# Queer Theory for Lichens

DAVID GRIFFITHS

*"Lichens are queer things"* —Wyndham

"We are all lichens." This is the concluding sentence of an article published in December 2012 in *The Quarterly Review of Biology*. The article, "A Symbiotic View of Life: We Have Never Been Individuals," is co-authored by biologist Scott F. Gilbert, historian of biology Jan Sapp, and historian and philosopher of science Alfred I. Tauber. The article identifies six criteria by which individuality is defined in the biological sciences: anatomical, embryological, physiological, immunological, genetic, and evolutionary. They also note that these criteria are neither mutually exclusive, nor has individuality been described in these terms in the history of biology. The article argues that organisms cannot be defined as individuals by any of these six criteria and suggests that no organism is autonomous and independent; rather, all organisms are like lichens, the symbiotic merger of a fungus and photosynthetic bacteria or algae.

In this article, I will outline Gilbert, Sapp, and Tauber's symbiotic view of life as well as offer an introduction to lichens, including a brief history of their taxonomic classification. Following this I will ask: if we have never been individuals—if we are all composites like lichens—then what does this mean for sexuality? I will stress that questions of biological classification and biological individuality are not just relevant to biology, but are always connected to various social and political questions. I will therefore gesture to some of the ways in which the symbiotic view of life can offer new perspectives on a number of bio-political questions. My approach is not to make a simple translation from the biological to the social, but rather to addend to the ways in which the biological and the social are always already interconnected, as well as to point to what Donna Haraway calls the "traffic on the bridge between what counts as nature and culture" (*Modest_Witness* 56). In this article, I will primarily focus on the primacy of heterosexual biological reproduction in discourses about human and non-human sexuality and sociality. This includes the overemphasis of sexual reproduction and vertical inheritance at the expense of many other forms of production and reproduction, as well as multispecies interconnections and co-involvements. I will argue that lichens and other examples of biological symbioses can offer ways of thinking about sexuality beyond this heteronormative framework. In fact, lichens and other symbioses suggest a queer ecological perspective that could go some way toward denaturalizing the primacy of heterosexuality and sexual reproduction in defining and legitimating bodies, practices and communities.

## The Symbiotic View of Life

Gilbert, Sapp, and Tauber trace the biological concept of the individual to the early modern period. They state that the notion of independent citizens emerged at the same time as "the notion of the autonomous individual agent framed a biology that was organised around the study of particulate, interacting, living entities" (Gilbert, Sapp, and Tauber 326). Building upon this, Darwinism focused on discrete individuals and identified competition between individuals as the driving force of evolution. As the article emphasizes, even the discovery that organisms are aggregates of living cells was used to support the primacy of the individual: cells existed to construct and sustain a singular and autonomous organism (Gilbert, Sapp, and Tauber 326). They identify the emergence of ecology in the second half of the nineteenth century as something of a turning point, complementing the focus on individuals in the biological sciences with the idea of ecological systems and relationships between individuals. Ecology encompasses all relationships between organisms at all scales. Scale is important; as Gilbert, Sapp, and Tauber point out,

technology has allowed the biological sciences to conceptualise relationships at ever smaller scales. The microscope revealed a world of bacteria, protists, and fungi, while further technological developments revealed organisms and biological agents such as viruses at an even smaller scale. This is important, as new technologies have revealed a "world of complex and intermingled relationships—not only among microbes, but also between microscopic and macroscopic life" (Gilbert, Sapp, and Tauber 326). What is clear in these scaled multispecies ecologies is that sexual reproduction and vertical inheritance are only part of the picture, and that it is a heteronormative misinterpretation of "life" and "nature" to overemphasize these. Ecological perspectives reveal a queer commingling, the production and reproduction of life between vastly different scales. This challenges the notion of individual discrete human bodies and the privileging of sexual reproduction in public discourse.

Gilbert, Sapp, and Tauber state that this symbiotic view of life is not new to the microbiological or botanical sciences, but that the zoological sciences are only recently starting to consider animals as multispecies composites. They argue that:

> The discovery of symbiosis throughout the animal kingdom is fundamentally transforming the classical conception of an insular individuality into one in which interactive relationships among species blurs the boundaries of the organism and obscures the notion of essential identity. (326)

The authors identify six ways that animals have been considered individuals in the biological sciences and provide examples of scientific research that challenge animal individuality within each definition. To challenge anatomical individuality, they refer to Lynn Margulis and Dorion Sagan's work on *Mastotermes darwiniensis*, commonly known as termites, which are part of a larger reproductive colony, and cannot digest the cellulose in their diet without the gut symbiont *Mixotricha paradoxa*, itself an aggregate of at least five separate species (Gilbert, Sapp, and Tauber 363; Haraway, *When Species Meet* 285–286). To challenge developmental individuality, they emphasise the importance of symbiosis in animal development, including the role of microbial symbionts in the life cycle of mammals (Gilbert, Sapp, and Tauber 328). Among much non-human animal research, physiological individuality is thrown into question by recent work on the Human Microbiome Project, which stresses the role of non-human microbiological agents within the traditional limits of the human body in normal and healthy human functioning (329; Turnbaugh et al.). The Human Microbiome Project also challenges notions of genetic individuality, as ecological metagenomics has revealed diversity in bacterial genomics within populations of humans (327).[1] The concept of immune individuality is challenged by a shift in how the immune system itself is conceptualised. The immune system has traditionally been considered a defensive system and the immune self is defined clearly against its external environment and its defence against dangerous and invasive "others" (330; Klein). However, recent research suggests that immune systems are "created, in part, by microbial symbionts" (331). With all this in mind, the authors conclude: "there is no circumscribed, autonomous entity that is *a priori* designated 'the self.' What counts as 'self' is dynamic and context-dependent" (333).

