



Momenta

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Cover Image

Barrett Lyon / The Opte Project

Visualization of the routing paths of the Internet

January 02, 2021

On a daily basis, human beings engage in multitudes of social interactions through vast networks of family, friends, and acquaintances. The floodgates of the internet have opened wide and our social interactions have come to fill vast virtual networks all over the world. A powerful example is the role the internet played in keeping us socially connected during the COVID-19 pandemic. Beyond day to day interactions, the internet also enables the possibility of great social mobilization and cultural and social change, and has come to be a key medium of such change around the world.

Every IP address in the internet is governed by one of five regional internet registries (RIRs). The colours of the routing paths in the image correspond to the different regions around the world as follows:

Blue - North America

Green - Europe

Red - Asia Pacific

Pink/Purple - Latin America

Yellow - Africa

White - Backbone (the core connections that link smaller networks)

momenta (n. pl.) Latin

1. The indwelling forces that are the principle of change.
2. The circumstances that precipitate change.

The papers in this volume are momenta in the sense

[ii] that they are reactions to a set of circumstances (the ideas, the work of understanding, the opportunity to consider those ideas), and also in the sense

[i] that they make contribution to ongoing scholarly discussions and so inevitably change the course of those discussions.

Translated by Darcy Otto, Professor of Philosophy and Classics at Quest University Canada

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FOREWORD

Welcome to Momenta 2021!

I'm excited for what you will experience as you read this wonderful issue. The topics range widely, from the biotechnology of plant-based protein production, to the changing scene of hip-hop, to emergency food systems, to tropical diseases. As I read the words, I was made conscious of how I interacted with them, because of a wonderful paper on the subject of interacting with what we read. I clawed my way through the jungle of jargon, as the topics changed and the myriad colours of this forest of knowledge and stories fascinated me, captivated me.

These stories share a few things. They are well-written. They address social justice, and they critique the norms that envelope our daily lives. They sensitize us to the injustices that have been amplified by the pandemic and disadvantage the poor. They challenge us to question our values and to examine the unexamined, in us. Get ready to get uncomfortable.

Are you ready to learn about plants getting injected with genes so they can mass-produce bespoke proteins on demand? Are you aware of how artists like Frank Ocean are daring to push the heteronormative and gender-binary boundaries to usher in more queer inclusion and acceptance in hip hop today? Are you ready to have your eyes open to the raw and out-dated realities behind food banks and other private emergency food systems? What will you do with the knowledge that 50 cents per person per year (yes, year) could eradicate a host of parasitic worm-related tropical diseases in the poorest corners of our world?

If you're ready for this, get a drink and get comfortable. You won't be moving until you read the last word. Oh, and by the way, by the time you finish consuming the last chapter, you might start re-reading the issue again, and observe how you interact with these words.

What a treat. Thank you, authors. Thank you, Momenta team for bringing us another great issue.

George Iwama

President & Vice Chancellor
Quest University Canada

Metaphors to Read By

Must we eat the book? Can we hear the book?

Zach DeWitt

How does one understand what it is to read? It's an odd phenomenological question: the experience of reading is both subconscious — being so intimately internalized by the reader, that they cannot not read words placed before them — and superconscious, impelling the reader into a state of trance-like focus, holding their consciousness in place as the novel runs its course. To understand this experience, the reader often draws together disparate metaphors to visualize the process. In his essay “Of Books”, Michel de Montaigne uses several such metaphors — “reading-as-eating” and “reading-as-hearing” — to describe his experience with books. In this essay, I analyze these metaphors, to consider how these turns of phrase imply *ethical* relationships between a reader and a book. Several of Jacques Derrida's essays on eating and hearing will guide this paper through the metaphorical relationships that Montaigne establishes between himself and his readings. Ultimately, this analysis of ethical reading will contribute to the parallel ethical analysis: “reading” other people. Because both the book and the other remain firmly outside of our internal experience while simultaneously effecting and creating that same internal space, these metaphors might help us understand the limit between ourselves and others.

Montaigne and Derrida: Eating our books well?

In his essay “Of Books”, Montaigne reflects on his passionate life of reading. He uses vibrant metaphors to explain why he likes certain books, what reading feels like, and how ultimately why he reads at all. In doing this, Montaigne frequently likens reading to eating: “I come fully prepared from my house [to read]; I need no allurements or sauce [to engage with the words]; I can perfectly well eat my meat quite raw; and instead of whetting my appetite by these

preparations and preliminaries, they pall and weary it” (1: 301). Montaigne expresses, with this extended set of metaphors and metonyms, a relatively simple idea: he does not need his readings prepared with any additional (flavorful) flair; he wants only the “raw” ideas, denoting that flowery, well-prepared, writing does not help him work up an “appetite” (1: 299) for the subject of his reading. In other words, Montaigne uses this metaphor to explain how the “preparations and preliminaries” distract from the actual “meat” of the text. The reader realizes that the image of raw meat stands in for the text Montaigne reads: we replace the metaphorical language, creating the intended meaning. Yet, in likening reading to eating, Montaigne risks conjuring the image of consuming a book as one consumes a meal, maybe even a steak, served rare. An odd series of images follow, as Montaigne reads the book by eating, chewing, swallowing, digesting the pages; reading becomes an act of survival, a necessity of life created through the death of the consumed book. It is here, in this literal reading of the reading-as-eating metaphor that we begin to see the implication that metaphors have on the readers' internalizations of the text.

So, what does it mean for us to understand reading as an act of eating? On the one hand, eating is an essential quality of the living human: one must eat to live, one must consume the life within other lives to be sustained. This reading of Montaigne might then imply some sort of life within the text that we consume to survive. Indeed, Montaigne cites, as one of his main reasons for reading, that books “instruct [him] in how to die well and live well” (1: 297). He looks for “fuller and stronger” books, which will teach him about himself and his life (1: 297). We might carry this metaphor to the (clichéd) “food for the mind/soul” metaphor, a description of reading which very few passionate readers would object to; we all relate to the feeling of mental satisfaction reading causes. Yet,

on the other hand, thoughts of consumption and digestion also recall the somewhat darker images. “I can perfectly well eat my meat quite raw” (1: 301) implies a murderousness in Montaigne’s reading, a tearing at the flesh of the text. He must hunt down the book, kill it, before feasting upon the meaning contained within. There is a destruction inherent in this description; the reader reduces the text to an object of consumption. So, in part, the reader lives — grows, even — through reading, yet the reader must also consume, and (partially) destroy what they read, *digesting the dead*. There is something moral at the heart of this relationship: an ethical paradox seems apparent within this metaphorical conception of reading as both life and death.

Notably, Jacques Derrida speaks directly to the subject of paradoxical metaphorical consumption in an interview entitled “‘Eating Well’, Or the Calculation of the Subject”. Specifically, he elaborates on his neologism “phallogocentrism” (coined in an essay entitled “Plato’s Pharmacy”), using prefixes to describe how logical (logo-) and masculine (phallo-) ways of knowing and being remain at the center of Western (metaphysical) understandings of subjecthood, reducing emotional, feminine thinking to lesser-than. Importantly, in “‘Eating Well’”, Derrida adds another prefix *carno*-phallogocentrism as this philosophical position also “implies carnivorous virility” (2: 280). This “schema or image ... installs the virile figure at the determinative center of the subject”, a masculine individual that must consume (meat) to *be* (2: 280). Montaigne certainly privileges, with these metaphors at least, the masculine consumption of the books he reads: he seems concerned with the clarity and logic contained within his reading material, hoping that he can consume without the distracting extras. Within the interview, Derrida refers first to the literal eating of living beings by people but turns to describe the metaphorical consumptive processes of anything external to the self: “...take seriously the idealizing interiorization of the phallus and the necessity of its passage through the mouth, whether it’s a matter of words or of things, of sentences, of daily bread or wine, of the tongue, the lips, or the breast of the other” (2: 280). All hearing or reading within the Western conception is profoundly masculine: the consumption “of words or of things, of sentences ... of the other” often become acts of destruction, a sort of masculine conquering. Montaigne,

in metaphorically eating his books, seems to be a perfect exemplification of this metaphysical relationship between logical man and the submissive text.

Yet, the “reading-as-eating” metaphor must still be grappled with. Derrida continues by proposing an ethics of consumption:

the moral question is... not, nor has it ever been: should one eat or not eat, eat this and not that, the living or the nonliving, man or animal, but since *one must* eat in any case and since it is and tastes good to eat, and since there’s no other definition of the good [*du bien*], *how* for goodness’ sake should one *eat well* [*bien manger*]? (2: 282)

Consumption and corresponding destruction — the eating of the killed chicken, the dead lettuce, etc. — must occur; this should be obvious. Derrida simply asks us to think about how eating can occur well — that is, ethically. To extend the metaphor back to Montaigne’s book eating, how can one read ethically, while still “consuming” their books? Derrida proposes that one must have “respect for the other at the very moment when, in experience (I am speaking here of metonymical ‘eating’ as well as the very concept of experience), one must begin to identify with the other, who is to be assimilated, interiorized, understood ideally” (2: 282). If the self is to respect the other — the other that is to be eaten, the other that is to be read — Derrida shows that the self must identify with that other: one must attempt to identify with the cow before it can be consumed, before it can be “internalized”; one must identify with the book before it can be identified as reading material to be “assimilated”, to be digested to sustain the self. A respect of those that we consume comes before the act of ethical consumption. In other words, Derrida describes “eating well” as a process of “*learning and giving to eat, learning-to-give-the-other-to-eat*”; ethical eating “does not mean above all taking in and grasping in itself...” (2: 282). In giving the rare steak to oneself to eat and recognizing that one is also giving oneself to the steak simultaneously, one consumes by acknowledging the act of consuming itself, by recognizing the gift that life has given us, that “one never eats entirely on one’s own...” (2: 282). If we extend this line of ethical thinking to the novel, the reader must give the other-text to themselves as a gift to

read, to consume, to appropriate in their own language, recognizing the inherent sacrifice that the meaning of the text will incur in being given to be read. A sort of metaphorical consumption defines our experience of reading, of interpreting anything for that matter. By recognizing that “one never [*reads*] entirely on one’s own”, one might read well, despite the potential destruction inherent in the relationship. Derrida offers us a way to think about the ethics of reading, with his explanation of eating well.

