"Microbial Representations in Yong's *Multitudes* and Sterling's *Schismatrix*"
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How has the recent blooming of microbiome science sparked our imaginations? The imagination of course is essential for understanding the unseen abundance of microscopic life as well as for responding to that understanding. Furthermore, what literary resources might we tap to foster our microbial imaginations? I think these questions are foundational for properly addressing what are arguably higher-stake problems from the status of the human individual's identity, biological or otherwise, to debates regarding the engineering of microbes for industrial, medical, and environmental purposes. To that end, this talk provides a groundwork exploration of how we talk about microbes.

I. A Multitude of Metaphors in Ed Yong's *I Contain Multitudes*

I will focus on Ed Yong's 2016 popular scientific account of microbiome **science**, *I Contain Multitudes: The Microbes Within Us and a Grander View of Life*. Yong is a science journalist who **writes** regularly for *The Atlantic* and posted videos on **YouTube** for a short while. To help synthesize an extensive set of scientific texts and interviews throughout the book, Ed Yong also develops numerous metaphorical representations of that material. Each chapter deploys a dominant metaphor to relate the details of microbiome research and their significance for understanding the human's place in a world constituted by

microbes. These linguistic techniques help to overcome the tension between the **microbiome's** "inevitable presence" and "invisible" scale. **Yong** "want[s] to show [us] what the animal kingdom really looks like." Without understanding microbiota and the symbiotic relations in which they **participate**, "we are looking at our lives through a key hole," writes **Yong**. "This book will open the door fully."

These quotations are from the book's first chapter, which is worth addressing at length for how it frames metaphors as making Yong's presentation of microbiome science possible. As you surely noticed, **vision** frequently stands in for knowledge and awareness. As Yong concludes the first **chapter**: "This is the living world as it actually is, and although it is still invisible to my eyes, I can finally see it." Here, Yong fills out the ocular paradigm with the phrase, "the living world as it actually is." To see the unseeable: this is to approach (a more) complete reality.

To calibrate this invisible vision, chapter one opens with, and recurs to, a conventional trope lifted from astronomy and geology: a spatial representation of **time**. Yong deploys a calendar year and a clock to imagine a chronicle of the Earth's deep history. While humans showed up no more than 30 minutes ago, and plants and animals in early October, microbes have been around since March. Organisms that are visible to the human eye therefore occupy a "coda." The definition of "coda" is "a concluding passage," "typically to a basic structure." This paints microscopic lifeforms in a privileged light both in temporal and

structural terms. The Anthropocene, Yong writes, could be set within, and on the basis of, an ongoing "Microbiocene."

Even before the first paragraph, the first chapter initiates the book's metaphorical work with its **title**, "Living Islands." At the macroscopic human level, no one is an island because of how social we are and how we interact with the world. But to **microbes**: "In fact, every individual is more like an archipelago —a *chain* of islands. Each of our body parts has its own microbial fauna, just as the various Galapagos islands have their own special tortoises and finches." Yong is saying that how animals presented their island-specific diversity to Charles Darwin applies just as well to the countless ecological niches inhabited by microbiota. Differentiation among macroscopic organisms, from body parts to individuals to species, serves as a recognizable parallel as well as a basis for the evolutionary differentiation of **microorganisms**. "They behave like a hidden organ," Yong explains.

At the book's outset, Yong therefore establishes a continuity between more familiar organisms and microbiota not merely in terms of biological processes but particularly in the way they are discussed. Just as macroorganisms are a natural extension of microorganisms, so too does the way we talk about the microbiological extend from how we already talk about the macrobiological. Indeed, after mentioning DNA and ATP, Yong invokes language as a medium that

renders disparate biological scales **commensurable**:

> "Picture a BLT sandwich: every component, from the lettuce and tomatoes to the pig that produced the bacon, to the yeast that baked the bread, to the microbes that surely sit on its surface, speaks the same molecular language."

