Examination of Myxobacteria by Scanning Electron Microscopy

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Fruiting bodies of representative genera of the order Myxobacterales Jahn 1915 were examined by using a "Stereoscan" electron microscope (Cambridge Instrument Co.). Species of Myxococcus, Chondrococcus, Melittangium, Chondromyces, Archangium, and Stigmatella were examined. The instrument was found to be of value in studying the detail of fruiting bodies.

RESULTS AND DISCUSSION

The scanning electron micrographs of the fruiting bodies are shown in Fig. 1 to 24.

A problem was encountered when examining strains of Chondromyces spp. and Stigmatella aurantiaca. The fruiting bodies of these organisms tended to accumulate charge, with the result that compact clusters of cysts repelled each other, causing rapid dismembering of the fruiting bodies while under observation in the SEM. Black lines across the photographs (Fig. 13) resulted from charging. The problem was partly overcome by fixation in osmium vapor. For any particular strain, there was no difference in appearance between the individual cysts from osmium-fixed and unfixed fruiting bodies of the above strains as observed under the SEM.

The process of evacuation prior to gold coating must cause substantial dehydration and may result in folding of the walls of cysts (Fig. 14) and the contraction of slime into an apparent membrane over myxospores in non-cyst-forming species (Fig. 20). It is difficult to resolve these folds (if they existed) in the unevacuated specimens with the light microscope.

The distribution of myxospores in the cysts of Melittangium lichenicolum was revealed by the folding of the cyst walls (Fig. 15). Large numbers of myxospores within the cyst of M. lichenicolum may physically prevent extensive folding; in the cysts of other species the myxospores may be fewer in number relative to the size of the cyst, and no physical evidence of their presence is revealed in the folding of the cyst walls. Our own observations of thin sections of cysts of species of Stigmatella and Chondromyces, confirming those of McCurdy and Khouw (3) and Voelz and Reichenbach (7), have revealed substantial areas of matrix. When cysts of M. lichenicolum are crushed under a
cover slip, the myxospores adhere together in sheaves. This is in agreement with the observations by McCurdy (2). Cysts of *Chondromyces* and *Stigmatella* readily liberate their myxospores. This suggests a marked variation in the viscosity of the matrix in mature cysts.

The stalk of *S. aurantiaca* (Fig. 13) appears superficially different from those of the four *Chondromyces* species (Fig. 2, 3, 10, and 11).

A comparison between several strains of *Myxococcus fulvus* and *Myxococcus virescens* has revealed a consistent difference in their fruiting bodies. *M. virescens* revealed myxospores enveloped in a folded blanket of condensed slime (Fig. 19, 20). In contrast, *M. fulvus* appears to have a uniform surface broken only by depressions, presumably caused by a partial collapse of the myxospores under vacuum (Fig. 21-24).

Fixation of the fruiting bodies in osmium vapor prior to examination did not prevent the formation of these depressions. Thin sections of myxospores (6) revealed no lateral depressions. These depressions are similar to those seen under the SEM by Williams and Davis (8) when examining spores of *Streptomyces viridosporus*. 

**FIG. 1.** *Chondromyces crocatus* MQ101. Fruiting body on agar. ×374. Fixed in osmium vapor.

**FIG. 2.** *Chondromyces crocatus* MQ101. Stalk. ×4,080. Fixed in osmium vapor.

**FIG. 3.** *Chondromyces apiculatus* MQ47. Fruiting body on agar. ×200. Fixed in osmium vapor.

**FIG. 4.** *Chondromyces apiculatus* MQ47. Cysts and slime appendages ×1,150. Fixed in osmium vapor.
FIG. 5. Chondromyces apiculatus MQ47. Early stage in formation of fruiting body. X488. Fixed in osmium vapor.

FIG. 6. Chondromyces apiculatus MQ47. Differentiation into cysts. X446. Fixed in osmium vapor.

FIG. 7. Chondromyces pediculatus. Fruiting body on bark showing cysts attached to stalk by pedicels. X467.


FIG. 12. *Chondromyces catenulatus*. The point of division of the main stalk into the cyst chains is shown. ×850. Fixed in osmium vapor.
FIG. 13. *Stigmatella aurantiaca* MQ89. Fruiting body on bark showing cysts attached to stalk by pedicels. ×952. Fixed in osmium vapor.

FIG. 14. *Stigmatella erecta* MQ42. Fruiting body on agar. ×1,215.

FIG. 15. *Melittangium lichenicum* MQ21. The myxospores within the cyst are revealed. ×2,890.

FIG. 17. *Chondrococcus coralloides* MQ25. Typical fruiting body on agar. X1,530.
FIG. 18. *Chondrococcus coralloides*. A slime membrane is visible around the fruiting body. X8,500.

FIG. 22 and 23. *Myxococcus fulvus* MQ41. Surface detail of two different areas of the fruiting body. X10,000.

FIG. 24. *Myxococcus fulvus* MQ2. Surface detail of fruiting body which was different to *M. fulvus* 0041. X 5,000.
The difference observed between *M. fulvus* and *M. virescens* may be due solely to the difference in the ratio of myxospores to slime in the fruiting bodies. The surface appearance of *Chondrococcus coralloides* was similar to that of *M. virescens* (Fig. 18). Since the differentiation of *Chondrococcus* from *Myxococcus* is based solely on deliquescence versus non-deliquescence of the slime of the fruiting body, the continued separation of these two genera appears unjustified.

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LITERATURE CITED