Etiology of Farcy in African Bovines: Nomenclature of the Causal Organisms *Mycobacterium farcinogenes* Chamoiseau and *Mycobacterium senegalense* (Chamoiseau) comb. nov.

G. CHAMOISEAU

Centre National d'Elevage et de Recherches Vétérinaires, B. P. 167, Nouakchott, Mauritanie

In 1973 the author proposed the name *Mycobacterium farcinogenes* for the causal agent of farcy in African bovines. Two varieties (subspecies) of this species were recognized by the author: *M. farcinogenes* subsp. *tchadense* and *M. farcinogenes* subsp. *senegalense*. Because the former is the type subspecies of the species, its name should have been *M. farcinogenes* subsp. *farcinogenes*. It is now proposed that these subspecies constitute two separate and distinct species: *M. farcinogenes* Chamoiseau and *M. senegalense* (Chamoiseau) comb. nov. IEMVT 75 (= NCTC 10955) and IEMVT 378 (= NCTC 10956) are herein designated the type strains of these two species, respectively.

Since 1970 it has been known both in Chad and in Senegal that farcy, the disease of African bovines, is really a mycobacteriosis and that in most cases it is not due to *Nocardia farcinica*, as had been believed for a long time.

The work of Asselineau et al. (1) and of Lanneelle et al. (6) on the lipid components of the farcy actinomycete isolated from zebu cattle in Chad and Senegal has recently been confirmed by Sudanese investigators (5), who studied the farcy actinomycete isolated from bovines in the Sudan.

These studies indicate that the etiological agent of farcy in African bovines is a mycobacterium, not a nocardia. The organisms isolated from the lesions of bovine farcy in Chad, Senegal, and the Sudan indeed exhibit the acidfastness, cultural characteristics, and lipid composition characteristic of *Mycobacterium*.

Since 1973, it has been apparent that the culture isolated from bovine sources in Chad differ in certain respects from those isolated in Senegal, as follows (4). (i) Cultural characteristics: Chad strains grow slowly and Senegal strains grow rapidly (2). (ii) Biochemical properties: Senegal strains exhibit broader and more intense amidase and glucolytic activities than do Chad strains (2, 3). (iii) Lipid composition: Senegal strains contain the rarely encountered mycoside C' (6). (iv) Pathogenicity for experimental animals: Senegal strains produce a massive, generalized peritonitis in guinea pigs; Chad strains cause a peritonitis with large but limited individual abscesses (4).

It was the above-mentioned differences that led to the separation of the Chad and the Senegal strains into two varieties (subspecies) of the

same species, both responsible for anatomically and pathologically identical clinical syndrome of bovine farcy, by me in 1973 (4). At this time, I proposed the names *Mycobacterium farcinogenes* subsp. *tchadense* and *M. farcinogenes* subsp. *senegalense* for these organisms. It has subsequently been determined that the name of the type subspecies, *M. farcinogenes* subsp. *tchadense*, should have been *M. farcinogenes* subsp. *farcinogenes* (7). Although type strains were not designated for these taxa, cultures of representative strains were deposited in the National Collection of Type Cultures (NCTC) in London; the Chad strain (IEMVT 75) was given the NCTC number 10955, and the Senegal strain (IEMVT 378), the number 10956.

Furthermore, it is now known that the Chad strains also differ from the Senegal strains because of the low degree of homology between their deoxyribonucleic acid bases. Indeed, Baess (personal communication) determined the percent relatedness of the deoxyribonucleic acid of *M. farcinogenes* subsp. *tchadense* IEMVT 93B and that of *M. farcinogenes* subsp. *senegalense* IEMVT 378 to be 48 ± 2.6 standard deviation; this value indicates that these organisms belong to different species. The name of the species that includes the Chad strains is *Mycobacterium farcinogenes* Chamoiseau 1973 (syn.: *M. farcinogenes* subsp. *tchadense* Chamoiseau); the name of the species that includes the Senegal strains is *Mycobacterium senegalense* (Chamoiseau) comb. nov. (7). The type strain of these species are herein designated as IEMVT 75 (= NCTC 10955) and IEMVT 378 (= NCTC 10956), respectively.

