TAXONOMIC STUDIES ON THE GENUS
THERMOACTINOMYCES

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SUMMARY. An examination of 104 strains of species included in the genus Thermoactinomyces from various sources and a critical study of the pertinent literature suggest the following revision of the genus:

Thermoactinomyces vulgaris Tsiklinsky 1899, 501 is the type species (monotype) of the genus, and alone should remain in the genus.

Thermoactinomyces thalpophilus Waksman and Corke 1953, 378 is a junior synonym of T. vulgaris.

Thermoactinomyces glaucus Henssen 1957 should be regarded as a nomen dubium.

Thermoactinomyces thermophilus (Berestnev) Waksman 1961, 308 should be regarded as a nomen dubium.

Thermoactinomyces monosporus (Lehmann and Schütze) Waksman 1953 should be regarded as a nomen dubium or as a possible synonym of Thermomonospora viridis (Schuurmans et al.) Küster and Locci comb. nov.

Thermoactinomyces viridis Schuurmans et al. 1956 is transferred to the genus Thermomonospora as Thermomonospora viridis (Schuurmans et al.) Küster and Locci comb. nov.

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The genus Thermoactinomyces is defined and characterized by the presence of an aerial mycelium and by the formation of single spores on both aerial and vegetative mycelia (Tsiklinsky 1899, Waksman and Corke 1953, Henssen 1957). The species are mainly thermophilic; recently also mesophilic species are said to have been found (Thirumalachar,

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personal communication 1962). Members of this genus have frequently been confused with organisms belonging in the genus Micromonospora, but they are clearly distinguished from the latter by the formation of aerial mycelium and by their thermophilic nature. The occasional occurrence of more than one spore arranged in pairs or short chains on the aerial mycelium (Schütze 1908, Henssen 1957) have been confirmed in our observations. The single-spore character in the aerial mycelium is not as uniform and typical as it is for the vegetative mycelium. The main morphological character of the genus Thermoactinomyces is the formation of single spores on the vegetative mycelium in combination with one or more spores on the aerial mycelium.

In the course of an examination of the microflora of peat a great number of thermophilic actinomycetes has been isolated (Küster and Locci 1963). The majority of the strains has been classified as Thermoactinomyces. This led to a detailed study of the genus. Six species are recognized in Waksman's monograph (1961) where they are differentiated by the colour of the aerial mycelium and the formation of a soluble pigment. Thermoactinomyces thalpophilus is there incorrectly designated as the type species. Our observations of numerous strains from various collections together with a critical review of the literature strongly suggest a revision of the genus Thermoactinomyces.

Thermoactinomyces vulgaris

This, the type species of Thermoactinomyces, is thermophilic, develops aerial mycelium, and forms single spores on both the vegetative and aerial mycelium. On the basis of morphological and cultural characteristics (Waksman et al. 1949, Erikson 1953) Micromonospora vulgaris is a synonym of T. vulgaris. All our strains of Thermoactinomyces, including a culture labelled as Micromonospora vulgaris Strain D (kindly supplied by Dr. D.M. Webley, Aberdeen), showed a morphological appearance which is typical for T. vulgaris. There were only a few small variations in cultural and physiological behaviour, such as growth on various media, NO₃ reduction, sugar fermentation, gelatin liquefaction, and amylase activity. In our opinion, these differences do not exceed the general extent of variation which may occur within a species. Our results indicate that T. vulgaris is the only species in the genus Thermoactinomyces.

