Koch's colonies and the culinary contribution of Fanny Hesse

Philip Mortimer

Today we take for granted the culturing and isolation of micro-organisms on agar plates. Philip Mortimer describes the pioneers of these techniques.

The Romans, when they settled in barbarian lands, established '*coloniae*'. The Elizabethans, also eager expansionists, preferred to use the word 'plantation', but a hundred years later the British too were founding 'colonies'. Colonialism flourished for another 200 years and then, at the end of the nineteenth century, imperial decline set in so that a further century on 'colony' had become an opprobrious term, no longer to be used. With one exception though; it remains a respectably neutral word to microbiologists. They use it to describe a visible clone, grown from an isolated bacterial cell on a solid medium, with its size, shape and surface features sometimes typical enough to identify the species.

The discovery of the technique for isolating and growing bacteria as colonies is generally credited to Robert Koch, but this attribution is less than generous to others, for he was certainly not unaided. There was a background of earlier mycological research and the contribution made by his first wife and assistant, Emily, may also be guessed at. The contribution made by the wife of one of Koch's colleagues, Walter Hesse, happily is recorded, though not now widely known.

Isolation and culture techniques

Koch's studies in the late 1870s, especially those on the blood of small animals infected with anthrax, persuaded him that specific infections might be due to particular micro-organisms; and he saw that a way had to be found to grow, free of other flora, each micro-organism to which an infectious disease might be ascribed. It was already well known to Koch's forerunners that the mixed flora seen microscopically in specimens taken from bodily sites grew as mixtures when inoculated into nutritive fluid media, and various investigators, Lister for instance, had isolated pathogenic microbes from these mixtures by preparing and culturing high dilutions. Koch, however, was the first to find a way of growing a putative pathogen so that it would form a pure isolate – what he referred to as a colony.

To achieve this Koch at first drew on his knowledge of how some fungi were being cultured, and so used a gelatin-based medium; but gelatin was inconvenient for several reasons. Various bacteria were found to liquefy it and on hot days it melted spontaneously. For the same reason gelatin could not be incubated at the temperature that most human pathogens needed to grow in a convenient time span.

Then, around 1881, a better substrate, at the time referred to as agar-agar but soon simply called agar, was found. The discoverer, as far as a microbiological application was concerned, was one Fanny Hesse, the doctor's wife referred to above. Her husband had just spent a few months in Koch's laboratory learning the new science of bacteriology and Fanny was at the time helping him to culture air-borne bacteria for studies of his own.

Fanny Hesse has been portrayed as 'just a housewife', but the historical record contradicts such a dismissive comment. She was born Fanny Eilshemius in New Jersey in 1850 to a first generation immigrant family who had prospered sufficiently to be able to send her, when she reached her early twenties, on a tour of Europe. In Germany she met and married Dr Hesse and, like others who were the wives of the pioneers of bacteriology, she acted as his laboratory assistant and technical artist. What has immortalized her, though, was not her exercise of these skills but her modest proposal that agar should be used in the growth medium for isolating bacteria. She had first learnt about agar from friends of her mother who had lived in the East Indies, where the seaweed extract originates. There it was, and is, widely used as a cooking ingredient.

Molten agar has the excellent property that it sets when its temperature falls below 45 °C, but will only melt again at over 90 °C. At first Koch used agar in its liquid state to suspend inocula in, and it was in this form that he employed it when mention was first made of Frau Hesse's discovery, for the isolation of *Mycobacterium tuberculosis*, in 1882. Her contribution was not acknowledged. Soon, however, it was realized that it was more convenient to grow bacteria not in but on the surface of agar and to have the medium pre-poured into a shallow circular 'Petri' dish. A loopful of bacterial suspension could then be swept back and forth across the surface of the set agar until the number of cells transferred from the loop was so few that they grew as single colonies. It is an isolation technique that has never been changed; there has simply been no need.

CENTRE:
A culture of bacteria growing on an agar plate.
PHOTO SGM

BELOW
Robert Koch (1843–1910).

