'Microontologies and the Politics of Emergent Life'

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For publication in:
Mathew Coleman and John Agnew (eds.) *Geographies of Power* (2018)
Northampton, MA: Edward Elgar.

Introduction

When Martyn Tranter, a biogeochemist conducting research in Greenland's Kangerlussuag region, forgot his glacier goggles and resorted to wearing tinted cycling glasses, he was surprised to see a kaleidoscope of mauve, green, red, and brown enlivening the ice sheets on which he was working (Witze 2016). While the phenomenon of chromatically-tinged `watermelon snow' has been observed for thousands of years, it is only recently been understood that proliferating microorganisms produce these colour effects as they awake from hibernation during relatively warmer temperatures. As global climate warms and polar ice sheets melt, conditions become increasingly hospitable for algal and bacterial species, as Tranter recognised. But at the same time, microbial ice coloration increases sunlight absorption, which in turn accelerates melting (Witze 2016).

Just as scientists are discovering the positive feedback potential of the ice-dwelling algal blooms on global climate change, they are also realising that this gigantic melting process is liberating unknown numbers and kinds of microbes that have been effectively cryogenized in deep ice reservoirs in both the Arctic and Antarctic (Katz 2012). Microorganisms frozen in the ice during glacial cycles that go back at least as far as the mid-Pleistocene epoch are now thawing out

and re-entering the biosphere after a break of up to a million years. Already, microbes taken from layers of ice laid down over 400,000 years ago have been successfully grown in laboratories.

While they believe these cold-loving organisms pose little immediate threat to the health of larger, warm-blooded creatures, scientists are concerned about their impact on marine ecosystems and on the earth system more generally. One threat they have been considering is that a flood of organic nutrients released from the break up of ice sheets could trigger blooms of `contemporary' bacteria that use up oxygen in the water, contributing to ocean dead zones. Another risk arises out of the possible decomposition of so much organic matter – the biomass of microbes in and beneath polar ice being estimated to be over 1000 times that of the Earth's human population – which would add a massive surcharge of carbon dioxide and methane to the already escalating greenhouse gas composition of the planet's atmosphere (Katz 2012).

Even less predictable are the consequences of ancient `bugs' joining the current web of life. Though they have been shaped by long gone terrestrial conditions, revivified Pleistocene microbes begin evolving afresh, and will once again exchange DNA with their fellow microbes – both old and new. As evolutionary biologist Scott Rogers explains: `What we think is happening is that things are melting out all the time and you're getting mixing of these old and new genotypes' (cited in Katz, 2012: unpag). And nobody, it seems, has any idea of the ultimate consequences of this exchange between life forms once believed to be extinct with those that have evolved to live on the Earth as we know it.

What kinds of political challenges, we ask in this chapter, arise out of situations like this, and how have these predicaments come about in the first place? The question that interests us is where exactly the power is in the multi-species meetings we sketched out above, and where it might lie in a range of other situations in which human beings are currently encountering microbial life forms

and microorganisms are busily encountering each other. This question, we argue, is inseparable from coming to an understanding of the times and spaces in which these encounters take place, or rather, from the space-times that these meetings and mixings themselves help forge or transform.

Over recent years, a rich and fluid set of conceptual approaches has emerged in human geography and cognate disciplines expressly to deal with the sort of interconnectivities, entanglements and enfoldings we have been talking about so far. Geographers, sociologists and fellow travellers have become fluent in the thematization of even the most miniscule creatures, skilled at tracking life's mobilizations and mutations, and especially adept at diagnosing the politics that shapes itself around the living world's incessant vitality. But as this chapter asks, have we gone far enough in our response to the provocation of the microorganismic world? More to the point, have we gone *deep* enough?

While the threat of expanding watermelon snow and thawing prehistoric microbial communities are only now being probed by scientists, microorganisms have been prompting us to act for a very long time. As Sarah Whatmore observes, drawing on the work of Bruno Latour and others, there are certain kinds of events that spark new kinds of collective action - not because they are the stuff of mainstream political concern but precisely because of their strangeness and surprise. There are, Whatmore contends: `moments of ontological disturbance in which the things on which we rely as unexamined parts of the material fabric of our everyday lives become molten and make their agential force felt' (2009: 587-588).

Microorganisms have a proclivity for such disruptions. They or their effects tend to turn up unexpectedly, their arrival frequently threatens our lives or the lives of creatures we value, and they have an uncanny ability to use our own pathways or conveyances with greater efficacy than we ourselves manage. In a related way, sociologist Ulrich Beck (1995: 109) speaks of a new kind of

manufactured accident that `loses its (spatio-temporal) limitations'– thereby posing collective challenges that are a definitive feature of the latest phase of our modernity. But there is an important sense in which microorganisms have been masters of a spatio-temporal undelimitability ever since their emergence billions of years ago (Hird, 2009: 21-6). And a more specific sense in which microbial capacities for mobility, proliferation and self-transformation have played a formative part in the shaping of polities earlier in our modernity than Beck would indicate.