Importantly, Gilbert, Sapp, and Tauber are making both a biological and socio-political point. The biological individual and the social individual—that is, the autonomous rights-holding citizen—are always connected. As Michel Foucault recognised in the first volume of *The History of Sexuality*, reproductive sexuality is a hinge that connects the "anatomo-politics" of the body and the "bio-politics of the population" (Foucault 139). Foucault's concept of bio-politics is intimately linked to bio-power: the regulation of bodies and practices through a number of discourses, health practices, laws, and other regulatory mechanisms that surround biological bodies and human populations. The crucial point for my argument is that the notions of a biological and social individual are not separate, but are both part of the emergence of the individual bio-political citizen. That is, a biological definition is always social and not in a simple one-to-one relationship; rather, biological and social definitions are linked in ways that are always complex as well as politically, socially, and historically situated. Furthermore, it is central to my argument, as the scientific research just discussed demonstrates, that there are no universal and transcendent traits that define the individual (human or otherwise); instead, the self or individual is always contingent and context-dependent.

What is clear in these scaled multispecies ecologies is that sexual reproduction and vertical inheritance are only part of the picture.

In this article, I pay attention to the queer connections and cominglings within and between organisms, and I will suggest that doing so offers a new scientific perspective on a number of bio-political issues. I will now offer brief examples that include certain biomedical theories and practices, and the stigmatisation of infected or diseased bodies. If we have never been individuals, then neither have we been uninfect-

ed and pure. I will discuss the example of people living with HIV/AIDS to argue that there are links among the biological status of the virus and the bio-political status of "individuals" who are infected and their biomedical treatment. Viewing all bodies as multispecies assemblages—rather than seeing bodies as necessarily being either clean, healthy and pure, or infected, unhealthy and impure—could thus have consequences for how infected bodies are conceived of, and therefore treated and cared for. My main focus, however, will be the primacy of sexual reproduction in biological and social discourses. This primacy delegitimises bodies, practices, and communities that are not arranged around heterosexual biological reproduction, or are arranged around non-normative sexualities. I will argue that the symbiotic view of life can challenge this conservative and heteronormative approach to human and non-human sexuality and sociality.

### Lynn Margulis and Symbiogenesis

In an article published in 1967, "On the Origin of Mitosing Cells," Lynn Margulis suggests that eukaryotic cells (cells with a membrane-bound nucleus) originated through the merger of previously free-living prokaryotic cells (cells lacking a nucleus). In particular, she hypothesizes that organelles such as mitochondria and chloroplasts can all be "considered to have derived from free-living cells, and the eukaryotic cell is the result of the evolution of ancient symbioses" (226). Margulis argues that in the case of mitochondria, the prokaryote's ability to provide energy through respiration provided the host cell with an evolutionary advantage. Similarly, chloroplasts—organelles that convert carbon dioxide into organic compounds including sugars using energy from sunlight—are thought to have once been photosynthesizing prokaryotes that survived absorption. Like the mitochondria, chloroplasts offered their host cells an evolutionary advantage through the production of energy. Margulis suggests that this originary absorption and symbiosis happened somewhere between 2.7 and 1.2 billion years ago, due to geological evidence that poisonous oxygen began to flourish in the atmosphere during this time (226). Margulis's theories on the origins of mitochondria and chloroplasts were not accepted at the time, but have since become widely accepted.[2]

Margulis has subsequently developed this theory and published widely on symbiosis and symbiogenesis. Symbiosis refers to long-term stable physical and behavioural association of different types of organisms. Symbiogenesis refers to a long-term stable symbiosis that leads to evolutionary change (Margulis and Sagan 12). Symbiogenesis theory emphasises the creative force of symbiosis. Free-living organisms are usually considered the object of natural selection; however, if two individuals form a close enough symbiotic relationship the association of organisms can become the target of selection. For example, certain animals have acquired photosynthetic symbionts, just as have the fungal partner in lichen symbioses, and as did the eukaryotes that became plants (Margulis and Schwartz 207). Examples include the green sea slug *Elysia viridis*, whose ancestors ingested green algae, which now permanently reside in the slug's tissue. Adult green sea slugs do not gain their energy from digestion, but rather from sunlight, in much the same way as plants do. As Margulis and Sagan state: "Green animals provide graphic examples of symbioses that lead to symbiogenesis" (13). Margulis argues that symbiosis is actually the primary mechanism of evolutionary novelty and speciation, rather than the gradual accrual of genetic mutation and variation. Margulis and Sagan describe this approach as "Darwinism not neodarwinism" (3–33). Symbiogenesis is not anti-Darwinian; on the contrary, "symbiogenetic acquisition of new traits by inheritance of acquired genomes is rather an extension, a refinement, an amplification of Darwin's idea" (15). The ancestors of *Elysia viridis* formed a symbiosis with green algae, which provided the slug with an evolutionary advantage: the ability to gain energy directly from sunlight. Slugs with the evolutionary advantage were selected for and produced more offspring, whereas those without did not. Margulis argues that this example of symbiogenesis is not an anomaly, but rather illustrates the fact that symbiosis is the major force of novelty and speciation in evolution. This is important: Margulis's account demonstrates that lichens are not anomalies but are rather illustrative of the fact that life and nature are found, if anywhere, in the complex and queer cobbling together of multispecies relationships. Crucially for my argument, this decenters heterosexual biological reproduction and vertical inheritance as the *only* way that life produces and reproduces and challenges a restricted and restricting view of human sexual reproduction.

If two individuals form a close enough symbiotic relationship the association of organisms can become the target of selection.