BACTERIOLOGICAL NOMENCLATURE
AND TAXONOMYThermoactinomyces thalpophilus

This species forms a white aerial mycelium and is distinguished from T. vulgaris in that it produces a red pigment in certain media. The descriptions of the pigment formation are contradictory. Waksman and Corke (1953) observed a pigment on glucose yeast agar only, Henssen (1957) on a sugar-containing salt medium only. Comparative experiments have been carried out with 102 strains of Thermoactinomyces and also with two cultures of T. thalpophilus NRRL 1982 which we obtained from Dr. C. W. Hesseltine (Peoria) directly and from Dr. P. A. Hartman (Ames). All these strains were examined on the following media which are recommended for pigment production: glucose yeast agar (Waksman 1961 No. 29), Czapek agar with and without yeast extract, sugar-containing salt medium (Henssen 1957 medium IV + 0.5% glucose), maintenance medium Ia, medium II, and synthetic medium VII (Tendler and Burkholder 1961). None of the strains examined produced the wine-red pigment which is characteristic of T. thalpophilus on any of the media tested. Some of the strains isolated by Uridil (Uridil and Tetrault 1959), which we obtained from Dr. P. A. Hartman (Ames), showed red spots on the reverse of some colonies on the original slopes (Tendler-medium Ia). Even with these strains we were unable to reproduce the red pigmentation in any of the media used under varied cultural conditions (temperature, light). In our opinion pigment formation by T. thalpophilus is a very unstable character even if it occurs under specific conditions. This character is insufficient to separate it from T. vulgaris as a definite species. Consequently, we propose that T. thalpophilus be regarded as a synonym of T. vulgaris. Further studies may show how far it is justified to classify pigmented forms as a variety of T. vulgaris. A few strains showed a brownish reverse of the vegetative mycelium when grown on yeast glucose agar or Tendler media Ia and VII, respectively. The browning is not due to a true pigment, but depends on the strength and consistency of the vegetative mycelium. When the growth is corrugated, mainly in the upper dried portion of the agar slope, the colour of the reverse becomes darker and orange-brown shades appear.

Thermoactinomyces glaucus Henssen 1957, 906

This species is characterized by formation of a bluish-green aerial mycelium and a strong cellulolytic activity. According to the original description by Henssen (1957) it seems to us this species is a thermophilic Streptomyces, rather than a Thermoactinomyces forming spore chains with 4-10 spores on the aerial mycelium. A culture (NRRL 1981) labelled as T. glaucus was obtained from Dr. C. W. Hesseltine (Peoria, Ill.). It possessed white aerial mycelium with single spores only and therefore resembled T. vulgaris. The typical growth of vegetative mycelium, which emerges from the agar surface like an arch, has been observed neither for T. glaucus NRRL 1981 nor for any of the other strains examined. Henssen stated (letter of 17th Dec. 1958) that some of her cultures were mislabelled and that she was unable to recultivate and reisolate T. glaucus. Therefore, we consider Thermoactinomyces glaucus a nomen dubium.

Thermoactinomyces thermophilus (Berestnev)
Waksman 1962

Different organisms have been described under this name (Berestnev 1897, Miehe 1907, Schütze 1908, Noack 1912). Baldacci (1940) suggested that the descriptions are incomplete and inadequate for a species determination. According to the description in Waksman's monograph (1961), mainly based on the study of Waksman et al. (1939), T. thermophilus seems to be a thermotolerant Streptomyces rather than a Thermoactinomyces. Cultures of the type strain are no longer available. For these reasons we consider T. thermophilus as a Streptomyces and suggest its elimination from the genus Thermoactinomyces. It should be regarded as a nomen dubium.

Thermoactinomyces monosporus (Lehmann and Schütze)
Waksman 1953

The name of this species should be considered as a nomen dubium because of the incomplete description of the organism and the lack of a type culture. According to the description (Schütze 1908), Thermoactinomyces monosporus is synonymous with Thermomonospora viridis (Schuurmans et al.) Küster and Locci 1963.

BACTERIOLOGICAL NOMENCLATURE
AND TAXONOMY

Thermoactinomyces viridis

Recent studies showed that Thermoactinomyces viridis resembles Thermomonospora. Thermoactinomyces viridis was therefore transferred to Thermomonospora as Thermomonospora viridis (Schuurmans et al.) Küster and Locci 1963.

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