In this passage, language both is a metaphor and encapsulates a slew of other metaphors: information and coding, currency, a sandwich, and arguably the notion of a machine associated with the word "component." Later in the book, Yong reups this framework of speech as second-order metaphor when he **writes**: "Our relationship with them isn't a one-off exchange but a continuous negotiation." Within another paragraph from chapter one that seeks to express the versatility of bacteria and their necessity for life as we know it, Yong uses a series of active verbs that implicitly place the human into the position of passive **object**: they "help to digest," "produce," "break down," "protect" by "crowding out" and "killing," they "guide," "educate," and "contribute." The only treatment of microbes as a grammatical object in this passage reinforces their productive **agency**: "we have outsourced surprising aspects of our lives to them." (Aside about outsourcing as starting from a coherent human.) The microbial subject in these sentences is repeatedly the third-person plural "they." Thus, Yong develops a two-sided strategy for appreciating the scope of microbial activity. On the one hand, the

microbiome is a teeming plenitude of diversity, while, on the other hand, these different functions can be reduced to an amorphous, omnipresent, seemingly omnipotent collective subject.

I could spend hours going through *I Contain Multitudes* to analyze its many metaphorical depictions of microbiota. **Yong**, I think, is very good at sustaining a particular analogy throughout a single chapter's topic all the while developing relatively short-term metaphors within that frame. [About the slide: cf. Emily Martin.] Instead, I'll now take a cross-sectional look at the recurring paradigm of technical utility. By "utility" I mean to highlight that what matters most in Yong's account is the function fulfilled by microbes for us and other plants and animals; by "technical" I mean to call attention to how this functional representation draws from the conceptual resources of already existing technologies.

In order to express just how important microbiota are to the biosphere, Yong frequently writes such lines as the **following**: "Without microbes to extract as much nourishment as possible from tough indigestible mouthfuls, these herbivores wouldn't exist. We wouldn't, either." Microbes share their agency by serving as necessary prostheses for macroorganisms. For example, different types of termites have different microbial methods of digesting wood fiber. In African macrotermite mounds, the queen lacks gut microbes altogether. "**Instead**, she relies on her worker daughters (and their microbes) to feed her. Her entire colony—thousands

of workers, billions of microbes, and giant nests laced with wood-breaking fungus —functions as her gut." Yong describes an exosomatic logistics network wherein to block one point of circulation would halt the entire ecological circuit. These **termites** "are ecosystem engineers. In the savannah, they secretly run things; or rather, their microbes do."

Yong also applies this paradigm of technical utility to the microbiome in its technical sense: the genomes belonging to a set of microbes. Consider desert woodrats in the Mojave desert: rodents that regularly eat the resin-covered leaves of the creosote bush thanks to the genetic specificity of their gut microbes. Yong refers to this evolutionary adaptation as "**experience**" and calls the Mojave woodrats "**veterans**" as compared to their "naive" northern cousins who live in an area without creosote. In experiments, giving Mojave desert woodrats **antibiotics** "reversed 17,000 years of evolutionary experience and turned the veteran creosote-eating rodents into complete amateurs." As for the reverse, feeding some fecal matter from Mojave woodrats to the rats in the Great Basin Desert to the north established in the latter's gut a microbiome capable of safely digesting creosote leaves. Yong relates the **process** as: "Naïve no more, they had gained millennia of experience in just a few meals."

This language of experience as an expendable material reflects the progression mechanics in a role-playing **game**: "Eventually, the rats unlocked the

ability to eat what would soon become the most common plant in the Mojave." Yong could be discussing not an evolutionary tree but a skill tree or tech tree featured in a variety of computer games. Likewise, speaking of bacteria that protect mountain pine beetle larvae from pine trees' defensively produced terpenes, Yong **explains** that they "possess a large suite of genes for degrading terpenes." Or **again**, the spider mite "packs an arsenal of detoxification genes, which are variously activated depending on the plant it decides to drink from." Yong is far from the first to deploy human-technology relations as an analogy for a microbial context. For instance, microbiome researchers Eshel Ben-Jacob and Herbert Levine **refer** to the "self-engineering capabilities of bacteria." Two decades prior, K. Eric **Drexler** invoked the biological cell as a proof of concept for self-replicating nanobots. Per Colin Milburn's **account**: Drexler models nanotech assemblers "on biological 'machines' like enzymes, ribosomes, and mitochondria—even the cell" (Milburn, *Nanovision* 19).

