NEWS IN FOCUS

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Trains are full of more than just people: bacteria stick to seats more effectively than they do to metal poles.

MICROBIOLOGY

Urban microbes unveiled

Genomics tracks the microscopic inhabitants of homes, transport systems and sewers.

BY RACHEL EHRENBERG

Embedded in the filth and chaos of the world's great metropolises, amid the people, pigeons, cockroaches and rats, there is a teeming world of bacteria, viruses, fungi and protists that scientists are only now surveying. Microbes are everywhere: on trains, pavements and lifts; in parks, libraries, hospitals and schools. Most are innocuous, some are friendly, and a handful cause death and disease. But the vast majority are unknown.

Researchers described results of early forays into this terra incognita at the Microbes in the City conference on 19 June, hosted by the New York Academy of Sciences and New York University (NYU) on the 40th floor of an antiseptic-looking glass office tower in Manhattan. "We're really at the infancy of a very interesting scientific endeavour," said Joel Ackelsberg, a medical epidemiologist for the New York City Department of Health and Mental Hygiene. "Right now, we know very little."

Researchers are not even sure how to survey this strange landscape. There are competing techniques for detecting, quantifying and keeping track of which microbes are doing what in the built environment, and where. But researchers believe that efforts could lead to new approaches for monitoring bioterrorism, tracking disease outbreaks or assessing the impact of storms and pollution.

Each month, high-throughput techniques allow scientists to sequence roughly 1,000 microbial genomes from samples collected in various environments, said computational biologist Curtis Huttenhower of the Harvard T. H. Chan School of Public Health in Boston, Massachusetts. That is an impressive amount of data, but it is dwarfed by the unfamiliar. Christopher Mason, a computational geneticist at Weill Cornell Medical College in New York City, told the conference how a baseline survey of genetic material from surfaces in the city's subway system had uncovered DNA from almost 1,700 known taxa, mostly harmless bacteria. But 48% of the genetic material did not match anything yet identified. "Half the world under our fingertips is unknown," said Mason.

Still, trends are emerging from the global Metagenomics and Metadesign of Subways and Urban Biomes initiative (MetaSUB), which aims to characterize the genetic material found on public-transport systems in 16 world cities to elucidate the microscopic riders that share the commute. Storms leave a mark: months after New York City's South Ferry Station was ▶

flooded in 2012's Hurricane Sandy, it still harboured DNA from bacteria associated with cold marine environments and fish, Mason said. However, most of the bacteria in the subway were harmless *Acinetobacter* species and others associated with human skin.

In his talk, Huttenhower described a survey of Boston's transit system that yielded similar flora. "Everything is covered in skin," he said. He noted that metal poles on the trains, which riders commonly consider hygienically suspect, actually retain much less bacterial biomass than the system's upholstered seats or plastic hand grips.

Microbiomes in houses tend to match those of the homes' human inhabitants — and quickly morph after a change in occupancy, said environmental microbiologist Jack Gilbert of Argonne National Laboratory in Illinois. He and his colleagues described results from a survey of ten homes, which found that they become populated with new residents' microbes within 24 hours.

Rodents are under study, too. White-footed mice (*Peromyscus leucopus*) in New York City carry more *Helicobacter* and *Atopobium* bacteria — associated with stomach ulcers and bacterial vaginosis in humans — than their suburban counterparts, but are totally free of tick-borne pathogens, reported biologist Alyssa Ammazzalorso of the Albert Einstein College of Medicine in New York City. The city's rats carry a number of bacteria known to cause problems in people, said epidemiologist Ian Lipkin, director of the Center for Infection and Immunity at Columbia University in New York. He and others have found pathogenic *Escherichia coli*, *Clostridium difficile*, *Salmonella enterica* and the Seoul strain of hantavirus, which can be fatal when transmitted to humans (C. Firth *et al. mBio* **5,** e01933-14; 2014).

Sewage samples from New York City's 14 wastewater-treatment plants turned up a disturbing number of genes for resistance to antibiotics, reported genomicists Susan Joseph and Jane Carlton of NYU's Center for Genomics and Systems Biology. As a rich human-derived soup spiked with antibiotics, sewage provides an ideal niche for the growth and spread of resistance, Joseph said. Martin Blaser, director of the Human Microbiome Program at the NYU School of Medicine, said that as populations of resistant microbes and their defensive tools become more diverse, the diversity of human-associated microbes in general is declining. He told how he and his colleagues have found that people in the West carry fewer protective bacteria than isolated human groups such as the Yanomami of the Amazon rainforest.

"We may have lost as much as half of our diversity already," said Blaser, "just as we are beginning to realize how important it might be." ■

The fungus that causes white-nose syndrome eats into bats' wings.

US FWS/RYAN VON LINDEN, NY DEPT ENVIRONMENTAL CONSERVATION/SPL

ECOLOGY

Bacteria may help bats to fight fungus

As white-nose syndrome spreads, researchers are trialling ways to stop colonies from collapsing.

BY NALA ROGERS

The bats at Marm Kilpatrick's two Illinois field sites perished right on schedule. The mines sheltered nearly 30,000 bats before white-nose syndrome, a deadly fungal disease, arrived in late 2012. By March 2015, less than 5% remained.

Kilpatrick, a disease ecologist at the University of California, Santa Cruz (UCSC), and his colleagues chose the mines because they lay right in the path of the fungus, which has spread from Europe through 26 US states and 5 Canadian provinces since January 2007.

Although researchers are currently helpless to halt the spread of the fungus, there is reason for cautious optimism: treatments could soon be available that will help the bats to keep the infection at bay, for a season at least.

The goal, says Chris Cornelison, a microbiologist at Georgia State University in Atlanta, is to ensure that when researchers find long-term solutions for the disease, "there are still bats to treat".

The fungus (*Pseudogymnoascus destructans*) grows on bats while they hibernate in winter, digging into their noses, ears and wings. Animals that survive until spring usually clear the infection as their bodies warm; some species do it year after year. But the pathogen causes other species to repeatedly rouse from hibernation, which burns up fat reserves and can cause the animals to starve to death. Some even flee their roosts in a futile search for food.

"They come out of caves in the winter, and they try to get into people's homes or churches or schools," says Jeremy Coleman, national coordinator for white-nose-syndrome research at the US Fish and Wildlife Service in Hadley, Massachusetts. "They're dead and dying on the ground."

Kilpatrick and his colleagues have discovered that a bacterium found on bats' wings may help them to combat infection. In April, the scientists published a paper in *PLoS ONE* showing that two strains of the bacterium *Pseudomonas fluorescens* kill white-nose fungus in cell culture (J. R. Hoyt *et al. PLoS ONE* **10,** e0121329; 2015). Last winter, the researchers applied the treatment to bats in the lab. They have not released their results, but Kilpatrick hopes to test the bacteria in the wild soon.

Others are examining whether volatile organic compounds produced by *Rhodococcus* bacteria, which are found in soils, can kill white-nose spores. During a field trial in Missouri last winter, Cornelison and his colleagues treated bats with such compounds for 48 hours before returning the caged animals to their cave for 4 months to finish hibernating. On 19 May, the researchers released the bats that were free of disease — prompting media coverage of a potential 'cure'.

Cornelison cautions against such