COMPARISON OF SOME DRIED HOLOTYPE AND
NEOTYPE SPECIMENS OF STREPTOMYCETES
WITH THEIR LIVING COUNTERPARTS¹

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ABSTRACT. A 42-year-old collection of dried specimens of streptomyces was examined. Insofar as possible, their characteristics were compared with those of living descendants of the cultures available from three major culture collections. The dried specimens represent 24 holotypes and 10 potential neotypes. None of the dried specimens was viable. Although color of aerial mycelium and spore-wall characteristics were retained, determination of colors of vegetative mycelium and diffusible pigments could not be made with confidence. Determination of morphology of spore chains was not particularly successful because preparation of materials for examination was difficult. Characteristics of the dried specimens showed a remarkable degree of similarity to comparable ones of their living counterparts. In only a few instances were determinations sufficiently different to place question on the authenticity of available living types. The results afford a sounder basis for taxonomic investigations of the streptomyces.

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Several years ago, Dr. Chester Benjamin of the National Fungus Collections at Beltsville, Maryland, brought to our attention the availability of a little-known collection of dried herbarium specimens of actinomycetes. This collection was prepared by Professor Emeritus S. A. Waksman in 1920 and deposited with the National Fungus Collections at that time. Its availability afforded an opportunity to determine whether certain characteristics of the specimens could be used in evaluating the status of present-day cultures presumed to be living descendants of the various strains. Also, information obtained from study of the herbarium specimens could confirm or deny certain current concepts with regard to some of the species involved.

Presumed living counterparts of most of the deposited specimens were available from three of the major collections of living specimens: The Institute of Microbiology at Rutgers University (IMRU), the American Type Culture Collection (ATCC), and the Centraalbureau voor Schimmeltcultures, Baarn, Netherlands, (CBS). Most of the cultures had been deposited in the ATCC and CBS some time after their initial isolation, characterization, and naming. Those in the IMRU collection, of course, have been maintained since their isolation about 1915-1919 by periodic transfer to fresh nutrient media. Accordingly, we believed it would be worth while to compare the characteristics of the dried specimens with those of their living counterparts and in turn, the living counterparts, one to another, using criteria and methodology at present recommended for streptomycete characterization.

Thirty-five herbarium specimens were available for study. Each had been carefully labelled (Figs. 1A and 1B), but original strain numbers were given for only a few and mainly for strains not assigned specific epithets at that time. Each specimen has been stored in a small cardboard box about $1\frac{1}{2} \times 3\frac{3}{4} \times 2$ inches and kept in metal filing cabinets. Over the years, certain chemicals had been placed in the file drawer to control insects.³ The exteriors of the boxes are reproduced in Figs. 1A and 1B.

³ p-dichlorobenzene was used in the storage cabinets as well as yearly fumigation with an insecticide whose composition was: pyrethrum extract, 40 g; cyclohexanone, 60 g; DDT, 100 g; Freon, 1800 g. Personal communication, C. R. Benjamin to T. G. Pridham, October 3, 1961.

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Figure 1A. Exteriors of herbarium specimen boxes containing actinomycetes and showing the original labels.

Figure 1B. Exteriors of herbarium specimen boxes containing actinomycetes and showing the original labels.

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The interiors of the boxes and the present appearance of the individual specimens are illustrated in Figs. 2A and 2B. Although the specimens are not in as good condition as might be hoped, sufficient material remains so that a study can be made of the preparations.

Cultures. Living cultures, purportedly descendants of the materials used for making the herbarium specimens, were obtained from the IMRU, ATCC, and CBS collections. Thus, for most herbarium specimens there were three different cultures of the same strain. Each of the strains also has been maintained in our ARS Culture Collection over the years as active slant cultures, in soil, and as lyophilized preparations.

Viability studies. To determine whether any of the herbarium specimens were viable, a minute drop of sterile water was placed on a suitable area of the dried growth. Some material was scraped from the area with a small loop and placed in tubes of tryptone-glycose-liver extract-yeast extract broth (TGLY). The tubes were incubated at 28-30°C on a rotary shaker (200 rpm) for 2 days and aliquots streaked on suitable agar media in petri dishes. After incubation at 28-30°C the dishes were examined for presence of typical actinomycete (streptomycete) growth. As expected, only bacterial contaminants grew from any of the herbarium preparations. Consequently, cultural studies were carried out only with the strains of living cultures representing descendants of the herbarium specimens.

Colors of aerial mycelium, vegetative mycelium, and diffusible pigments. The colors of the herbarium specimens were compared with color tabs in Color Standards and Color Nomenclature (Ridgway, 1912), but no attempt was made to key out the colors of the living cultures. Instead their colors were keyed out to the appropriate series outlined in the guide of Pridham, Hesselstine, and Benedict (1958).

Electron microscopy of spores. Each herbarium specimen and each living culture was examined with an RCA⁴-EMU-3F electron microscope to obtain information about spore morphology and nature of spore walls. The second

⁴ The mention of firm names or trade products does not imply that they are endorsed or recommended by the Department of Agriculture over other firms or similar products not mentioned.

Figure 2A. Interiors of specimen boxes showing present appearance of 42-year-old dried cultures of actinomycetes.

Figure 2B. Interiors of specimen boxes showing present appearance of 42-year-old dried cultures of actinomycetes.

criterion has assumed considerable importance during recent years as an objective means for categorizing isolates into about five groups; i. e., those whose spores are glabrous (smooth) to scabrous (rough); verrucose (warty); echinulate or spinose (spiny); and hirsute (hairy). The technique followed was essentially that described by Tresner et al. (1961).

Morphology of spore chains. Determinations of the morphology of spore chains of the herbarium specimens were made by a tape-impression slide technique. A piece of cellophane tape about 1-1/2 in. long was folded to form a "U." The outside curve of the U was gently pressed on a suitable area of the specimen, so that fragments of aerial mycelium stuck to the tape. The tape with impression side down then was placed on a microscope slide so that the curve of the U was in contact with a small drop of 1% aqueous methylene blue. The entire length of the tape was then pressed flat on the slide and excess stain removed by rolling a glass rod along the length of the tape. Each preparation was examined at 200, 500, and 1,800 magnifications. Immersion oil could be placed directly on the tape stuck to the slide for examination at 1,800 X.

The tape-impression technique was described by E. Shirling at a Workshop on Actinophages held at the University of Minnesota, January 1961. Examination of the tape-impression slides and of electron micrographs allowed a reasonable assessment of the morphology of the spore chains of the herbarium specimens. That of the living cultures was determined according to methods outlined by Pridham, Hesse, and Benedict (1958).

Cultural studies of living specimens. Each of the living cultures was characterized following methods outlined in Pridham and Lyons (1961), Lyons and Pridham (1962), and Pridham (1964). Criteria that were studied were: darkening of peptone-iron agar; chromogenicity; utilization of D-glucose, D-xylose, L-arabinose, L-rhamnose, D-fructose, D-galactose, raffinose, D-mannitol, *i*-inositol, and salicin in the chemically defined agar of Pridham and Gottlieb (1948); ability to grow on Czapek's solution agar containing sucrose; and some antibiotic sensitivities and productivities.

RESULTS

Viability studies. As expected, none of the herbarium

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specimens was viable. Their age (42 years) in a dry state and the use of chemical insecticides in the storage cabinets possibly are responsible for their lack of viability.

Colors of aerial mycelium, vegetative mycelium, and diffusible pigments. In the color determinations as recorded in Table 1, some of the herbarium specimens had faded by comparison of our results with those cited by Waksman and Curtis (1916) for corresponding cultures. Colors of the vegetative mycelium of the herbarium specimens had not faded so greatly, but it was difficult to key them out because of the presence of aerial mycelium and the nature of the background of the box. No information as to colors of any diffusible pigments of the herbarium specimens could be secured. Only the color of the dried substrate was visible.

Electron microscopy of spores. The electron micrographs were the most rewarding part of this study and serve as a useful basis for assessing the authenticity of living cultures carrying the epithets and strain designations of the streptomycete species involved. Spores and their spore-wall characteristics were demonstrated with material from 25 of the herbarium specimens as illustrated in Figs. 3A and 3B and in Table 1. After 42 years of storage the glabrous, spinose, or hirsute nature of the spores still can be distinguished with ease. It even was possible to make some assessment about spore-chain morphology for some of the preparations. Comparisons of electron micrographs of some herbarium specimens with those of their living counterparts suggest that the nature of spore-wall ornamentation is a stable characteristic; e.g., the first electron micrograph made of the herbarium specimens was Fig. 3f, of Actinomyces viridochromogenus (sic). The spinose nature of the spores and the coiled habit of the spore chains are clearly evident. These two features are characteristic of the living descendants of this particular strain.

Examination of the originally developed electron micrograph plates with a 3X-4X hand lens suggests that the distinction between spines and hairs is more quantitative than qualitative. Both appear to be hollow, transparent tubulations tapering from the base to rounded ends. The diameters of the base portions of the projections seem to regulate the hairiness or spininess of the structures. Also, there seems to be a similarity between these structures and the sporidesmolides reported by Bertaud et al. (1963) although

FIGURE 1. Summation of accumulative data from original descriptions, herbarium specimens, and their living counterparts.

Original epithet or designation	Present epithet	Strain designation	Spore wall ornamentation	Morphology of chains of spores	Percentage of spores germinating	Chromogenicity percentage on agar	Basal medium for utilization tests	Utilization of carbon compounds										Growth on Caspary's solution - sucrose agar	Color series		Number of antibiotic factors reported	Remarks	Sensitivity to streptomycin (µg./L)	References
								No carbon control	Glucose	Xylose	Arabinose	Rhamnose	Fructose	Galactose	Raffinose	Mannitol	Inositol		Salicin	Aerial mycelium				
<u>alboboreum</u>	<u>alboboreum</u>	(Evelyn)			-	-																		Soil Sci. 1: 99-134 (1916) Arch. II, 1: 642-688 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman & Curtis)		RPT	-	-	Waks syn.	+																Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)		S	-	-																		Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	?	S	-	-																		Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>	<u>alboboreum</u>	(Wehman)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Soil Sci. 1: 99-134 (1916)
<u>alboboreum</u>																								

TABLE 1. Summary of comparative data from original descriptions, bacterium specimens, and their living counterparts

Original epithet or designation	Present epithet	Strain designation	Spore wall ornamentation	Morphology of chains of spores	Behaviour of peptone from agar	Chromogenicity	Basal medium for utilization tests	Utilization of carbon compounds										Growth on Capak's medium - sucrose agar	Color series		Number of antibiotic factors reported	Remission	Sensitivity to streptomycin (mg/l)	References
								No carbon control	Glucose	Xylose	Arabinose	Rhamnose	Fructose	Galactose	Raffinose	Mannitol	Inositol	Salicin						
		ATCC 5310	?	U	-	-	PMG	-	+	+	+	+	+	+	+	+	+	-	M-Z	U → R	Y, or PM	antibacterial activity	26	
		CBS (Wakeman)	Sm → R	ST	-	-	PMG	-	+	+	+	+	+	+	+	+	+	-	P-F	OT	PM, PM, PM	antibacterial activity	25	
																						antibacterial		
		(Wakeman & Curtie)		S	-	-																		
		(Wakeman)	Sm	S	-	-																		
		(Wakeman)	Sm	F	-	-																		
		IMRU 5312	Sm	F	-	-	PMG	-	+	+	+	+	+	+	+	+	+	-	P-F	U → R	PM	HOLOTYPE STRAIN	13	
		ATCC 5312	?	F	-	-	PMG	-	+	+	+	+	+	+	+	+	+	-	P-M	U → R	Y, PM, PM	nonpolyenic, anti-fungal activity	7	
		CBS (Wakeman & Curtie)	Sm	F	-	-	PMG	-	+	+	+	+	+	+	+	+	+	-	P-F	Y → R	PM, PM		4	
		(Casperini)																						
		(Wakeman & Curtie)		RF	-	-																		
		(Wakeman)		S	-	-																		
		Herbarium specimen	Sm	RA?	-	-																		
		IMRU 5574	Sm	Sabb	-	-	PMG	-	+	+	+	+	+	+	+	+	+	-	M-E	Y	Y, PM, PM		26	
		ATCC 10974	Sm	Sabb	-	-	PMG	-	+	+	+	+	+	+	+	+	+	-	P	Y	Y, PM, PM		30	
		CBS (Wakeman)	Sm	F	-	-	PMG	-	+	+	+	+	+	+	+	+	+	-	P-F	Y	Y, PM, PM		18	
		(Trevisky)			-	-																		
		(Wakeman & Curtie)		S	+	+																		
		(Wakeman)		S	-	-	Maka. Syn.		+		+													
		Herbarium specimen	Sp	S	-	-																		
		ATCC 5315	Sm	F	-	-	PMG	-	+	+	+	+	+	+	+	+	+	-	P-P	Y	Y, PM		90	
		CBS (Wakeman & Curtie)	Sm	S	-	-	PMG	-	+	+	+	+	+	+	+	+	+	-	M-E	OT	Y, PM		27	