To encapsulate the breadth and speed of this fluctuating diversity, as well as to suggest what it means—and could mean in the future—for us humans, Yong offers a **science fiction**: "imagine a world where friends and colleagues can swap genes at will." Here his metaphors get the better of him: the dynamic scheme of interrelation has been replaced by a liberal economic marketplace for the free exchange of genetic tools and microbial prostheses. Problematically, this implies

an overly static macroscopic individuality that serves as a stable basis or core from which to engage in microbial experimentation. On the whole, though, Yong respects the ecological complexity argued for by microbiome scientists. His rhetorical strategy of metaphorically equating the micro with the macro brings out a productive tension between anthropomorphizing microbes and turning us into microbes. Anthropomorphism might be a good thing for undoing anthropocentrism —but only when paired with its inverse. Let's pursue Yong's science-fictional turn with a sci-fi novel that frames humans in intimate connection with, and even as, microbes.

II. Invisible Mess in Sterling's *Schismatrix*

Schismatrix, Bruce Sterling's 1985 sort-of-cyberpunk space opera, is a strange book: part cosmic epic starring humanist romantic Abelard Lindsay, part speculative chronicle in which the characters are ideologies and galactic corporate-states. Sometimes it leaps from scene to scene by the decade, from putting on a Shakespeare play to earn money on a corporate artificial world in lunar orbit to a woman whose flesh becomes a building. Most humans left Earth after a series of environmental catastrophes and developed into two dominant **factions**: the Shapers and the Mechanists. Mechanists are the human-machine hybrids we typically think of as cyborgs or posthumans, and what Shapers pejoratively refer to as "**wireheads**." Shapers, by contrast, wield "**psychotech**" to train the flesh at an

extreme level of detail and control (66). This is the split whence a multiplicity of clades differentiate in order to adopt, adapt to, and create as many ecological niches as there are "**multiple humanities**." (Define "clade.")

Ordinarily my reading of *Schismatrix* hinges upon the lateness with which the term "**posthuman**" appears (109). It denotes the subsumption of post-Earth human societies into the trade network of a mercantilist species of aliens who call themselves the Investors. Returning to the novel now, however, I am inclined to focus both on the prevalence of microbes as well as on the extent to which the narrative's human-scale and interplanetary action analogizes the fluctuating diversity of microbiota. Sterling's diction shares some of Yong's own linguistic strategy, as critics like Scott Bukatman have **noted** how it "conflat[es] a number of irreconcilable terms such as life/nonlife, biology/technology, human/machine" (Bukatman, *Terminal Identity* 277).

But first, from where does Sterling's multiscalar, ecological sensibility derive? In his introduction to the collection *Schismatrix Plus*, Sterling lists **three books** with scientist authors. For all three sources, he seeks not the accurate translation of scientific conepts but language's ability to invent new feelings, images, and ideas. Here's what he says of Ilya **Prigogine**:

> "...awesomely beautiful scientific jargon ...otherworldly majesty… resembled Scripture. […] I used his terminology as the basis for the Shaper/

Mechanist mysticism. It worked like a charm."

When Prigogine read some of the Schismatrix short stories, he "remarked perceptively that these stories had nothing whatever to do with his Nobel Prizewinning breakthroughs in physical chemistry. Well, that was very true, but charms are verbal structures. They work regardless of chemistry or physics." Great—that gets me off the hook for reviewing my grad school notes on Prigogine's far-from-equilibrium thermodynamics. Nevertheless, Sterling brings to bear on his world-building a sensitivity for lifeforms big and small, whether enduring or brief, and to the emergent unpredictability that comes with complex systems.