The characters of the type strains are given in

TABLE 1. *Characteristics of the strains of M. farcinogenes and M. senegalense*

Characteristic	<i>M. farcinogenes</i>	<i>M. senegalense</i>
Involvement of the ganglions, lymphatic vessels, and visceral parenchyma of cattle with the disease farcy	+	+
Strains originally isolated in:		
West Africa (Senegal)		+
Central Africa (Chad)	+	
East Africa (Sudan)	+	
Morphology of cells		
In pus from lesions: short or long filaments, bent and branched, assembled in clumps or tangled, lacey network	+	+
No fragmentation into bacillary forms	+	+
Staining properties		
Coloration by Gram stain	+	+
Acid-alcohol resistant by Ziehl-Neelsen stain	+	+
Morphology in smears from culture: same characteristics as above	+	+
Cultural characteristics		
Coletsos or Löwenstein-Jensen medium:		
Time for growth	15 to 20 days	24 to 48 h
Rough, convoluted colonies firmly attached to medium, surrounded by iridescent halo	+	+
Pigment	Honey yellow	Ochre
Emulsion in distilled water	Impossible	Relatively easy
Tryptose broth with serum:		
Time for growth	15 to 20 days	24 to 48 h
Thick, rough, dry, whitish surface veil	+	+
Broth remains clear	+	+
Sauton medium (plain or with serum):		
Time for growth	20 to 30 days	24 to 48 h
Dry, whitish surface veil	Very thin	Fairly abundant
Cytochemical reactions		
Catalase	++++	++++
Nitrate reductase	+	+
Niacin production	-	-
Iron citrate test	-	-
Neutral red test	-	-
Amidase activity		
Acetamidase and formamidase	++++	++++
Allantoinase	++	++++
Benzamidase, nicotinamidase, and isonicotinamidase	++	++++
Urease	+/-	++++
Salicylamidase	+/-	+
Glucolytic activity		
Glucose	-	+++
Fructose	+++	+++
Sucrose, mannitol, glycerol	-	++
Utilization of organic acids		
Pyruvate, citrate, benzoate	+	+
Malonate	-	+
Proteolytic activity		
Urea	-	+
Gelatin	-	-
Casein, tyrosine, hypoxanthine, xanthine	-	± or -

TABLE 1.—Continued

Characteristic	<i>M. farcinogenes</i>	<i>M. senegalense</i>
Antibiotic susceptibilities		
Isoniazid	Resistant	Resistant
<i>p</i> -Aminosalicylic acid	Resistant	Resistant
Ethionamide	Resistant	Limited susceptibility
Viomycin	Susceptible	Susceptible
Cycloserine	Susceptible	Susceptible
Streptomycin	Resistant	Limited susceptibility
Kanamycin	Susceptible	Susceptible
Lipid composition		
Abundance of chloroform-soluble fraction	+	+
Presence of normal fatty acids with > 20 C atoms	+	+
Presence of β -hydroxy mycolic acids, which yield tetra-cosanoic acid on pyrolysis	+	+
Cord factor in chloroform extract	+	+
Hexacosanoic acid present	—	—
Nocardomycolic acid present	—	—
Mycoside C' present	—	+
Pathogenicity to guinea pigs		
Subcutaneous injection		
Time period	8 days	2 days
Draining abscess healing slowly	+	+
Intraperitoneal injection		
Time period	6 to 7 days	3 to 4 days
Abscesses observed in testes, seminal vesicles, or vagina	+	+
Abscesses in peritoneal walls and viscera	Large, localized, rare	Very numerous mil-iary
Susceptibility to tuberculin	+	+
Mortality after prolonged infection	+	+
Survival	Rare	Rare
Organism recovered from pus has morphology and staining properties already cited	+	+

Table 1. The majority of the strains examined by the author to date have characters identical to those reported here for the type strains.

M. farcinogenes and *M. senegalense* differ from other known mycobacteria in that they are obtained from lesions of the lymphatic system or the parenchyma of African bovines and present: (i) A very stable mycelium (does not break into bacillary fragments) whether in natural or experimental lesions, in culture, or in smears (2, 4) (ii) A distinctive pathogenicity for the guinea pig, which is very characteristic of these species (4). (iii) A positive malonamidase test, which is rarely encountered with "atypical" mycobacteria (3). (iv) A low deoxyribonucleic acid relatedness with otherwise closely related species; e.g., *M. senegalense* NCTC 10956 and *Mycobacterium fortuitum* ATCC 9820 show a percent relatedness of only 46.5 ± 5 standard deviations (Baess, personal communication) (v) A new my-

coside, C', in *M. senegalense*, which makes this a unique species (6)

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REPRINT REQUESTS

Address reprint requests to: Dr. G. Chamoiseau, CNERV, B.P.:167 Nouakchott, Mauritanie.

LITERATURE CITED

- Asselineau, J., M. A. Laneelle, and G. Chamoiseau. 1969. De l'étiologie du farcin de zébus tchadiens: nocardiose ou mycobactériose? II. composition lipidique. Rev. Elev. Med. Vet. Pays Trop. 22:205-209.
- Chamoiseau, G. 1969. De l'étiologie du farcin de zébus tchadiens: nocardiose ou mycobactériose? I. Etude bactériologique et biochimique. Rev. Elev. Med. Vet. Pays Trop. 22:195-204.

3. Chamoiseau, G. 1972. De l'étiologie du farcin de zébus tchadiens: nocardiose ou mycobactériose? III. Activité amidasique. *Rev. Elev. Med. Vet. Paays Trop.* **25**:191-194.
4. Chamoiseau, G. 1973. *Mycobacterium farcinogenes* agent causal du farcin du boeuf en Afrique. *Ann. Microbiol. Inst. Pasteur* **124 A**:215-222.
5. El Sanoussi, S. M., M. H. Tageldin, and S. M. Abdel Wahab. 1977. Classification of the bovine farcy organism. *Trop. Anim. Health Prod.* **9**:124.
6. Laneelle, G., J. Asselineau, and G. Chamoiseau. 1971. Présence de Mycosides C' (formes simplifiées de mycoside C) dans les bactéries isolées de bovines atteints de farcins. *FEBS Lett.* **19**:109-111.
7. Lapage, S. P., P. H. A. Sneath, E. F. Lessel, V. B. D. Skerman, H. P. R. Seeliger, and W. A. Clark (ed). 1975. International code of nomenclature of bacteria. 1976 revision. American Society for Microbiology. Washington, D.C.