For Michel Foucault, as we will see, attempts to manage the distribution of human bodies so as to delimit the transmission of disease-inducing microorganisms played a formative role in the emergence of modern modes of political ordering, while Bruno Latour tells a story of how microbes came to feature as key actors in the recomposition of 19th century collective life. Drawing on Latour and Foucault, among others, more recent critical thinkers continue to conceive of microorganismic profusion and vitality as an incitement for the rise or intensification of new forms of governance. For a new generation of socio-spatial thinkers, it is the propensity of pathogenic bacteria, viruses and other microscopic agents to both transform themselves and traverse the globe that renders them paradigmatic of a new kind of emergent hazard.

In short, engagement with global microbial agency and with the measures governing bodies take to contain `emergent life' has become a vital impetus for advancing *relational* approaches to space and power. Whether conceived of in terms of networks, assemblages or topological enfoldings, human entanglement with microorganisms is taken to be a prime example of how relations between diverse entities compose or shape the spaces they share. For critical socio-spatial theorists, efforts by political actors to manage these encounters are proffered as evidence that space is the very terrain and medium of power relations. But at the same time, the incessant capacity of microrganismic life to confound these efforts provides the telling reminder that power is always

distributed, an expression of complex relations rather than the sole property of humans or any other category of being.

Using the example of how marine bacteria were enrolled during the Deepwater Horizon crisis to support claims the environmental impacts of spilled oil were not as severe as first feared, we revisit the idea that microorganisms can play an active role in geographies of space and power. For us, however, the depth of uncertainty about the ultimate effects of a proliferation of oil-consuming bacteria not only highlights human-microorganismic relations, it also gestures towards another kind of relating that *does not significantly involve humans at all*. We develop this idea by turning to the issue of the disposal of human discard materials in landfills and its potential long term consequences for microbial life inhabiting the subsurface. Here we find that bacteria, despite a certain recalcitrance to being enroled in *our* politics or knowledge practices, very much have their own spatial relations and power relations.

What our case studies suggest is that the kind of human entanglements with microorganisms that critical socio-spatial thinkers have been exploring are important – but not the whole story. For all our current inter-relating or co-relating with the world of microorganisms, their presence on Earth precedes our own by billions of years. And this means that to a large degree, we humans inhabit spaces and enter power relations composed for us in advance by myriads of ancient microorganisms.

What does this mean for the kinds of `ontological disturbance' microorganismic agency can or might provide to contemporary human existence? What are the implications of microbial life supporting or `subtending' human life for the ways we might think more generally about power relations and the composition of space? Over the course of the chapter we raise some difficult and far-from-resolved questions about whether it is possible to `politicize' microorganisms whose interactions and transformations will probably remain forever opaque to

us. And we begin to ask the broader question of what needs to be done with our current relational geographies if we are to encompass the deep, abyssal domain of subtending relations.

Emergent Life in an Interconnected World

Given their characteristic invisibility and their resoundingly inhuman characteristics, it may seem strange that microorganisms feature prominently at several crucial junctures in social thought. But there is an important sense in which microbes have shadowed many of our `achievements' as a species – including migration and dispersal, animal domestication, food storage and preservation, urbanization, medical advances, globalization – and as their recent appearance in climate change narratives suggests, they will most likely continue to do so.

In the work of Michel Foucault (1997), it is the unforeseen `pathogenic' consequences of intensifying and extensifying human relationships that serve as the `ontological disturbance' that triggers a new political project. As the globe became increasingly traversed through trade, warfare, and colonization, Foucault (1997: 195-200) argues that what began as exceptional measures during outbreaks of plague – draconian controls over the movement of bodies and goods - gradually developed into more mundane ways of organizing collective urban life. Beyond simply controlling disease, the object of this political strategy – what Foucault and others term biopolitics or biopower – comes to encompass the entire biological life of individuals and populations: the ordering and enhancement of desirable vital processes and the corresponding containment or weeding out of what authorities deem to be undesirable. This is tightly coupled with new understandings of the way territory is to be `secured' and administered. As Foucault sums up, `it was a matter of organizing circulation, eliminating its dangerous elements, making a division between good and bad circulation, and maximizing the good circulation by diminishing the bad'

(2007 [1978]: 18).