To return to where we began, Montaigne offers some of his own practical processes of ethical book consumption: “I have adopted the habit for some time now of adding at the end of each book ... the time I finished reading it and the judgment I have derived of it as a whole ...” (1: 305). This habit of annotating his texts establishes his engagement with reading that acknowledges that he takes a place within the reading act and thus, must respond to the work. With Derrida’s ethics in mind, we might see this act of annotation as a process of giving oneself to the text, even an acceptance of the fact that the text is responded to, rather than something consumed alone. Finally, and somewhat paradoxically, Montaigne at once critiques books for having too much “sauce” to wet his “appetite” (1: 299), while simultaneously using the exact sort of preparatory sauces, the exact same flowery language, to write his essay. By reading Derrida through this essay, we see that Montaigne simultaneously appreciates the digestible (masculine) logic of clear writing, while also playing with the flowery emotional metaphors that fail to fit within the carno-phallogocentric vision of writing that Montaigne claims to enjoy. In other words, the ironic written structure Montaigne employs works as an exemplification of both the simple and the more complex metaphorical plays that reading often engages the reader in. He plays with his own reader’s reading, thus pushing them to recognize that the text has its own ironic power; the metaphorical plays within the text reveal the other-text as something that one is interpreting. Most simply, this flowery language reveals to the reader that they are not reading alone.

Hearing the other-text

In assessing the reading-as-eating metaphor, we have established several points: first, the metaphors we use to describe reading set up an ethical relationship

between the reader and the text; second, these metaphors are challenging in that they imply different often contradictory relationships and realities; third, by comparing the process of eating and reading, this reading metaphor has paralleled other ethical relationships, implying that an understanding of the relationship between reader and text might hint at similar relationships between other ethical subjects. Yet, in playing with metaphors, we certainly might get lost, for reading-as-eating is not the only metaphor we might use to understand the ethics of reading. For example, the careful reader of Montaigne might have noticed a myriad of other metaphors: he says that his “books speak” (1: 305) and that he talks back to them. We arrive at the reading-as-hearing metaphor. I argue that the two metaphors discussed in this paper exist parallel to each other. They interlace in strange and contradictory ways, implying different things about the reading process: the layering of auditory and gustatory metaphors complicates any easy understanding of the phenomenological or ethical process of reading. Montaigne describes reading as eating and as hearing simultaneously within one essay: what are the contradictions that arise from these two very different metaphors and how might they help us understand reading?

To explore the complexities that arise from these two metaphors, we must begin again by analyzing the new metaphor: reading-as-hearing. On the one hand, the process of “hearing” the words on the page feels endemic to the process of meaning making with phonetic language; many readers experience the mental reading out loud of the words on the page. There is a certain literalness to us the metaphor hearing a “book speak”: we all learn to read by connecting sounds to letters, by hearing others read to us, by reading out loud to ourselves. Learning to read is not just a process of seeing the words but also a process of hearing and speaking the words while viewing the letters on a page. Thus, this metaphor — reading-as-hearing — seems intuitive, even real, whereas the reading-as-eating metaphor seems a bit more colorful. Yet, on the other hand, hearing the book remains metaphorical: most read silently, thus “hearing the author speak through the pages” does not fully reflect reality. Further, literary theorists use auditory language to describe reading. In Stanley Fish’s writing, the word “utterance” (3: 65) is used frequently, where the word “passage” might have

made more sense. Wolfgang Iser uses the word “statement” when “passage” might have sufficed, referring to what the “[sentence] actually says”, both of which have auditory connotations (4: 277). These examples highlight the frequent use of auditory language when talking about a silent process. This metaphor already implies, at least in part, a contradiction, while also accurately describing many readers’ experience reading.

To navigate this contradiction, we ought to turn to Derrida’s essay entitled “Tympan”. In his work, he uses the word “tympan” as a metaphor to describe the limits between inside and outside, and the regulatory process by which we engage with others, be them books or other people. This tympan is “the cloth stretched taut in order to take its beating, to amortize impressions, to make the *types (typoi)* resonate, to balance the striking pressure of the *typtein*, between the inside and the outside” (5: xii). While this general definition extends to many different explicit examples, Derrida focuses on the eardrum — scientifically named the tympanic membrane: “[The hammer] is placed on the *internal* surface of the tympanic membrane. It always has the role of mediation and communication ...” (5: xiii). The vibrations that hit the eardrum pass through this bone down the inner ear, where the sound then passes, along nerves, to the brain. Yet, this function is paradoxical: “This small bone protects the tympanum while acting upon it” (5: xiii). The hammer bone, resting on the inside of the eardrum, mediates and controls the vibrations experienced at the eardrum by muffling the tympanic membrane while simultaneously internalizing the vibrations to create meaning. In other words, the inside both allows access to the outside sounds, while protecting the inside from the potentially damaging outside pressures.

With this Derridean metaphor in mind, what does it mean to hear our texts? How does the metaphorical tympan help us to understand our relationship with the text? As with the reading-as-eating metaphor, the reading-as-hearing metaphor involves an internalization of information. Something outside comes inside. The text is outside of the body, outside of the mind, and reading allows for it to transgress this gap, to cross this limit, into the self. Yet, the hearing metaphor denies that there is ever a full internalization of the text; words do not cross to the inside of the eardrum, they are merely mediated across the limit; there is a sort of exchange,

along the hammer bone, that allows for communication, but never a puncture of the barrier. Further, reading-as-hearing implies a certain distance between the self and the other: there is not a penetration of the self by the other, as this would imply the rupture of the tympanum, creating a metaphorical and literal loss of hearing. Reading then might be understood as transmission of information on the internal terms of the reader; we can only understand the words on the page by balancing “internal pressures and external pressures” (5: xiii) on our own terms, we can only ever relate to books through our own understanding of words. In fact, Montaigne states “whatever language my books speak, I speak to them in my own”, implying that he regulates the language of the text, with his own understanding of language (1: 305). When we hear the book, we internalize those sounds by balancing our inside understanding of the words with the outside “vibrations”.

So, on the one hand, the metaphorical tympan-limit is vital to our understanding; on the other hand, they create the potential for problematic relationships in which the reading-self internalizes the other-text with self understandings rather than on the terms of the other. Our metaphorical reading-tympan both allows for and limits our engagement with a text. To navigate this challenge, we might claim that Derrida’s “Tympan” joins Montaigne in playing with contradictions, in reveling in the linguistic games that one can play with metaphors. Irony is used to engage with complexity, which challenges us to engage with reading. We might also draw from “Eating Well”, as hearing the book “well” might involve a sort of respect for the limit between the reader and the text, respect for the necessity of reading as an act of mental sustenance, or learning about the world around oneself, and the fact of our limitation in approaching a text with our own understandings and language. Perhaps, giving the reading to one’s own limits, would be the ethical response. In this case, an ethical hearing of the other-text must come by recognizing limitations in that hearing, with active attempts to hear past those limitations, active attempts to welcome in the text, welcome in the other, both of whom might be read. In other words, if one’s understanding will always be limited by the self, perhaps responding to the reading with one’s own limits in mind would be the most ethical approach

to understanding the outside.

While these two metaphors both relate the limitations between the inside-reader-self and the outside-reader-text, these two metaphors also contradict: the process of internalization is conceptually different. In the former case, the text becomes fully internalized through the metaphorical process of consumption, in the latter case, full internalization results in a punctured eardrum, a metaphorical loss of hearing. Each metaphor offers a different relationship, one that implies a different ethical response to the act of reading: on the one hand, we might argue that when we read, we should give the other, and perhaps ourselves, to the process of consuming the text; on the other hand, we might argue that we should simply acknowledge the loss that will occur at the limit, the fundamental difference that separates the inside from the outside, and the reality that this limit must exist in order for reading to occur at all. The ethical relationships seem at odds. However, I argue that this should not be evidence of the impossibility of such analysis, but rather that both metaphors offer different ways of describing the same sort of problem. Ethical understandings are complicated, and the metaphors we use to describe such relationships will reflect that. Engaging with paradox and complexity will, inevitably, help us think through this complexity, despite not offering clear answers. In this sense, we ought — joining Montaigne in his ironic serious and playing stance towards writing and reading — revel in this complexity of the metaphors we live by, as this certainly reveals much about the nature of our own limits. To give the text to be eaten, or give the book to one's limits, one might realize this by taking irony and paradox seriously, and engaging in the complexity of books.

