

*THE TAXONOMIC POSITION OF THE GENUS ACTINOMYCES*

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To the genus *Actinomyces* are usually assigned a variety of peculiar and very minute filamentous organisms, widely distributed in nature, concerning the taxonomic relationship of which divergent views have been held. Most of the earlier medical writers, whose attention was centered on forms associated with human and animal diseases, placed the genus with the pleomorphic bacteria. Others recognized conidia in the clavate elements produced by one of these pathogenic forms, *Act. bovis*, within the animal body, and referred this parasite to the Fungi. These elements were later shown to represent degenerative structures; but as subsequent investigations on a number of species, including various saprophytic forms, as well as the common potato scab

organism and several pathogenic types clinically similar to *Act. bovis*, revealed decidedly fungoid characteristics, not only in the profusely branched condition of the vegetative thallus when grown in culture, but also in the production of an aerial mycelium and Oidium-like spores, the view that the genus is to be placed with the Hyphomycetes has continued to receive support.

According to another view which has gained quite wide acceptance, Actinomyces represents an intermediate group and a phylogenetic connection between the Bacteria and the Fungi. It is held that the genus originated either as the result of the development of bacterial forms possessing a tendency toward the branched condition, like the tubercle and the diphtheria organisms; or as the result of the reduction of hyphomycetous types, which, in their ultimate stages, yielded the much simpler true bacteria.

In order to determine the merits of these contending views, the writer subjected a large number of saprophytic species isolated from the soil, air, etc., as well as several virulent strains of the potato scab organism secured from Mr. M. Shapavalov, to morphological study. The results may be summarized as follows:

(1) The vegetative thallus of Actinomyces consists of a mycelium composed of profusely branching hyphae, the terminal growing portions of which are densely filled with protoplasm. Toward the center of the thallus, the vacuoles increase in size, and may be associated with the presence of meta-chromatic granules; the latter having nothing in common with bacterial endospores or 'micrococci,' for which they were mistaken by early observers.

(2) The vegetative mycelium attains an extent incomparably greater than the branching figures recorded for bacteria of the acid-fast group; and the hyphae lack the uniformity in diameter generally characteristic of the Schizomycetes.

(3) The aerial mycelium produced on suitable substrata by most species, occurs, usually, in the form of a mat of discrete fructifications; but in other species, these fructifications are frequently combined to form numerous peculiar erect Isaroid sporodochia.

(4) In any case, each individual fructification represents a well characterized sporogenous apparatus, consisting of a sterile axial filament bearing branches in an open racemose, or dense capitate arrangement. The primary branches may function directly as sporogenous hyphae, or may proliferate branches of the second and of higher orders; sporogenesis, in the latter case, being confined to the terminal elements, the hyphal portions below points of attachment of branches remaining sterile.

(5) Two tendencies in the development of fructifications are recognizable, one leading to an erect dendroidal type in which successively proliferated fertile elements undergo processes of sporogenesis in continuous sequence; and the other leading to a prostrate, racemose type, in which sporogenesis is delayed in the older branches until the younger branches have also attained their

final extension. The majority of species show these tendencies combined in different ways.

(6) The sporogenous hyphae of most species are coiled in peculiar spirals sometimes resembling the spores of the hyphomycetous genus *Helicoön*. These spirals exhibit pronounced specific characteristics in the number, diameter, and obliquity of their turns, and especially in the direction of rotation (whether dextrorse or sinistrorse).

(7) Sporogenesis, where it can be followed, begins at the tips of the fertile branches and proceeds basipetally. In the larger number of species the process involves the insertion of septa, which in certain cases, are relatively very massive, and in others, so thin as to be barely discernible. The disposition of these septa while the delimited spores undergo maturation processes, varies with the species: (1) they may remain more or less unaltered; (2) they may suffer a median split, the two resulting halves being then separated as the result of the longitudinal contraction of the young spores, leaving alternate portions of hyphal wall completely evacuated; (3) or they may first become considerably constricted and subsequently converted into non-stainable isthmuses connecting the mature spores. The apparent absence of septa in the sporogenous hyphae of other forms, is, perhaps, attributable to optical difficulties.

(8) Granules are readily differentiated in the spores of many species, which possess the staining properties and uniformity of size characteristic of nuclei; they generally occur singly, but in the larger spores of a few forms, two are often found occupying diagonally opposite positions.

(9) As in the vegetative thallus, metachromatic granules occur in the aerial mycelium, being very rarely found in spores or sporogeneous hyphae but becoming very abundant in degenerate sterile hyphae.

(10) The older axial filaments of some species show marked distensions, which, in extreme cases, result in figures simulating *Leptomitus*. These arise as local distensions at the points of attachment of the more extensive lateral sporogenous processes. Cuneate modifications of the sterile axial filaments below the origin of branches, also occur.

(11) Curious spherical structures appear regularly in some forms, both in the sterile axial hyphae, where they may contain either a median septum or a number of peripheral metachromatic granules, and in the sporogenous hyphae where they are associated with the regularly spaced septa.

(12) The spores germinate readily in suitable solutions, producing from one to four germ tubes, the approximate number being more or less characteristic of the species.

(13) Owing to the absence of any well defined bacterial characteristics, the writer is of the opinion that the view that *Actinomyces* represents a transition between the Hyphomycetes and the Schizomycetes, as well as the phylogenetic corollary based upon it, may safely be abandoned. If mere size is to be regarded as important, it would appear to be equally profitable to look

for bacterial affinities in some ascomycetous and sphaeropsidaceous forms, the hyphae of which are similarly very minute. It is doubtful whether far-reaching taxonomic generalizations can be based upon the 'acid-fast' staining reaction, especially as this reaction has not played a very important rôle in mycological research. There seems to be no adequate reason why the genus should not be classed, in an unqualified manner, with the Hyphomycetes, as a Mucedineous group with tendencies toward an erect Isaroid habit.

A more complete illustrated account will appear shortly in the *Botanical Gazette*.

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