On one hand, *Schismatrix* glimpses some future scenarios toward which Yong gestures when he **says**, "The world around us is a gigantic reservoir of potential microbial partners." On the other hand, *Schismatrix* takes place on a long enough timeframe with enough speculative originality that the worldly agency of microbes gets its due, whereas Yong's explanatory focus and optimism centers on the use-case scenarios in which microbes have an agency akin to a prosthetic functionality.

Sterling includes some of the latter, to be sure, like the "**rejuvination virus**," which eats away at old skin during two decades and leaves behind a fresh epidermis. But for the most part, microbes are simply there, constitutive of the environment, contributing to the unique makeup of **worlds**:

> "The smell was vile. Each of the ten circumlunar worlds of the Concatenation had its own native smell. [...] His nose began to run.
>
> "Every Concatenate world faced biological problems as the habitat aged [...]
>
> "Fertile soil required a minimum of ten million bacterial cells per cubic centimeter. This invisible swarm formed the basis of everything fruitful. Humanity had carried it into space" (12).

When traveling to a new planet, one's microbiome must adapt to the novel microbial flora both on the spaceship and at the **destination**. A nerdy drinking game could be devised for the audiobook revolving around the frequency of words related to microbially induced **effluvia**. Characters are constantly coughing, sneezing, and observing smaller organisms consuming their bodily detritus. There's some overlap with Yong's emphasis on the invisible necessity of microbes, but Sterling also emphasizes the messiness of microbes—something that is more at home in Steve **Mould's** microbe primer for kids (there's a lot of fart humor).

And this microbial shaping of worlds shapes the protagonist's **ethics**: "Worlds were frail places," Lindsay reflects. "The safety of worlds was the universal basis of morality" (13). Sterling's microbial realism, if you will, does much more than signal a scientifically critical perspective on a weird, disgusting

reality—i.e. the respective elements in Darko Suvin's generic definition of science fiction as cognitive estrangement. It proposes that we adopt an ethics of care toward a constantly ramifying invisible world that may well always already be in the process of alienating our present reality, of alienating us. The microbially churning worlds in *Schismatrix* lay the fictional groundwork for a story in which characters continually recreate themselves. Yong says that the flux in our microbiomes enables the stability of ourselves. Sterling, by contrast, throws that macroscopic stability into flux, partially due to the microscopic generation of the world. The just quoted passage about bacteria in the soil **continues**:

> "Without bacteria, the soil was a lifeless heap of imported lunar dust. With them, it was a constant mutational hazard.
>
> "The Republic constantly struggled to control its Sours. In the Zaibatsu [definition: 'a powerful financial and industrial conglomerate of Japan' (Mir-Web)], the souring had become epidemic. Mutant fungi had spread like oil slicks, forming a mycelial crust beneath the surface of the soil. This gummy crust repelled water, choking trees and grass. Dead vegetation was attacked by rot. The soil grew dry, the air grew damp, and mildew blossomed on dying fields and orchards, gray pinheads swarming into blotches of corruption, furred like lichen…
>
> "When matter reached this stage, only desperate efforts could restore

the world" (12).

We are told about refugees forming their own nomadic societies when forced to relocate when such worlds are sterilized and reseeded. Later, a small conclave on an asteroid becomes infected by such **travels**:

> "The worst was sepsis. The organisms brought from the Zaibatsu wreaked havoc on the delicate biosystems of ESAIRS XII. […]
>
> "The attenuated blossoms of the Shaper garden [engineered to live without bacteria] mildewed and crumbled at the touch of raw humanity. The vegetation took strange forms as it suffered and contorted, its stems corkscrewing in rot-dusted perversions of growth" (103).

Here, "raw humanity" refers equally to the microbiome borne by human bodies as to the modification of plants to live without bacteria. The challenge *Schismatrix* presents from its perspective of ecological complexity is learning to care for the individual in abstraction from any one individual. For an actually existing individual is already an ossification of life's creativity—even as much as it is a result of that creativity. In concrete terms, this means caring for the conditions of possibility for human individuality. To do so would demand a change in Yong's rhetoric of what technology means—a change from anthropocentric prosthetic utility to a processual outlook on the invention of worlds.