For Bruno Latour (1988) too, how authorities in a modernizing Europe sought to control the spread of infectious disease features pivotally in his exploration of the shifting relationships between space and power. More than simply repeating the claim that Louis Pasteur broke new ground in discovering causes and preventions of infectious diseases, Latour proposes that the 19th century chemist-microbiologist is best seen as a canny performer of feats of visualisation and an astute constructor of new alliances. Pasteur makes microbes visible, demonstrates how they might be brought under control, and institutionalises measures for operationalizing these controls. And in this sense Pasteur and his allies offer a paradigmatic case of how power comes from making connections, from enrolling other actors – human and nonhuman - and from building robust and enduring networks. As Latour concludes, not only Pasteur and his human accomplices but the microbes themselves:

> are all renegotiating what the world is made up of, who is acting in it, who matters and who wants what. They are all creating – this is the important point- *new sources* of power and new sources of legitimacy, which are irreducible to those that hitherto coded the so-called political space (1988: 40).

Although their approaches differ in important ways, Latour and Foucault share the intent to reveal the work that goes into composing modern political spaces. They each seek to show that, far from being `given', these spaces are the expression of specific ways of intervening in or constructing flows, connections, and circulations. Microscopic pathogens, for both Foucault and Latour, are good to theorise with, we might say, because their disturbingly effective spatial maneuverings help us see our own efforts to order and shape space in a new light. So proficient are microbes at networking or circulating, we gain new perspectives on our own spatial agency through examining the relational and

constructive work we ourselves need to do to try and stay on top of them.

Over the intervening years, social thinkers have continued to find responses to microorganismic agency a fertile site for discerning emergent political and spatial orderings. In the context of accelerating economic globalization, new technoscientific capacities to manipulate life at the genetic level, rising antibiotic resistance, and environmental change favouring redistribution of infectious disease, a new generation of social theorists have been focussing on the global scale of human-microoganismic dynamics. What they have been detecting is a growing anxiety by political authorities over the unpredictable qualities of `life itself': the fear that dangerous biological agents might emerge in any form, at any moment, anywhere in the world (Clark, 2013: 22-4). If threats like HIV/AIDS, SARS, Ebola, bovine tuberculosis or avian influenza reveal the permeability of human and other bodies, so too do they disclose the risks of global interconnectivity. While critical socio-spatial thinkers may themselves share such apprehensions, what concerns them is the way that the fears of `emergent' life is being used to justify new procedures of detection and containment that threaten existing political freedoms (Dillon, 2007). What is worrying about this, as Bruce Braun puts it, is both that securitization is being presented as `the only available response' and that the entire globe is being constructed as a space of intensive surveillance and possible emergency intervention (2007: 15).

In sum, the study of how potential outbreaks of microorganisms (or quasi-life such as viruses and prions) are being dealt with is leading critical researchers to diagnose a rising form of political power whose sphere of action extends far beyond the bounds of the nation state. In this way, the issue of emergent life pits two versions of relationality against each other: putting `official' strategies of securitization up against alternative ways of framing and responding to global interconnectivity, flow, circulation, and networking.

But there are also approaches in which critical attention to these kinds of trans-national connective relations is being supplemented by an appreciation of another kind of `boundary-crossing'. As Steve Hinchliffe and his colleagues would have it, the emergence of an infectious disease involves the crossing of a tipping point or threshold (2013: 538-9). This is a threshold of intensivity rather than extensivity, they contend, a border in the operating state of a dynamic physical system rather than any simple borderline inscribed around a political territory. By this logic even the unsettling of territory by crosscutting flows or networks isn't enough. If our `geographies of infection' are to effectively account for the power of life itself – rather than simply human political power *over* life, Hinchliffe *et al* argue what is needed is a kind of topological folding of the territorial imagination, rather than just its perforation by the relays, flows and circuits that operate on the surface of the planet (2013: 541).

With this sense of a dynamic enfolding - the concern with life passing over thresholds in time as well as space - we suggest, something important is starting to happen to the idea of political space and its ordering. Territorialised spaces – the political divisions inscribed on the Earth's surface - are being opened up not simply to that which is outside, across or even within it, but to that which is beneath or before it – in ways that seem to resonate with our example of ancient hibernating bacteria being awoken by the effects of climate change. What we also want to signal however, is that this idea of life passing into new forms or modalities also seems to be turning up in affirmative appraisal of human-microorganismic relations. Alongside `geographies of infection', cases are also being made for what we might call `geographies of remediation', where attention is on the potential of adaptive and prolific microbial life to solve problems created by injudicious action (Clark, forthcoming).

