Type Strains of Species of the Order *Mycoplasmatales*, Including Designation of Neotypes for *Mycoplasma mycoides* subsp. *mycoides*, *Mycoplasma agalactiae* subsp. *agalactiae*, and *Mycoplasma arthritidis*

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Only in a minority of the original descriptions of named species of the order *Mycoplasmatales* has a type strain been unequivocally designated, although in some instances only a single strain was described, that strain thus becoming the type strain by monotypy. These species and their type strains are listed in the American Type Culture Collection Catalogue of Strains. Strain PG1 (NCTC 10114) is here designated as the neotype of *Mycoplasma mycoides* subsp. *mycoides*, strain PG2 (NCTC 10123) as the neotype of *M. agalactiae* subsp. *agalactiae*, and strain PG6 (ATCC 19611) as the neotype of *M. arthritidis*. Type strains are designated for the named species of the order *Mycoplasmatales* which lack type strains, in most instances the wishes of the original author being followed. Authors are urged, when describing new species in the future, to designate the type strain, avoiding ambiguous wording, and to deposit that strain in at least one of the permanently established collections, its catalogue number in that collection being stated in the paper.

The International Code of Nomenclature of Bacteria (31) recommends that authors, when publishing the name of a new taxon, designate the nomenclatural type of that taxon (Recommendation 9b). Moreover, in the case of a new species or subspecies, so that the original "type" material on which the description was based may be preserved, an authentic culture of the designated type strain should be deposited with one or more permanently established culture collections (Recommendation 9c). Only in a minority of the original descriptions of named species of the order *Mycoplasmatales* has a type strain been unequivocally designated, although in other instances only a single strain was described, that strain thus becoming the type by monotypy (Rule 9d[2]). These species are listed in Table 1 with their type strains.

The situation where a type strain has not been clearly designated is covered by Rule 9d[3], which states: "If the author in the original publication of the name of a species or subspecies failed to designate a type strain, a

type strain may be designated by a subsequent author, and the author who first makes the choice must be followed." Rule 9d[1](c) describes the procedure necessary for designating a neotype strain. The purpose of this paper is to designate type strains, according to these rules, for those species of *Mycoplasmatales* where a type strain has not previously been designated. In some instances neotypes will be proposed; in others, the intentions of the original authors in the choice of type strain will usually be followed, even though it was not unequivocally expressed in the original publication. It is hoped that the existing untidy situation will thus be clarified. For the future, authors are urged, when describing and naming a new species or subspecies, to designate a "type strain," avoiding ambiguous terms such as "representative," "reference," or "prototype" strain. A culture of the type strain should be deposited in at least one national collection of type cultures and its catalogue number in that collection should be stated in the paper.

TABLE 1. *Species of the order Mycoplasmatales for which type strains either have already been designated or are the type by monotypy*

Species	Type strain	ATCC no. ^a	NCTC no. ^b	Status	References and comments
<i>Acholeplasma axanthum</i> Tully and Razin	S743	25176	10138	Type	59
<i>Mycoplasma anatis</i> Roberts	1340 ^c	25524		Type	44 (Type by monotypy)
<i>M. bovigentialium</i> Freundt	PG11 (B2)	19852	10122	Type	50, 24, 12
<i>M. canis</i> Edward	PG14 (C55)	19525		Type	50, 15, 16
<i>M. conjunctivae</i> Barile et al.	HRC581	25834		Type	4
<i>M. cynos</i> Rosendal	H 831	27544	10142	Type	45
<i>M. dispar</i> Gourlay and Leach	462/2	27140	10125	Type	27
<i>M. edwardii</i> Tully et al.	PG24 (C21)	23462	10132	Type	60
<i>M. fermentans</i> Edward	PG18 (G)	19989	10117	Type	15, 47 40 (Type by monotypy)
<i>M. feliminutum</i> Heyward et al.	Ben.	125F49		Type	29 (Type by monotypy)
<i>M. gallinarum</i> Freundt	PG16 (Fowl)	19708	10120	Type	24, 14, 23, 13 (Type by monotypy)
<i>M. hyopneumoniae</i> Mare and Switzer	11 ^d	25617	10127	Type	38 (Type by monotypy)
<i>M. maculosum</i> Edward	PG15 (C27)	19327		Type	50, 15, 16
<i>M. mycoides</i> subsp. <i>capri</i> (Edward) Freundt	PG3		10137	Type	13, 14 (Type by monotypy)
<i>M. primateum</i> Del Giudice et al.	HRC292	25948		Type	10
<i>M. salivarium</i> Edward	PG20 (H110)	23064	10113	Type	50, 15, 40
<i>M. spumans</i> Edward	PG13 (C48)	19526		Type	50, 15, 16
<i>M. suis</i> Goodwin et al.	J	25934	10110	Type	26 (Type by monotypy)

