of cultures of *Nocardia dassonvillei* to cultures of *Streptomyces griseus* is illustrated in Pl. 2.

The 26 strains of *Nocardia dassonvillei* in our collection dissolved adenine, casein, hypoxanthine, tyrosine, and xanthine; did not grow at 45° and 10°; utilized lactate, malate and succinate, but not mucate or oxalate; were sensitive to lysozyme and salicylate; did not ferment glucose; hydrolysed hippurate and starch; formed acid from glucose, maltose, mannitol, and mannose; did not produce acid from adonitol, dulcitol,

Table 2. Comparison of some reactions of *Nocardia dassonvillei* and of *Streptomyces griseus*

Property	<i>Nocardia dassonvillei</i> (26 strains)	<i>Streptomyces griseus</i> (123 strains)
	Positive strains (%)	
Decomposition of		
Adenine	100	98
Casein	100	100
Hypoxanthine	100	100
Tyrosine	100	100
Urea	35	97
Xanthine	100	100
Growth at		
45°	0	0
40°	80	33
10°	0	100
Survival at 50° for 8 hr	92	99
Nitrite from nitrate	92	73
Utilization of		
Citrate	96	99
Lactate	100	90
Malate	100	100
Mucate	0	0
Oxalate	0	0
Succinate	100	100
Resistance to		
Lysozyme	0	1
Salicylate	0	2
Oxidation of glucose	85	98
Fermentation of glucose	0	0
Hydrolysis of		
Hippurate	100	5
Starch	100	100
Acid from		
Adonitol	0	43
Arabinose	60	63
Dulcitol	0	0
Erythritol	0	1
Galactose	62	99
Glucose	100	100
Inositol	0	15
Lactose	0	100
Maltose	100	100
Mannitol	100	97
Mannose	100	100
Melibiose	31	0
α -Methyl-D-glucoside	23	98
Raffinose	0	2
Rhamnose	65	31
Sorbitol	0	0
Trehalose	65	99
Xylose	81	100
Meso-diaminopimelic acid	100	0*
LL-diaminopimelic acid	0	100*

* Twenty-one strains analysed.

erythritol, inositol, lactose, raffinose or sorbitol; had the *meso*-form of DAP in hydrolysates of whole organisms (Table 2). Survival at 50° for 8 hr, reduction of nitrate to nitrite, and utilization of citrate were considered to be fairly reliable properties, although not shared by all the strains. Because of their variability, the remaining characteristics listed in Table 2 were not included in the pattern of reactions of the species. A comparison (Table 2) of the properties of *N. dassonvillei* with those of *Streptomyces griseus* (Gordon & Horan, 1967) discloses that the two taxa are differentiated only by growth at 10°, hydrolysis of hippurate, acid formation from lactose and the form of their DAP.

Table 3. *Some criteria for identifying six species of Nocardia*

	<i>N. aster- oides</i> (137 strains)	<i>N. caviae</i> (24 strains)	<i>N. brasi- liensis</i> (62 strains)	<i>N. madurae</i> (44 strains)	<i>N. pelle- tieri</i> (15 strains)	<i>N. dasson- villei</i> (26 strains)
	Positive strains (%)					
Property						
Acid-fastness	55	66	80	0	0	0
Decomposition of						
Adenine	0	4	3	0	0	100
Casein	0	0	98	100	100	100
Hypoxanthine	4	100	94	100	100	100
Tyrosine	1	0	100	86	100	100
Urea	96	92	100	0	0	35
Xanthine	0	100	0	0	0	100
Growth at						
45°	41	50	2	36	13	0
10°	15	13	37	0	67	0
Survival at 50° for 8 hr	94	88	0	100	100	92
Nitrite from nitrate	86	100	90	100	100	92
Utilization of						
Citrate	38	29	98	80	7	96
Malate	97	100	100	84	53	100
Succinate	92	100	100	80	0	100
Resistance to lysozyme	100	100	100	5	0	0
Hydrolysis of						
Aesculin	100*	100	100*	100	0	12
Hippurate	—	—	—	2	0	100
Starch	67	54	55	100	13	100
Acid from						
Adonitol	0	0	0	91	0	0
Arabinose	0	4	0	100	0	60
Dulcitol	0	0	0	0	0	0
Erythritol	7	0	2	0	0	0
Galactose	27	0	94	81	7	62
Glucose	98	100	97	100	100	100
Inositol	3	100	100	61	0	0
Lactose	0	0	0	55	0	0
Maltose	6	18	4	32	0	100
Mannitol	1	90	94	100	7	100
Mannose	17	36	68	61	0	100
Melibiose	—	0	—	0	0	31
α -Methyl-D-glucoside	0	0	0	0	0	23
Raffinose	0	0	0	0	0	0
Rhamnose	32	5	0	100	0	65
Sorbitol	0	0	0	0	0	0
Xylose	0	5	0	100	0	81