In the examples we now turn to, the emergent qualities of bacteria are variously presented as promises of *and* threats to human flourishing. We are interested not only in the question of how microorganisms are being enrolled in or as

political issues, but also what the agency of bacteria and other microscopic creatures might tell us more generally about the way we - as critical social and spatial thinkers - conceive of relations. As our case studies prompt us to ask, what happens when the most important relational `entanglements' don't involve humans at all? What kind of politics or power relations are we talking about when the pivotal events may be beyond our practical reach, indifferent to our negotiations, or not even on the same spatio-temporal plane as us?

Human Problems, Microbial Powers

Microbes do not play a significant or even supporting role in the 2016 movie *Deepwater Horizon*, which understandably focuses on the human tragedy and drama surrounding the 2010 explosion on the eponymous drilling rig. But as seepage from the uncapped wellhead grew into the world's largest accidental oil spoil, and concern over impacts in the Gulf of Mexico escalated into one of the worst ever environmental crises, microorganisms came to play a pivotal part in the narrative. For scientific observers, what made the Deepwater Horizon spill unique was not only its scale – an estimated 4.9 million barrels and a slick covering 112,000 km2 of the ocean's surface – it was also the fact a massive plume of hydrocarbons reached a depth of around 1100 metres (Kimes et al. 2014; Beyer et al. 2016). With its widespread impacts on marine life and coastal ecosystems and its devastating implications for human livelihoods around the Gulf, the accident soon escalated into a political controversy – in which questions of culpability and compensation were fiercely debated.

These debates were complicated by the locality of the oil discharge – in particular by its positioning in the deep sea: or what Steinberg and Peters (2015: 247) depict as `the ocean itself … its three-dimensional and turbulent materiality'. This soon came to include the role of biological life – not simply marine ecosystems in general, but the specificities of living communities inhabiting different depths and layers of the ocean (Clark and Hird, 2014). A

crucial question that emerged was the degree to which marine microorganisms would be able to consume and degrade the submarine hydrocarbon plume. With a speed and efficacy that would likely have surprised even Pasteur, bacteria that few people even knew existed were enrolled as major actors in the political spaces that took shape around the spill.

Although offshore oil drilling had been taking place in the Gulf for over 50 years, and despite the fact that bacteria have been consuming naturally occurring hydrocarbon seepage in the marine environment for hundreds of millions of years, prior to the disaster `relatively little was known about northern Gulf of Mexico bacterioplankton' - especially with regard to their diversity (King et al. 2015: 379). Early scientific evidence suggested that blooming populations of microorganisms were making short work of consuming the hydrocarbon plume (Hazen et al. 2010). `The microbes did a spectacular job of eating a lot of the natural gas', concluded biogeochemist Chris Reddy, adding "The rate and capacity is a mind-boggling testament to microbes" (cited in Biello 2015 unpag). In a widely-reported public lecture at the University of Southern Mississippi entitled `Can Mother Nature Take a Punch?: Microbes and the BP Oil Spill in the Gulf of Mexico', microbiologist Terry Hazen answered largely in the affirmative, recounting that bacteria pre-adapted to the natural presence of hydrocarbons in their ecosystem had thronged to the plume like "oil-seeking missiles" (cited in Kirgin, 2011 unpag). Unsurprisingly, this was a narrative that appeals to powerful vested interests in the oil economy. Six years after the event BP senior vice president Geoff Morrell, picking up on the microbial remediation narrative, insists: `There is nothing to suggest other than that the Gulf is a resilient body of water that has bounced back strongly' (cited in Elliott, 2015).

However, the success of the microbial clean up has been strongly contested. Even after the publication of over 500 scientific research papers on environmental impacts of the spill, there remain large areas of uncertainty about the microorganismic response to the massive hydrocarbon influx and its

ecological consequences (Beyer et al.: 2016: 29; King et al. 2015: 392). Earlier research suggested that the enhanced oxygen consumption of the bacteria that consumed the spilled oil could be having severe deleterious impacts on photo-synthesizing marine bacteria (Widger et al. 2011). As time went on, one of the major unanswered questions was what became of contaminants as they moved through and up the marine food web – as hydrocarbon-consuming bacteria, archaea and micro-fungi were in turn consumed by other organisms (Beyer et al.: 2016: 35).

But this kind of profound and lingering uncertainty is difficult to get and keep on the political agenda. That `global' concern amongst political authorities with the transgressions of `life itself' that we looked at above, it would appear, has its limits. For the apparatuses of surveillance and the procedures of securitization that have so interested critical socio-spatial thinkers seem far short of capturing the distant and complex communities of the marine ecosystem.