END OF TABLE

TABLE 1. Summation of comparative data from original descriptions, herbarium specimens, and their living counterparts

Original epithet or designation	Present epithet or designation	Strain designation	Spore wall ornamentation ^a	Morphology of chains of spores ^b	Percentage of postconic-tricon agars ^c	Chromogenicity ^d	Basal medium for utilization tests	Utilization of carbon compounds ^e										Growth on Czapek's solution -- sucrose agar ^f	Color series		Number of antibiotic factors reported	Remarks ^g	Sensitivity to streptomycin (μg.) ^h	References
								No carbon control	Glucose	Xylose	Arabinose	Rhamnose	Fructose	Galactose	Raffinose	Mannitol	Inositol		Salicin	Aerial mycelium ⁱ				
161	<i>Erythroneura</i>	(Waksman)		S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	G+	N+		Soil Sci. 8: 71-215 (1919)	
161	<i>Erythroneura</i>	1st Herbarium specimen	?	RA?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
161	<i>Erythroneura</i>	2nd Herbarium specimen	Sp	RA?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
<i>Erythroneura</i>		IMU 3056	Sm	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
<i>Erythroneura</i>		ATCC 11912	Sm	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
<i>Erythroneura</i>		CBS (Waksman 161)	Sm	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
<i>Erythrolatus</i>		(Waksman & Curtis)		RP?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	G+			Soil Sci. 1: 99-134 (1916)	
<i>Erythrolatus</i>		(Waksman)		S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	G+	S-or- N+		Soil Sci. 8: 71-215 (1919)	
<i>Erythrolatus</i>		Herbarium specimen	?	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
<i>Erythrolatus</i>		IMU 5316	Sm	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
<i>Erythrolatus</i>		ATCC 12627	Sm	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
<i>Erythrolatus</i>		CBS			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
168	<i>Flavococcus</i>	(Waksman)		S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	G+	S+	N+	Soil Sci. 8: 71-215 (1919)	
168	<i>Flavococcus</i>	Herbarium specimen	H	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
	<i>Flavococcus</i>	IMU 3319	H	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
	<i>Flavococcus</i>	ATCC 2319	H	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
	<i>Flavococcus</i>	CBS (Waksman & Curtis)	?	S?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
	<i>Flavovirens</i>	(Waksman)		S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	G+	S+	N+ or	Soil Sci. 8: 71-215 (1919)	
126	<i>Flavovirens</i>	Herbarium specimen	Sm	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					

BACTERIOLOGICAL NOMENCLATURE AND TAXONOMY

Original epithet or designation	Present epithet	Strain designation	Spore wall ornamentation & Morphology of chain of spores	Darkening of peptone-iron media	Chromogenicity & Basal medium for utilization tests	Utilization of carbon compounds & Growth on Czapek's agar											Color series		Number of antibiotic factors reported	Remarks	Sensitivity to streptomycin (mg.)	References				
						No carbon control	Glucose	Xylose	Arabinose	Rhamnose	Fructose	Galactose	Mannitol	Inositol	Salicin	Aerial mycelium	Vegetative mycelium									
CLAVUS	Clavotinea	IMRU 3320	Sm → R	F	-	PG	-	+	+	+	+	+	+	+	+	+	+	+	GY	GY	GY	HOLOTYPE STRAIN	30			
	Clavotinea	ATCC 3320	Sm → R	F	-	PG	-	+	+	+	+	+	+	+	+	+	+	+	GY	GY	GY	HOLOTYPE STRAIN	52			
	Clavotinea (Chester)	CBS (Waksman)	Sm	F	-	PG	-	+	+	+	+	+	+	+	+	+	+	+	GY	GY	GY	HOLOTYPE STRAIN	55			
	Clavus	(Krainik)																	GY	Y	Y	G+	S+	N-	Man. det. Bact. (1901)	
	Clavus	(Waksman & Curtis)		RF?		+													Y → GR → Y Light Grey Blue-Y	Y	Y	G+	S+	N-	Man. det. Bact. (1901)	
	Clavus	(Waksman)	Herbarium specimen	S		-													Y → GR → Y Light Grey Blue-Y	Y	Y	G+	S+	N-	Man. det. Bact. (1901)	
FREDII	Clavus	IMRU 3321	Sm → R	Babb.	-	PG	-	+	+	+	+	+	+	+	+	+	+	+	GY	GY	GY	HOLOTYPE STRAIN	55			
	Clavus	ATCC 3369	Sm → R	Babb.	-	PG	-	+	+	+	+	+	+	+	+	+	+	+	GY	GY	GY	HOLOTYPE STRAIN	22			
	Clavus	CBS (Waksman & Curtis)	Sm	Babb.	-	PG	-	+	+	+	+	+	+	+	+	+	+	+	Y	Y	Y	HOLOTYPE STRAIN	4			
	Clavus	(Waksman & Curtis)		RF	-														R	R	R	G+				Soil Sci. 1: 99-134 (1916)
	Clavus	(Waksman)		S	-	Waks syn.	+	+	+	+	+	+	+	+	+	+	+	+	R	R	R	G+	S+	N+		Soil Sci. 8: 71-215 (1919)
	Clavus	Herbarium specimen	Sm	BA	-														buff	buff	buff	HOLOTYPE STRAIN	17			
104	Clavus	IMRU 3535	Sm	BA	-	PG	-	+	+	+	+	+	+	+	+	+	+	+	R	R	R	HOLOTYPE STRAIN	17			
	Clavus	ATCC 10745	Sm	BA	-	PG	-	+	+	+	+	+	+	+	+	+	+	+	R	R	R	HOLOTYPE STRAIN	12			
	Clavus	(Waksman)		S	-	Waks syn.	+	+	+	+	+	+	+	+	+	+	+	+	GY	GY	GY	G+	S+	N+		Soil Sci. 8: 71-215 (1919)
	Clavus	Herbarium specimen	Sm → R	S?	-														Light Neutral Grey, buff	?						
	Clavus	IMRU 3323	Sm	RF	-	PG	-	+	+	+	+	+	+	+	+	+	+	+	GY	GY	GY	HOLOTYPE STRAIN	19			
	Clavus	ATCC 3323	Sm	RFabb.	-	PG	-	+	+	+	+	+	+	+	+	+	+	+	GY	GY	GY	HOLOTYPE STRAIN	20			
104	Clavus	CBS (Waksman & Curtis)	Sm	RFabb.	-	PG	-	+	+	+	+	+	+	+	+	+	+	+	?	?	?	HOLOTYPE STRAIN	12			
	Clavus	(Waksman & Curtis)			-	PG	-	+	+	+	+	+	+	+	+	+	+	+				HOLOTYPE STRAIN	12			

TABLE 1. Summary of comparative data from original descriptions, herbarium specimens, and their living counterparts

Original epithet or designation	Present epithet	Strain designation	Spore wall ornamentation	Morphology of chains of spores	Densuring of peptone-iron agar	Chromogenicity	Basal medium for utilization tests	Utilization of carbon compounds										Growth on Czapek's solution - sucrose agar	Color series		Number of antibiotic factors reported	Remarks	Sensitivity to streptomycin (μg.)	References	
								No carbon control	Glucose	Xylose	Arabinose	Rhamnose	Fructose	Galactose	Raffinose	Mannitol	Inositol		Saltin	Aerial mycelium					Vegetative mycelium
218	<i>griseobrunneus</i>	(Wakeman)		S		+														Y	y, b	G+ S+ N+	Soil Sci. 6: 71-215 (1919)		
218	<i>griseobrunneus</i>	Herbarium specimen	Sm	RP?																Pale olive brown	AL				
	<i>griseobrunneus</i>	LMU 3068	Sm	F	+	-	PdC	+	+	+	+	+	+	+	+	+	+	+	+	Y	y, oy, ey	HOLOTYPE STRAIN	8		
96	<i>griseolus</i>	(Wakeman)		RP, Phb.		+														OY	y, blk	G+ S+ Shw- N+	Soil Sci. 6: 71-215 (1919)		
96	<i>griseolus</i>	Herbarium specimen	Sm	S?																Gray olive brown	7				
	<i>griseolus</i>	LMU 3325	Sm → R	F	-	+	PdC	+	+	+	+	+	+	+	+	+	+	+	+	OY	y, yb, ey, blk	HOLOTYPE STRAIN	20		
	<i>griseolus</i>	ATCC 3325	Sm	F	-	+	PdC	+	+	+	+	+	+	+	+	+	+	+	+	OY	y, yb, ey, blk		28		
	<i>griseolus</i>	CBS (Wakeman)	Sm → R	Phbb	-	-	PdC	+	+	+	+	+	+	+	+	+	+	+	+	OY	ey, blk, yb		28		
	<i>griseus</i>	(Krasinsky)				-														Y	gray	G+ S+ N+			Contr. Bot. 6: 66-67 (1924)
	<i>griseus</i>	(Wakeman & Curtis)		RP	-	-	Waks syn.													G	y, b, ey	G+			Soil Sci. 1: 99-134 (1916)
	<i>griseus</i>	Herbarium specimen	Sm	S																G	y, oy, ey	G+ S+ N+			Soil Sci. 6: 71-215 (1919)
	<i>griseus</i>			?																Pale olive brown	AL				
	<i>griseus</i>	LMU 3326	Sm	Phbb	-	-	PdC	+	+	+	+	+	+	+	+	+	+	+	+	Y → R	y, yb, ey	HOLOTYPE STRAIN		23	
	<i>griseus</i>	ATCC 3326	Sm	Phbb	-	-	PdC	+	+	+	+	+	+	+	+	+	+	+	+	Y → R	y, yb	HOLOTYPE STRAIN		24	
	<i>griseus</i>	CBS (Wakeman & Curtis)	Sm	Phbb	-	-	PdC	+	+	+	+	+	+	+	+	+	+	+	+	OY	y, yb, ey	HOLOTYPE STRAIN		29	
	<i>halstedii</i>	(Wakeman & Curtis)		S		+														OY	y, blk	G+			Soil Sci. 1: 99-134 (1916)
	<i>halstedii</i>	(Wakeman)		S	-															OY	y, blk	G+ S+ N+			Soil Sci. 6: 71-215 (1919)
	<i>halstedii</i>	Herbarium specimen	?	?																U	y, blk				
																					y, b				