### Lichens

Before exploring some of the bio-political consequences of thinking of human beings as symbiotic multispecies communities, it is important to have a clear idea of what Gilbert, Sapp, and Tauber are referring to when they say, "We are all lichens." To explore how a human is like a lichen, I will offer a brief naturalcultural history of lichens.[3] Lichens are a symbiotic merger of what is called a mycobiont and a photobiont.[4] A mycobiont is a lichen-forming fungus, whose role in the symbiosis is to

construct the thallus—that is, a plant or fungal body that is undifferentiated into roots, stems, or leaves—that houses the photosynthetic symbiotic partners. These partners, the photobionts, provide the thallus with energy through photosynthesis, and are either cyanobacteria or algae. Myra Hird states: "Cyanobacteria invented oxygeneic photosynthesis, which has come to dominate metabolism for producing fixed carbon from carbon dioxide" (*The Origins of Sociable Life* 32). Green algae photosynthesise through their chloroplasts, which are themselves ancestral symbiotic cyanobacteria. This is symbiosis within symbiosis, or as Hird says, "symbionts all the way down" (*The Origins of Sociable Life* 84).[5] As Thomas H. Nash III stresses in *Lichen Biology*, lichen symbioses are very complex, and may involve more than two partners. Lichens generally exist as discrete thalli, and are implicitly treated as individuals in many studies, even though, as Nash points out, they may well be a symbiotic fusion of organisms from three kingdoms of life; Nash argues that this misrepresentation has consequences for the biological sciences (1). I will return to this point and argue that thinking of all organisms, including humans, as non-individual multispecies communities does indeed have consequences for the biological and medical sciences, but also has consequences for thinking about human and non-human sociality and sexuality.

Prior to the discovery of the symbiotic nature of lichens, they were considered autonomous and individual organisms. In 1867, the botanist Simon Schwendener proposed the dual theory of lichens on September 10 at the annual general meeting of the Swiss Natural History Society (Honegger, "Simon Schwendener (1829–1919) and the Dual Hypothesis of Lichens" 307). Schwendener was a respected botanist, and held the Chair of Botany at the University of Basel. At the meeting, Schwendener proposed a hypothesis based on work he had done on lichens, algae, and fungi with a light microscope. Although not confirmed by experimental evidence, Schwendener proposed that lichens are not autonomous plants, but rather a symbiotic relationship of fungi and algae. Schwendener's hypothesis was vigorously rejected by the scientific community for some time—at least until the end of the nineteenth century. The last published attempt to disprove the dual theory of lichen was published as late as 1953, even though this was fourteen years after a lichen was first successfully resynthesized from its independently cultured fungal and algal partners under sterile conditions (Schmidt; Thomas; Honegger, "Simon Schwendener" 308). There is an interesting parallel here with Margulis's proposal of the endosymbiotic origins of eukaryotic cells. Each proposal was rejected outright to begin with, and took decades of further research and experimental evidence to be taken seriously in the scientific community. The idea of individual, autonomous organisms seems to be very deeply entrenched in the biological sciences, and still has a hold as a seeming given that is difficult to challenge. As mentioned previously, the notion of the biological individual is linked with the notion of the social, or bio-political, individual citizen. I will return to the fact that the bio-political individual is central to theories and discourses of social and sexual normativity. I will suggest that thinking with lichens can potentially offer a queer way out of heteronormative narratives of human and non-human sexuality and sociality by decentering heterosexual biological reproduction as the *only* way that life (re) produces.

Schwendener proposed that lichens are not autonomous plants, but rather a symbiotic relationship of fungi and algae.

Rosmarie Honegger argues that the rejection of Schwendener's proposal of a dual theory of lichen should be placed in an historical context:

> The main problem of Schwendener's opponents was, with high probability, the holistic view of living beings in general which persisted far into the 19th century and even beyond. At the beginning of the 19th century, it was not known that different organisms may live in close connection or even one within the other. Microbial, plant, animal, and human pathogens were not recognized as such e.g., rust or smut pustules were considered as ill outgrowths of the plant proper. The identification of pathogenic micro-organisms and the study of their life cycles and development on or within their hosts were among the most fascinating and important discoveries of the 19th century. ("Simon Schwendener [1829–1919] and the Dual Hypothesis of Lichens" 311)

While for Schwendener, the dual theory of lichens elegantly explained the observations he had made with a light microscope of lichens, fungi, and algae, the prevailing scientific paradigm of the time was that all organisms were individuals and could be taxonomically defined as such. Thus, while the hypothesis had some appeal among some botanists working with lichens, in general it was rejected until further evidence, such as experimental resynthesis, was provided.

Lichens are involved in ecological relationships with many animals, including serving as food or shelter for invertebrates. M.R.D. Seaward states that some insect larvae "have cases partially

constructed out of lichen fragments" and that some weevils "actually have carapaces which facilitate the growth of lichens on them for protective crypsis [protection from predators via camouflage]" (276). In some of the larger, flightless weevils, this lichen covering is even used as a habitat for some species of mite (276). Once again, it is symbionts all the way down. Many birds use lichens as material for their nests, and some even show a preference for species of lichen (290). Birds also use lichens for camouflage, and for decorative display. A large number of mammal species feed on lichens, and Seaward lists "deer, elk, ibex, gazelle, musk ox, mountain goat, polar bear, lemming, vole, tree mouse, marmot, squirrel, monkeys, and some domestic animals" as including lichens in their diets, particularly as winter feed (291). The winter diet of reindeer and caribou can be more than 50% lichen (291). Humans have used and continue to use lichens for a number of different purposes. Lichenologist Sylvia Duran Sharnoff has compiled a huge bibliographical database of "lichens and people" which demonstrates the diversity of ways in which lichens have been used by humans. These include in brewing, as cosmetics, in dyes, as fuel and food, in medicine, and as perfumes and poisons. These examples demonstrate that not only are lichens a symbiotic relationship between at least two partners of different species (if not kingdoms), they are also interconnected and involved in complex naturalcultural relationships with humans and non-human animals.[6]