Metaphors to read by or metaphors to live by?

We could, in a longer essay, explore any number of other metaphors. It suffices to say that there is a near-infinite number of ways to describe reading. It is precisely this multiplicity of metaphors which implies the need for a certain ethical analysis of reading relationships. In playing with these two metaphors, we have already revealed ethics hidden within their literary folds; the multiplicity only implies that there are more ethical relationships to untangle. In “Tympan” Derrida

works through several different tympan, describing and playing with the various metaphors we might use to understand the limits. Reading-as-hearing and reading-as-eating, and the contradictions they reveal, only scratch the metaphorical surface of a metaphorical and ethical understanding of reading.

Yet, these metaphors and their contradictions, do help us establish ethical understandings. I think the complexity of our metaphors mirror the more general ethical paradoxes of relating to others. In fact, much of Derrida's work uses reading as a metaphor to understand all relationships; much of his work is interested in the importance of ethics in processes of interpretation and engagement with things external to the self. If we “read” others, an understanding of the paradoxical complexity of limits and the ethical meaning of eating will help us begin to engage with the complexity of all metaphorical understanding. Of course, the differences between reading books and reading others must be acknowledged. Yet, our analysis of reading highlights the ethical relationships that define all “reading” of the world — the world of things, the various media we consume daily, and the people we interact with. In other words, Derrida teaches us that reading exemplifies the meeting of inside and outside, allowing us a way to practice, or learn how to consume or hear the other text. We read the world, and thus we relate to the world through a metaphor, one that implies relations, contradictions, destructive internalizations, *ethics*. When we begin to assess the metaphors by which we read, by aiming to engage with their contradictions, we may find a way to “read” others well, reveling in the paradox and irony of human life.

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See on Both Sides like Chanel

Subverting Hypermasculinity and Gender Binaries in Contemporary Hip-Hop

Lucia Belakova

Introduction to Black Masculinity in Hip-Hop

Around the time of its inception, hip-hop as an art form was unmistakably anti-establishment. The defining characteristics of the genre were graphic lyrical content and thought-provoking political subject matter that brought attention to the everyday issues of marginalized youths from marginalized backgrounds and low-income areas. Over time, hip-hop became a highly acclaimed multibillion dollar industry, catapulting rappers towards stardom and financial success. However, with its rapid popularization among White Americans, hip-hop suffered a narrative switch. Performances of black masculinities that played into the White imagination of the Black man became omnipresent in American media. The perfect embodiment that portrays this white supremacist patriarchal conceptualization of the Black man is the trope of a ‘thug’—a man that is aggressive, violent, hypersexual, straight, and angry. This precise identity formation within the hip-hop subculture has, according to Miles White, “had a deleterious effect on how Black people are viewed everywhere” (1). What had started as a diverse display of disenfranchised communities’ experiences grappling with oppression both personal and institutional morphed into a homogeneous expression of misogyny, violence, and homophobia (2).

It is important to note here, however, that this monolithing did not occur in a vacuum; as Crystal Belle argues, “one cannot fully analyze Black masculinity in hip-hop music without thinking of larger societal structures in place” (3). Indeed, as hip-hop broke into the mainstream culture and garnered popularity among a White audience in the 1990s, record companies began privileging the narratives of violence, misogyny, transphobia, and homophobia, marginalizing artists

who represented differing notions of masculinities (2). In that vein, capitalist focus on hypermasculinity and hypersexuality within hip-hop became a way of policing the sexuality and gender norms perpetuated by the White heteronormative framework. The impossibility of attaining fame without embracing the norms imposed by White capitalist labels pushed hip-hop artists into performing the stereotype of a thug, which created a culture of vilification and ultimate rejection of homosexuality and transsexuality within the genre, thus posing hip-hop as an antithesis to queerness.

As Joey Tan writes in the opening sentences of his essay ‘LGBTQ+ Representation and Activism in the Music Industry’ (4), 20% of 18-34 year olds identify as queer; 92% of those people are self-proclaimed music enthusiasts. However, queer visibility and representation of alternative masculinities in hip-hop, the most popular genre of our time based on total music consumption, is virtually non-existent (4). Representing alternative masculinities and queerness is an imperative step to normalize the LGBTQ+ community as well as to challenge the discrimination and the harmful rhetoric that leads to violence and abuse of the members of this community.

Despite the scarcity of queer musicians in the past, within contemporary hip-hop now exist a number of disruptors that purport a subversive rhetoric that seeks to reject the values of heteronormative masculinity promoted in the mainstream media. These artistic disruptors have been creating substantial waves of change in hip-hop in their attempt to break down the homophobic and transphobic barriers within the genre. Frank Ocean, Cakes da Killa, iLoveMakonnen, Le If, and Tyler, the Creator are among the most prominent black queer hip-hop artists who fall under the ‘disruptor’ category. Instead of promoting hegemonic

masculinity, as is still the norm within the industry, these artists' personas and music propound an articulation of complex masculinities that undermine the capitalist commodification of manhood, squashing the desire for hypermasculinity and heteronormativity within hip-hop identities. Through the theories of Judith Butler and Jacques Derrida, I will explore how White capitalism has privileged the 'thug' narrative of Black manhood in contemporary hip-hop as most conducive to commercial success. Using J. Jack Halberstam's low theory as a critical lens, I will simultaneously consider how Frank Ocean's use of lyrical imagery in his music breaks down gender binaries and subverts the notions of hegemonic masculinity as the industry standard, by utilizing both emotional unmasking and vulnerability, but also the coded language of heteronormativity.

Commodification of Hip-Hop

As the last decade of the 20th century commenced, rap/hip-hop producers started entering distribution and record deals with corporate conglomerates, such as when Def Jam, a largely hip-hop focused record label, merged with the industry giant CBS Records (5). By 1996, all independently owned national distributors of hip-hop ceased to exist and independent labels were forced to either follow Def Jam's suit or leave the market entirely (2). Hip-hop was, thus, introduced to a White middle class audience which consumed the genre with fervor. White youths relished in the 'otherness' and rebelliousness of Black manhood and embraced it as a representation of their own dissatisfaction with contemporary White American life (5). This enthusiasm was reflected in the sales—in 1996, hip-hop/rap garnered over 800 million US dollars in revenue, which accounted for a significant proportion of the 12 billion US dollars generated by the record industry that year (5).

With an explosion in sales, however, a rigid regulation of what were deemed 'appropriate' and 'authentic' identities in hip-hop emerged. Market research conducted at the time by record labels demonstrated interest in severe lyrical content that resonated with White America's preconceived notions and stereotypes of urban Blackness, namely the Black man as a 'thug' (5). In this way, the content of hip-hop became subject to the consumption habits of White suburban Americans (2). Record labels recognized that hip-hop was

only lucrative when properly packaged for the largest demographic it appealed to. The genre was, therefore, commodified and institutionalized as hypermasculine, homophobic, misogynist, and violent, with the intention to shock a receptive White audience rather than represent the realities of the Black experience (2). Musical expressions that fell outside of the edifice of heteronormativity were disowned by record labels that offered little to no support to artists who did not conform to their standards. By consequence, diverse representations of masculinities disappeared from the mainstream by the end of the 1990s.

Gender Performativity and Binaries in Hip-Hop

In her seminal publication, 'Gender Trouble: Feminism and the Subversion of Identity' (6), Judith Butler postulates that gender and sex are performative rather than completely natural phenomena, naturalized overtime through ritualistic repetitions of acts both bodily and verbal. This is a profound assertion that has had radical implications for the notion of gender, as it posits gender as imitation without an original rather than a reference to an idea of manhood or womanhood that precedes culture and language (6). All genders are a form of impersonation; they are the result of particular behaviors associated with the desired gendered effect that one has perceived and internalized for later reproduction (6).

In hip-hop, gender acts the same way it does everywhere else—men perceive, internalize, and reproduce the standards and stereotypes associated with an 'authentic' rapper within the industry. To perform the desired hypermasculinity in order to receive attention from record labels, the rapper then publicly renounces the Other, the feminine and the homosexual, and reenacts the ways that solidify their manhood and superiority over the Other through displays of violence, independence, abuse, and objectification. Since failing to reenact the heavily entrenched heteronormative masculinity and its most patriarchal significations would affect hip-hop artists' social legitimacy and label endorsement, the adherence to this public persona remains a pervasive praxis in the industry.

The music industry, with the aid of the White heteronormative audience, has successfully pitted queerness and hypermasculinity against each other

within the context of hip-hop, creating an admittedly dangerous binary, but not one that is uncommon. The entrenched edifice of hegemonic hypermasculinity in hip-hop that seeks to vilify the feminine and the homosexual by privileging its own narrative and subjugating the perceived Other is customary practice within binary oppositions in most imaginable contexts. In a Derridian sense, the construction of the rigid, normative binary reifies the hypermasculine heterosexual by Othering that which is queer, as a way of “establishing conceptual order”; and the stronger the distinction within the gender binary, the easier it is to reinforce heteronormativity (7). Without the conceptualization of the Other to oppose it, hypermasculinity would lose its meaning, and since heteronormativity can be a lucrative narrative in hip-hop to perpetuate, the gender binary is, time and time again, affirmed and policed by rappers both old and new.

