MICROBIOME

Matthew Gandy

This chapter examines the presence of life forms that have flourished on the concrete surface of one of London's best examples of "brutalist" architecture. The conceptualization of concrete as a microbiome brings an entropic sensibility to urban environmental discourse, emphasizing different scales and temporalities that are routinely overlooked within conventional readings of urban nature. It considers how concrete presents something of an ecological paradox: while its production is a significant source of environmental degradation, the gradual weathering and decay of the material itself can support an abundance of microorganisms. It reveals how surface ecologies are a vibrant dimension to the multi-species city.

There is a block of striking university buildings on Bedford Way in central London designed by the modernist British architect Denys Lasdun. This massive structure, completed in 1976, is among the finest examples of "brutalist" architecture, marked by its extensive use of concrete materials (see, for example, Clement 2018). For many years I worked in part of this complex, but

I didn't reflect very much on the building's surface ecologies: my encounters with urban nature were dominated by interstitial landscapes, nearby squares, or the occasional glimpse of an urban fox from my office window.

In order to carry out research for this essay I decided to return to take a closer look at the concrete surfaces that form part of the architectural design for these buildings. As I approached the site on a warm and cloudy July morning, I felt a strange sense of curiosity and expectation. From a distance the buildings presented a familiar gray appearance but as I got nearer I could see a variety of discolored streaks, including rust-colored lines extending below metal bolts and other fixtures. In places the surface of the concrete had become heavily pitted with coarser kinds of aggregate becoming visible. On some of the gently sloping slabs of concrete nearer to street level there were microbial rainbow effects comprising different shades of green and gray. The concrete surfaces displayed a variety of patterns of microscopic life in response to contrasting degrees of exposure to sun, wind, rain, and atmospheric pollutants.

How might we consider concrete to be an ecosystem in itself? The production of concrete forms a part of the multiple extractive frontiers and operational landscapes associated with late modernity (see, for example, Keulemans 2016, and Watts 2019). The abandonment of concrete structures has also formed part of a "ruin aesthetic" with its characteristic assemblages of ruderal and adventive plants. But what I am interested in here are the unseen dimensions to the ecology of concrete: in other words, the diversity of microorganisms such as algae, archaea, bacteria, fungi, and protists that live on the surface of the city. These complex communities of microscopic life constitute what has been called an "urban microbiome," which is a rapidly expanding field of scientific research (King 2014).

These surface ecologies are ubiquitous yet largely overlooked. Sometimes the presence of these organisms is only revealed by visible traces such as "ink stripes" beneath dripping pipes or greenish discoloration produced by chlorophyll. Systematic interest in these urban microbiomes has thus far been dominated

Figure 25.1. Bedford Way, London (July 2021). An urban microbiome has formed across the surface of the concrete with clear signs of biodeterioration caused by organic acids secreted by microorganisms. Photo by the author.

by concerns with the preservation of buildings and other types of concrete structures. Studies have shown how specific organisms such as *Chaetomorpha antennina* (a kind of algae) can colonize concrete surfaces and secrete organic acids that begin to dissolve cement to release calcium, aluminum, silica, and iron needed for the organism's metabolic development. Similarly, the fungus *Aspergillus niger* breaks down concrete through the production of a range of organic acids, leading to the formation of soluble compounds such as calcite and calcium oxalate in a form of "bioinduced chemical degradation" (Roux 2018, 281). In many cases these processes only cause superficial damage rather than structural deterioration but where more complex ecological assemblages develop — such as the presence of biofilms inside pipes — there is the potential for pathogenic organisms such as the gram-negative bacteria *Pseudomonas aeruginosa* to flourish (Roux 2018, 281).

Figure 25.2. Bedford Way, London (July 2021). The greenish dark lower band of coloration is likely caused by algae. Photo by the author.

More recently, as part of a wider upsurge of interest in all aspects of urban nature, there has been closer attention directed toward these unseen ecologies. The study of urban microbiomes has become a focus of scientific fascination exploring hidden dimensions to urban biodiversity including air, soils, a variety of different surfaces, as well as the human body itself which contains trillions of microorganisms. The microbiologist Gary King, for instance, has highlighted how "microbes undoubtedly constitute the greatest reservoir of urban species and genetic biodiversity, exceeding the diversity of all urban plants and animals combined" (2014, 723). The focus on urban microorganisms forms part of an emerging emphasis on "multi-species cities" as an expanded conception of synanthropic ecologies that moves beyond the presence of more familiar organisms that have become adapted to urban life, such as pigeons, rats, or cockroaches.