What might this tell us about the political geographies of `emergent life' in the contemporary world? Bacteria that willingly consume oil pollution and potentially pathogenic microorganisms have at least one important thing in common: they are both bound up with human actors in ways that can be, with a little effort, brought to light. Their worlds and our worlds are mutually implicated, or in the language of relational ontologies, *co-enacted* (see Clark, 2011: 30—34). So too, it has been argued, are `we' entangled with the ocean itself, which Steinberg and Peters describe as `a volume of vibrant matter that is enlivened and made forceful through its *relation* with human life' (2015: 256 authors italics). But a big part of the `ontological' trouble with oil-consuming bacteria as they or their residues negotiate complex marine food webs would seem to be that any such relation to humans withdraws deep into the distance.

From the perspective of the marine organisms themselves and from the vantage point of the many human actors - who will unlikely ever fully access the

ecosystem dynamics in question - the relationships that count have effectively ceased to include humans (see Clark, 2011: 46-50). And this, we would argue, has important implications for the way socio-spatial thinkers might conceive of `*new sources* of power' and constructions of new political spaces. In our second example – which concerns encounters between microbes and diverse materials consigned by humans to subterranean spaces, we probe this sense of constitutive relations that exceed the human and the profound challenge they pose to inherited political architectures and imaginaries.

While the Deepwater Horizon oil spill suddenly `broke' as a political issue, the question of what to do with waste generated by modern production processes and consumption patterns has been moving up political agendas for many decades – though not quickly enough for those concerned with the environmental or public health effects of current disposal practices. It is estimated that 95% of all refuse worldwide is disposed of by burial in the terrestrial subsurface – otherwise known as landfill (Hird, 2013: 111). There are, in some places, political aspirations towards complete recycling, just as there are visions of a massive rollout of bioremediation - the use of microorganisms to safely break down harmful components of modern waste (Clark, forthcoming). But the current and foreseeable situation is that most waste ends up unremediated and underground (Hird, 2013: 116).

In many senses, the practice of storing human refuse subterraneously might be viewed as a kind of terrestrial Deepwater Horizon - only on a massively extrapolated and temporally extended scale (Clark and Hird, 2014). Whereas the relatively narrow spectrum of the marine bacterial phyla that benefitted from the Gulf spill were fuelled by a fairly uniform feedstock of petroleum hydrocarbons, waste matter intentionally deposited in landfills is generally characterized by the heterogeneity of ingredients unique to each individual landfill. Depending on its spatial location and the period in which it was operative, any given landfill might contain chemicals whose health and

environmental consequences are well-known, chemicals that have since been prohibited or are banned elsewhere, and those whose long-term consequences are scarcely known at all (Hird 2013). Once in the ground, at least in some highly regulated western social formations, sophisticated containment techniques involving different kinds of liners, cells, and covering contain this material for periods of time. These differences or inconsistencies are greatly intensified when we consider the uneven geography of disposal contents, practices, and regulations across the globe.

A landfill anywhere on the planet is likely to contain a sample of the seven million known chemicals (including the 1000 or so new chemicals that enter into use each year), along with a full spectrum of organic matter, which might include any number of the 14,000 food additives and the manifold contaminants found in our food scraps (Hird, 2012). To give one example, when food is recalled from supermarket shelves, it often ends up in landfills. XL-Foods, Canada's largest food processor, processes over 40% of the country's cattle and accounts for 30% of the beef on store shelves. In the fall of 2012, approximately 5.5 million kilograms of beef presumed to be contaminated with *E. coli* was recalled, equivalent to 12,000 cattle. Of that, 500,000 kilograms were landfilled. When XL-Foods wanted to re-open their plant to resume production, they were required to do a pilot test to ensure their corrective measures after the recall were effective. This test required the slaughter of 5000 cattle, the carcasses of which were also landfilled after being tested for contamination, regardless of whether they had themselves been contaminated (see Lougheed and Hird, forthcoming).

It is here, in landfills, that microorganisms enter the story, though they are, of course, always already present in organic and other refuse. Once in the ground, bacteria get to work on the more easily metabolized ingredients of refuse, converting them into a heady soup or `leachate'. Landfill containment, however technologically advanced, is understood even by its constructors to be

impermanent, making it inevitable that leachate will eventually seep into the surrounding soil (Hird 2012).

Leachate consists of a heterogeneous mix of materials that may contain heavy metals, endocrine disrupting chemicals, plthalates, herbicides, pesticides and various gases including methane, carbon dioxide, carbon monoxide, hydrogen, oxygen, nitrogen, and hydrogen sulphide (Hird 2012: 457). Here again, as percolating fluids escape, microorganisms come into the picture. For the terrestrial subsurface, even more than its oceanic counterpart, is populated by complex and diverse micro-ecologies: bacteria, archaea, fungi, algae, and protozoa. Indeed with some 40 million microorganisms inhabiting every gram of earth, microbial life is populous and metabolically active that it practically *is* the soil (Clark and Hird, 2014: 45-6).

