

## Embracing the monsters: moving from infection control to microbial management



“The old world is dying, and the new world struggles to be born: now is the time of monsters.”<sup>1</sup> Slovenian philosopher Slavoy Žižek’s loose translation of *Prison Notebooks*—a series of essays written by Italian communist leader Antonio Gramsci—rings eerily familiar in 2022. Around the world, societies are facing intense pressure due to the accelerating climate emergency and the environmental monsters it is unleashing, which range from rising oceans and scorching heatwaves to a rapidly accelerating cycle of emerging and re-emerging diseases. During the past few months alone, we have seen reports about an ever-increasing number of SARS-CoV-2 variants, Crimean–Congo haemorrhagic fever from Spain,<sup>2</sup> international monkeypox outbreaks,<sup>3</sup> the re-emergence of wild-type poliovirus on the African continent,<sup>4</sup> and the first confirmation of Marburg virus in Ghana.<sup>5</sup> All are taking place against a problematic socioeconomic background of stuttering routine vaccination programmes and rising antimicrobial resistance. By themselves, each event would be worrying. Taken together, they signal the arrival of an era in which pathogen emergence is not the exception but the new normal.

Adapting, surviving, and thriving in this time of monsters will require more than rehashing old preparedness politics and hopes for a reassertion of human control over microbial threats. During what some social scientists call the era of hygienic modernity,<sup>6</sup> societies increasingly relied on a mix of surveillance and biomedical interventions to remove or contain microbial threats. This old focus on containment is no longer feasible in a world where stressed ecosystems leak into each other and international tensions and rising inequality prevent the meaningful strengthening of global health systems.

So how should we react to the ever-increasing number of microbial threats emerging around us? Instead of trying to banish them, we should recognise these monsters of our age as strange and ominous signs—like the Latin root of the word monster—of the precarious state of our wider microbial commons.<sup>7</sup> Although microbes will exist long after our species ends, it is equally clear that humanity is dependent on favourable

microbial environments for its ongoing survival. So far, the innate adaptability of microbes means that much of our activity has been tolerated by microbial communities that have co-evolved over aeons. During the past century, however, the release of unprecedented amounts of antimicrobial substances into our biosphere, climate change, and accelerating human encroachment into previously isolated environments have already resulted in planetary shifts in microbial epidemiology and genetic content that are probably irreversible. If we accept that protecting microbial environments is crucial to healthy societies, we can begin thinking about how to care for these microbial commons instead of merely containing them. Transitioning from containing to curating the diverse microbial environments in and around us will require a broader interdisciplinary discussion about what kind of communities and ecologies are beneficial, or, at least, not harmful.

Although notions to move from microbe hunting to microbial management date back to the early 20th century,<sup>8,9</sup> debates about what is desirable in broader regional or even global microbial environments have so far been secondary to similar discussions focusing on animal-associated microbiomes.<sup>10</sup> As a consequence, we still do not have a definition of microbial sustainability or even microbial health that is commensurable to those developed for the two other domains of the One Health approach—human and animal health—despite the profound knock-on effects it could have in orienting debates about pandemic preparedness, climate change mitigation, pharmaceutical waste management, and antimicrobial resistance. How can one formulate and coordinate meaningful policy interventions that attempt to manage different areas of the microbial biosphere without knowing what kind of long-term goal to aim for?

A first step towards galvanising people to think about a new ecological systems approach to managing microbial environments would be to survey and debate the disciplinary processes that would be needed to merge metrics, such as species and genetic diversity, species-level epidemiology, and metabolic networks, at different spatial scales. Building on the interest in

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the animal gut microbiome could serve as a pathway for such activity.<sup>11,12</sup> The complexity of microbial communities, and our sparse knowledge of them, mean that this discussion will be open-ended; most likely, a collective of metrics will be needed to measure effects on microbial ecologies and genetics with time. However, these difficulties should not preclude us from thinking about microbes and their environments more holistically, nor stop us from shaping policy tools (situated somewhere between One Health and environmental impact studies) around resource use, food production, industrial, animal, and human waste production and management, recycling, engineering, agriculture, and animal and human health care in a way that causes least damage to established microbiomes or even with the aim of restoring lost microbial diversity. In short, we should advocate for a formal microbial health impact assessment of various microbial ecologies in any new policy activity, in the same way considerations are given to the effects of climate change.

The time to integrate microbial complexity in politics is now. Rather than mourn the dying age of containing and mastering infectious disease, we should reflect carefully on what the microbial monsters can teach us about how we should manage and protect our microbial commons in the next.

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