Original epithet or designation	Present epithet or designation	Strain designation	Spore wall ornamentation	Morphology of chains of spores	Blebbing of peptone-iron agar	Chromogenicity	Basal medium for utilization tests	Utilization of carbon compounds										Growth on Czapek's solution - sucrose agar	Color series			Number of antibiotic factors reported	Remarks	Sensitivity to streptomycin (m. %)	References
								No carbon control	Glucose	Xylose	Arabinose	Rhamnose	Fructose	Galactose	Raffinose	Mannitol	Inositol		Saltin	Aerial mycelium	Vegetative mycelium				
	<u>Mutatis</u>	MU 528	Sm	Feb.	-	-	PMG	-	+	+	+	+	+	+	+	+	+	P	GY Y ₁ Y ₂ Y ₃ Y ₄ Y ₅ Y ₆ Y ₇ Y ₈ Y ₉ Y ₁₀ Y ₁₁ Y ₁₂ Y ₁₃ Y ₁₄ Y ₁₅ Y ₁₆ Y ₁₇ Y ₁₈ Y ₁₉ Y ₂₀ Y ₂₁ Y ₂₂ Y ₂₃ Y ₂₄ Y ₂₅ Y ₂₆ Y ₂₇ Y ₂₈ Y ₂₉ Y ₃₀ Y ₃₁ Y ₃₂ Y ₃₃ Y ₃₄ Y ₃₅ Y ₃₆ Y ₃₇ Y ₃₈ Y ₃₉ Y ₄₀ Y ₄₁ Y ₄₂ Y ₄₃ Y ₄₄ Y ₄₅ Y ₄₆ Y ₄₇ Y ₄₈ Y ₄₉ Y ₅₀ Y ₅₁ Y ₅₂ Y ₅₃ Y ₅₄ Y ₅₅ Y ₅₆ Y ₅₇ Y ₅₈ Y ₅₉ Y ₆₀ Y ₆₁ Y ₆₂ Y ₆₃ Y ₆₄ Y ₆₅ Y ₆₆ Y ₆₇ Y ₆₈ Y ₆₉ Y ₇₀ Y ₇₁ Y ₇₂ Y ₇₃ Y ₇₄ Y ₇₅ Y ₇₆ Y ₇₇ Y ₇₈ Y ₇₉ Y ₈₀ Y ₈₁ Y ₈₂ Y ₈₃ Y ₈₄ Y ₈₅ Y ₈₆ Y ₈₇ Y ₈₈ Y ₈₉ Y ₉₀ Y ₉₁ Y ₉₂ Y ₉₃ Y ₉₄ Y ₉₅ Y ₉₆ Y ₉₇ Y ₉₈ Y ₉₉ Y ₁₀₀ Y ₁₀₁ Y ₁₀₂ Y ₁₀₃ Y ₁₀₄ Y ₁₀₅ Y ₁₀₆ Y ₁₀₇ Y ₁₀₈ Y ₁₀₉ Y ₁₁₀ Y ₁₁₁ Y ₁₁₂ Y ₁₁₃ Y ₁₁₄ Y ₁₁₅ Y ₁₁₆ Y ₁₁₇ Y ₁₁₈ Y ₁₁₉ Y ₁₂₀ Y ₁₂₁ Y ₁₂₂ Y ₁₂₃ Y ₁₂₄ Y ₁₂₅ Y ₁₂₆ Y ₁₂₇ Y ₁₂₈ Y ₁₂₉ Y ₁₃₀ Y ₁₃₁ Y ₁₃₂ Y ₁₃₃ Y ₁₃₄ Y ₁₃₅ Y ₁₃₆ Y ₁₃₇ Y ₁₃₈ Y ₁₃₉ Y ₁₄₀ Y ₁₄₁ Y ₁₄₂ Y ₁₄₃ Y ₁₄₄ Y ₁₄₅ Y ₁₄₆ Y ₁₄₇ Y ₁₄₈ Y ₁₄₉ Y ₁₅₀ Y ₁₅₁ Y ₁₅₂ Y ₁₅₃ Y ₁₅₄ Y ₁₅₅ Y ₁₅₆ Y ₁₅₇ Y ₁₅₈ Y ₁₅₉ Y ₁₆₀ Y ₁₆₁ Y ₁₆₂ Y ₁₆₃ Y ₁₆₄ Y ₁₆₅ Y ₁₆₆ Y ₁₆₇ Y ₁₆₈ Y ₁₆₉ Y ₁₇₀ Y ₁₇₁ Y ₁₇₂ Y ₁₇₃ Y ₁₇₄ 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TABLE 1. Summary of comparative data from original descriptions, herbarium specimens, and their living counterparts

Original epithet or designation	Present epithet	Strain designation	Spore wall ornamentation ^a	Morphology of chains of spores ^b	Peptonizing of peptone-iron agar ^c	Chromogenicity ^d	Basal medium for utilization tests	Utilization of carbon compounds ^e										Growth on Czapek's solution-sucrose agar ^f	Color series		Number of antibiotic factors reported	Remarks ^g	Sensitivity to streptomycin (nm.) ^h	References	
								No carbon control	Glucose	Xylose	Arabinose	Rhamnose	Fructose	Galactose	Mannitol	Inositol	Saltin		Aerial mycelium ⁱ	Vegetative mycelium ^j					
<i>chromogenus</i> 205	<i>olivochromogenus</i>	(Wakeman) Herbarium specimen	SM → R	S	+	+	Waks Syn.	+	-	-	-	-	-	-	-	-	-	-	GY	colorless			Soil Sci. 8: 71-215 (1919)		
	<i>olivochromogenus</i>	(Wakeman) Herbarium specimen	SM → R	S	+	+	Waks Syn.	+	-	-	-	-	-	-	-	-	-	-	GY	colorless			Soil Sci. 8: 71-215 (1919)		
<i>chromogenus</i> 205	<i>olivochromogenus</i>	IMRU 3356	Sm	ST	+	+	PKG	-	+	+	+	+	+	+	+	+	+	+	U-GY	Y-GY		Lost		Personal comm. R. L. Gordon to T. G. Priddy, January 3, 1963	
	<i>olivochromogenus</i>	ATCC 3356	Sm	ST	+	+	PKG	-	+	+	+	+	+	+	+	+	+	+	U-GY	Y-GY		HOLOTYPE STRAIN	22	NY State Agr. Exp. Sta., Com- m. N. Y. Tech. Bull. 60: 1-25 (1917)	
<i>olivochromogenus</i>	<i>olivochromogenus</i>	(Conn)			+	+													GY	b, grey		+		Soil Sci. 8: 71-215 (1919)	
<i>olivochromogenus</i>	<i>olivochromogenus</i>	(Wakeman) Herbarium specimen	Sm	R → RA	+	+													GY	Y, b					
<i>olivochromogenus</i>	<i>olivochromogenus</i>	IMRU 3356	Sm	R	+	+	PKG	-	+	+	+	+	+	+	+	+	+	+	GY	Y, b					
<i>olivochromogenus</i>	<i>olivochromogenus</i>	ATCC 3356	Sm	R	+	+	PKG	-	+	+	+	+	+	+	+	+	+	+	R	Y, b, yb					
<i>olivochromogenus</i>	<i>olivochromogenus</i>	QCS (Wakeman)	?	U	+	+	PKG	-	+	+	+	+	+	+	+	+	+	+	Y	W, b, gb					
<i>poolensis</i>	<i>poolensis</i>	(Taubenhaus)			-	-																			
<i>poolensis</i>	<i>poolensis</i>	(Wakeman & Curtis) Herbarium specimen		RP?	+	+													GY	Y, b				Y Agr. Research 13: 437-450 (1916)	
<i>poolensis</i>	<i>poolensis</i>	(Wakeman) Herbarium specimen	Sm	S	-	-	Waks Syn.	+	+	-	+	+	+	+	+	+	+	+	GY	Y, b				Y Agr. Research 13: 437-450 (1916)	
<i>poolensis</i>	<i>poolensis</i>	(Wakeman) Herbarium specimen	Sm	RP	+	+													buff color- less					Soil Sci. 8: 71-215 (1919)	
<i>poolensis</i>	<i>poolensis</i>	IMRU																							
<i>poolensis</i>	<i>poolensis</i>	(Wakeman & Curtis)		Poidia?	+	+																		Personal comm. R. L. Gordon to T. G. Priddy, January 3, 1963	
<i>poolensis</i>	<i>poolensis</i>	(Wakeman) Herbarium specimen		S	+	+													GY → blk	b, y, y				Soil Sci. 1: 99-134 (1916)	
<i>poolensis</i>	<i>poolensis</i>	(Wakeman) Herbarium specimen	?	S	+	+													U	b				Soil Sci. 8: 71-215 (1919)	
<i>poolensis</i>	<i>poolensis</i>	IMRU 3343	?	P	+	+	PKG	-	+	+	+	+	+	+	+	+	+	+	U	b, yb					
<i>poolensis</i>	<i>poolensis</i>	ATCC 3343	Sm → R	P	+	+	PKG	-	+	+	+	+	+	+	+	+	+	+	Y → R	Y, b, yb					
<i>poolensis</i>	<i>poolensis</i>	QCS (Wakeman & Curtis)	Sm	F	+	+	PKG	-	+	+	+	+	+	+	+	+	+	+	Y → R	Y, b, yb					
<i>poolensis</i>	<i>poolensis</i>	(Wakeman & Curtis)	Sm	F	+	+	PKG	-	+	+	+	+	+	+	+	+	+	+	Y → R	Y, b, yb					

BACTERIOLOGICAL NOMENCLATURE
AND TAXONOMY

TABLE 1. Summation of comparative data from original descriptions, herbarium specimens, and their living counterparts.

Original epithet or designation	Present epithet	Strain designation	Spore wall ornamentation ^a	Morphology of chain of spores ^b	Darkening of peptone-iron agar ^c	Chromogenicity ^d	Basal medium for utilization tests	Utilization of carbon compounds ^e										Growth on Czapek's solution-sucrose agar ^f	Color series		Number of antibiotic factors reported	Remarks ^g	Sensitivity to streptomycin (cm.) ^h	References
								No carbon control	Glucose	Xylose	Arabinose	Rhamnose	Fructose	Galactose	Mannitol	Inositol	Salicin	Aerial mycelium ⁱ	Vegetative mycelium					
<u>reticul</u>	<u>reticul</u>	(Wakeman Curtia)	RF?	-	+	+	Waks. syn.	-	-	-	-	-	-	-	-	-	-	GY	y, b	C+		Soil Sst. 1: 99-134 (1916)		
<u>reticulum</u>	<u>reticul</u>	(Wakeman)	MF-S	-	+	+	Waks. syn.	-	+	-	-	-	-	-	-	-	-	Y	y, gray	C+ C+ S+	N+	Soil Sst. 8: 71-215 (1919)		
<u>reticulum</u>	<u>reticul</u>	Sm	BIV	-	-	-	Waks. syn.	-	-	-	-	-	-	-	-	-	-	Light Bull. XV	y, gray					
<u>reticul</u>	<u>reticul</u>	IMRU 3344	Sm	F	-	-	PAG	-	+	+	+	+	+	+	+	3	Y	y, y, b, gy		not reticuli non-fungal activity	5/10			
<u>reticul</u>	<u>reticul</u>	ATCC 3344	Sm	F	-	-	PAG	-	+	+	+	+	+	+	+	M	Y → R	y, gy, w		not reticuli non-fungal activity	4/8			
<u>reticul</u>	<u>reticul</u>	GBS (Wakeman & Curtia)	Sm	RF?	-	-	PAG	-	+	+	+	+	+	+	+	P	GY	y, gy, blk		not reticuli fungal activity	20			
<u>rubriteticol</u>	<u>rubriteticol</u>	(Wakeman)	BIV-S	-	+	+	Waks. syn.	-	+	-	-	-	-	-	-	-	-	R	p, k, r	C+ C+ S+ N+		Soil Sst. 8: 71-215 (1919)		
<u>rubriteticol</u>	<u>rubriteticol</u>	Herbarium specimen ?	?	-	-	-	Waks. syn.	-	-	-	-	-	-	-	-	-	-	Light Bull. XV	Black					
<u>rubriteticol</u>	<u>rubriteticol</u>	IMRU 3631	Sm	BIV	+	+	PAG	-	-	-	-	-	-	-	-	-	-	R	y, y, r, b		HOLOTYPE STRAIN	17		
<u>rubriteticol</u>	<u>rubriteticol</u>	ATCC 32629	Sm	BIV	+	+	PAG	-	+	-	-	-	-	-	-	-	-	R	y, y, r, b			17		
<u>rubriteticol</u>	<u>rubriteticol</u>	GBS (IMRU 3631)	Sm	BIV	+	+	PAG	-	+	-	-	-	-	-	-	-	-	R	y, y, r, b			17		
<u>roseus</u>	<u>roseus</u>	Strains from soil with strain (Wakeman)	?	-	-	-	Waks. syn.	-	-	-	-	-	-	-	-	-	-	W?	w, j, k	C-	common absciss	Zentr. Bakteriell., Parasitenkult. Abt. I, orig., 65, 564-565 (1912)		
<u>roseus</u>	<u>roseus</u>	(Krasinsky)	S	-	-	-	Waks. syn.	-	-	-	-	-	-	-	-	-	-	R	y, color	C+ S+	N+	Zentr. Bakteriell., Parasitenkult. Abt. II, 41: 645-656 (1916)		
<u>roseus</u>	<u>roseus</u>	(Wakeman & Curtia)	S	-	+	+	Waks. syn.	-	-	-	-	-	-	-	-	-	-	R	r, p, k	C+		Soil Sst. 1: 91-134 (1916)		
<u>roseus</u>	<u>roseus</u>	Herbarium specimen	?	-	-	-	Waks. syn.	-	-	-	-	-	-	-	-	-	-	R Pale Vitis Paeonies Rosa AL	y, b	C+ C+ S+	N+	Soil Sst. 8: 71-215 (1919)		
<u>roseus</u>	<u>roseus</u>	IMRU	RA?	-	-	-	PAG	-	+	+	+	+	+	+	+	P	R	y, cy, b, y, b		Original strain strains from soil. Morphology	29			
<u>roseus</u>	<u>roseus</u>	IMRU 3372	Sm	RA?	-	-	PAG	-	+	+	+	+	+	+	+	P	R	y, cy, b, y, b						