Koch's colonial journeys

The application of the word 'colony' to describe a discrete, pure growth of a bacterium was due to Koch (he was already using it in 1881), and his choice of term may well have reflected the political pre-occupations of the time. Subconsciously, at least, Koch could have been influenced by the growing colonial rivalries in Europe. A few years before, at the Conference of Berlin in 1878, the 'Great Powers' had discussed colonization at length, but without resolving their conflicting interests. And over the next 30 years these disputes intensified, both regarding Africa, the Near and Far East, and Latin America. Britain, France, Germany and the United States all sought to establish new colonies, and Germany, the youngest state at the conference table, felt keenly the disadvantage of being a late comer to colonialism. This sense of grievance almost certainly affected Koch, a man whose patron was the Kaiser himself, and who gave free expression to his Prussian pride, for example in scorning the French school of bacteriology and its senior figure, Pasteur.

Starting with his investigation of cholera in British India in 1883, Koch travelled widely throughout his life. Indeed, colonial travel became after 1890 a kind of refuge for him following the embarrassments of a controversial divorce, subsequent marriage to a teenage actress and the sustained professional criticism that he endured after he had published exaggerated claims for the therapeutic powers of tuberculin. Even if his nationality denied him access to its grander pretensions, Koch enjoyed the rewards of European colonialism.

The parallel between a colony on a plate and colonies on the face of the globe may now seem a little far-fetched, but it is reasonable to speculate that this was in Koch's mind when he first used the word in bacteriology. And whether this is true or not, Koch, with Fanny Hesse, does deserve everlasting credit for bequeathing to bacteriology a simple and enabling technique for isolating and growing bacterial species. Visualization of bacterial colonies remains essential for clinical diagnosis and they are sources of pure microbial DNA and proteins. Furthermore, the agar on which Koch was the first to grow bacterial colonies has proved invaluable for other purposes. Other living cells can be suspended in it, immunological reagents will diffuse through it and large molecules can be separated electrophoretically in it. Frau Hesse's agar is, in fact, a prime example of how, over the years, the art of cookery has contributed to microbiological technique.

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Further reading

Hitchens, A.P. & Leikind, M. C. (1939). The introduction of agar-agar into bacteriology. *J Bacteriol* 37, 485–493.

Koch, R. (1882). Die Aetiologie der Tuberculose. *Berl Klin Wochenschr* 19, 221–230.

Wainwright, M. (2001). Microbiology before Pasteur. *Microbiol Today* 28, 19–21.

Robert Koch is famous for being the first scientist to conclusively identify the etiological agent of any disease (anthrax in this instance). He established a set of criteria which must be satisfied in order to do this, called â€œKochâ€™s Postulates.â€ They are: 1) All diseased animals must display the putative pathogen.Â He realized that these colonies were pure cultures (clones) of bacteria because each arose from a single cell. Fortuitously, Bacillus anthracis, the etiological agent of anthrax, was able to grow on potato, and would yield a pure culture by which he was able to satisfy his postulates. EQUIPMENT: sterile petri dishes, one per two students clean cutting board sharp paring knife Bunsen burner tweezers in an EtOH beaker 37Â°C incubator. SUPPLIES Kochâ€™s colonies and the culinary. contribution of Fanny Hesse. Philip Mortimer. Today we take â— The Romans, when they settled in barbarian inconvenient for several reasons.Â The discovery of the technique for isolating and Fanny Hesse has been portrayed as â€¯just a house- growing bacteria as colonies is generally credited to wifeâ€™, but the historical record contradicts Robert Koch, but this attribution is less than generous such a dismissive comment. She was born to others, for he was certainly not unaided. There was a Fanny Eilshemius in New Jersey in background of earlier mycological research and the 1850 to a first generation immi- contribution made by his first wife and assistant, Emily, grant family who had prospered may also be guessed at. Fannie Hesse had been inspired by the use of agar to prepare fruit jams and. jellies (agar had been used as a gelling agent in parts of Asia for centuries. 4.Â important contributions to research and discovery in agriculture, animal chemistry, pharmacology and food chemistry. The Liebig Extract of Meat Company (LEMCO).Â " Kochâ€™s colonies and the culinary contribution of Fanny. Hesse", Microbiology Today, Vol. 28, pp136-137. 15. Hitchens, A.P. and Leikind, M. C. (1939). "The introduction of agar-agar into.