Low Theory

For binaries of any kind, a problem arises when individuals emerge that fall between or outside the constructions of the oppositional poles. The individuals that do not ‘fit in’ disrupt the foundations of these binaries, undermining their very existence. And it is precisely through providing visibility to these uncertain possibilities and positionalities that a meaningful cultural reset can occur. In his 2011 publication ‘The Queer Art of Failure’ (8), J. Jack Halberstam proposes ‘low theory’ as a mode of countering hegemony by “locating all the in-between spaces that save us from being snared by [its] hooks”. The in-between spaces that Halberstam refers to can very well be interpreted as identities and experiences excluded from the traditional narrative within the mainstream culture, and, especially in this particular context, those violently excluded from hip-hop in its current iteration.

When Halberstam proposes that “feminine success is always measured by male standards” (8), an extrapolation can be made that queer success is always measured by heteronormative standards. In the same way that failing to perform womanhood can, according to Halberstam, offer unexpected pleasures (8), so can failure to live up to heteronormative standards be a form of liberation. As Halberstam proposes, “under certain circumstances, failing, losing, forgetting, unmaking, undoing, unbecoming may in fact offer more

creative, more cooperative, and more surprising ways of being in the world” (8). In the same vein, by casting aside the norms of the hip-hop industry, which repress non-normative expressions of gender and the queer self, an artist can deliberately subvert gender and disrupt oppositional binaries, while partaking in liberated forms of creative cultural productions.

Frank Ocean and Subversions of Gender and Sexuality

Subverting gender binaries and the heterosexual/homosexual dichotomy is a radical act with beneficial effects for the marginalized groups identifying with the queer experience. The artists mentioned in the introductory paragraphs, such as Frank Ocean, Le1f, iLoveMakonnen, Cakes da Killa, and Tyler, the Creator, both conform to gender roles as well as subvert them, positing themselves in the deeply disruptive liminal spaces Halberstam describes within low theory. Therefore, critical analysis of the works produced by these artists, and particularly Frank Ocean for the purposes of this essay, is imperative to understand the mechanisms of disruption within the hip-hop music scene.

Christopher Breaux, better known by his stage name Frank Ocean, is a Black musician hailing from Long Beach, California. Ocean is among the most successful artists of his generation, earning his recognition through his critically acclaimed studio albums ‘channel ORANGE’ (2012) and ‘Blonde’ (2016), with the former having won a GRAMMY award for the ‘Best Urban Contemporary Album’ of 2013 and the latter being named the album of the decade by the renowned online music publication Pitchfork. Ocean’s diverse music enjoys immense popularity, which has been the case since his first studio album broke into the mainstream, conquering streaming services and charts seemingly out of nowhere.

Frank Ocean’s courageous coming out as bisexual mere weeks before his debut studio album ‘channel ORANGE’ began to climb the ranks of commercial success remains a landmark of queer expression in contemporary hip-hop as well as popular culture at large. In a tumblr post (9), published in 2012 and since deleted, Ocean shared with his following that the first love he ever had was a man. This was a revolutionary act for Queer Black music, as Ocean was one of the

first men in hip-hop and rap to do so. Throughout his post and subsequent interviews, Ocean remained ambiguous in relation to his sexual orientation, implying his bisexuality, but never truly declaring it, thus avoiding definitions of the self in relation to sexuality. The implication, as opposed to a direct declaration, is an important facet of Ocean's subversiveness of the 'authentic' male rapper, as it demonstrates the possibilities of fluidity and multilateralism that lie outside the binaries of gender and sexuality.

Contradictions in the Tracks on 'channel ORANGE' and the Song 'Chanel'

Just like Frank Ocean's ambiguity regarding his sexuality, 'channel ORANGE' is an endlessly elusive, multifaceted form of self-expression, exhibiting both lyrics reflecting Ocean's heteronormative conformity as well as content that propounds his queer non-conformity. As described by Halberstam's low theory, Ocean sorts through the contradictions of his own existence through inhabiting different narrative roles: an Egyptian king and a pimp on the diptych 'Pyramids', a trust fund beneficiary on 'Super Rich Kids', the character Jenny from 'Forrest Gump' on an eponymous track, and a lamenting sinner that longs for a straight man on 'Bad Religion' (10). He does not commit to a single narrative, but instead chooses to explore a myriad of corporeal temporalities that reflect his own gender potentiality. Ocean's characters crafted for 'channel ORANGE' illustrate his queer multilateralism which breaks down the boundaries of fixed sexuality and gender identities, allowing for the disruption of simple oppositional binaries. As an unnamed author writes in their review of 'channel ORANGE' for the Pitchfork article 'The 200 Best Albums of the 2010s, "inhabiting someone you are not is inherent to the queer experience; after all, pretending to be straight is nothing if not the assumption of a persona" (10).

The second track on the album, 'Thinkin Bout You', is a reflective piece on hypermasculinity as a performance, experienced by Ocean himself. The main character of the song deliberately masks his vulnerability and homosexual desires by articulating traditionally masculine behaviors, such as addressing his secret love interest in a hypermasculine vernacular ('No, I don't like you, I just thought/you were cool enough to kick it'), which keep him from experiencing true happiness

of being with the one he loves (11). A piece of evidence for the sorrow of unfulfilled homosexual desire and longing can be found in the line "My eyes don't shed tears, but boy, they pour when/I'm thinkin' 'bout you", where the word 'boy' connotes a double entendre—an interjection as well as a way of addressing his past male love interest (11). The words "Of course I remember, how could I/forget how you feel?/You know you were my first time, a new feel" elicit his coming out tumblr post, a vulnerable confession of experiencing love for another man, thus further cementing the song as a descriptor of the queer experience (11).

The song 'Super Rich Kids' features a character similar to the hypermasculine man in 'Thinkin Bout You'. The unnamed character lives an opulent lifestyle, but a sense of unfulfillment induces him to keep 'searching for a real love' amidst the glitz, meaningless sex, and drug abuse (12). Towards the end, the trust fund beneficiary realizes that the only way to achieve real love is to transgress the boundaries of hegemonic masculinity by giving up the signifiers of his social status, such as his penthouse and his car, the women he surrounds himself with, and the drugs and alcohol. This is evident in the line "We end our day up on the roof/I say I'll jump, I never do". The image of a roof serves as a metaphor for the lavish lifestyle and the act of jumping portrays a transgressive escape towards the authentic self (12). The character achieves this when he falls off the roof of his penthouse, thereby starting his life anew, free of the confines of his previous hypermasculine identity (12).

Another song called 'Chanel', which can best be described as a boastful metaphor of bisexuality and gender transgressions, perfectly encapsulates Ocean's subversion of binary conceptions of sexuality and heteronormativity through the paradox of simultaneous conformation and nonconformity. In the opening lines of the song, Ocean starts off with the assertion "My guy pretty like a girl" (13). On the one hand, through this line, Ocean challenges heteronormative masculinity so pervasive throughout lyrical content in the genre of hip-hop by openly discussing the fact that his love interest is a man. On the other hand, the fact that he chooses to describe the man as "pretty like a girl" insinuates that the state of being 'pretty' is a gendered trait that is emblematic of womanhood, which in a sense equates his male love interest to a woman

(13). Ocean develops the line further by singing that his guy has “fight stories to tell”, complicating the gender identity of his love interest, thus highlighting gender and sexuality as spectra rather than binaries (13).

Ocean then closes the first verse with the hook, “I see both sides like Chanel/I see on both sides like Chanel” (13). Through this line, Ocean alludes to his position within the liminal spaces of heterosexuality/homosexuality as a bisexual, hence “seeing both sides” (13). This metaphor is portrayed through the mirrored “C” logo of the brand Chanel, which implies his sexuality, but also acts as an admittance to the existence of hegemonic hypermasculinity within him, as Chanel is an expensive brand and thus a signifier of wealth utilized within hip-hop to assert patriarchal dominance.

Conclusion

The historical pressure placed on Black male hip-hop artists by White capitalist record labels and the White audience to perform hegemonic hypermasculinity has caused queer representation to practically disappear from the genre. However, throughout the last decade, a new wave of alternative masculinities have made their way into the mainstream, demanding a cultural shift away from oppressive norms and towards more complex articulations of gender. Through his music as well as public discourse regarding his sexuality, Frank Ocean changed the very fabric of hip-hop genre and the industry, ushering in an era of queer acceptance and inclusiveness. I argue that Frank Ocean, through both conforming to and challenging heteronormative structures as well as by avoiding a full disclosure of his sexuality disrupts the gender binary, creates liminal spaces for queer hip-hop artists to realize themselves regardless of their gender or sexuality. Ocean’s lyrical boasts of opulence, wealth, and power, juxtaposed by simultaneous meditations on vulnerability, queer desire, and love demonstrates that masculinities are not defined by a rigid binary. Instead, they are dynamic and fluid, elusive yet liberating in their endless creative possibilities. His music reminds us that masculinity does not have to be expressed within the constraints of heteronormative boundaries to be considered ‘authentic’ and that being the Other does not make one less of a man.