### We Have Never Been Individuals

So how is a human like a lichen? Every human cell has a bacterial power source, much like the lichen's reliance on its photobiont. Mitochondria are organelles within the eukaryotic cell that have distinct DNA and are involved in the production of adenosine triphosphate (ATP), a source of chemical energy. Further, as Margulis suggested in 1967, eukaryotic cells were once non-nucleated prokaryotes that survived absorption by another cell. Mitochondria thus provide animal cells with energy in much the same way as a photobiont provides photosynthetic energy to the lichen. Further, human health also depends upon bacteria, particularly the bacteria living permanently in the gut. These bacteria (or "human gut microbiota") produce enzymes absent from the human genome, which allow humans to gain energy from complex sugars in terrestrial plants. As Ruth E. Ley et al. emphasise, these plants have dominated diet throughout human evolution. Their research demonstrates the symbiotic relationship between human and bacteria, through a comparison of "the bacterial assemblages that are associated with humans and other mammals, metazoa and free-living microbial communities that span a range of environments" (776). Importantly, this research emphasizes the consequences this symbiotic relationship has had on bacterial, as well as human evolution. They state that their "analyses indicate that gut-associated microbiotas are profoundly different from other free-living microbiotas from across the biosphere" (786). The symbiotic co-evolution of human and gut bacteria has shaped the morphology and behaviour of both humans and gut bacteria. Neither is viable without the other; human gut microbiota have evolved to live in the specific environment of the human gut, while humans have evolved to depend upon food that could not be fully digested without this specific internal symbiotic community. What becomes clear from this perspective is interconnectedness in an ecological "mesh," to use Timothy Morton's term, in which relationships are formative and co-constitutive (*The Ecological Thought*).

The symbiotic co-evolution of human and gut bacteria has shaped the morphology and behaviour of both.

This is what Gilbert, Sapp, and Tauber call the symbiotic view of life. And it depends upon one of the most important consequences of Margulis's theory of symbiogenesis: the impossibility of thinking of life in terms of individuals. As Margulis states:

> of all the organisms on Earth today, only prokaryotes (bacteria) are individuals. All other live beings ("organisms"—such as animals, plants and fungi) are metabolically complex communities of a multitude of tightly organized beings. That is, what we generally accept as an individual animal, such as a cow, is recognizable as a collection of various numbers and kinds of autopoietic entities that, functioning together, form an emergent entity—the cow. "Individuals" are all diversities of co-evolving associates. ("Big Trouble" 273)

This diversity of co-evolving associates is observable at the level of symbiotic gut microbiota and at the level of the human cell. It is impossible to think in terms of individual human bodies, as these bodies are emergent entities formed through the co-evolution of more-than-human agencies. As Dorion Sagan describes: "The human body . . . is an architectonic compilation of millions of agencies of chimerical cells" (367). Crucially, in Margulis's symbiogenetic account it is not the case that lichens are anomalies in being symbiotic fusions of more than one species; rather, humans are like lichens because there are no such things as individuals, except perhaps prokaryotic bacteria (although

these too depend upon their interconnectedness and co-involvement in the ecological mesh). Symbiosis is the rule, not the exception. All organisms are emergent multispecies aggregates and communities.

This rethinking of the human individual as a lichen-like symbiotic multispecies community offers possible rewards in the area of medicine and health care. An example of this approach in scientific practice is the Human Microbiome Project. Described as the "logical conceptual and experimental extension of the Human Genome Project," the Human Microbiome Project proposes that the human body be thought of as a "supra-organism"—that is, a collection of organisms that function as an organic whole, such as an ant colony (Turnbaugh et al. 804). Peter J. Turnbaugh et al. suggest that applying this approach to genomic science demands the sequencing of the genetic material from all the organisms that make up the human body, referred to as the microbiome. Specifically, they claim that the Human Microbiome Project can have positive effects on personal medicine (in particular for the treatment of malnourishment, obesity, autoimmune disorders, and some cancers) as well as providing answers to "some of the most inspiring, vexing and fundamental scientific questions today" (804). This appears to confirm Gilbert, Sapp, and Tauber's assertion that coming to terms with the fact that we have never been individuals will have benefits across the biological and medical sciences. This is biopolitical as much as it is biomedical. If bodies are reconsidered as supra-organisms, always already "infected" or "inhabited" by countless infectious agents such as bacteria or viruses and, because the biological and the social are always interconnected, then this could potentially go some way to alleviate the social stigma that accompanies certain illnesses, diseases, or conditions.

This is particularly pertinent to people living with HIV/AIDS. As early as 1983, Larry Kramer drew attention to the intersection of class, sexuality, and race in the bio-politics of HIV/AIDS and its scientific research and medical treatment:

> There have been no confirmed cases of AIDS in straight, white, non-intravenous-drug-using, middle-class Americans. The only confirmed straights struck down by AIDS are members of groups just as disenfranchised as gay men: intravenous drug users, Haitians, eleven haemophiliacs (up from eight), black and Hispanic babies, and wives or partners of IV drug users and bisexual men. (30)

Although the spread of HIV/AIDS has affected many other groups since the early 1980s, disenfranchised communities are still disproportionately affected. HIV/AIDS also demonstrates the complex traffic between the biological and the social, as these communities are also disproportionately targeted by a form of bio-power that functions through the classification, identification, elimination, or constraint of individuals considered dangerous to the overall health or fitness of the population, nation, or race. Until 2010, the United States continued to deny immigrants citizenship on the basis of HIV/AIDS status. The ban on people with HIV/AIDS entering the USA and becoming US citizens was enacted in 1988 and only lifted in 2010. Crucially, the US ban suggests that an individual with HIV/AIDS is considered a dangerous entity—much like a virus—that must be prevented from entering the body of the nation.