^a ATCC, American Type Culture Collection, Rockville, Maryland, U.S.A.^b NCTC, National Collection of Type Cultures, London, England.^c In the original description this strain was labeled simply as "Weybridge."^d The prefixed letters VMRI were given to this strain when sent to the collection at the Wellcome Research Laboratories, and the letters VPP when sent for inclusion in the ATCC. It is usually known as strain 11.

PROPOSALS

The naming of species now regarded as belonging to the order *Mycoplasmatales* has taken place in stages over the past 63 years. The first organism of this type to be recognized was that causing contagious bovine pleuropneumonia. Borrel et al. (5), after a study of the morphology of this organism, proposed the name *Asterococcus mycoides* without designating a type strain. The generic name is illegitimate, but the specific epithet is legitimate.

Because of its filterability and peculiar morphology, the organism remained unique for many years, and it was not until much later that properties, such as the ability to ferment carbohydrates, were described (55). Strain PG1, which had originally been deposited in the National Collection of Type Cultures (NCTC 3278; now held as NCTC 10114) in 1931 by Sir Patrick Laidlaw as a strain of the organism causing contagious bovine pleuropneumonia, has already been proposed as the representative

strain of the species (15, 17). Although the exact origin of the strain is not known and cultures of it are no longer pathogenic, it has the same biochemical (14) and serological properties as vaccine strains (2, and Leach quoted in 42) and fresh pathogenic isolates (E. A. Freundt, unpublished observations). Recently, metabolic and growth inhibition tests have been used to confirm the serological identity of PG1 with several other strains of the species, including pathogenic strains (1). Strain PG1 is therefore here designated the neotype of *Mycoplasma mycoides* subsp. *mycoides* (Borrel et al.) Freundt.

The organism causing contagious agalactia of sheep and goats was the next organism of those now placed in the order *Mycoplasmatales* to be recognized. Wroblewski (61), after demonstrating its filterability and describing its morphology, proposed the name *Anulomyces agalaxiae* for this organism; no type strain was designated. The specific epithet, corrected to *agalactiae*, remains legitimate in the name of this species. Edward (13), who was unable to find a description of the biochemical properties of the species, studied a number of isolates from cases of the disease obtained from other laboratories. Although it was not possible to examine the pathogenicity of the strains, one typical strain (A2) isolated by Dr. C. Lopez of Madrid from an infected sheep, was proposed, as strain PG2, as the representative strain of the species (15). The biochemical properties of this strain are the same as those that have been described subsequently for freshly isolated pathogenic isolates from the disease in Turkey (7). Unfortunately, in this investigation a different reference strain was used, but this strain and PG2 have been shown by the metabolic inhibition test to be indistinguishable (R. H. Leach, personal communication). Therefore, strain PG2 is here designated as the neotype of *Mycoplasma agalactiae* subsp. *agalactiae* (Wroblewski) Freundt.

As other organisms with similar morphological and cultural properties were isolated, Sabin (49) proposed a classification of them based on habitat and pathogenicity, together with antigenicity. Although his nomenclature was largely illegitimate, the specific epithets he gave to four species are legitimate; type strains were not designated for these species. He gave the specific epithet *arthritis* to the "etiological agent of spontaneous arthritis in the rat (L4)." The symbol L4 had been applied to isolates studied by Klieneberger (33). As none of her original strains were in existence, Edward (15) and Edward and Freundt (17) chose "Preston," an early isolate (43), as the representative

strain of the species. Although no longer capable of producing arthritis in the rat, the strain has been shown to have the same biochemical and serological properties as recent isolates from spontaneous arthritis in rats, including strains still capable of producing arthritis experimentally (25). Strain Preston (PG6) is therefore designated here to be the neotype of *Mycoplasma arthritis* (Sabin) Freundt.