What happens then is even more difficult to ascertain or predict than the ultimate fate of hydrocarbons in marine ecosystems - given that the composition of the average landfill may well be the most rich and heterogeneous `feedstock' to which microorganisms have been exposed at any point in their three and half billion year history (Clark and Hird, 2014). Like miniature ocean currents, subsurface flows of water extend this process spatially and temporally - potentially conveying uncollected leachate through the pores and seams of the Earth's crust in the direction of ever more distant microbial populations. Here too, as in our opening example of awakening ice-bound bacteria, communities of microorganisms that have evolved separately over extended geological periods are brought into contact and will likely exchange genetic material. Which bacterial taxa are present at each stage of this trajectory, which populations will be deleteriously impacted by the specific mix of chemicals or chemical-nourished fellow microbes they are exposed to, and which will adapt and proliferate under novel conditions are queries of almost unfathomable complexity. They are questions that are effectively unanswerable (see Clark and Hird, 2014: 48).

Again, this prompts us to ask - in a world in which anxieties about `emergent' microorganismic life is purportedly one of the prime incitements for the advance of novel political techniques and whole new global regimes of governance - where is the politics of landfilling? Given the vast regulatory, engineering, transportation, science, policy, governance, behavioral, and other infrastructures and processes necessary to maintain our modern waste management system, it is remarkable that waste is globally, for the most part, so unremarkable. The current politics of waste has rendered it a normal part of everyday life, as inconspicuous as it is unremarkable (Hird et.al. 2014; Hird 2015). This is achieved through the cooperation of waste management corporations and, typically, small regional governments. With in-house engineers and scientists, networks with government, and sophisticated, well-budgeted, in-house public relations management teams, these corporations and their brokers increasingly manage regional and public discussions of waste management through feasibility reports, town hall meetings, presentations, and other forms of consultation that organize a particular kind of public and their participation in discussion and decision-making. And this politics of public participation remains firmly focused on relations between humans and our infrastructures, regulations, and policies. The microbes feeding on our waste stocks are framed within technological discourses of containment and control, and their non-containment is dealt with politically in terms of responsibility and liability (ibid).

In some places, waste disposal becomes an issue of a lively and contentious material politics (ibid). How much refuse could be reduced or recycled, whether it is preferable to incinerate or bury waste, where landfill facilities should be cited, whether or not waste should be inter or intra-nationally exported or imported, whose responsibility – state, industry, local government, citizenry – is the mounting mass of waste? These are all questions that are being subjected to political debate, especially when waste is brought to our attention through such ontological disturbances as garbage collection strikes, tankers filled with

waste attempting to dock and discharge their waste, or when landfills leak, explode or catch fire. But what is the most far-reaching and serious impact of subsurface waste disposal in this political landscape? Where are the impacts on, and the agency of, bacteria?

Thus, at present, concern about the long term impact on microorganisms of the massive, globally-distributed practice of consigning human refuse to (temporary) subterranean spaces is largely confined to technical and scientific practitioners who specialise in certain aspects of the disposal process and its consequences. Is this oversight a matter of the material politics of the waste-microorganism interface still awaiting its Pasteur? There is more at stake than this, we would insist, for the waste predicament is not just a question of how mainstream politics chooses its issues or stages its controversies (Hird 2015; Hird et.al. 2014). It is also, we contend, a question of the kinds of relations, the sorts of entanglements that critical social, political, and spatial thinkers have been putting on the intellectual agenda. It is as much *our* problem. In the final section, we consider the question of what kind of political challenge - for ourselves as analysts of space and power – might arise out of closer attention to the `microontologies' of the planet on which we find ourselves.

Microontologies and Subtending Relations

Earlier, we suggested that the encounter between critical socio-spatial thinkers and dominant political approaches to threats of emergent life might be seen as a clash of different ways of conceiving of relationality – especially at a global scale. If on the mainstream side `securitization' is increasingly rolled out as the only viable option, critical commentators are more likely to explore other possibilities – such as acknowledging the inevitability that humans and nonhumans will share networks, and seeking to negotiate this coexistence in flexible and dynamic ways (see Hinchliffe and Bingham, 2008: 1547-8). Our

sympathies lie emphatically with the latter. But there is another sense, we would argue, in which both sides of this debate adhere to certain assumptions about the composition of spaces that encompass human-nonhuman interactions - and the associated opportunities for effective collective action. What our analysis thus far has been building towards is a fundamental questioning of these assumptions.