TABLE 1. Summary of comparative data from original descriptions, herbarium specimens, and their living counterparts

Original epithet or designation	Present epithet	Strain designation	Spore wall ornamentation	Morphology of chains of spores	Derivation of name	Chromogenicity	Basal medium for utilization tests	Utilization of carbon compounds										Growth on Czapek's solution-sucrose agar	Color series		Number of antibiotic factors reported	Remarks	References
								No carbon control	Glucose	Xylose	Arabinose	Rhamnose	Galactose	Raffinose	Mannitol	Inositol	Salicin		Aerial mycelium	Vegetative mycelium			
<u>ruber</u>	<u>ruber</u>	(Krause)				-													R	r, or		G+ S+ N+	In Pilgze Die Mikroorganismen, Aufl. 3, vol. 2, p. 67 (1896)
<u>ruber</u>	<u>ruber</u>	(Krausky)				-													Y → R	Y, r		G+ S+ N+	Zeitschr. f. Bot. 1896, 1897, 1898, 1899, 1900, 1901, 1902, 1903, 1904, 1905, 1906, 1907, 1908, 1909, 1910, 1911, 1912, 1913, 1914, 1915, 1916, 1917, 1918, 1919, 1920, 1921, 1922, 1923, 1924, 1925, 1926, 1927, 1928, 1929, 1930, 1931, 1932, 1933, 1934, 1935, 1936, 1937, 1938, 1939, 1940, 1941, 1942, 1943, 1944, 1945, 1946, 1947, 1948, 1949, 1950, 1951, 1952, 1953, 1954, 1955, 1956, 1957, 1958, 1959, 1960, 1961, 1962, 1963, 1964, 1965, 1966, 1967, 1968, 1969, 1970, 1971, 1972, 1973, 1974, 1975, 1976, 1977, 1978, 1979, 1980, 1981, 1982, 1983, 1984, 1985, 1986, 1987, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 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2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 2679, 2680, 2681, 2682, 2683, 2684, 2685, 2686, 2687, 2688, 2689, 2690, 2691, 2692, 2693, 2694, 2695, 2696, 2697, 2698, 2699, 2700, 2701, 2702, 2703, 2704, 2705, 2706, 2707, 2708, 2709, 2710, 2711, 2712, 2713, 2714, 2715, 2716, 2717, 2718, 2719, 2720, 2721, 2722, 2723, 2724, 2725, 2726, 2727, 2728, 2729, 2730, 2731, 2732, 2733, 2734, 2735, 2736, 2737, 2738, 2739, 2740, 2741, 2742, 2743, 2744, 2745, 2746, 2747, 2748, 2749, 2750, 2751, 2752, 2753, 2754, 2755, 2756, 2757, 2758, 2759, 2760, 2761, 2762, 2763, 2764, 2765, 2766, 2767, 2768, 2769, 2770, 2771, 2772, 2773, 2774, 2775, 2776, 2777, 2778, 2779, 2780, 2781, 2782, 2783, 2784, 2785, 2786, 2787, 2788, 2789, 2790, 2791, 2792, 2793, 2794, 2795, 2796, 2797, 2798, 2799, 2800, 2801, 2802, 2803, 2804, 2805, 2806, 2807, 2808, 2809, 2810, 2811, 2812, 2813, 2814, 2815, 2816, 2817, 2818, 2819, 2820, 2821, 2822, 2823, 2824, 2825, 2826, 2827, 2828, 2829, 2830, 2831, 2832, 2833, 2834, 2835, 2836, 2837, 2838, 2839, 2840, 2841, 2842, 2843, 2844, 2845, 2846, 2847, 2848, 2849, 2850, 2851, 2852, 2853, 2854, 2855, 2856, 2857, 2858, 2859, 2860, 2861, 2862, 2863, 2864, 2865, 2866, 2867, 2868, 2869, 2870, 2871, 2872, 2873, 2874, 2875, 2876, 2877, 2878, 2879, 2880, 2881, 2882, 2883, 2884, 2885, 2886, 2887, 2888, 2889, 2890, 2891, 2892, 2893, 2894, 2895, 2896, 2897, 2898, 2899, 2900, 2901, 2902, 2903, 2904, 2905, 2906, 2907, 2908, 2909, 2910, 2911, 2912, 2913, 2914, 2915, 2916, 2917, 2918, 2919, 2920, 2921, 2922, 2923, 2924, 2925, 2926, 2927, 2928, 2929, 2930, 2931, 2932, 2933, 2934, 2935, 2936, 2937, 2938, 2939, 2940, 2941, 2942, 2943, 2944, 2945, 2946, 2947, 2948, 2949, 2950, 2951, 2952, 2953, 2954, 2955, 2956, 2957, 2958, 2959, 2960, 2961, 2962, 2963, 2964, 2965, 2966, 2967, 2968, 2969, 2970, 2971, 2972, 2973, 2974, 2975, 2976, 2977, 2978, 2979, 2980, 2981, 2982, 2983, 2984, 2985, 2986, 2987, 2988, 2989, 2990, 2991, 2992, 2993, 2994, 2995, 2996, 2997, 2998, 2999, 3000, 3001, 3002, 3003, 3004, 3005, 3006, 3007, 3008, 3009, 3010, 3011, 3012, 3013, 3014, 3015, 3016, 3017, 3018, 3019, 3020, 3021, 3022, 3023, 3024, 3025, 3026, 3027, 3028, 3029, 3030, 3031, 3032, 3033, 3034, 3035, 3036, 3037, 3038, 3039, 3040, 3041, 3042, 3043, 3044, 3045, 3046, 3047, 3048, 3049, 3050, 3051, 3052, 3053, 3054, 3055, 3056, 3057, 3058, 3059, 3060, 3061, 3062, 3063, 3064, 3065, 3066, 3067, 3068, 3069, 3070, 3071, 3072, 3073, 3074, 3075, 3076, 3077, 3078, 3079, 3080, 3081, 3082, 3083, 3084, 3085, 3086, 3087, 3088, 3089, 3090, 3091, 3092, 3093, 3094, 3095, 3096, 3097, 3098, 3099, 3100, 3101, 3102, 3103, 3104, 3105, 3106, 3107, 3108, 3109, 3110, 3111, 3112, 3113, 3114, 3115, 3116, 3117, 3118, 3119, 3120, 3121, 3122, 3123, 3124, 3125, 3126, 3127, 3128, 3129, 3130, 3131, 3132, 3133, 3134, 3135, 3136, 3137, 3138, 3139, 3140, 3141, 3142, 3143, 3144, 3145, 3146, 3147, 3148, 3149, 3150, 3151, 3152, 3153, 3154, 3155, 3156, 3157, 3158, 3159, 3160, 3161, 3162, 3163, 3164, 3165, 3166, 3167, 3168, 3169, 3170, 3171, 3172, 3173, 3174, 3175, 3176, 3177, 3178, 3179, 3180, 3181, 3182, 3183, 3184, 3185, 3186, 3187, 3188, 3189, 3190, 3191, 3192, 3193, 3194, 3195, 3196, 3197, 3198, 3199, 3200, 3201, 3202, 3203, 3204, 3205, 3206, 3207, 3208, 3209, 3210, 3211, 3212, 3213, 3214, 3215, 3216, 3217, 3218, 3219, 3220, 3221, 3222, 3223, 3224, 3225, 3226, 3227, 3228, 3229, 3230, 3231, 3232, 3233, 3234, 3235, 3236, 3237, 3238, 3239, 3240, 3241, 3242, 3243, 3244, 3245, 3246, 3247, 3248, 3249, 3250, 3251, 3252, 3253, 3254, 3255, 3256, 3257, 3258, 3259, 3260, 3261, 3262, 3263, 3264, 3265, 3266, 3267, 3268, 3269, 3270, 3271, 3272, 3273, 3274, 3275, 3276, 3277, 3278, 3279, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3289, 3290, 3291, 3292, 3293, 3294, 3295, 3296, 3297, 3298, 3299, 3300, 3301, 3302, 3303, 3304, 3305, 3306, 3307, 3308, 3309, 3310, 3311, 3312, 3313, 3314, 3315, 3316, 3317, 3318, 3319, 3320, 3321, 3322, 3323, 3324, 3325, 3326, 3327, 3328, 3329, 3330, 3331, 3332, 3333, 3334, 3335, 3336, 3337, 3338, 3339, 3340, 3341, 3342, 3343, 3344, 3345, 3346, 3347, 3348, 3349, 3350, 3351, 3352, 3353, 3354, 3355, 3356, 3357, 3358, 3359, 3360, 3361, 3362, 3363, 3364, 3365, 3366, 3367, 3368, 3369, 3370, 3371, 3372, 3373, 3374, 3375, 3376, 3377, 3378, 3379, 3380, 3381, 3382, 3383, 3384, 3385, 3386, 3387, 3388, 3389, 3390, 3391, 3392, 3393, 3394, 3395, 3396, 3397, 3398, 3399, 3400, 3401, 3402, 3403, 3404, 3405, 3406, 3407, 3408, 3409, 3410, 3411, 3412, 3413, 3414, 3415, 3416, 3417, 3418, 3419, 3420, 3421, 3422, 3423, 3424, 3425, 3426, 3427, 3428, 3429, 3430, 3431, 3432, 3433, 3434, 3435, 3436, 3437, 3438, 3439, 3440, 3441, 3442, 3443, 3444, 3445, 3446, 3447, 3448, 3449, 3450, 3451, 3452, 3453, 3454, 3455, 3456, 3457, 3458, 3459, 3460, 3461, 3462, 3463, 3464, 3465, 3466, 3467, 3468, 3469, 3470, 3471, 3472, 3473, 3474, 3475, 3476, 3477, 3478, 3479, 3480, 3481, 3482, 3483, 3484, 3485, 3486, 3487, 3488, 3489, 3490, 3491, 3492, 3493, 3494, 3495, 3496, 3497, 3498, 3499, 3500, 3501, 3502, 3503, 3504, 3505, 3506, 3507, 3508, 3509, 3510, 3511, 3512, 3513, 3514, 3515, 3516, 3517, 3518, 3519, 3520, 3521, 3522, 3523, 3524, 3525, 3526, 3527, 3528, 3529, 3530, 3531, 3532, 3533, 3534, 3535, 3536, 3537, 3538, 3539, 3540, 3541, 3542, 3543, 3544, 3545, 3546, 3547, 3548, 3549, 3550, 3551, 3552, 3553, 3554, 3555, 3556, 3557, 3558, 3559, 3560, 3561, 3562, 3563, 3564, 3565, 3566, 3567, 3568, 3569, 3570, 3571, 3572, 3573, 3574, 3575, 3576, 3577, 3578, 3579, 3580, 3581, 3582, 3583, 3584, 3585, 3586, 3587, 3588, 3589, 3590, 3591, 3592, 3593, 3594, 3595, 3596, 3597, 3598, 3599, 3600, 3601, 3602, 3603, 3604, 3605, 3606, 3607, 3608, 3609, 3610, 3611, 3612, 3613, 3614, 3615, 3616, 3617, 3618, 3619, 3620, 3621, 3622, 3623, 3624, 3625, 3626, 3627, 3628, 3629, 3630, 3631, 3632, 3633, 3634, 3635, 3636, 3637, 3638, 3639, 3640, 3641, 3642, 3643, 3644, 3645, 3646, 3647, 3648, 3649, 3650, 3651, 3652, 3653, 3654, 3655, 3656, 3657, 3658, 3659, 3660, 3661, 3662, 3663, 3664, 3665, 3666, 3667, 3668, 3669, 3670, 3671, 3672, 3673, 3674, 3675, 3676, 3677, 3678, 3679, 3680, 3681, 3682, 3683, 3684, 3685, 3686, 3687, 3688, 3689, 3690, 3691, 3692, 3693, 3694, 3695, 3696, 3697, 3698, 3699, 3700, 3701, 3702, 3703, 3704, 3705, 3706, 3707, 3708, 3709, 3710, 3711, 3712, 3713, 3714, 3715, 3716, 3717, 3718, 3719, 3720, 3721, 3722, 3723, 3724, 3725, 3726, 3727, 3728, 3729, 3730, 3731, 3732, 3733, 3734, 3735, 3736, 3737, 3738, 3739, 3740, 3741, 3742, 3743, 3744, 3745, 3746, 3747, 3748, 3749, 3750, 3751, 3752, 3753, 3754, 3755, 3756, 3757, 3758, 3759, 3760, 3761, 3762, 3763, 3764, 3765, 3766, 3767, 3768, 3769, 3770, 3771, 3772, 3773, 3774, 3775, 3776, 3777, 3778, 3779, 3780, 3781, 3782, 3783, 3784, 3785, 3786, 3787, 3788, 3789, 3790, 3791, 3792,