The specific epithet *neurolyticum* was applied to the name of a murine strain, Type A, which Sabin (48) had described himself. Since the strain he studied has now become available (58), it becomes the type of the species *Mycoplasma neurolyticum* (Sabin) Freundt.

The L3 organism, isolated from the lungs of rats by Klieneberger and Steabben (34) and studied by Klieneberger (32), was named *Murimycus pulmonis* by Sabin (49). One strain, "Ash," included in that study and representative of the L3 organism, is still in existence and was chosen as the representative strain by Edward (15) and Edward and Freundt (17). It is now designated as the type strain of the species *Mycoplasma pulmonis* (Sabin) Freundt.

Laidlaw and Elford (35), from the results of agglutination tests, placed their isolates from sewage into three groups, sewage A, sewage B, and sewage C. Strains of the third serologically distinct group no longer exist, but there still exist strains of the serologically closely related groups sewage A (strain PG8) and sewage B (strain PG9). Sabin (49) proposed an incorrect species name, *Sapromyces laidlawi* AB, for these organisms. Although Sneath and Skerman (50) were uncertain whether strain PG8 was a holotype or a paratype, it is clearly a strain on which the original description of this organism, currently known as *Acholeplasma laidlawii* (Freundt) Edward and Freundt, was based; hence, it is here designated as the type strain.

As new species continued to be described, they were at first referred to by symbols, but later Freundt (23, 24) and Edward (15) proposed names for them, finally collaborating in a systematic classification and nomenclature (17). For each species a "representative" strain was designated. It would seem evident that the authors intended the representative strains to be type strains, for it was stated as a principle: "It is thus desirable that for each named species there should be kept in collections of type cultures a representative strain upon which the properties of that species have been based" (15). All of the strains except one were deposited in and are available from the only collection of freeze-dried cultures of mycoplasmas then in existence, namely, that at the

TABLE 2. *Species of the order Mycoplasmatales whose type or neotype strain is designated here*

Species	Type strain	ATCC no. ^a	NCTC no. ^b	Status	References and comments
<i>Acholeplasma granularum</i> (Switzer) Edward and Freundt	BTS-39	19168	10128	Type	54 (Deposited in ATCC as type strain)
<i>A. laidlawii</i> (Freundt) Edward and Freundt	PG8 (Sewage A)	23206	10116	Type	49, 35, 24
<i>Mycoplasma agalactiae</i> subsp. <i>agalactiae</i> (Wroblewski) Freundt	PG2		10123	Neotype	61, 13, 14
<i>M. agalactiae</i> subsp. <i>bovis</i> Hale et al.	Donetta (PG45)	25523	10131	Type	28 (Sent as representative strain and maintained in WRL Collection)
<i>M. arginini</i> Barile et al.	G230	23838	10129	Type	3 (Designated as 'prototype' strain)
<i>M. arthritis</i> (Sabin) Freundt	PG6 (Preston)	19611		Neotype	49, 43, 14
<i>M. bovirhinis</i> Leach	PG43 (5M331)	19884	10118	Type	36, 8 (Deposited in WRL Collection; designated later as 'representative' strain)
<i>M. caviae</i> Hill	G122	27108	10126	Type	30 (Deposited as type strain in NCTC)
<i>M. felis</i> Cole et al.	CO	23391		Type	6 (Deposited in ATCC)
<i>M. flocculare</i> Meyling and Friis	Ms42	27399	10143	Type	39
<i>M. gallisepticum</i> Edward and Kanarek	PG31 (X95)	19610	10115	Type	20 (Designated as 'representative' strain and deposited in WRL Collection)
<i>M. gateae</i> Cole et al.	CS	23392		Type	6 (Deposited in ATCC)
<i>M. hominis</i> (Freundt) Edward	PG21 (H50)	23114	10111	Type	23, 15, 40
<i>M. hyorhinis</i> Switzer	BTS-7 ^c	17981	10130	Neotype	53 (Deposited as type strain in ATCC)
<i>M. hyosynoviae</i> Ross and Karmon	S16	25591		Type	46 (Designated as 'prototype' strain; deposited in ATCC)
<i>M. iners</i> Edward and Kanarek	PG30 (M)	19705		Type	20 (Designated as 'representative' strain; deposited in WRL Collection)
<i>M. meleagridis</i> Yamamoto et al.	17529	25294		Type	62 (Deposited in WRL Collection as a 'representative' strain)
<i>M. mycoides</i> subsp. <i>mycoides</i> (Borrel et al.) Freundt	PG1		10114	Neotype	5, 12, 14
<i>M. neurolyticum</i> (Sabin) Freundt	Type A	19988		Type	49, 48, 58
<i>M. orale</i> ^d Taylor-Robinson et al.	CH19299	23714	10112	Type	56 (Designated as 'prototype' strain)