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The Political Ecology of the Private Emergency Food System

McKenzie Boyle

Without food, human bodies cannot function nor exist. A lack of food or a lack of adequate nutritious food produces hunger, a chronic condition experienced globally by over 690 million people (1). However, rather than just a bodily process, hunger is also inextricably linked to the external social, economic, ecological, and political processes that produce food (2). In this paper, I utilize urban political ecology as a framework for understanding hunger as a deeply political phenomenon, as the discipline interrogates how humans are physically, bio-chemically, socially, economically, culturally, and politically tied to the land through food. This land-food link, Abel Wolman (3) describes as a metabolic relationship, a “circulatory processes that underpin the transformation of nature into essential commodities such as food,” connecting the natural to the social and transforming environments both rural and urban (4, p.281). From harvest to digestion, this process of metabolism encompasses labor, immigration policy, local and national market regulation, commercial distribution, surplus management, and charity, and traverses geography, race, gender, and class. In this way, food systems “cannot be divorced from the political ecological systems they operate within” but rather who eats what and who goes hungry is tied to federal and local socio-economic policy, identity politics, and issues of inequality, sexism, racism, and classism (2, p.127). As such, political ecology serves as a useful tool to examine the socio-natural processes that “(re)produce inequalities, exclusion and injustice between people and places which underpin the current geography of food insecurity” (4, p.280).

In this paper I take these theoretical groundings of urban political ecology to explore the political ecology of food production and the private emergency food system (PEFS), a network of food banks, food pantries, and soup kitchens that redistribute donated

food within Washington state, during the time of the COVID-19 pandemic (5). Through a summer job, I had the opportunity to work within the PEFS, assisting a local nonprofit with emergency food distribution during the pandemic in Seattle, a time when food banks and pantries saw a threefold increase in use coupled with mass food shortages (6). While doing this work, I became intrigued by the process in which I was participating and the larger implications of my work. Was I actually doing anything to change the social conditions of the people the PEFS served? What did the people receiving food think of it? Were they being adequately nourished? What were the socio-economic-ecological pathways through which the food reached this destination? What was I not seeing? These questions guide my explorations of the PEFS, as I do what Moragues-Faus & Marsden (4) cite as the goal of political ecology: “[to expose] the role of power in shaping socio-natural relations that reproduce inequality and injustice” (p.279).

In this article I expose the discrepancies and contradictions present within Washington’s food system and the PEFS exposed by the COVID-19 pandemic and show how a system that ostensibly intends to eradicate hunger and health/ hunger-based inequities, perpetuates them. To do so, first I examine the exploitative power relations and use of migrant labor involved in the production level of the metabolic process within Washington. Then, I discuss the fetishization and commodification of surplus food donated to the PEFS. Finally, I dissect the use and fetishization of volunteer labor within the PEFS and its role within a neoliberal enterprise.

H2-A and the Metabolization of the Land

The current social organization of the metabolic process - the mode through which nature is transformed

into food - produces unequal socio-ecological conditions (4). This social organization is arranged into modes of production including the harvesting, processing, shipping, distribution, sale, etc., all of which is primarily mediated through labor. According to sociologist, John Bellamy-Foster (7), labor is the means through which people transform nature for society. Within Washington state and across the U.S., the metabolic process makes use of certain forms of exploitable labor organized by the H-2A temporary agricultural worker program, a visa program that allows U.S. employers to bring foreign workers to the U.S. to fill temporary seasonal agricultural jobs (8). Through the particular organization of this program and a food system dependent on the labor it provides, the pandemic exposed how this arrangement fails both workers and Washington's hungry, revealing gaps in a delicate system and the unjust conditions faced by laborers.

With its labor-intensive crops such as berries, cherries, apples and pears, Washington has the fourth highest number of H-2A workers in the U.S., requesting over 26,000 workers in 2019 (9)(10). Laborers predominantly from Mexico and Guatemala come to Washington farms, through their contract guaranteed a standardized minimum wage and lodging (8). These migrant workers are essential to many farm's operations as they provide a cheap and reliable form of labor that most domestic workers do not.

With the advent of the COVID-19 pandemic, the Department of Homeland Security deemed farm workers "essential," however workers' close proximity and cramped communal housing has put these laborers at heightened risk of exposure to the virus (11). In August two H-2A workers at Gebbers Farm in Washington died from complications of the virus, and into the fall workers continued to have high rates of COVID-19 (10). However, fear of job loss and deportation compelled many workers to stay despite unsafe conditions. One worker at Gebbers described to a newspaper how he caught the virus and had trouble breathing, a high fever, and body aches, yet still went to work for fear of being fired, or worse being sent to an isolation camp and "left for dead" (10). These fears are not unwarranted for seasonal agricultural workers. In a 2018 federal lawsuit, blueberry pickers at Surbanand farm in Washington claimed they worked 12-hour days with little food. When 70 workers held a strike

to protest these conditions, they were all fired and sent back to their home countries immediately (9). These types of conditions compounded with the COVID-19 risk create a deadly environment for workers.

In addition to these risky work conditions, many farms across Washington were found to be in non-compliance with COVID-19 safety rules, housing workers in dormitory style lodges in groups of fifteen people, not providing sufficient access to soap and water, and not increasing social distancing because it reduced production (10). In an interview with a Seattle newspaper, Edgar Frank, a political director of a Washington farm-worker union said "I haven't seen much enforcement of existing guidelines in the fields. No social distancing, no giving out masks, too little spacing between rows and trees, and everyone huddling close together during crew meetings" (11).

Amidst these dangerous conditions, many H-2A visa workers chose to return home or simply not come to the U.S. at all for the season. As one worker who chose to leave Gebbers Farm said, it "was a choice between work and life, so we chose life." (10). For those who remained however, they were asked to make up for this lost labor, forcing roughly 12,000 to attempt to do the work of 30,000 (12). Working harder and longer hours, one worker at Gebbers described waking up every day at 2:30 am so everyone in his residence could take showers (13).

This labor shortage compounded by the shutdown of restaurants, shops, and processing plants due to the pandemic forced farmers across the state to throw away tens of thousands of pounds of produce (14). This enormous loss of food came as the number of people facing hunger in the state doubled with the pandemic, with nearly 2.2 million people facing food insecurity (15). This scenario revealed the food system's inherent contradictory and static socio-metabolic arrangement. As farm workers submitted to longer hours and more dangerous conditions, more and more people became food insecure. As farms left mass amounts of food to rot in the fields, food banks faced unprecedented shortages. This contradiction, Bellamy-Foster (7) argues results from the distinct alienation of workers from the labor process through industrialization and urbanization, a concept he calls "metabolic rift." Developed from Karl Marx's work on the relationship between humans and nature, metabolic rift describes the separation of

humans from the land and consequently from the food they eat (7). Modern day lifestyles contribute to this rift. Today the majority of people's jobs, relationships, and daily activities are severed from food production, as currently only 1.3% of U.S. citizens are employed directly as farm laborers (16). With this metabolic rift, access to food is dependent upon a complex and unseen process of production and distribution. Coupled with rising inequality, the contemporary metabolic rift means that many people in cities have less direct access to food. This creates a disparity between availability and accessibility. As Henyen (2) writes:

[e]ating is obviously related to nutrition, but in humans this physiological necessity is imbedded in a complex matrix: within which what is eaten, whom you eat with, how often you eat, who prepares the food, which foods are necessary for a sense of well-being, who goes hungry and who overeats have all been torn loose from the requirements of nutrition and the availability of food (p.129).

Although for the centuries since industrialization and urbanization this has been the case, the disparities caused by the pandemic calls into question the functionality of this current arrangement.

Within this arrangement, slow and often-overloaded third-party distribution organizations predominantly link farms to food banks, however the pandemic disrupted this distribution pathway (17). To bridge this supply-accessibility gap, one western Washington woman organized a caravan of people to drive across the state to salvage 12,600 pounds of potatoes and 9,500 pounds of onions from farmers abandoning their crops to donate to Seattle families (14). The need for this rescue mission highlights the human-food alienation built into today's modern food system. This contemporary system is structured according to an exploitative metabolic process that determines what people are expendable (read: migrant workers) and for whom food is available. Far from a simple misalignment of consumption and demand, this modern-day food system is not designed to feed the hungry nor to support fair conditions for laborers.

“Generosity” and the PEFS: The Commodification of Surplus Food

The severe disruption the pandemic caused within Washington's food system is about more than just a surge in users, but also highlights the delicate and contingent historical and economic process through which food travels from farms and factories to food banks. Usually food banks within Washington receive food from three main distributors, Second Harvest, Food Lifeline, and Northwest Harvest (18). Nearly all of the food received by these organizations comes from private donations, wholesalers and grocery stores as “grocery rescue,” unsold food or near expiry food that would otherwise be tossed in the garbage (19). However, due to increased demand from shoppers during the pandemic, there was no longer a surplus of waste to be donated to distribution organizations (19). This factor, compounded by an uptick in PEFS clientele, resulted in severe shortages at food banks and pantries across the state.

This complication exposed the deep flaws of a system that relies on feeding its clients through a reliance on “charitable” donations of “waste food.” The emergence of this arrangement traces back to a crucial shift within U.S. economic and social policy during the recession of the early 1980's, a time that marked a move from the Keynesian social welfare state into neoliberal governance (20). Along with rising unemployment and decreasing job security, the neoliberal evisceration of social safety-net programs through cutbacks in federal social spending transformed the realm of social service provision into a privatized industry (20). Local charities and nonprofits established new “emergency food” programs across the country, passing food donations from corporations on to kitchens and pantries (20).