An individual with HIV/AIDS is considered a dangerous entity–much like a virus–that must be prevented from entering the body of the nation.

Ed Cohen describes viruses as "transboundary by nature," moving genetic material between organisms and ecosystems, while also troubling attempts to maintain boundaries, to define organisms as individuals, and to localize "life" within bounded membranes against the exterior world (18). This is what he describes as the "paradoxical politics of viral containment": multispecies (here human-viral) interdependence and the permeability of organisms are only recognised through the framework of the microbiological as external, foreign, and dangerous. Thus, "viral 'illness' [is] an anthropomorphic qualification dependent on the understanding of the human body as a unified, bounded, political whole *that must survive any threat to it*" (Livingston and Puar 10, emphasis in original). This discourse also reflects, complements, and even justifies the bio-political reconfiguration of people living with viral infections as dangerous intruders themselves: intruders that must be eradicated or kept out of the political nation state. The symbiotic view of life, however, recognizes the fact that all organisms are always already infected. Certain illnesses, infections, and conditions such as HIV/AIDS have historically been (and are contemporarily) linked to non-normative individuals, communities, and practices. The bio-political status and biomedical treatment of individuals living with these infections depend upon several biological definitions, such as that of organisms as bounded and unitary and viruses and other microbiological agents as foreign and dangerous intruders. While it is beyond the scope of this article to fully explore, the symbiotic view of life rethinks the difference between the body of a person living with HIV/AIDS and

the body of a "healthy" person as one of degree, not of kind. Seeing all bodies and organisms as already infected offers a perspective that could go some way to counter the stigma that surrounds HIV/AIDS, as well as other illnesses and infections.

The symbiotic view of life suggests that we are not individuals, and that we have never been individuals. While the traditional view of organisms (including humans) is that they are self-contained, discrete, and autonomous individuals, scientific research is increasingly suggesting that this is misleading; the view of organisms as individuals is perhaps no longer viable. This is illustrated in the symbiotic bacterial ancestry of the mitochondria in "human" cells, as well as in the contemporary symbiotic relationships that are at work in the human gut microbiota. Eating, digesting and living are impossible without our symbiotic relationships. The brief naturalcultural history of lichens that I have offered illustrates these points and demonstrates that if life and nature are to be found anywhere, it is not autonomous individuals but the constitutive comminglings, involvements, and interconnected relationships that make up the ecological mesh.

## What Does this Mean for Sexuality?

Observations of non-human social and sexual behaviour are often used to explain and support normative ideas about human sociality and sexuality. However, as evolutionary biologist Joan Roughgarden's *Evolution's Rainbow* suggests, biologists tend to observe and interpret nature through a frame of social and sexual normativity. Roughgarden suggests that this leads either to misinterpreting or simply missing a large amount of biological diversity. Nature is then used as a comparison to human sociality and sexuality, and, consequently, non-normative practices, identities, and communities lose out—reframed as necessarily unnatural. However, as Sharon Kinsman asks:

> Because most of us are not familiar with the species, and with the diverse patterns of DNA mixing and reproduction they embody, our struggles to understand humans (and especially human dilemmas about "sex", "gender" and "sexual orientation") are impoverished. Shouldn't a fish whose gonads can be first male, then female, help us to determine what constitutes "male" and "female"? Should an aphid fundatrix ("stem mother") inform our ideas about "mother"? There on the rose bush, she neatly copies herself, depositing minuscule, sap-siphoning, genetically identical daughters. Aphids might lead us to ask not "why do they clone?" but "why don't we?" Shouldn't the long-term female homosexual pair bonding in certain species of gulls help define our views of successful parenting, and help reflect on the intersection of social norms and biology? (197)

Nature is interpreted through the lens of heteronormativity to justify, explain, or support a conservative, normative status quo in human sociality and sexuality. Roughgarden and Kinsman both point out that if we start to look at the true social and sexual diversity of nature, this not only reveals a wealth of biological diversity previously ignored, but also can offer resources for thinking of human practices, identities, and communities outside of the frame of heteronormativity.

As well as viewing human sexuality through a lens of "natural" sexuality (based in part on misinterpretations of nature) normative theories of sexuality are, more often than not, founded on the idea of individual human beings or bodies, and the numerous ways they can combine. What is often ignored or effaced in these accounts is the very multiplicity of the body itself. One account that attempts to remedy this is Hird's article "Re(pro)ducing Sexual Difference." In this article, Hird argues against the primacy of sexual reproduction and vertical inheritance as signifiers of sexual difference in public discourse, and questions "the assumption that human 'reproduction' has much to do with either sex or the constitution of 'femininity'" (94).

I argue that human bodies are constantly engaged in reproduction and only sometimes (and for a short time) engaged in specifically "sexual" reproduction. The networks of bacteria, microbes, molecules and inorganic life which exist beneath the surface of our skin take little account of "sexual" difference and indeed exist and reproduce without any recourse to what we think of as reproduction. Human imagination may be limited to a narrow understanding of "sexual" reproduction, but a prolific variety of reproductive means occur in "nature" (Hird, "Re(pro)ducing" 94).