Understandably, when politics – mainstream or alternative - engages explicitly with biological life, the focus tends to be on the *entanglement* of humans with other potentially significant life forms. Indeed, in much critical socio-spatial thought, a clear mapping out of the relational materialities that bind humans and nonhumans often seems to be the very basis for the positing and exploration of political possibility (see Clark, 2011: 30-34; Barnett, 2008). In this regard, politics worthy of the name concerns itself with the knots of relating through which human actors and their more-than-human counterparts mutually construct one another. The question, as it is often posed, is how might these relationships be organised in ways that are more just, more careful, more enabling of mutual flourishing (see Bennett, 2010: 12-19). As in the critical approaches to emergent life we touched upon earlier, `progressive' politics aspires towards a collective making of space in which modes of relating themselves are up for consideration – as opposed to those forms of politics favouring spatial orderings that would seek to confine different types of being to some pre-given position or role. And in this way, space is seen to be an expression of power relations, while power itself inevitably operates in and through space.

But what happens when significant aspects of a situation or predicament involve relations in which humans are not present – or in which they are so distant or marginal as to be ineffectual? The examples we have looked at –thawing Pleistocene bacteria, dispersal of degraded hydrocarbons through marine food webs, trajectories of leachate through subterranean micro-ecologies – each

involve human agency at some vital point. Each of these situations has the potential to impact back upon human lives, at some spatially and temporally indeterminate moment, with severe consequences. But a common refrain in our case studies has also been that substantial sequences of each story unfold in domains in which human presence is negligible or non-existent. Here too – within and beneath polar ice sheets, deep in the ocean, in subterranean pore spaces - there is plentiful entanglement and co-enactment taking place. It is just that none of the key participants happen to be human (see Clark, 2011: 46-8; Clark and Hird, 2014: 50-1).

It could be argued that human agency – climate change, oil discharge, landfilling- is the trigger of the predicaments in question. But we need to question assumptions that the igniting spark or force of inauguration lies solely or even primarily with ourselves. And in this regard, like many of our predecessors, we find microorganisms extremely useful to think with. For us, the crucial point here is not simply that microorganisms respond in obscure and unpredictable ways to our provocations. It is as much that microbial communities are capable of reacting in multiple ways to heterogeneous or novel stimuli because this is what they have been doing ever since life emerged in the Archaean epoch some 3.8 billion years ago (Hird, 2009: 21-6)

The point we are getting at here is that, as a platform for staging the politics of human-nonhuman relations, ontologies that hinge upon co-enactment tend to bypass considerable stretches of geologic and evolutionary eventfulness. To put it another way, prevailing modes of relational materialism – with their insistence that world-building activities are *socio*spatial - are generally not strong on space-shaping processes that precede or exceed any human presence. By contrast, our case studies oblige us sooner or later to face up to the claims of evolutionary biology that for at least 85 percent of the Earth's history, its biota consisted solely of microorganisms (Smil 2002). If we pursue their incitements, our contemporary `microontological' concerns draw us back to the first 2.5

billion years of terrestrial life in which single and multi-celled organisms from the Bacteria and Archaea domains were the only life forms around; they invite us to consider how the proliferation, promiscuous exchanges, and evolutionary radiation of these primordial communities generated our solar system's only biosphere; to recognize that bacteria continue to perform the (re)cycling processes of oxygen, nitrogen, phosphorous, sulfur and carbon and other elements crucial to life on Earth (von Helmholtz 2007).

Ultimately, we contend, any confrontation with `emergent life' in the current context lacks a vital depth if it fails to acknowledge that microbial life invented the basic metabolic processes, including photosynthesis and chemical conversion, that every other life form remains utterly dependent on (Hird 2009, 21–57, 133–143). For it is this proficiency at metabolising available matter-energy, everything from solar radiation to organic matter, metallic ores to acidic sulphates, we would insist, that make bacteria such dynamic actors when they encounter the accidental or incidental byproducts of our own productive processes. To which we might add that without photosynthesising bacteria there would be no reserves of fossilised biomass to fuel human industrial production. And given that microorganisms provide the basic cellular and metabolic componentry from which all multicellular life has constructed itself, without our bacterial building blocks there would be no humans to extract oil, to generate mountains of waste - or to collectively contest these practices. Or to spell it out, the power of microbial life is the condition of possibility of our own existence as social and political beings.