Solidifying this new relationship, in 1983, the Temporary Emergency Food Assistance Act (TEFAP) ensured a constant and reliable stream of food into the PEFS through incentives that gave companies defined as C corporations according to tax code (most companies are) a tax deduction equal to 50% of the value of the food donated into the PEFS (5). As McEntee & Naumova (5) write, “This arrangement allows for unwanted food (food that would otherwise be considered waste) to be utilized [and] it acts as a vent for unwanted food, allowing large corporate entities to dump surplus product of questionable nutritional quality upon the

PEFS” (p.239). By dumping this surplus product onto the PEFS, corporations cut 50% of their losses of food that would otherwise be tossed in the trash.

Following this shift in emergency service provision, when the economy emerged from the recession of the early 1980’s, the stark wealth gap, decline in job security, erosion of minimum wage, cutbacks in food assistance and housing subsidies left in the wake of neoliberal rollout necessitated the continuation of emergency food programs (20). Today, there are tens of thousands of emergency food programs across the country, providing food to approximately one tenth of the U.S. population (20). This organizational apparatus reveals that “the PEFS is largely ‘emergency’ in name only” (5, p.240). Over half of food bank and food pantry clients report using the service on a regular and long-term basis (5). Additionally, since many companies would in other circumstances throw away their surplus food, food banks often receive large donations of low-quality and low nutritional value food (5). In turn, this low-quality food is distributed to food bank clientele and food insecure populations, feeding a vicious cycle of under-nourishment.

This physical and biochemical metabolization of nutrient deficient food by food bank clientele is directly tied to the socio-economic and historical maneuvers that produced the PEFS and to the scalar processes through which food moves through the process of metabolism. However, this insidious structural process is left largely unexamined within the U.S., replaced with rhetoric of personal responsibility and the need for compassion, kindness and generosity towards those who are less fortunate. As Janet Poppendieck (20) notes, millions of Americans support the PEFS through donations of food, money, and time. She writes:

They pack grocery bags at food pantries. They prepare and serve meals at soup kitchens and deliver sandwiches to encampments of homeless people. They organize canned good drives in their schools and Sunday schools, and send their youth groups and scout troops to help sort the proceeds at the food bank (IX).

This philanthropic front of the PEFS obscures the reality of the PEFS – that it is a system that manages rather than truly solves hunger. James Carrier (21) refers to this concealment as “fetishism,” a concept

developed from Marx’s work in *Capital* (22) which he defines as “the ignoring or denial of the background of objects” (p.674). I apply this concept of fetishism to describe the cognitive failures that underpin how the PEFS is popularly understood.

Recognizing the PEFS as a system premised upon corporate and citizen generosity fetishizes the profound contradictions within the PEFS and the larger food system in general during the COVID-19 pandemic. Fetishism, “whether witnessed on a local or global scale, or applied to the environment or food, is able to “veil and hide[s] the multiple socioecological process of domination/subordination and exploitation/repression that feed the capitalist urbanization process” (23, p.218). Within this process, the unsafe and unjust conditions on Washington farms for migrant workers who are exploited to stock the shelves of corporate food retailers is fetishized by corporate responsibility and “generous” donations made to the PEFS. This fetishization further obscures how donations allow retailers to cut their waste disposal costs, providing food bank clients with nutrient deficient food and commodifying “generosity.” Given this arrangement, as is, the current structure of the PEFS clings to a set of social arrangements that do not advocate for food access and equity but continue to “give symbolic scraps to the forsaken...” (24, para. 18).

The Fetishization of Volunteer Labor

Just as the charity model of the PEFS is incompatible with ending hunger, that the PEFS is largely staffed by a volunteer workforce further fetishizes the system as benevolent, concealing the mechanisms at play that drive the continual existence of food insecurity. In Washington, the three main distributors rely on 19,000 volunteers a year to run their operations (18). However, with the pandemic, rising unemployment, financial insecurity, and social distancing protocols, these organizations had only 15 to 20 volunteers available to do the labor to feed a rising number of people (18). This lack of a consistent/paid labor force available to support the distribution organizations began with the privatization and slashed funding of emergency food provision efforts in the 80’s, forcing organizations to rely heavily on an unpaid labor force to carry out services (25). Premised on a generosity of time and resources, Maggie Dickinson (25) writes, “Emergency food

providers are not organized around a right to adequate food, but on the institutionalization of sympathy—the sympathetic response to need” provided by these volunteers (p.19). The volunteer workforce is conditioned to see volunteerism as “an obligation of citizenship [of] the working and middle classes,” feeding a vicious cycle in which little investment is made into ending food insecurity, rather volunteers are continually mobilized to meet demand (26, p. 288). In this way, well intentioned volunteers and staff who care deeply about hunger supply the labor to an organizational structure where people’s needs are not designed to be truly met.

The “institutionalization of sympathy” that drives this system relies on an ideology of charity and deservingness. This ideology perpetuates the notion that those donating their time are not the ones receiving the benefits and are thus acting upon their own generosity. In return, those receiving food should be “grateful for what they get” no matter the quality of the food they are given. In these circumstances, food bank clients are not afforded standards nor expectations, as they are the recipients of food provided to them through volunteer “generosity.” As McEntee & Naumova (5) write, volunteer-run operations “routinely eschew the aesthetic values that dominate our retail system” and therefore “distribution of visibly substandard or otherwise undesirable products is achieved because clients have few if any rights” (p.240). For those reliant on the PEFS to survive, and consequently on volunteers, this unpaid workforce operates as a sort of “moral armour” to deflect and deter critiques and demands clients may voice, as the volunteers cannot be held to employee standards (25).

Neoliberal Metabolism

Through the use of this free volunteer labor sector, through corporate donations, and through the exploitation of seasonal migrant workers, the current food system and emergency food system reveals itself as an essential part of the expansion of capitalist accumulation (4). Rather than seeking to put an end to hunger, this market-based approach to food insecurity will serve its own existence into perpetuity and the “quantity, quality, and variety of food” people eat will continue to be a product of their socio-economic position (2, p.129). This “reinforces the idea that healthy food is a privilege, only accessible to those with

adequate financial and social capital” (5, p.249). Within Seattle, this disproportionately excludes people of color, non-native English speakers, and LGBTQ folks who are most frequently denied access to a healthy and stable food source (27). Through our current metabolic arrangement, these populations are “structurally recognized as less worthy of sustenance” (4).

Conclusion

In response to the severe strain on food banks due to the pandemic, in April, Washington Governor, Jay Inslee and nonprofits within the PEFS announced an initiative called the WA Food Fund that aimed to raise money to keep food banks and food pantries across the state stocked (18). This call for individual citizen donations to bail out a system that by nature does not have the capacity to eliminate hunger or health disparities exemplifies the contradictions inherent within the contemporary socio-metabolic arrangement of the PEFS. Food shortages and strains on the PEFS are not a result of food scarcity or unavailability in grocery stores, but rather as Agyeman & McEntee, (23) write, “contemporary food injustices are the direct result of a commodity-driven system where hunger is a by-product of profit” (p.218).

The socio-metabolic processes that transform nature into food have produced multiple overlapping and contradictory environments during the COVID-19 pandemic through biochemical, material, cultural, social, economic, and political power relations that underpin the geography of the food system. In one such environment, migrant laborers submit to exploitive and unsafe conditions on farms. In another, farmers let tens of thousands of pounds of crops rot in the fields. In another, 2.2 million Washingtonians face food insecurity. In yet another, the PEFS experiences severe strains from a lack of donations and volunteer support. These environments are simultaneous and mutually reinforcing, and within their confines reveal no way to emancipate Washingtonians from hunger and food insecurity.

After exploring some of the questions I posed at the beginning of this paper during my time working within the PEFS, I came to see how my work sorting and distributing food to families did little to challenge the existing structures of the food system in which persistent and widespread food insecurity is inevitable.

As long as we operate within a system where the ability to feed people is contingent on exploitative labor, third party organizations bridging the metabolic rift, “generous” donations, and the benevolence of volunteers with time to donate, the right to adequate food will not be secured for all. As the pandemic laid bare the contradictions and inherent flaws within our food system and within the PEFS, we must begin to imagine a new metabolic relationship with the land, laborers, and infrastructures that provide us with food.

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The Health Plight of the Tropical Poor

A Review of a Neglected Tropical Disease: Lymphatic Filariasis

Tharcille Tuyisenge

Introduction

James is fifteen years old. One day, he wakes up with a headache, fever, and swollen limbs. His condition quickly worsens and he must deal with aggravating muscle pain and brain damage. Eventually, he learns that he has elephantiasis, one of the neglected tropical diseases that rarely receives attention from both the general public and the scientific community. Even though his quality of life is rapidly deteriorating, he does not have hope for treatments. Unfortunately, James is one of 1.5 billion people struggling in silence with diseases that are curable, yet ruin lives of individuals in communities like his.