Heteronormativity depends upon overstating the importance of sexual reproduction between two individual human bodies. As an alternative, Hird emphasizes the fact that bodies are always already multiple, and engaged in continual reproduction. What might be thought of as "human" cells—bacterial ancestry aside—continually reproduce: "We reproduce our own livers every two months, our stomach linings every five days, new skin every six weeks and ninety-eight percent of our atoms

Non-human social and sexual behaviour are often used to explain and support normative ideas about human sociality and sexuality.

every year" (Hird, "Re(pro)ducing" 102). Beyond that, the human body is a teeming multispecies ecosystem that is constantly engaged in reproduction, connections and transfer outside of the narrow understanding of sexual reproduction in heteronormative public discourse.

### Queer Ecologies

Queer ecologies emphasise the interconnectedness of all organisms, along with their naturalcultural histories. Sketching a preliminary framework of queer ecology, Timothy Morton asks: "Ecology stems from biology, which has nonessentialist aspects. Queer theory is a nonessentialist view of gender and sexuality. It seems the two domains intersect, but how?" ("Queer Ecology" 275). Morton's framework embeds the human in a network or mesh of living and non-living agencies, and in doing so, opens the human up to unpredictable encounters with strange and unknowable others. It also stresses the fact that humans are themselves networks of living and non-living agencies, and not singular sovereign individuals. Hird's approach outlined in "Re(pro) ducing Sexual Difference" could also be described as a queer ecological account. It recognises the ecological interconnectedness and involvement of what is commonly thought of as the individual human organism with countless bacterial, microbial, and other agencies. It also stresses that the ignorance of such entanglements supports and is supported by heteronormative narratives in the social and sexual status quo. Attention to bacteria reproducing on and underneath our skin, in our guts, and in our cells is part of a queer ecological perspective that deemphasises heteronormativity and sexual reproduction while drawing attention to the myriad of queer phenomena that make up life and nature.

I want to argue that lichens are queer things, and that human individuals are indeed all lichens; we are all queer multispecies consortia, always already involved in countless and unpredictable constitutive relationships at all scales. Earlier, I discussed Cohen's definition of viruses as "transboundary by nature." I want to expand this to suggest that transboundary by nature is in fact the rule, rather than the exception. Haraway discusses transuranic elements, comparing them to transgenic creatures or organisms, organisms that carry and transmit exogenous genes (genes from other organisms) to their offspring:

> Like the transuranic elements, transgenic creatures, which carry genes from "unrelated" organisms, simultaneously fit into well-established taxonomic and evolutionary discourses and also blast widely understood senses of natural limit. What was distant and unrelated becomes intimate. (*Modest_Witness* 56)

The symbiotic view of life suggests that all organisms are involved in boundary crossings and gene-shuffling. All organisms (including humans, carrying genes from other organisms on and beneath our skin, in our guts and in our cells) are thus transboundary, and like Haraway's transuranic elements or transgenic creatures, simultaneously fit within historically and socially constructed taxonomies while drawing attention to their constructed, non-essential and non-transcendent nature. As Nash states, lichens may well be symbiotic mergers of organisms from three distinct kingdoms of life, and so offer a specific challenge to the boundary making practice of taxonomy (1). A symbiotic ecological view of lichens draws attention to the (hetero)normativities involved in taxonomic practice that lead to the definition of biological individuals. Focussing on lichens draws attention to natural limits in taxonomy, while simultaneously challenging those limits and threatening to destabilize species (even kingdom) boundaries.

Lichens also demonstrate the queer ways, sexual and otherwise, that life reproduces. Many lichens reproduce by forming offshoots that include both mycobiont and photobiont, whereas some produce mycobiont spores that must then "find" photobiont cells to incorporate, or to encourage in their colonization of the new organism. Through the lens of heteronormativity, which over-emphasizes heterosexual biological reproduction between individual organisms, this may seem like a queer way to reproduce indeed. But, as Hird argues, a normative account of human reproduction also misses much queer ecological reproduction that is going on in what is commonly thought of as the human body. Even human sexual reproduction is not as simple as two individual humans producing a child with a mix of human genetic material. Human babies are born with gut microbiota. While it has long been assumed that the entirety of a baby's gut microbiota must colonize the baby after leaving the womb (and research has shown that breast milk encourages this colonization), recent research shows that even in the womb, a foetus is not sterile and has its own unique symbiotic community (Hamzelou; Wiley). Once again, this could have biological and political ramifications. Briefly, the argument about when a foetus becomes an individual bio-political citizen with individual rights is potentially complicated by the symbiotic view of life. Furthermore, this assumed "purity" and "sterility" of the foetus is connected to the contested notion of the "innocence" of foetuses in

Focussing on lichens draws attention to natural limits in taxonomy while destabilizing species boundaries.

abortion rights debates. This is an example of a potential social consequence of the view that "we have never been individuals"; there is not any clean and pure space of transcendent individuality, even in the womb. The symbiotic view of life can have important social and bio-political ramifications that deserve further exploration. The important point to draw out for my argument is that symbiotic bacteria are as essential for human life and reproduction as photobionts are to lichens. We are all lichens then, and even heterosexual biological reproduction turns out to be a rather queer phenomenon, involving multispecies interactions and interconnections.

Queer theory for lichens suggests that we have never been invidivuals, and that attention to this can have positive biomedical consequences.