TABLE 2—Continued

Species	Type strain	ATCC no. ^a	NCTC no. ^b	Status	References and comments
<i>M. pneumoniae</i> Somerson et al.	FH	15531	10119	Type	51 (Designated as 'prototype' strain)
<i>M. pulmonis</i> (Sabin) Freundt	Ash (PG34)	19612		Type	49, 34, 32
<i>M. synoviae</i> Olson et al.	WVU 1853	25204	10124	Type	41 (Deposited as a 'representative' strain in the WRL Collection)
<i>Thermoplasma acidophilum</i> ^c Darland et al.	122-1B2	25905		Type	9

^a ATCC, American Type Culture Collection, Rockville, Maryland, U.S.A.

^b NCTC, National Collection of Type Cultures, London, England.

^c Now regarded as the type strain by the original author in place of PG29, previously designated as the 'representative' strain (19).

^d *M. orale* type 2 (57) and *M. orale* type 3 (22) have been described, and it is clear that each was intended by the authors to be a separate species rather than a subspecies or an infrasubspecific form of an existing species. The status of *M. orale* type 2 as a separate species was confirmed by the ICSB Subcommittee on the Taxonomy of *Mycoplasmatales*, which recommended that it should be given a correct name and that further studies should be carried out on *M. orale* type 3 to determine its status (52).

^e The classification of this genus in the order *Mycoplasmatales* requires confirmation.

Wellcome Research Laboratories, Beckenham, England. These strains were regarded by Sneath and Skerman (50) as being effectively the types; they have therefore already been designated as type strains under Rule 9d(3) and are included in Table 1. It is still necessary to designate PG21 as the type strain of *Mycoplasma hominis* (Table 2), because it was regarded as a "co-type" by Sneath and Skerman, two serotypes of the species then being recognized. Subsequently, the second serotype has been withdrawn (18).

New species have continued to be described and named, but in a number of these a type strain has not been unequivocally designated. Nevertheless, the intentions of the authors have been clear. The International Committee on Systematic Bacteriology Subcommittee on Taxonomy of the *Mycoplasmatales* in its "Recommendations on Nomenclature of the Order *Mycoplasmatales*" urged microbiologists, when naming a new species, not only to publish an adequate description in a suitable journal but also to supply a national type culture collection "a representative prototype strain" (21). It can therefore be inferred that strains so deposited were regarded by the authors as the type strains. Prior to the acceptance of mycoplasmas by the American Type Culture Collection and the National Collection of Type Cultures, the only collection was that at the Wellcome Research Laboratories (WRL); thus strains deposited in that collection by an author may also be regarded as candidate type strains. In

some descriptions a strain has been designated as "a representative strain" or "a prototype strain" in the belief that this wording was sufficient to nominate a type strain. Species in this category are listed in Table 2; for each, the author's apparent choice of a type strain is noted, together with the manner in which this choice was indicated. These strains are herewith designated as the type strains of the species with which they are associated in the table.

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