Over the past century, modern medicine has played an integral role in shaping healthcare systems across the world and has improved the quality and longevity of billions of lives (1). Scientific developments such as antiretroviral drugs, cancer therapies, vaccines, diabetes treatments, antibiotics, and antimalarials have improved success in both preventative and therapeutic medicines across the world (1) (2). However, it is important to examine who is fully benefiting from these impressive achievements and who is being left behind. The benefits of medical progress are not equally distributed around the world (3). Evidence of unfair distribution is apparent in a category of diseases called neglected tropical diseases (NTDs). This paper aims to highlight the marginalization of communities affected by NTDs. It argues that insufficient medical, political, and public attention toward NTDs perpetuates poverty and unnecessary suffering to impoverished communities across tropical regions. This paper explores an NTD known as lymphatic filariasis to shed light on the further neglect of curable diseases leading to loss of health and life.

NTDs are a set of 20 disabling and disfiguring

infectious diseases that prevail in tropical and sub-tropical conditions, and currently affect people in over 149 countries (4) (5) (6). Most of these diseases are chronic, cause severe pain, impair physical and cognitive growth, and have the potential to deteriorate the mental health of victims. These symptoms lead to stigmatization and exclusion of victims from their communities (6) (7). Tropical neglected diseases are known to affect the most vulnerable groups of people living in the poorest countries, mainly located in the global south (8) (9). Poverty is an overarching socio-economic factor that contributes toward the existence and persistence of NTDs as vectors and pathogens tend to thrive in poor behavioral and physical settings (10). Such socio-economic conditions include lack of access to clean water, proper housing, sanitation, and basic healthcare services (6).

Lymphatic Filariasis

Lymphatic filariasis (LF), commonly known as elephantiasis, is one example of a prominent NTD. It is a parasitic disease caused by roundworms of the family Filariodidea (4). There are three types of thread-like filarial worms which are responsible for LF: *Wuchereria bancrofti*, which is responsible for 90% of LF, *Brugia malayi*, and *Brugia timori* (4). The disease spreads through an infected mosquito bite, which transports microscopic worms through the skin and to the lymph vessels (4). Those microscopic worms stay in the lymph vessels and grow into adult worms. Adult worms can stay for about five to seven years inside the patient's lymph vessel and destroy the lymphatic system, which causes lymphedema (11) (12). Lymphedema is a condition caused by improper functioning of the lymphatic system. Usually, lymphedema results in swelling of different body parts such as legs, breasts, and genital

organs (13). For men, it can lead to a condition called hydrocele, which is the swelling of the scrotum (11) (13). Over 120 million people are affected by LF spanning 72 countries in Asia, Africa, South America, the Western Pacific, and parts of the Caribbean (11) (13).

The noticeable lack of attention from the general public, the scientific community, and policymakers puts individuals affected by LF and their communities at risk of social and economic suffering. LF is notorious for causing disfigurement of the body. The affected body part increases several times in size. Several studies suggest that improved living conditions such as clean water, sanitation, and appropriate health-seeking behaviors can prevent transmission of LF. Unfortunately, the indifference from both the public and private health sectors means that the victims and communities are not advised on preventative measures, let alone provided with access to any sort of treatment. In addition, LF patients experience stigmatization and exclusion from communities. Women are particularly the most stigmatized since their identities are attached to their beauty and ability to give birth (14). Consequently, they are forced to lead solitary lives to hide their illness, since their limited marriage prospects can make them a burden to their families (14). Furthermore, those infected with LF are more susceptible to HIV/AIDS, tuberculosis, and malaria (14). LF, like other NTDs, increases poverty in already impoverished areas since patients are too sick to go to work. For example, India loses 1 billion dollars per year due to LF while Ghana loses up to 7% of male labor due to LF (15).

Will We Stop Failing the Poor?

Unlike other infections such as HIV, SARS, and tuberculosis that only emerged in the last century, NTDs have been around for much longer. In fact, incidences of NTDs were documented in primeval texts such as the Bible, Ceccarelli, Talmud, Papyrus Ebers, and the writings of Hippocrates (16). NTDs can be chronic, debilitating, and disfiguring; they cause high morbidity and low mortality, which means that they do not kill victims as much as they disorient their lives. Additionally, these diseases are part of the reasons why the 'bottom billions' countries cannot escape from poverty since the labor force is affected. The poor in the tropics are being crippled by curable diseases and are dying in silence, which raises questions of why the

global health community is overlooking their suffering. The global health community has the potential to eradicate LF the same way they did with smallpox, measles, and yellow fever. The underlying difference between NTDs and other diseases such as measles, smallpox and yellow fever is that NTDs affect the poor unlike their counterparts. We seem to have forgotten that a healthy population is an integral part of creating wealth, and have ignored the plight of a significant portion of the global population. The fact that funds invested in medical research to treat diseases of the poor, such as LF and other NTDs, are drastically lower than those invested in treating diseases such as cancer and other non-communicable diseases that mostly affect the rich in developed countries (17) is a testament to the intersectionality of poverty and health. While pharmaceutical companies invest in projects that benefit their wealthy clientele, it is more sustainable for the global health community to ensure a more equitable healthy planet.

China, Cambodia, Thailand, and Togo have proven that LF can be entirely eradicated if given proper attention (18). These countries have been able to fully eradicate LF using several strategies, especially mass drug administration (MDA) (19). Through MDA, safe and inexpensive essential medicines are administered to a group of people based on preventive chemotherapy without individual diagnosis (20). This is a way to implement a strategy of annual, single dose mass chemotherapy with antifilarial drugs (21). In this case, multiple drugs can be administered collectively to treat multiple NTDs at the same time. For example, administering ivermectin and albendazole treats LF, onchocerciasis, and soil transmitted helminths (STHs) at the same time. MDA is relatively affordable because it costs \$ 0.5 USD to treat one person per year (20). This shows that at least some NTDs are treatable and controllable using MDA programs. Hence, if policymakers and the larger global health community makes NTDs a priority, LF can be eradicated in other parts of the world as well.

Conclusion

It is time to start fairly distributing the benefits of medical and pharmaceutical developments in all regions of the world. Access to healthcare developments should not be a by-product of privilege, but a universal

human right. In order to achieve Millennium Development Goals (MDGs) for global health and human rights, the World Health Organization, financial institutions, public and private sectors should be willing to invest sufficient resources to reduce the burden of NTDs and transform the lives of the most disadvantaged people across the world. Funds and public attention should be poured into medical research to eradicate NTDs because it is unacceptable that the lack of attention costs millions of lives. The poor have a right to as much dignity and are entitled to a fundamental human right of access to healthcare.

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Agroinfiltration in Molecular Pharming—A Review

Umayeer Milky

Abstract

As the need for cost effective large-scale production methods of pharmaceuticals proteins rises, the developments in the field of genetic engineering have allowed scientists to exploit plant cells for the expression of desired pharmaceutical proteins. Agroinfiltration is one of the simplest and most commonly used techniques to deliver *Agrobacterium tumefaciens* containing the gene of interest into the host plant cells. In this review, I focus on the development of agroinfiltration since its initial conception over 30 years ago and how it is currently being used, especially in the field of molecular pharming.

Introduction

Since the advent of genetic technologies, scientists have exploited various living organisms to express foreign genes coding for proteins useful to humans. Recombinant proteins for human health applications are currently produced by different cell culture technologies^{1*} including mammalian, insect, and bacterial cell-based systems (1, 2). However, the maintenance of these cell culture facilities is an expensive enterprise (3). By contrast, plant-based expression systems are a cost-effective alternative for producing recombinant proteins as they do not require the need for holding facilities or bioreactors (3). The production of recombinant proteins is much faster in plants, highlighting the potential significance of commercial agriculture in large-scale biomass production (3). Additionally, a plant-based expression system reduces risks of transmitting human pathogens as plants rarely host human pathogens and animal-derived products are not required for plant culture (4-5). Finally, the eukaryotic-endomembrane system* in plant cells can perform post-translational modifications and assembly of complex proteins (e.g. antibodies), something bacterial cells are not capable of doing (4-5). Together, these features make plant-based expression systems the most ideal of those available for the production of pharmaceuticals.

The production of recombinant proteins in plants with the aim of utilizing the protein product for human health benefits is called molecular pharming (6). Molecular pharming—the field and the term—was born after the publication of an article describing the production of a functional recombinant antibody in tobacco plants (7). The development of “deconstructed viruses” (see section Agroinfiltration in Steps) and the approval of the first plant-derived therapeutic enzyme for Gaucher’s Disease, along with the success of several human clinical trials with plant-made pharmaceuticals have highlighted the promise held by this field in recent years (8, 9).

The major drawback of using transgenic plants for high-scale production of recombinant proteins is the low level of foreign gene expression (usually 1% of the total soluble protein) (10). Moreover, selecting for stable transgenic plants* can take as long as a year (10, 12). Alternatively, transient expression of the gene of interest* (GOI) in plants is known to yield a higher amount of recombinant protein within a much shorter timescale (11). The only major disadvantage of transient expression—it does not yield transgenic seeds and plasmid DNA has to be re-introduced into plant cells for each batch of recombinant protein production—is outweighed by its advantages (11). Transient expression

1 * Terms with asterisks are defined in the Glossary section found at the end of the paper.

is therefore preferred over stable gene expression for large scale production of pharmaceuticals, especially in the case of a pandemic when certain pharmaceutical products (e.g. vaccines) are in high demand (12). However, given the major disadvantage transient gene expression possesses, it is critical to ensure the use of a transgene transfer technique that will be efficient for large-scale protein production in plants.

