Life on us

▶ *Adam and Eve*, 1526 (oil on panel, 117x80 cm) by Lucas Cranach I (1472–1553). Did the microbes of hunter–gatherers in Eden differ from those of modern humans? *Courtauld Institute of Art Gallery, London*

This issue of *Microbiology Today* takes a look at some of the microbes who share our bodies. SGM President **Robin Weiss** wonders just how human we are.

More than 30 years ago, Michael Andrews wrote an entertaining book entitled *The Life That Lives On Man* (London: Faber & Faber, 1976), concerning human ectoparasites such as fleas, lice, mites and ticks, and the diseases they carry: plague, typhus and lyme disease. This issue of *Microbiology Today* is devoted to the microbes that live on or in us. Humans are mobile ecosystems that harbour numerous bacteria, viruses, fungi and single-cell eukaryotes. Even our own genome has been repeatedly colonized by retroviral genomes constituting some 8 % of human DNA sequences (see Voisset & Griffiths, p. 30), and that's not counting other transposons and parasitic DNA.

Articles on the skin (Farrar & Bojar, p. 14, oral cavity (Spratt, p. 22), large bowel (Tannock, p. 26) – a veritable chemostat for *Escherichia coli* – illustrate what a wonderful habitat we provide for microbes. Relatively few of them are routinely pathogenic, but in specially susceptible hosts such as the immunocompromised individual, viruses and fungi that we carry for decades without ill effects can suddenly run wild. There is also the danger of MRSA leaving its commensal niche in our nostrils to invade surgical wounds with devastating effects (as Foster describes on p. 18).

As an ecosystem, it has become clear that we are only part human, because a significant amount of our biomass is microbial. In demographic terms, microbes outnumber our own cells. While there are 10^{14} human cells in the average adult, there are probably ~10^{15} bacteria and >10^{17} viruses associated with the human body. In terms of genetic diversity and complexity, the microbial metagenome of humans may be greater than the 3×10^{9} base pairs of human DNA.

Are the microbes that live on us on to a good thing? Yes, if we consider that for a large mammalian host, our current population of 6 billion is substantial, and widely distributed. Even viruses that do not actually infect us may find that humans serve as a useful vector for dispersal. At the September 2007 SGM meeting we were reminded by Mya Breitbart that the most prevalent virus to be found in human faeces is pepper mild mottle virus. This curious finding is thanks to our diet of solanacaeous vegetables (tomatoes, potatoes, peppers and so on), all of which came from the Americas. It is ironic that the post-Columbian exchange resulted in the introduction of novel foods (*Solanaceae* and *Zea mais*) from the New World to the Old, whereas almost all the pathogens such as smallpox, measles, yellow fever and tuberculosis made the transatlantic journey in the other direction. Since human numbers and activity affect the global ecosystem, it would seem sensible from a microbial point of view to adopt the attitude 'if you can't beat them, join them'. Humans certainly provided the SARS coronavirus with a brief world tour before it retreated to its fruit bat reservoir with occasional forays into civet cats.

Zoonoses in turn raise the question, how similar is our microbial flora to that of our closest living relative, the chimpanzee? It would be interesting to compare, say, the oral flora of chimpanzees to that of humans. Considering viruses, many of the ubiquitous, endemic not highly pathogenic viruses have co-evolved with the human host, e.g. herpesviruses. In contrast, most of the highly pathogenic, epidemic viruses came to humans from diverse animal sources, long after we left the forest for the savannah and eventually spread out of Africa. Many of them, such as measles, smallpox and influenza, became part of the human microbial scene only during the last 12,000 years or so, when we domesticated livestock, and when other animals, such as dogs, cats, rats and mice, chose to colonize human settlements. Thus while we share >98 % host DNA sequence similarity with the chimpanzee, the microbial and viral species that live in or on us are only ~50 % shared with the great apes.

Does life on us represent a harsh and challenging environment? It may sometimes seem so, given our modern habits of washing with soap, brushing our teeth, taking antibiotics and separating drinking water from sewage. But, as the articles in this issue illustrate, we still abound with microbes. One interesting human ecological niche (not explored here) is the vagina. Together with the uterine cervix, it is home to the symbiont *Lactobacillus acidophilus* and frequently to the more irritating *Candida* and *Gardnerella*, not to mention sexually transmitted papilloma viruses, herpes simplex virus type II, *Chlamydia, Gonococcus, Trepanema, Haemophilus ducreyi* and *Trichomonas*. The lactobacilli help to maintain the vaginal mucosal surface at pH 4.2, but after ejaculation of semen, this can rise to pH 8.0. This sudden shift from an acid to an alkaline milieu might strike an environmental microbiologist as dramatic, although I would not go as far as calling sexually transmitted microbes extremophiles!

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