Original epithet or designation	Present epithet	Strain designation	Spore wall ornamentation ^a	Morphology of spores ^b	Parenting of peptide-iron assay ^c	Chromogenicity ^d	Basal medium for utilization tests	Utilization of carbon compounds/ Growth on Czapek's solution-sucrose agar ^e										Color series		Number of antibiotic factors reported	Remarks ^f	Sensitivity to streptomycin (mm.) ^g	References																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
								No carbon	Glucose	Xylose	Arabinose	Rhamnose	Fructose	Galactose	Mannitol	Inositol	Saltin	Aerial mycelium ^h	Vegetative mycelium																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										

Footnotes to Table 1

- a. Sm = glabrous (smooth walled); R = scabrous (rough); Sp = echinulate (spiny); H = hirsute (hairy); W = verrucose (warty).
- b. RF = Straight to flexuous or fascicled chains of spores; R = straight chains of spores; F = flexuous chains of spores; RA = chains of spores in hooks, open loops, or greatly extended (primitive) coils; S = chains of spores in short, gnarled, or compact coils or extended long and open coils; BIV = equidistant sporophores in verticils or whorls on long straight branches, chains of spores in verticils or whorls on sporophores, chains of spores not coiled; BIV-S = equidistant sporophores in verticils of whorls on long straight branches, chains of spores in verticils or whorls on sporophores as hooks or in coils of few volutions; U = morphology of spore chains could not be determined.
- c. + = Formation of typical bluish-black diffusible pigment after growth on peptone-iron agar (supplemented with 0.1% yeast extract) at 28-30°C; readings made at 1 and 10 days.
- d. + = Formation of a brown to black diffusible pigment after growth in TGLY broth with shaking at 28-30°C; readings made at 2 and 3 days.
- e. + = Positive utilization [+ and ⊕ of Pridham and Gottlieb (1948)];
- = no utilization [- and ⊖ of Pridham and Gottlieb (1948)]; readings made after growth at 28-30°C for 10 days.
- f. P = poor growth; M or F = fair to moderate growth; E = excellent growth; readings made after growth at 28-30°C for 14 days.
- g. Color series of Pridham et al. (1958); W = white; OB = olive-buff; Y = yellow; B = blue; R = red; GY = gray; U = no macroscopically visible aerial mycelium; all other color names from Ridgway (1912).
- h. G = Gelatin liquefaction; C = casein hydrolysis or peptonization; S = starch hydrolysis; N = nitrate reduction; + = positive reaction; - = negative reaction.
- i. Inhibition in mm observed after cross-streaking against a known streptomycin producer; readings made after growth of secondary streaks at 28-30°C for 5 days.

Figure 3A. Electron micrographs of 42-year-old herbarium specimens of actinomycetes.

- a, Actinomyces aureus (ca. 8300 X);
- b, A. diastaticus (ca. 3200 X);
- c, A. 161 (erythraeus) (ca. 8300 X);
- d, A. 168 (flaveolus) (ca. 8300 X).

Figure 3B. Electron micrographs of 42-year-old herbarium specimens of actinomycetes.

- e, Actinomyces lavendula (sic) (ca. 8300 X);
 f, A. viridochromogenus (sic) (ca. 8300 X);
 g, A. griseus (ca. 3200 X);
 h, A. fradii (sic) (ca. 3200 X).

statements in their paper suggest that the structures are not similar in other characteristics. Too, it is possible that the streptomycete structures do not truly represent ornamentation of the free spores per se, but rather ornamentation of the sporangia (hyphal elements within which spores are formed by fragmentation).

Morphology of spore chains. As seen from Table 1, results were somewhat disappointing from studying the morphology of spore chains of the herbarium specimens. Those from the living cultures were more satisfactory.

Cultural studies of living strains. Also recorded in Table 1 are results of the cultural studies which allow comparison of characteristics of the same culture carried in three different collections with those originally cited.

DISCUSSION

There is no question that dried herbarium specimens of streptomycetes can afford useful characterization information even after long periods of storage. Spore-wall ornamentation is an especially useful characteristic retained by dried specimens. If herbarium specimens are prepared with relatively large amounts of material and with as much care as these were, useful information on spore-chain morphology and colors of aerial and vegetative mycelium and of diffusible pigments most likely could be obtained. Professor Waksman must be credited with much foresight to have made these preparations in 1920.

Our results also suggest that maintenance of streptomycetes in continuous active culture might lead to gradual diminution in abilities to form aerial mycelium. This decrease would lead to a diminution in ability to form chains of spores with concomitant difficulties in determining spore-chain morphology. Our study further suggests that some coiled forms may become aberrant, forming fewer and less perfect volutions per coil. Continuous transfer of cultures on agar slants does not appear either to alter the color of the vegetative mycelium or to influence chromogenicity markedly. Also, when carbon utilization patterns are determined under standardized conditions, they do not appear to be significantly changed because of different methods and substrata used for maintenance. Consequently, it is recommended that isolates be characterized and preserved by

lyophilization as soon as possible after isolation. Lyophilizing would aid materially in preventing confusion in future years with regard to characterization and authenticity of reference cultures of named strains or economically important ones. Preparation of dried herbarium specimens of streptomycetes does offer another means for preserving type material of streptomycetes and streptovercillia, and it would appear that this should always be done for important strains.

As a consequence of studies of actinomycetes over the past few years one of us (TGP) has concluded that the most objective way, at present, to handle classification and identification of streptomycetes and streptovercillia is to rely on nature of spore-wall ornamentation and morphology of spore chains as the primary criteria for speciation. Application of this concept immediately "lumps" a great many forms and reduces the number of species to only a few. These are characterized as:

Genus Streptomyces:

1. Streptomyces albus (Rossi-Doria) Waksman and Henrici
Glabrous to scabrous spores in coiled chains.
(Section Spira) Neotype strain: Streptomyces albus
subs. albus IMRU 3004 = ATCC 3004.
2. Streptomyces griseus (Krainsky) Waksman and Henrici
Glabrous to scabrous spores in flexuous chains to
chains occurring as large aberrant loops of hooks
(Section Rectus-Flexibilis). Proposed neotype strain:
Streptomyces griseus subs. griseus IMRU 3326.
3. Streptomyces venezuelae Ehrlich et al.
Glabrous to scabrous spores in straight chains (Sec-
tion Rectus-Flexibilis). Holotype strain: Streptomy-
ces venezuelae subs. venezuelae Burkholder A-65 =
Parke, Davis and Co. 04745 = ATCC 10712.
4. Streptomyces lavendulae (Waksman and Curtis) Waksman
and Henrici. Glabrous to scabrous spores occurring
in hooks, open-loops, or greatly extended (primitive
spirals (Section Retinaculum-Apertum). Proposed
neotype strain: Streptomyces lavendulae subsp.
lavendulae IMRU 3440 = ATCC 8664.

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5. Streptomyces fradiae (Waksman and Curtis) Waksman and Henrici. Glabrous to scabrous spores occurring in hooks, loops, or coils of small diameter (Section Retinaculum-Apertum). Holotype strain: Streptomyces fradiae subsp. fradiae IMRU 3535 = ATCC 10745.
6. Streptomyces diastaticus (Krainsky) Waksman and Henrici. Echinulate spores occurring in coiled chains (Section Spira). Holotype strain: Streptomyces diastaticus subsp. diastaticus, the dried herbarium specimen in The National Fungus Collections, Beltsville, Maryland. Living descendants of the holotype strain are no longer available.
7. Streptomyces erythraeus (Waksman and Curtis) Waksman and Henrici. Echinulate spores occurring in hooks and atypical loops of large diameter (Section Retinaculum-Apertum). Proposed neotype strain: Streptomyces erythraeus subsp. erythraeus Eli Lilly and Co. M5-12559 = ATCC 11635.
8. Streptomyces flaveolus (Waksman) Waksman and Henrici. Hirsute spores occurring in coiled chains (Section Spira). Holotype strain: Streptomyces flaveolus subsp. flaveolus IMRU 3319 = ATCC 3319.

Genus Streptoverticillium:

1. Streptoverticillium reticulum (Waksman and Curtis) Baldacci. Glabrous to scabrous spores occurring in straight chains arranged as the secondary component of compound verticils (whorls) attached to long straight branches; no coils (Section Biverticillus). Holotype strain: Streptoverticillium reticulum subsp. reticulum, the dried herbarium specimen preserved in the National Fungus Collections at Beltsville, Maryland. Authentic living descendants of the holotype strain are no longer available.
2. Streptoverticillium netropsis (Waksman) comb. nov.: Glabrous to scabrous spores occurring in coiled chains arranged as the secondary component of compound verticils (whorls) attached to long straight branches; elements of secondary verticils (whorls) are coiled (Section Biverticillus-Spira). Holotype strain: Streptoverticillium netropsis subsp. netropsis Charles Pfizer and Co. 2937-6 = NRRL 2268.

Because of the importance to actinomycete taxonomy of each of the species involved in this study, the results obtained with each set of cultures and herbarium specimen(s) are discussed individually in the light of the classification scheme outlined above. Some of the results place question on authenticity of the living strains of certain species available now and on nomenclature used in the past.

1. Streptomyces albus (Rossi-Doria) Waksman and Henrici subsp. albosporeus (Krainisky) subsp. nov. The proposed neotype strain is IMRU 3003.

Synonyms:

Actinomyces albosporeus Krainisky, 1914.

Nocardia albosporea (Krainisky) Chalmers and Christopherson, 1916.

Actinomyces ruber (Krainisky) subsp. albosporeus (Krainisky) Krasil'nikov, 1941.

Streptomyces albosporeus (Krainisky) Waksman and Henrici, 1948.