* Fifty strains examined.

The pattern of reactions that seems distinctive for *Nocardia dassonvillei* and separates the species from the other species represented in our collection was compared (Table 3) with the same reactions of five other species of *Nocardia* (Gordon, 1966). The following combination of characteristics sets the strains of *N. dassonvillei* apart from the strains of *N. asteroides*, *N. caviae*, *N. brasiliensis*, *N. madurae* and *N. pelletieri*: lack of acid-fastness; decomposition of adenine, casein, hypoxanthine, tyrosine, and xanthine; survival at 50° for 8 hr; utilization of citrate and succinate; hydrolysis of hippurate; sensitivity to lysozyme; acid production from maltose, mannitol, and mannose; no acid from adonitol or inositol. Inability to hydrolyse aesculin was a somewhat less dependable property.

DISCUSSION

The original strains of *Nocardia dassonvillei*, named *Streptothrix dassonvillei* by Brocq-Rousseu (1907), were isolated from mildewed grain and fodder. Two years later, Liégard & Landrieu (1911) isolated a strain from a case of ocular conjunctivitis. They concluded that this strain was the same as Brocq-Rousseu's *S. dassonvillei* and suggested its assignment to the genus *Nocardia*. Accounts by Brumpt (1913) Forbes (1924) and Langeron (1922) are the only reports we have found in the literature of other strains named *N. dassonvillei*. *Actinomyces listeri*, described by Erikson (1935) and transferred to the genus *Streptomyces* by Waksman & Henrici (1948), is considered in the synonymy of *N. dassonvillei*.

The distribution of the first strains of *Nocardia dassonvillei* is repeated in the histories of the strains listed in Table 1. Nine of the 26 strains came from soil, and 15 were described as isolations from human or animal infections. Although pathogenicity is outside the scope of our studies, we are tempted to speculate on the discarding in medical laboratories of cultures of *N. dassonvillei* as contaminants because of their macroscopic resemblance to cultures of *Streptomyces griseus*.

With allowance for microbial variation, the combination of 32 properties given here is believed to be a reliable basis for differentiating strains of *Nocardia dassonvillei* from the other strains of aerial hyphae-forming nocardias and streptomycetes in our collection. We cannot, however, suggest a combination of a few properties as a presumptive test for the recognition of *N. dassonvillei*. Among the properties of the six species of nocardias in Table 3, the decomposition of adenine is useful for separating *N. dassonvillei* from the other five species and, if the nocardias were limited to six species, could be proposed as a presumptive test for *N. dassonvillei*. The genus *Nocardia*, however, is not so obligingly simple.

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EXPLANATION OF PLATES

PLATE I

Aerial hyphae of *Nocardia dassonvillei*, strain 794, on yeast dextrose agar after 10 days of incubation at 28°.

PLATE 2

Growth of cultures of *Nocardia dassonvillei* and *Streptomyces griseus* on slants of yeast dextrose agar after 14 days of incubation at 28°.