Urban microbiomes play a significant role in geochemical processes: there are specific physio-chemical properties associated with assemblages of microorganisms. In this sense we are moving away from concerns with the "biodeterioration" of materials toward a recognition that these organisms play a variety of roles within urban ecosystems (Acosta 2021). Examples include naturally occurring bacteria or algae that are capable of "fixing" atmospheric pollutants so that microorganisms might be welcomed within an expanded conception of urban nature on account of their ability to deliver "ecological services" such as better air quality. In this sense we could say that the metabolic activities of microorganisms provide an example of non-human work within the modern city. Yet we encounter a tension in the literature between an anthropocentric emphasis on the usefulness (or otherwise) of nature, and more critical perspectives that explore the affective and ethical dimensions to co-habitation with non-human others. A narrowly utilitarian conception of surface ecologies ignores the aesthetic dimensions to urban entropy and also the possibility for microorganisms to reveal new insights into the ecological characteristics of urban space as a focus of scientific curiosity in its own right.

Microbial traces have been referred to as the "signature" of urban space: they can provide complex information about the material characteristics of specific parts of the urban environment. The surface of the city can provide insights into what has been termed "microbial community metagenomics" as part of an expanded conception of urban ecology (Alberti 2014). The term "metagenomics" encompasses a suite of novel analytical and methodological approaches that can be used for the transformation of the microbial realm into a knowable field of concern. The genetic sequencing of urban space moves beyond the limits of taxonomic knowledge since many microorganisms remain unknown at the species level. There are interesting connections here with debates over the use of DNA barcoding to provide quicker and more accurate appraisals of the living world. Yet the articulation of post-Linnaean classificatory schemas for microorganisms, in which the idea of relations between species is replaced by a matrix of nucleotide patterns, is also suggestive of

Figure 25.3. Bedford Way, London (July 2021). The darker patches are likely created by cyanobacteria. Photo by the author.

a degree of distance from existing modes of ecological research rooted in field observation and relations between organisms.

A fascination with urban microbiomes includes the "swabbing" of the surfaces of the city, including concrete, in order to discover genetic traces of both human and non-human life. Research programs such as the MetaSub project have targeted the microbial ecosystems associated with subway systems, for instance, linking with urban epidemiology and public health concerns (Zolfo et al. 2018). In the context of the coronavirus pandemic there has been intense interest in the longevity of viruses and other potential pathogens that can live on urban surfaces ranging from unseen networks to elements of architecture that are repeatedly touched such as buttons or handrails on public transport infrastructure. The dabbing of "urban swabs" on the multiple surfaces of the city also holds connotations of forensic science practice and the linking of specific sites with the high-tech analytical realm of the laboratory. There is a collaborative and experimental dimension to these new aspects of urban ecology that unsettles existing distinctions between "field" and "non-field" forms of knowledge.

In the case of concrete surfaces, a microbial signature can also be interpreted in terms of the visible hieroglyphics of microscopic life. My aesthetic encounter with the diverse microbiomes of the Bedford Way building brought to mind examples of twentieth-century art. The blocky patches of black, gray, and green coloration can be compared with the later monochrome works of Mark Rothko such as *Untitled (black on grey)* (1969–1970) produced shortly before his death. Similarly, the rough textures and striations caused by microorganisms hold similarities with the cracked and multi-layered canvases of Alberto Burri. In his *Mold (Muffa)* paintings, for example, completed in the early 1950s, Burri sought to emulate the living matter of mold-encrusted surfaces. His sculptural use of ridges and excrescences of paint conveys a dynamic interface between the organic and inorganic dimensions to modernity. The discoloration of urban surfaces illustrates a kind of environmental entropy whereby non-human temporalities intersect with the cyclical dimensions to the production of space.

The idea of a microbial signature can be likened to an urban language inscribed into the surface of the city. These lines, blotches, or swirls of color reveal traces of non-human life that are otherwise invisible to the human eye. In this sense, looking carefully at the concrete surfaces of the city is a kind of "close

Figure 25.3. Bedford Way, London (July 2021). The darker patches are likely created by cyanobacteria. Photo by the author.

reading" that allows the realm of urban microbiomes to be connected with expanded conceptions of urban ecology. The urban microbiome illuminates a zone of intersection between multiple discourses spanning aesthetics, architecture, epidemiology, critical theory, and many other fields. An enlarged conception of urban nature that extends to invisible life forms has the potential to enrich public culture in multiple and unexpected ways.

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