The characteristics of strain IMRU 3003 agree reasonably well with those cited by Krainisky (1914). The CBS (Waksman and Curtis) strain likewise appears to be authentic. Strain ATCC 3003 is not an authentic one and represents a member of a subspecies of S. griseus. The characteristics of the three strains are given in Table 1. We consider the IMRU and CBS strains as members of a subspecies of S. albus because the spores are glabrous and occur in coiled chains. More objective characterization and determination of relationship with other subspecies of S. albus would require study of antibiotic sensitivity and productivity of the two authentic strains.

2. Streptomyces aureus (Waksman and Curtis) Waksman and Henrici:

The original description of a presumed actinomycete with the epithet "aureus" was first given by Johan-Olsen in 1893, and his description should serve as the basis for any taxonomy and nomenclature, particularly for actinomycetes with which the generic names Actinomyces, Streptothrix, Nocardia, Discomyces, or Oospora have been associated. None of the three strains studied represent descendants of the 1915 isolate of Waksman and Curtis. These three are considered identical and represent members of a subspecies

of S. griseus because the spores are glabrous and occur in flexuous chains. Study of the reported characteristics for strains with the specific epithets "aurea" or "aureus" assigned in the literature on actinomycetes, especially in connection with the genera cited above, suggests that the species A. aureus, Streptothrix aurea, Nocardia aurea, and Oospora aurea are taxonomically questionable ones and should not be recognized.

3. Streptomyces albus (Rossi-Doria) Waksman and Henrici subsp. bobiliae (Waksman and Curtis) subsp. nov.
The holotype strain is IMRU 3310.

Synonyms:

Actinomyces bobili Waksman and Curtis, 1916.

Actinomyces ruber (Krainsky) var. bobili (Waksman and Curtis) Krasil'nikov, 1941.

Streptomyces bobiliae (Waksman and Curtis)
Waksman and Henrici, 1948.

The three living strains are authentic descendants of the original 1915 isolate. The results suggest that the organism originally had glabrous to scabrous spores in coiled chains and hence would represent a member of a subspecies of S. albus. More definitive characterization will require study of antibiotic sensitivity and productivity. The Swiss group (Corbaz et al., 1957) have reported that strains ATCC 3310 and CBS (Waksman) both produce a cinerubin-like antibiotic.

4. Streptomyces griseus (Krainsky) Waksman and Henrici subsp. californicus (Waksman and Curtis) subsp. nov.
The holotype strain is IMRU 3312.

Synonyms:

Actinomyces californicus Waksman and Curtis, 1916.

Actinomyces albus (Rossi-Doria) Gasperini var.

californicus (Waksman and Curtis) Krasil'nikov, 1941.

Streptomyces californicus (Waksman and Curtis)
Waksman and Henrici, 1948.

Streptomyces puniceus Patelski, 1950.

Streptomyces vinaceus Ciba, 1951.

Streptomyces floridae Bartz, Ehrlich, Mold et al., 1951.

Streptomyces griseus (Krainsky) Waksman and Henrici var. purpureus Burkholder, Sun, Anderson et al., 1955.

The three living strains studied are authentic descendants of the 1915 isolate of Waksman and Curtis. They are considered identical and represent a subspecies of S. griseus because the spores are glabrous and occur in flexuous chains. The herbarium specimen also contains flexuous (not coiled) chains of spores. The work of Burkholder et al. (1955) suggests that strain ATCC 3312 might produce the viomycin complex. We have detected antibacterial and antifungal activity with this same strain. Also, we have detected antibacterial activity with strain IMRU 3312. Contrary to the results of Burkholder et al. we have found that the three strains show some sensitivity to streptomycin. More definitive information on antibiotic productivity and sensitivity of the three strains is needed.

5. Streptomyces citreus (Krainsky) Waksman and Henrici

The IMRU and ATCC strains appear to be authentic descendants of the strain used for preparation of the herbarium specimen. The CBS (Waksman) strain is different. So far as we know, no one has reported on sensitivity to antibiotics or antibiotic productivity of the three strains. We consider the IMRU and ATCC strains to represent members of a subspecies of S. albus because the spores are glabrous and occur in coiled chains. The CBS (Waksman) strain is considered a member of a subspecies of S. griseus because the spores are glabrous and occur in flexuous chains. The original description of an actinomycete with the epithet "citreus" was first given by Gasperini in 1894, and his paper should serve as the basis for any taxonomy and nomenclature particularly with actinomycetes for which the generic names Actinomyces, Streptothrix, Nocardia, or Streptomyces are associated. Study of the reported characteristics for strains with the epithets "citrea" and "citreus" assigned in the literature on actinomycetes, especially in connection with the genera cited above, suggests that the species Actinomyces citreus, Streptothrix citrea, Nocardia citrea and Streptomyces citreus are taxonomically questionable ones and should not be recognized.

6. Streptomyces diastaticus (Krainsky) Waksman and Henrici subsp. diastaticus Krainsky.

The proposed neotype strain is the dried herbarium specimen preserved in the National Fungus Collections,

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Beltsville, Maryland, under the designation Actinomyces diastaticus Krainsky emend. Waksman and Curtis, May 15, 1920, N. J. Agr. Exp. Station.

Synonyms:

Actinomyces diastaticus Krainsky, 1914.

Actinomyces chromogenes (Gasperini) Lachner-Sandoval var. diastaticus (Krainsky) Krasil'nikov, 1941.

Streptomyces diastaticus (Krainsky) Waksman and Henrici, 1948.

The original description of an actinomycete with the epithet "diastaticus" was first given by Krainsky (1914), and his paper should serve as the basis for any taxonomy and nomenclature. Any neotype based on Krainsky's concept of the species would have to be nonchromogenic and would have to form a gray-brown or brown-gray aerial mycelium. The characteristics of the ATCC and CBS (Waksman and Curtis) strains do not agree with those shown by the herbarium specimen. The ATCC strain is considered a member of a subspecies of S. griseus because the spores are glabrous and occur in flexuous chains. The CBS strain is considered a member of a subspecies of S. albus because the spores are glabrous and occur in coiled chains. Any living neotype culture based on Waksman and Curtis' concept would have to have echinulate spores occurring in coiled chains. From a practical standpoint we believe it best to consider the dried herbarium specimen as the only available neotype material and to use the species as a basis for classification and naming of isolates with echinulate spores in coiled chains.

7. Streptomyces erythraeus (Waksman) Waksman and Henrici subsp. erythraeus. The proposed neotype strain is Eli Lilly M5-12259 = ATCC 11635.

Synonyms:

Actinomyces 161 of Waksman, 1919.

Actinomyces erythreus (sic) Waksman, 1923.

Actinomyces krainskii Duché, 1934.

Actinomyces ruber Krainsky var. erythreus (sic) Krasil'nikov, 1941.

Streptomyces erythreus (sic) (Waksman) Waksman and Henrici, 1948.

None of the three strains studied represent authentic descendants of the 1919 Waksman isolate. They are identical

and represent members of a subspecies of S. griseus because the spores are glabrous and occur in flexuous chains. Because the holotype strain no longer exists, we propose that the Eli Lilly strain M5-12559 producing erythromycins A, B, and C be designated the neotype. The spores of this strain are echinulate and occur in chains in loose coils and large diameter hooks as the morphology of the herbarium specimen suggests.

8. Streptomyces griseus (Krainsky) Waksman and Henrici subsp. exfoliatus (Waksman and Curtis) subsp. nov.
The holotype strain is IMRU 3316.

Synonyms:

Actinomyces exfoliatus Waksman and Curtis, 1916.

Actinomyces chromogenes (Gasperini) Lachner-Sandoval emend. Krasil'nikov var. exfoliatus Krasil'nikov, 1941.

Streptomyces exfoliatus (Waksman and Curtis) Waksman and Henrici, 1948.

The holotype strain (IMRU 3316) must be considered authentic as little or no information could be obtained from study of the herbarium specimen. The ATCC strain is identical with the IMRU strain. So far as we know, there is no definitive published information on antibiotic productivity or sensitivity of the two strains. We consider the taxon to represent a subspecies of S. griseus because the spores are glabrous and occur in flexuous chains.

9. Streptomyces flaveolus (Waksman) Waksman and Henrici subsp. flaveolus Waksman. The holotype strain is IMRU 3319 = ATCC 3319.

Synonyms:

Actinomyces 168 of Waksman, 1919.

Actinomyces flaveolus Waksman, 1923.

Actinomyces heimi Duché, 1934.

Actinomyces flavus (Krainsky) emend. Krasil'nikov var. flaveolus (Waksman) Krasil'nikov, 1941.

The three living strains are authentic descendants of the 1919 isolate of Waksman. Actinomyces flaveolus, as a name, was first assigned to Waksman's strain 168 by Waksman in 1923 (Breed et al., 1923). Subsequently, Duché studied the strain and gave it another name, Actinomyces heimi. At that time (1934) Duché deposited the strain in the

CBS collection. Waksman also had deposited the same strain in the CBS collection. Villax (1963) has reported that S. flaveolus strain CBS (Duché) produces tetracycline, oxy-tetracycline, and actinomycin. If this is true, it should be possible to demonstrate production of these antibiotics with the three strains used here. To our knowledge, there is no other definitive information published about their sensitivity to antibiotics or their antibiotic productivity.

Examination of the original electron micrograph plates made at magnification ca. 8,000 X, and subsequently examined with a 3X-4X hand lens, suggests that the distinction between hairy spores and spiny spores may be only quantitative. Nevertheless, we consider S. flaveolus to represent a distinct species because the spores are hirsute and occur in coiled chains. This species appears to be the earliest named one having hirsute spores and represented by authentic strains.

10. Streptomyces griseus (Krainsky) Waksman and Henrici subsp. flavovirens (Waksman) subsp. nov. The holotype strain is IMRU 3320 = ATCC 3320.

Synonyms:

Actinomyces 128 of Waksman, 1919.

Actinomyces flavovirens Waksman, 1923.

Actinomyces albobiridis Duché, 1934.

Actinomyces viridochromogenes Krainsky var.

albobiridus (Duché) Krasil'nikov, 1941.

Streptomyces flavovirens (Waksman) Waksman and Henrici, 1948.

The three living strains are authentic descendants of the 1919 isolate of Waksman. So far as we know, no definitive information has been published with regard to their antibiotic productivity or sensitivity. We consider these strains to represent members of a subspecies of S. griseus because their spores are glabrous and occur in flexuous chains.

11. Streptomyces flavus (Krainsky) Waksman and Henrici, 1948

Strain IMRU 3321 and strain ATCC 3369 appear to be authentic descendants of the Waksman and Curtis 1915 isolate. Strain CBS (Waksman and Curtis) appears to be different from the other two. Villax (1963) reported that a strain of S. flavus (no strain number given) obtained from the ATCC

produces tetracycline, oxytetracycline and chlortetracycline. He also reported that S. flavus CBS strain (Waksman and Curtis) produces tetracycline, oxytetracycline, chlortetracycline, and actinomycin. So far as we know, this account is the first published about simultaneous production of oxytetracycline, chlortetracycline, and actinomycin by a wild-type actinomycete. It would be worth while to determine whether Villax' results can be confirmed with the three strains used in our study because there is some question about the particular strains used in his work. We consider the two authentic strains to represent members of a subspecies of S. griseus because the spores are glabrous and occur most probably in flexuous chains.

The original naming of an actinomycete with the epithet "flava" or "flavus" was done by Chester (1901) for an organism originally isolated and described by Bruns (1899). The descriptive information in their papers should serve as a basis for any taxonomy and nomenclature particularly with actinomycetes for which the generic names Actinomyces, Streptothrix, and Streptomyces are associated. Study of the reported characteristics for strains with the epithets "flava" and "flavus" assigned in the literature on actinomycetes, especially in connection with the genera cited above, suggests that the species Actinomyces flavus, Streptothrix flava and Streptomyces flavus are taxonomically questionable ones and should not be recognized.

12. Streptomyces fradiae (Waksman and Curtis) Waksman and Henrici subsp. fradiae Waksman and Curtis.

The holotype strain is IMRU 3535 = ATCC 10745.