## As Queer as Lichens

We have never been individuals. Attention to this fact reveals the queer multiplicity of ways in which life goes about cobbling itself together, producing and reproducing organisms and ecological relationships. I have argued that a queer ecological view (building on Gilbert, Sapp, and Tauber's symbiotic view of life) might open up the naturalcultural mesh for exploration and interrogation and this may have a number of bio-political consequences. I agree with Gilbert, Sapp, and Tauber that resisting the normativities of defining humans (and other organisms) as individuals can contribute positively to the biological sciences, bio-political and the Human Microbiome Project seems to suggest one of the ways in which this view of life could impact medicine and health practices. I have also gestured to some bio-political consequences of this view of life, including the definition of individuals as bio-political citizens and the stigma that surrounds diseased or infected bodies, particularly those historically and contemporarily linked to non-normative bodies, communities and practices. A queer ecological perspective also helps to illuminate areas of research that may be obscured when viewing human and non-human biology through the lens of heteronormativity and with an undue emphasis on sexual reproduction. This should, in turn, work to question the sorts of narratives and discourses that brand some bodies, communities and practices natural and some unnatural. If heteronormativity and sexual reproduction no longer define the frame through which nature is viewed, then this will have an effect on the definition of some social and cultural practices as "natural." This is important politically, as normativity masquerading as nature necessarily supports the conservative status quo and is hostile to non-normativity. Queer theory for lichens suggests that we have never been individuals, and that attention to this can have positive biomedical consequences. This symbiotic view of life can also work to denaturalize the primacy of heterosexual biological reproduction in discourses of normative and non-normative bodies, practices and communities.

## Notes

1. Research suggests that microbiome populations are diverse and related to specific national and cultural histories. Jan-Hendrik Hehemann et al. used comparative gut metagenome analyses to characterise enzymes from a particular species of marine bacteria which live with marine red algae of the genus *Porphyra*. Importantly, their research demonstrates that genes coding for the enzymes that specifically aid digestion of *Porphyra* algae have been transferred to a particular gut bacterium isolated from Japanese individuals. Hehemann et al. show that these enzymes and the genes that code for them are frequent in the Japanese population and are absent from North American individuals. They suggest that nori seaweed makes a large contribution to daily diet in Japan suggests that these enzymes are likely acquired via bacteria. This community of bacteria, living in a symbiotic relationship with and within the human body, illustrates the non-individuality of what is thought of as "the human" as well as the importance of horizontal gene transfer (that is, a method of passing on genes that gets on just fine without heterobiological sexual reproduction) to both bacterial and human life.
2. Other scientists have recognised Margulis's refusal to give up on her endosymbiotic theory against the prevailing paradigm science of the time. Richard Dawkins stated: "I greatly admire Lynn Margulis's sheer courage and stamina in sticking by the endosymbiosis theory, and carrying it through from being an unorthodoxy to an orthodoxy. . . . This is one of the great achievements of twentieth-century evolutionary biology, and I greatly admire her for it" (Margulis, "Gaia is a Tough Bitch" 129).
3. I take the phrase naturalcultural from Donna Haraway's term "naturecultures." She uses this term to emphasise the inseparability of nature and culture. Nature is always a product of, and understood through, culture. Yet at the same time, culture is a product of biological beings and not restricted to humans; thus culture is a product of nature. Rather than discrete and oppositional, nature and culture are inseparable as naturecultures (Haraway, *When Species Meet*).
4. My biological account of lichens is drawn from Thomas H. Nash III's textbook, *Lichen Biology*. Particularly Nash's "Introduction"; T. Friedl and B. Büdel's chapter, "Photobionts"; R. Honegger, "Mycobionts"; R. Honneger and S. Scherrer's chapter on "Sexual reproduction in lichen-forming ascomycetes"; and M. R. D. Seaward's chapter on "Environmental role of lichens".
5. Hird's phrase "symbionts all the way down" is a play on the phrase "turtles all the way down" which refers to the problem of infinite regress. The "turtles all the way down" story was popularised in Stephen Hawking's *A Brief History of Time: From the Big Bang to Black Holes* in which he wrote: "A well-known scientist (some say it was Bertrand Russell) once gave a public lecture on astronomy. He described how the earth orbits around the sun and how the sun, in turn, orbits around the center of a vast collection of stars called our galaxy. At the end of the lecture, a little old lady at the back of the room got up and said: 'What you have told us is rubbish. The world is really a flat plate supported on the back of a giant tortoise.' The scientist gave a superior smile before replying, 'What is the tortoise standing on?' 'You're very clever, young man, very clever,' said the old lady. 'But it's turtles all the way down!'" (1).
6. I am employing the term "involvement" to signal an alliance with Carla Hustak and Natasha Myers' ecological approach as outlined in "Involutionary Momentum: Affective Ecologies and the Sciences of Plant/Insect Encounters." In particular, I wish to signal that "being involved" with another organism is not necessarily to be part of a neo-Darwinist functional economy, but rather to be part of the "creative, improvisational, and fleeting practices through which plants and insects *involve* themselves in one another's lives" (77).

## Works Cited


Cohen, Ed. "Viral Containment; or, How Scale Undoes Us One and All." *Social Text* 29.1 (2011): 15–35. Print.

Foucault, Michel. *The History of Sexuality. Volume 1: The Will to Knowledge*. Trans. Robert Hurley. Harmondsworth: Penguin, 1990. Print.

Friedl, Thomas and Burkhard Büdel. "Photobionts." *Lichen Biology*. Ed. Thomas H. Nash. Cambridge: Cambridge UP, 2008: 9–26. Print.

Gilbert, Scott F., Jan Sapp, and Albert I. Tauber. "A Symbiotic View of Life: We Have Never Been Individuals." *The Quarterly Review of Biology* 87.4 (2012): 325–341. Print.

Hamzelou, Jessica. "Babies are born dirty, with a gutful of bacteria." *New Scientist* 12 Apr. 2012. Web. 1 Oct. 2013. <http://www.newscientist.com/article/mg21428603.800-babies-are-born-dirty-with-a-gutful-of-bacteria.html?full=true#.Ukqt1oash8E>.

