comment

Scotoma in contemporary microbiology

Howard Gest explodes what he considers to be the myth of 'unculturable' bacteria.

The eminent neurologist Dr Oliver Sacks describes scotoma as involving the deletion of what was originally perceived, a loss of knowledge, a loss of insight … a regression to less perceptive explanations. '*All these not only beset neurology but are surprisingly common in all fields of science. They raise the deepest questions about why such lapses occur.*' A scotoma has apparently afflicted many molecular biologists, and others, who maintain that most (>95 %) of bacteria living in nature are 'unculturable' in the laboratory. This view is frequently used as a crutch to justify molecular metagenomics as the panacea for understanding the complexities of bacterial ecology.

The myth of unculturability is repeated so often that it has penetrated to semi-popular science writing. In a recent issue of the *American Scientist*, Dorit asks '*Why did it take so long to acknowledge our inner microbe? The answer stems, in part, from the fact that most bacteria cannot be grown in the laboratory. Consequently, until recently, microbiologists could not identify – let alone understand – microbes that refused to live in the world of Petri dishes and culture flasks.*'

The myth of 'unculturability' persists because it is promoted by scientists who have little experience in growing fastidious bacteria or knowledge of past investigations in which nutritional idiosyncracies of numerous types of organisms were defined by intensive studies. For over a century, a legion of microbiologists has provided numerous examples of bacteria that have complex growth requirements that are not satisfied by simple concoctions of yeast extract and similar supplements. An interesting case in point: in 1910, F.W. Twort undertook to isolate the agent responsible for tuberculosis of cattle. The disease was causing great losses of cattle in Britain and Europe. In a classic 1911 paper, Twort and his colleague Ingram noted, '*All writers on this disease state that the causative agent cannot be cultivated outside the animal body*'. They went on to demonstrate that *Mycobacterium pseudotuberculosis* can be grown in pure culture by adding extracts of dead cells of *Mycobacterium phlei*. This was one of the earliest researches showing requirements of many bacteria for 'essential' growth factors, later identified in this instance to be a form of vitamin K.

In support of the myth of unculturability, it is repeatedly claimed that '*only a fraction of less than 1 % of bacteria on or in natural sources can be recovered as colonies on standard laboratory media.*' This, of course, is a vague and inadequate criterion of culturability. As indicated by Twort & Ingram, it is not news to knowledgeable microbiologists that the definition of nutritional requirements of bacteria is often difficult and requires lengthy laboratory studies. To illustrate the point, I have posted several more significant examples from the literature on the web at http://hdl.handle.net/2022/3149

My critique of the myth of 'unculturability' on the internet is '*dedicated to the pioneering microbiologists who isolated pure cultures of microbes responsible for (a) infectious diseases of animals and plants, and (b) the cyclic transformations of major chemical elements on the Earth. Their characterization of the biological, physiological, and genetic properties of these organisms paved the way for current research.*' The careers and contributions of more than 300 of the early pioneers are profiled in William Bulloch's 1938 classic book *The History of Bacteriology*. Back in 1993, I summarized the problem under discussion as follows: '*The requirements for growth and reproduction of extant species of bacteria are obviously met in environments that provide appropriate chemical and physical conditions. Whether or not the requirements can be satisfied in the laboratory depends on many factors, which include the knowledge, skill, and patience of the investigator … There is no doubt that studies on nucleic acid sequences of bacterial species are enlarging our understanding of species relationships and evolutionary patterns. But justification for pursuing such research hardly needs to be based on the myth that the 'molecular approach' is necessary because many species are 'unculturable'.*'

In my opinion, the study of pure cultures remains the most reliable source of basic information for understanding the properties and evolutionary relationships of the vast majority of bacteria, as well as the dynamics of changes they catalyse in the biosphere.

▲ *Tek Image / Science Photo Library*

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Further reading

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Dorit, R. (2008). All things small and great. *Am Sci* 96, 284–286.

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Twort. F.W. & Ingram, G. (1911). *Proc R Soc* LXXXIV, 517–542.

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