Synonyms:

Actinomyces fradii Waksman and Curtis, 1916.

Streptomyces fradiae (Waksman and Curtis)

Waksman and Henrici, 1948.

The two strains studied represent authentic descendants of the 1915 isolate of Waksman and Curtis. The ability of the two to produce neomycin A, neomycin B, neomycin C, and fradycin is clearly established. We consider S. fradiae to represent a distinct species at the present state of our work.

13. Streptomyces griseus (Krainsky) Waksman and Henrici subsp. gelaticus (Waksman) subsp. nov. The holotype strain is IMRU 3323.

Synonyms:

Actinomyces 104 of Waksman, 1919.

Actinomyces gelaticus Waksman, 1923.

Actinomyces albus (Rossi Doria) Gasperini var. gelaticus (Waksman) Krasil'nikov, 1941.

Streptomyces gelaticus (Waksman) Waksman and Henrici, 1948.

The three strains studied appear to be authentic descendants of the 1919 isolate of Waksman. There is some question with regard to the morphology of the chains of spores of these strains because of the sparse formation of aerial mycelium. Definitive information on their sensitivity to antibiotics or on their antibiotic productivity remains unreported. At present we consider the taxon to represent members of a subspecies of *S. griseus* because the spores are glabrous and appear to occur in flexuous chains.

14. Streptomyces griseus (Krainsky) Waksman and Henrici subsp. griseobrunneus (Waksman) subsp. nov. The holotype strain is IMRU 3068.

Synonyms:

Actinomyces 218 of Waksman, 1919.

Streptomyces griseobrunneus Waksman, 1961.

For the most part, the living culture is considered to be an authentic descendant of the Waksman 1919 isolate. So far as we know, no definitive information is published on antibiotic sensitivity or productivity of strain IMRU 3068. We consider the taxon to represent a member of a subspecies of *S. griseus* because the spores are glabrous and occur in flexuous chains.

15. Streptomyces griseus (Krainsky) Waksman and Henrici subsp. griseolus (Waksman) subsp. nov. The holotype strain is IMRU 3325.

Synonyms:

Actinomyces 96 of Waksman, 1919.

Actinomyces griseolus Waksman, 1923.

Actinomyces candidus Krasil'nikov var. griseolus Krasil'nikov, 1941.

Streptomyces griseolus (Waksman) Waksman and Henrici, 1948.

The three strains studied are identical and represent authentic descendants of the 1919 isolate of Waksman. There has been no definitive information published, so far as we know, with regard to sensitivity to antibiotics or to antibiotic productivity. We consider them to be members of a subspecies of S. griseus because their spores are glabrous and occur in flexuous chains.

16. Streptomyces griseus (Krainsky) Waksman and Henrici subsp. griseus Krainsky. The proposed neotype strain is IMRU 3326 = ATCC 3326.

Synonym:

Actinomyces griseus Krainsky, 1914.

The original description of an actinomycete with the epithet "griseus" was first given by Krainsky (1914) and his description should serve as the basis for any taxonomy and nomenclature. Strain IMRU 3326 should be the neotype strain. We already have proposed that it be considered the neotype strain (Lyons and Pridham, 1962). Waksman (1961) has listed strain IMRU 3463 as the "type culture." The history of this strain can be traced back to a culture numbered 18-16 that was one of the first streptomycin-producing strains isolated in the 1940's. Strains IMRU 3326 and ATCC 3326 are authentic descendants of the 1915 isolate of Waksman and Curtis. Strain CBS (Waksman and Curtis) is a questionable one and does not appear to be an authentic descendant of the 1915 isolate. The identity of any antibacterial antibiotics produced by these particular strains has never been published to our knowledge. We have detected the production of hexaene and heptaene antifungal activity, sensitivity to streptomycin, and the production of slight, as yet unidentified, antibacterial activity with the IMRU and ATCC strains. According to our concept of speciation and subspeciation, streptomycin-producing strains of S. griseus would represent another subspecies of S. griseus, e.g., S. griseus (Krainsky) Waksman and Henrici subsp. streptomycini (Krasil'nikov) Pridham and Lyons.

17. Streptomyces griseus (Krainsky) Waksman and Henrici subsp. halstedii (Waksman and Curtis) subsp. nov.
The holotype strain is IMRU 3328 = ATCC 10897.

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Synonyms:

Actinomyces halstedii Waksman and Curtis, 1916.

Streptomyces halstedii (Waksman and Curtis)

Waksman and Henrici, 1948.

Both strains IMRU 3328 and ATCC 10897 appear to be identical and represent authentic descendants of the 1915 isolate of Waksman and Curtis. The sensitivity to antibiotics and antibiotic productivity of these particular strains have not yet been reported. We consider the taxon to represent a subspecies of S. griseus because the spores are glabrous and occur in flexuous chains.

18. Streptomyces lavendulae (Waksman and Curtis) Waksman and Henrici subsp. lavendulae. The proposed neotype strain is IMRU 3440 = ATCC 8664.

Synonyms:

Actinomyces lavendulae Waksman and Curtis, 1916.

Actinomyces chromogenes (Gasperini) Lachner-

Sandoval emend. Krasil'nikov var. lavendulae

(Waksman and Curtis) Krasil'nikov, 1941.

Streptomyces lavendulae (Waksman and Curtis)

Waksman and Henrici, 1948.

The strain studied (IMRU 3330) does not appear to be an authentic descendant of the 1915 isolate of Waksman and Curtis. Indeed most, if not all, of the strains labeled "lavendulae" that we have examined do not possess characteristics that conform to those exhibited by the original isolate. The herbarium specimen clearly shows the presence of spores with spines. All of our electron micrographs of strains labeled "lavendulae" show spores with smooth or rough walls. Almost all exhibit morphology that would allow placement in Section Retinaculum-Apertum of Pridham et al. (1958). The color of the aerial mycelium of these strains always has given rise to some doubt that these cultures represent strains related to the original isolate. Probably, living material representing the true S. lavendulae now is known as Streptomyces violascens (Preobrazhenskaya and Sveshnikova) Pridham, Hesseltine, and Benedict, 1958. The spores are spinose and occur in coiled chains. Also, the aerial mycelium exhibits colors more definitely characterized as "lavender or violet" than do strains now labeled "lavendulae."

Characteristics of the strain⁵ studied by Moore and Chapman (1959) appear to conform to those cited in the original description for Actinomyces lavendulae (S. lavendulae). In our opinion, there is need to designate a suitable neotype strain for the species S. lavendulae. Because of the vast amount of literature on strains named A. lavendulae and S. lavendulae and because many have characteristics different from those of the original isolate, we propose that strain IMRU 3440 be designated the neotype strain. This strain, now deposited in the ATCC as ATCC 8664, has a considerable background of relatively new taxonomic information, supplemented with definitive information on antibiotic productivity (ability to produce the streptothricin complex). The antibiotic data not only allow the detection and identification of individual members of the complex (Horowitz and Schaffner, 1958; Lumb et al., 1962) but also the rather precise characterization of the strain.

19. Streptomyces griseus (Krainsky) Waksman and Henrici subsp. lipmanii (Waksman and Curtis) subsp. nov.
The holotype strain is IMRU 3331 = ATCC 3331.

Synonyms:

Actinomyces lipmanii Waksman and Curtis, 1916.

Actinomyces viridis (Lombardo-Pellegrino) Sanfelice var. lipmanii (Waksman and Curtis)
Krasil'nikov, 1941.

Streptomyces lipmanii (Waksman and Curtis)
Waksman and Henrici, 1948.

Actinomyces diastaticus (Krainsky) var. lipmanii
Waksman and Curtis) Baldacci, 1955.

The holotype strain is IMRU 3331. The three strains studied are identical and represent authentic descendants of the original 1915 isolate of Waksman and Curtis. So far as we know, no definitive information has yet appeared concerning the sensitivity to antibiotics or antibiotic productivity of these strains. We consider the taxon to represent a subspecies of S. griseus because the spores are glabrous and occur in flexuous chains.

⁵ The strain was sent to T. G. Pridham for characterization and identification. Subsequently, it was identified as a strain of S. violascens.

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20. Streptomyces griseus (Krainsky) Waksman and Henrici subsp. nigrifaciens (Waksman) subsp. nov.

The holotype strain is IMRU 3067.

Synonyms:

Actinomyces 145 Waksman, 1919.

Streptomyces nigrifaciens Waksman, 1961.

Strain IMRU 3067 is an authentic descendant of the 1919 Waksman isolate. So far as we know, there is no published information on the sensitivity of this strain to antibiotics or on its antibiotic productivity. We consider the taxon to be a subspecies of S. griseus because the spores are glabrous and occur in flexuous chains.

21. Streptomyces albus (Rossi-Doria) Waksman and Henrici subsp. olivaceus (Waksman) subsp. nov.

The holotype strain is IMRU 3335.

Synonyms:

Actinomyces 206 Waksman, 1919.

Actinomyces olivaceus Waksman, 1923.

Actinomyces flavus Krainsky subsp. olivaceus (Waksman) Krasil'nikov, 1941.

Streptomyces olivaceus (Waksman) Waksman and Henrici, 1948.

Strain IMRU 3335 is the holotype strain. The three strains studied are identical and are authentic descendants of the 1919 isolate of Waksman. To our knowledge, no definitive information on sensitivity to antibiotics or antibiotic productivity of these particular strains has been reported. We consider the taxon to represent a subspecies of S. albus because the spores are glabrous and occur in coiled chains.

22. Streptomyces albus (Rossi-Doria) Waksman and Henrici subsp. olivochromogenes (Waksman) subsp. nov.

The holotype strain is ATCC 3336.

Synonyms:

Actinomyces chromogenus 205 Waksman, 1919.

Actinomyces olivochromogenus Waksman, 1923.

Streptomyces olivochromogenus (Waksman) Waksman and Henrici, 1948.

Actinomyces chromogenes subsp. olivochromogenes Krasil'nikov, 1949.

Streptomyces olivochromogenes (Waksman) Waksman, 1957.

Strain ATCC 3336 is an authentic descendant of the 1919 isolate of Waksman. Again, there is no definitive information concerning its sensitivity to antibiotics or antibiotic productivity. We consider the taxon to represent a subspecies of S. albus because the spores are glabrous and occur in coiled chains.

23. Streptomyces phaeochromogenus (Conn) Waksman and Henrici, 1948.

The original description of an actinomycete with the epithets "phaeochromogenus," "phaeochromogenes," "pheochromogenus," or "pheochromogenes" was first given by Conn (1917), and that description should serve as the basis for any taxonomy and nomenclature. The three strains studied appear to be identical and represent authentic descendants of the 1919 isolate of Waksman. It is proposed that strain IMRU 3338 be designated the neotype strain of the species. Sensitivity to antibiotics or antibiotic productivity of these particular strains is not known to us. The status of this species is somewhat questionable because the source of IMRU 3338 is not definitely known. Strain CBS (Waksman) has been proposed as the neotype strain (Arch. Mikrobiol. 39:158-194, 1961).

24. Streptomyces poolensis (Taubenhaus) Waksman and Henrici, 1948.

The original description of an actinomycete with the epithet "poolensis" was first given by Taubenhaus (1918), and that work should serve as the basis for any taxonomy and nomenclature. The species is a taxonomically questionable one. No living strains are available. Study of the herbarium specimen leads us to consider the taxon as a subspecies of S. griseus. Because no strains are available, we designate the name as a nomen rejiciendum propositum.

25. Streptomyces griseus (Krainsky) Waksman and Henrici subsp. purpureochromogenus (Waksman and Curtis) subsp. nov. The holotype strain is IMRU 3343.

Synonyms:

Actinomyces purpeo-chromogenus Waksman and Curtis, 1916.

Actinomyces purpeochromogenes (Waksman and Curtis) Krasil'nikov, 1941.