Haraway, Donna. *Modest_Witness@Second_Millenium.FemaleMan©_Meets_OncoMouseTM: Feminism and Technoscience*. New York: Routledge, 1997. Print.

---. *When Species Meet*. Minneapolis: Minnesota UP, 2008. Print.

Hawking, Stephen. *A Brief History of Time: From the Big Bang to Black Holes*. London: Bantam, 1988. Print.

Hehemann, Jan-Hendrik et al. "Transfer of Carbohydrate-Active Enzymes from Marine Bacteria to Japanese Gut Microbiota." *Nature* 464 (2010): 908–912. Print.

Hird, Myra J. *The Origins of Sociable Life: Evolution after Science Studies*. New York: Palgrave Macmillan, 2009. Print.---. "Re(pro)ducing Sexual Difference." *Parallax* 8.4 (2002): 94–107. Print.

Honegger, Rosmarie. "Mycobionts." *Lichen Biology*. Ed. Thomas H. Nash. Cambridge: Cambridge UP, 2008: 27–39. Print.

---. "Simon Schwendener (1829–1919) and the Dual Hypothesis of Lichens." *The Bryologist* 103.2 (2000): 307–313. Print.

Honegger, Rosmarie, and Sandra Scherrer. "Sexual Reproduction in Lichen-Forming Ascomycetes." *Lichen Biology*. Cambridge: Cambridge UP, 2008: 94–103. Print.

Hustak, Carla, and Natasha Myers. "Involutionary Momentum: Affective Ecologies and the Science of Plant/Insect Encounters." *Differences: A Journal of Feminist Cultural Studies* 23.3 (2012): 74–117. Print.

Kinsman, Sharon. "Life, Sex, and Cells." *Feminist Science Studies: A New Generation*. Eds. Maralee Mayberry, Banu Subramaniam, and Lisa H. Weasel. London: Routledge, 2001. Print.

Klein, Jan. *Immunology: The Science of Self-Nonself Discrimination*. New York: John Wiley & Sons, 1982. Print.

Kramer, Larry. "1,112 and Counting." *Queer Theory*. Eds. Iain Morland and Annabelle Willox. Basingstoke: Palgrave, 2005: 28–39. Print.

Ley, Ruth E. et al. "Worlds within Worlds: Evolution of the Vertebrate Gut Microbiota." *Nature Reviews Microbiology* 6 (2008): 776–788. Print.

Livingston, Julie, and Jasbir K. Puar. "Interspecies." *Social Text* 29.1 (2011): 3–14. Print.

Margulis, Lynn. "Big Trouble in Biology: Physiological Autopoiesis versus Mechanistic neo-Darwinism." *Slanted Truths: Essays on Gaia, Symbiosis, and Evolution*. Eds. Lynn Margulis and Dorion Sagan. New York: Springer-Verlag, 1997: 129–146. Print.

---. [published as Lynn Sagan]. "On the Origin of Mitosing Cells." *Journal of Theoretical Biology* 14.3 (1967): 255–274. Print.

---. "Gaia is a Tough Bitch." *The Third Culture: Beyond the Scientific Revolution*. Ed. John Brockman. New York: Simon and Schuster, 1995: 129–146. Print.

Margulis, Lynn and Dorion Sagan. *Acquiring Genomes: A Theory of the Origins of Species*. New York: Basic, 2002. Print.

Margulis, Lynn, and Karlene Schwartz. *Five Kingdoms: An Illustrated Guide to the Phyla of Life on Earth*. New York: W.H. Freeman, 1998. Print.

Morton, Timothy. *The Ecological Thought*. Cambridge, MA: Harvard UP, 2010. Print.

---. "Queer Ecology." *PMLA* 125:2 (2010): 273–282. Print.

Nash, Thomas H. "Introduction." *Lichen Biology*. Ed. Thomas H. Nash. Cambridge: Cambridge UP, 2008: 1–8. Print.

Roughgarden, Joan. *Evolution's Rainbow: Diversity, Gender, and Sexuality in Nature and People*. Berkeley: California UP, 2004. Print.

Sagan, Dorion. "Metametazoa: Biology and Multiplicity." *Incorporations*. Eds. Jonathan Crary and Sanford Kwinter. New York: Zone, 1992: 362–385. Print.

Schmidt, A. "Essay d'une biologie de l'holophyte des lichens." *Mémoires du Muséum National d'Histoire Naturelle, série B. Botanique* 3 (1953): 1–159. Print.

Seaward, Mark R.D. "Environmental role of lichens." *Lichen Biology*. Ed. Thomas H. Nash. Cambridge: Cambridge UP, 2008: 274–298. Print.

Sharnoff, Sylvia Duran. "Lichens and People: A Bibliographical Database of the Human Uses of Lichens." *Lichens of North America*. n.d. Web. 1 Oct. 2013 <http://www.lichen.com/people.html>.

Thomas, Eugen A. "Über die Biologie von Flechtenbildnern." *Beitr. Kryptogamenflora Schweiz* 9 (1939):1–208. Print.

Turnbaugh, Peter J. et al. "The Human Microbiome Project." *Nature* 449 (2007): 804–810. Print.

Wiley. "Breast is best: Good bacteria arrive from mum's gut via breast milk." *ScienceDaily* 22 Aug. 2013. Web. 1 Oct. 2013. <http://www.sciencedaily.com/releases/2013/08/130822091026.htm>.

Wyndham, John. *Trouble with Lichen*. Harmondsworth: Penguin, 1963. Print.