By this logic, Latour was surely right to conceive of microbes as active partners in `renegotiating what the world is made up of, who is acting, who matters and…. creating ….*new sources* of power'. Microbes are indeed consummate networkers: globe-spanning, promiscuous and cosmopolitan in their interconnectivity (Clark, 2000: 25-7). But what we need to keep in mind that they are amply capable of doing all these things on their own, whereas human modes

of relating – whether local or global – would be unthinkable without the platform provided by bacterial life (Hird, 2009: 83-90). So we would argue that the indeterminacy of microorganismic responses to the physico-material provocations of human actors derives not so much from our mutual entanglements - as from the profound *asymmetry* of these relations (Clark and Hird, 2014: 50-1). It is effectively impossible for us for predict or even apprehend what microbial life makes of `our' stuff because this is, always has been, and in all likelihood will remain, a world largely of their making.

This leads to a more general point. As we have been noting, the prevailing ontological orientation of contemporary relational materialist approaches to questions of space and power hinges on notions of human-nonhuman co-enactment – which is to say that it is potentially within our grasp to collectively recompose the spaces we share with other beings or entities precisely because we are always already in relations with them. That may be true, we suggest, but only to a point. As a very recent presence on this planet, `we' are constitutively entangled with nonhuman others. But those that have been around far longer than us are by no means `always already' enmeshed with us. So for us, thematizations of human-nonhuman entanglement and co-composition do sterling work at the sites or zones at which we and our others are co-present. But if we are to journey beyond this rather slender province of co-existence, we would argue, such approaches need a supplement. They need a way of conceptualising the antecedence, the dependency, the radical asymmetry that characterize `our' relationships with the domain of microorganisms and with much of the rest of the living and geologic Earth. In short, we need a theory of `subtending relations' (see Clark and Hird, 2014: 50-51).

Subtending relations can be defined as transactions in which one realm or field of existence provides the conditions of possibility for that which emerges out if it or comes to pass within it (Clark, 2016a: 134-6; Grant, 2011). In critical social and philosophical thought, such modes of relating seem to have been unpopular

for some time, perhaps because they are often misconstrued as determinism – the idea that earlier or more basal forms preordain all that is yet to come. As the microorganisms we have been thinking with ought to make abundantly clear, what we find when we look before, beneath or beyond human worlds tends to be an excess of possibility rather than the grip of necessity or determination.

What, then, could a more intense focus on subtending relations do for the kinds of problems or predicaments we have been looking at in this chapter? What might it do for the way we imagine power relations and the collective project of shaping and reshaping the spaces we inhabit? Perhaps, for all the commitment we share with other progressive thinkers to opening up the sphere of political contestation, we should not be afraid of acknowledging that there are real – if shifting and indefinable – limits to what `the political' can achieve. Like many other inhuman forces that radically precede human presence on this planet, microbial agency is an insistent reminder that there are still vast reaches of existence that at any moment exceed the reach of collective human decision-making action.

And so rather than imagining that the ontological – the domain of what we (at least provisionally) accept as existing – overlaps fully with the political, it might be more judicious to recognise that all political acts will sooner or later confront an exteriority than resist capture and internalization. Or as literary theorist Claire Colebrook puts it: `our' politics inevitably comes up against the `monstrously impolitic' (2011: 11). As Colebrook would insist, however, it would be short sighted to conceive of this shifting interface between the political and its outside as a constraint or limiting factor. Precisely because the inhuman forces out of which human worlds have emerged are vast, unbounded and dynamic, because the potentiality of this `ungrounding ground' always exceeds the actual forms or expressions it has given rise to, an avowal of subtending relations is above all a way of opening up possibility (Clark, 2016a: 135-8; 2016b

17-19).

How might such an understanding of power – in the very broadest sense - help us to collectively construct more liveable, more equitable and generative spaces? How might it aid us in engaging with emergent challenges such as the appearance of bacteria from a past geological epoch or the obscure, intractable blooming of microbial populations in response to novel surges of `feedstock'? There are, we concede, no easy answers to such questions. It is integral to our argument than any ontology worthy of the name ought to be wide-open and immodest in its embrace, whereas politics tends to be a more cautious, modest activity. Even if an ontological gesture such as our subtending vision of microorganismic worlds points in certain directions, there is no necessity for politics to follow. And no guarantee that any politics that does follow would be of the kind that we desire. A politics that incited by novel or emergent events – sparked by `ontological disturbances' - is one that requires the work of issue formation, the assembling of a public, the labours of setting, and sustaining agendas. No less than maneuvering of microorganisms, the timing and the content of human political mobilizations characteristically defy prediction. But what we would suggest is that the collective task of learning to live well in a world of microorganisms is a vast and unending one, a project we have barely begun.

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