Actinomyces melanocyclus Krainsky subsp.
purpeochromogenes Krasil'nikov, 1941.
Streptomyces purpeochromogenus (Waksman and
Curtis) Waksman and Henrici, 1948.
Streptomyces purpureochromogenus (Waksman and
Curtis) Waksman, 1957.

Insofar as could be determined, the characteristics of strain IMRU 3343 agree with those of the herbarium specimen. The CBS (Waksman and Curtis) strain may be identical with the IMRU strain, but only further study would clarify this point. So far as we know, there is no definitive information published on sensitivity to antibiotics or antibiotic productivity with these strains. Because strains ATCC 3343 and CBS (Waksman and Curtis) have glabrous spores occurring in flexuous chains, they represent a member of a subspecies of S. griseus.

26. Streptoverticillium reticulum (Waksman and Curtis) subsp. reticulum Baldacci. The holotype strain is the dried herbarium specimen preserved in the National Fungus Collections, Beltsville, Maryland under the designation Actinomyces reticulus (sic) Waksman and Curtis, May 15, 1920, N.J. Agr. Exp. Station.
Synonyms:

Actinomyces reticulus Waksman and Curtis, 1920
(on herbarium label).
Actinomyces reticuli Waksman and Curtis, 1916.
Streptomyces reticuli (Bergey et al.) Waksman and
Henrici, 1948.
Streptoverticillium reticuli (Waksman and Curtis)
Baldacci, 1958.

None of the three strains studied represent authentic descendants of the 1915 isolate of Waksman and Curtis. A suitable neotype probably could be selected from any of the streptoverticillia that are chromogenic and form a gray or grayish-yellow aerial mycelium. At present, the holotype is represented by the herbarium specimen. The spores would be glabrous and would occur without coils on secondary verticils. The organism should be placed in the genus Streptoverticillium Baldacci (1958). Because this species is the first true biverticillate form described, we consider all other true biverticillate species without coiled chains of glabrous spores to represent subspecies of Streptoverticillium reticulum.

27. Streptomyces roseus (Krainsky) Waksman.

The original description of an actinomycete with the epithets "rosea" or "roseus" was first given by Namyslowski (1912), and this description should serve as the basis for any taxonomy and nomenclature. The species is a taxonomically questionable one. The original holotype strain of Namyslowski is no longer extant, neither is the original (neotype?) strain of Krainsky, nor the 1915 isolate of Waksman and Curtis (a presumed neotype strain?). The characteristics of the available IMRU strain (3372) conform, in part, with those cited in the original description but could just as easily be identified with some other species. If a neotype strain should be designated, probably IMRU 3372 would be as suitable as any. There is a question in our minds whether a neotype should be designated because of the inadequacies of the original descriptive material on the species. At the present stage of our work we consider that this strain may be related to S. griseus because the spores are glabrous and because the morphology of the spore chains represents the far end of a series of morphological deviations from the typical flexuous type. We consider the name S. roseus a nomen rejiciendum propositum.

28. Streptomyces ruber (Krainsky) Waksman and Henrici, 1948.

The original description of an actinomycete with the epithets "ruber," "rubra," or "rubrum" was first given by Kruse (1896), and should serve as the basis for any taxonomy and nomenclature. The species is a taxonomically questionable one. The two strains studied probably represent authentic descendants of the 1915 isolate of Waksman and Curtis, although it is difficult to connect the characteristics found with those cited in the original description. The two strains studied are considered to represent members of a subspecies of S. griseus because the spores are glabrous and probably occur in flexuous chains. To our knowledge, there is no definitive information published on sensitivity to antibiotics or antibiotic productivity of these strains. We consider the name S. ruber a nomen rejiciendum propositum.

29. Streptoverticillium reticulum (Waksman and Curtis) Baldacci subsp. rubrireticulum (Waksman and Curtis) subsp. nov. The holotype strain is IMRU 3631.

Synonyms:

- Actinomyces reticulus-ruber Waksman and Curtis, 1916.
- Actinomyces reticulus Bergey et al., 1923.
- Actinomyces reticuli subsp. reticulus ruber Krasil'nikov, 1941.
- Streptomyces rubrireticuli (Waksman and Curtis) Waksman and Henrici, 1948.
- Actinomyces reticulus ruber (Waksman and Curtis) Krasil'nikov, 1949.
- Streptomyces reticulus-ruber (Waksman and Curtis) Takahashi, Ishimoto and Shoji, 1949.
- Actinomyces rubrireticuli (Waksman and Henrici) Comaschi, Scotti and Spalla, 1953.
- Streptomyces reticuloruber (Waksman and Curtis) Shinobu, 1955.
- Actinomyces reticulus var. ruber Bekhtereva, Kosheleva and Khrzhanovskaia, 1958.
- Streptoverticillium rubrireticuli (Waksman and Henrici) Baldacci, 1958.
- Actinomyces rubriraeticuli (Waksman and Henrici) Baldacci, Spalla and Grein, 1954.
- Streptomyces rubrireticulae (Waksman and Henrici) Mitscher, Andres and McCrae, 1964.

The three strains studied are identical because they originated from the same source and represent authentic descendants of the 1919 isolate of Waksman. So far as we can determine, no definitive information has been reported on their sensitivity to antibiotics or antibiotic productivity. We have detected antibacterial and antifungal activity, as yet unidentified, with these strains. We consider the taxon to represent a subspecies of Streptoverticillium reticuli.

30. Streptomyces griseus (Krainsky) Waksman and Henrici subsp. rutgersensis (Waksman and Curtis) subsp. nov. The holotype strain is IMRU 3350.

Synonyms:

- Actinomyces rutgersensis Waksman and Curtis, 1916.
- Actinomyces chromogenes subsp. rutgersensis Krasil'nikov, 1941.
- Streptomyces rutgersensis (Waksman and Curtis) Waksman and Henrici, 1948.

Strains IMRU 3350 and ATCC 3350 are identical and represent authentic descendants of the 1915 isolate of Waksman and Curtis. Strain CBS (Waksman and Curtis) appears to be different. The only definitive information published about sensitivity to antibiotics or antibiotic productivity of either of these strains is that of Thompson et al. (1962). They reported the production of pentaene and hexaene antifungal antibiotics with strain ATCC 3350 (NRRL B-1256). We have detected nonpolyenic antifungal activity with strain ATCC 3350. We consider the taxon to represent a subspecies of S. griseus because the spores are glabrous and occur in flexuous chains.

31. Streptomyces albus (Rossi-Doria) Waksman and Henrici subsp. verne (Waksman and Curtis) subsp. nov.

The holotype strain is IMRU 3353.

Synonyms:

Actinomyces verne Waksman and Curtis, 1916.

Actinomyces viridis (Lombardo-Pellegrino)

Krasil'nikov subsp. verne (Waksman and Curtis)

Krasil'nikov, 1941.

Streptomyces verne (Waksman and Curtis) Waksman and Henrici, 1948.

Strains IMRU 3353 and ATCC 3353 appear to be identical and to represent authentic descendants of the 1915 isolate of Waksman and Curtis. The CBS (Waksman and Curtis) strain is different. So far as is known, there has been no definitive information published on sensitivity to antibiotics or antibiotic productivity of these strains. We consider the taxon to represent a subspecies of S. albus because glabrous spores occurring in coiled chains were detected on examination of the holotype strain (IMRU 3353), despite the fact that no macroscopically visible aerial mycelium generally is produced by the living strains.

32. Streptomyces novaecaesareae (Waksman and Curtis) Waksman and Henrici. The holotype strain is IMRU 3831.

Synonyms:

Actinomyces violaceus caesari Waksman and Curtis, 1916.

Actinomyces violaceous-caesari Waksman and Curtis, 1916.

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Streptomyces novaecaesareae (Waksman and Curtis) Waksman and Henrici, 1948.

Streptomyces violaceus-caeseri (Waksman and Curtis) Pridham, Hesselstine and Benedict, 1958.

Formerly known by the name Actinomyces violaceus-caesari, strain IMRU 3831 is the holotype strain and must be considered an authentic descendant of the 1915 isolate of Waksman and Curtis. Definitive information remains to be published on sensitivity to antibiotics and on antibiotic productivity of the two strains that are available. Such information might afford a more reasonable assessment of the taxon. The status of this taxon is questionable because we could detect no chains of spores with the two living strains studied. The taxon most probably would be placed in Section Spira (Pridham et al., 1958). Only further work directed toward identifying antibiotic activities or inducing the living strains to form sufficient aerial mycelium so that a reasonable assessment can be made will allow accurate placement.

33. Streptomyces albus (Rossi-Doria) Waksman and Henrici subsp. violaceoruber (Waksman and Curtis) subsp. nov. The holotype strain is IMRU 3355

Synonyms:

Actinomyces violaceus-ruber Waksman and Curtis, 1916.

Actinomyces alma-ataensis Novogradsky, 1950.

Actinomyces coelicolor (Müller) var. achrous Ryabova and Preobrazhenskaya, 1957.

Also incorrectly known as Streptomyces coelicolor, strain ATCC 3355 is the holotype strain. It and CBS strain (Waksman) are considered identical and represent authentic descendants of the 1915 isolate of Waksman and Curtis. The only definitive information on sensitivity to antibiotics or antibiotic productivity of the strains studied appears to be a report by Vetlugina et al. (1963) that a strain of S. coelicolor (3355) produces celicomycin (actinomycin K), which may consist of at least four factors. We are not certain that the particular strain (3355) represents an authentic transplant of either the IMRU 3355 or the ATCC 3355 cultures although the similarity of strain numbers is suggestive. Originally, the celicomycin-producing strain was proposed as a new species, Actinomyces alma-ataensis by Novogradsky (1950). Somewhat later, Ryabova and Preobrazhenskaya (1957) re-

named S. coelicolor (Waksman's strain 3355) as a new variety Actinomyces coelicolor var. achrous. Subsequently, A. alma-ataensis was stated to be identical with A. coelicolor N3355 (personal communication, T. P. Preobrazhenskaia to T. G. Pridham, August 21, 1963). All of these facts suggest that strains labeled S. violaceus-ruber, S. violaceoruber, or S. coelicolor carrying the designations IMRU 3355, Waksman 3355, ATCC 3355, or CBS (Waksman) can be demonstrated to produce celicomycin (actinomycin K) or such antibiotics as have been shown to be identical with celicomycin (actinomycin K). We consider the taxon a subspecies of S. albus because the spores are glabrous and occur in coiled chains.

Further, much genetic work on streptomycetes has been conducted with strains identified as S. coelicolor (Sermonti and Casciano, 1963; and preceding papers). These strains and derived mutants probably are more closely related to S. violaceoruber than to S. coelicolor. The true S. coelicolor represents a subspecies of S. griseus. Some years back interpretations regarding the species S. coelicolor became confused. Many strains subsequently isolated and identified have been given that name incorrectly.

34. Streptomyces diastaticus (Krainsky) Waksman and Henrici subsp. viridochromogenes (Krainsky) subsp. nov.
The proposed neotype strain is strain CBS (Millard).
Synonyms:

Actinomyces viridochromogenus (Krainsky)
Waksman and Curtis, 1916.

Streptomyces viridochromogenes (Krainsky)
Waksman and Henrici, 1948.

The original description of an actinomycete with the epithet "viridochromogenus" (sic) or "viridochromogenes" was first given by Krainsky (1914), and that description should serve as the basis for any taxonomy and nomenclature. Strain IMRU 3356 probably should be the neotype strain. The three strains studied are identical and represent authentic descendants of the 1915 isolate of Waksman and Curtis. Trejo and Bennett (1963) have presented good reasons why the strain designated CBS (Millard) should be the neotype strain of the species. We concur because it does not seem as aberrant as IMRU 3356. So far as we know, there is no definitive information published with regard to sensitivity to antibiotics or antibiotic productivity of the

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strains studied here. We have detected no antibacterial or antifungal activity with strain ATCC 3356 (Hesseltine et al., 1954). Lindenfelser and Pridham (1962) reported detection of slight antibacterial activity but no antifungal activity with strain CBS (Millard). We consider the taxon as a subspecies of S. diastaticus because the echinulate spores occur in coiled chains.

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