Irrespective of the plant species being used or the protein being produced, the transgene has to be introduced into the host plant cells. The most common method of delivering transgene into plant cells for the development of transient systems includes direct delivery by biolistics* or indirect delivery by *Agrobacterium tumefaciens* (See **Box 1**) (13). While biolistics greatly simplifies the gene delivery process by not depending on a vector, it usually results in severe tissue damage and a reduction in the amount of biomass available for protein production (13). *A. tumefaciens* mediated gene transfer performs significantly better in terms of transgene expression in host plant cells according to the evidence presented by the long-term studies carried out in this field (13). As a result, *Agrobacterium*-mediated gene transfer is more desirable for pharmaceutical protein production in transient systems.

Agroinfiltration is the method used to deliver *Agrobacterium*-based genes into the plant cells (12). The observation of the significantly high levels of the transgene expression in transient assays with agroinfiltration in comparison to that of stable transgenic plants gave rise to its use in the development of transient systems for the production of pharmaceutical proteins (13). Owing to its simplicity and effectiveness, agroinfiltration is a popular tool in the field of biotechnology and botany. In this review, I explore the evolution of agroinfiltration since its inception, the basic principles behind the methods involved, and how it is being utilized in the field of molecular pharming today.

The Development of Agroinfiltration

Agroinfiltration was initially developed as a tool to study plant-virus interactions. In earlier experiments carried out by Grimsley *et al.*, whole or partial genomes of plant viruses (such as cauliflower mosaic virus) were cloned into binary vectors and transformed into *Agrobacterium* hosts which were then inoculated into the leaves of turnip plants by nicking the bottom surface of the leaves using sterile toothpicks (14). As the turnip plants were infected with viral genes, this process was initially termed “agroinfection” (14). Rossi *et al.* first used the term ‘agroinfiltration’ in 1993 to describe the method they used to introduce an “improved version” of *uid A* gene (gene coding for β -glucuronidase) into tobacco seedlings using vacuum (15). Following this, Kapila *et al.* were the first to describe the development of an efficient and reproducible *Agrobacterium*-mediated transient gene expression system for intact leaf tissue in 1996 using vacuum infiltration introduced by Rossi *et al.* (16). Today, we use the basic principles of the methods described by Grimsley *et al.*, Rossi *et al.*, and Kapila *et al.* to optimize agroinfiltration for different plant species.

Syringe versus Vacuum Agroinfiltration

The most popular method of agroinfiltration is “syringe agroinfiltration” (**Figure 1**). It involves the use of a syringe to transfer the *Agrobacterium* into the plant leaves. First, a small nick is created in the epidermis on the backside of the leaf, as described by Grimsley *et al.* but with a needle instead of a toothpick (17). Using a syringeless needle to disrupt leaf tissue integrity as little as possible, *Agrobacterium* in the infiltration medium is injected into the leaf through this nick (17). Successful infiltration is marked by the darkening of leaf color upon the injection of the infiltration medium (17). Syringe infiltration provides flexibility in terms of the

Box 1. *Agrobacterium tumefaciens*

Agrobacterium tumefaciens is a plant pathogen which induces tumor in plants by inserting a part of its Tumor Inducing (Ti) plasmid called T-DNA(44). The Ti plasmid also contains the virulence (*vir*) genes, which play important roles in the transfer and integration of T-DNA into the plant genome (44). Because of its ability to insert part of its own genome into the plant, it is often referred to as a natural “genetic engineer”. This process has been adapted to plant molecular farming, enabling the transfer of a desired gene coding sequence into the nucleus of the host plant for protein expression. The exact mechanism of how *Agrobacterium* transfers T-DNA into plant cells can be found in this well-reviewed paper by B *et al.* (2006) (44).

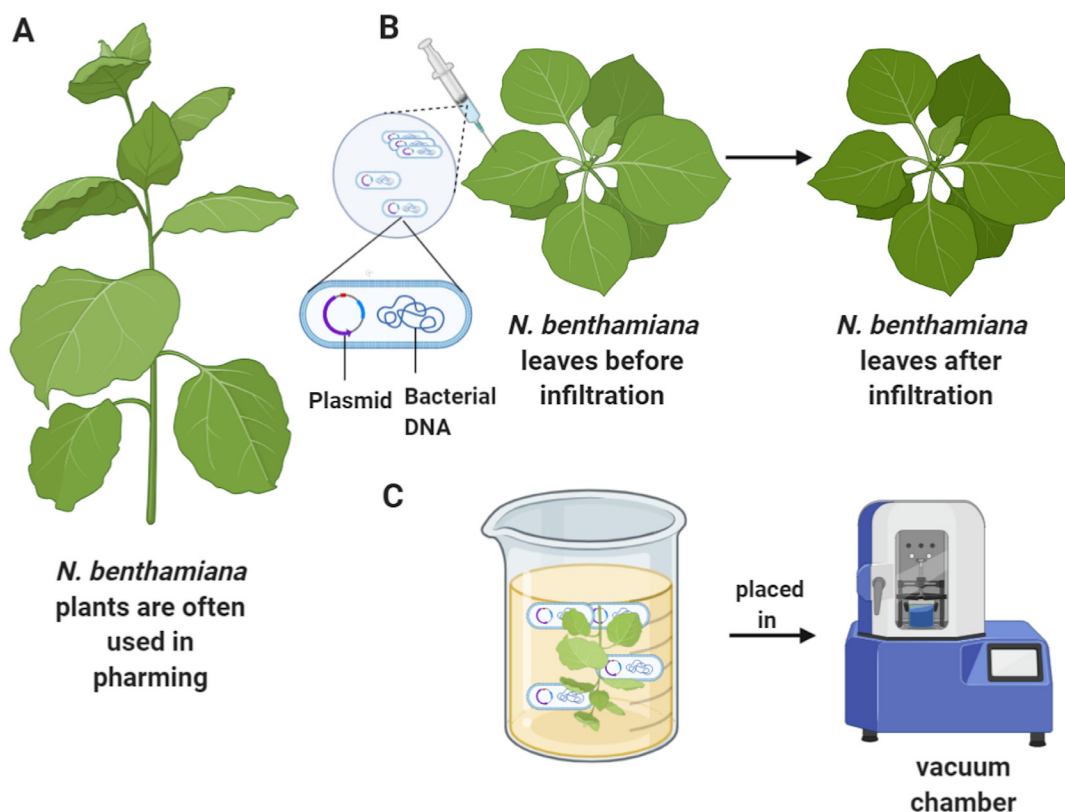


Figure 1. The two methods of infiltrating plants

A. *N. benthamiana* is the most common host plant for recombinant protein because it is amenable to genetic transformation and can rapidly yield high amounts of biomass. B. Syringe infiltration is the most popular method of agroinfiltration despite its limitation when it comes to large-scale protein production. Improvements have been made to the basic principle depicted here over the years (42). C. Vacuum infiltration allows for rapid production and large scalability by infiltrating whole plants at once, making it popular in the field of molecular pharming.

Figures generated using BioRender & Adobe Illustrator

number of assays that can be performed in a leaf (18). Additionally, it does not require the use of complex equipment. Due to the demonstration of these vital advantages, syringe infiltration has been optimized for several plant species, including tomato and *Arabidopsis* (18). Because of how simple it is, syringe infiltration could, theoretically, be a useful tool for budding geneticists or botanists to study plants in a university laboratory setting.

Not all plants can be infiltrated using syringe infiltration. For those plants, vacuum infiltration is used. The basic principle of vacuum infiltration (Figure 1) involves submerging the plant leaves into an infiltration medium containing the *Agrobacterium* strains holding the GOI. The submerged leaves are then subjected to a negative atmospheric pressure in a vacuum chamber. The vacuum draws air out of the interstitial spaces in the submerged plant leaves. When the vacuum is

released, the air spaces are occupied by the *Agrobacterium* strains (17). While not as simple or flexible as syringe infiltration, vacuum infiltration provides enormous scalability potential and can infiltrate a large number of plants in a short time (17). These properties make vacuum infiltration the preferred method for the development of transient expression systems for the large-scale production of pharmaceutical proteins.

Agroinfiltration in Steps

Regardless of the method of gene delivery, there are four basic steps (summarized in **Figure 2**) involved in agroinfiltration for the production of pharmaceutical proteins—construction of vector(s) containing both viral genome and GOI, growing plants for agroinfiltration, preparation of the infiltration culture, and the process of infiltration itself (14-17).

Vector Construction

Agroinfiltration can be performed by numerous vectors*, including non-viral or plant virus-based vectors. Research has shown that while non-viral vectors can drive high-levels of protein expression, the yield is still low when compared to transient assays performed using vectors based on plant-viruses (19,20). Vectors based on plant-viruses can efficiently replicate and carry out transcription in plant cells, contributing to the higher yield of associated recombinant proteins (19, 20). The selection of which plant virus to base the vector on is essential for gene expression. In earlier experiments, viral vectors based on cauliflower mosaic virus (CaMV) were used (14). However, CaMV and other viruses with double-stranded DNA genome have limited packaging capacity, i.e. they lose their essential genome function even if just a small number of genes is substituted or removed (19). It is important that the viral vector be able to carry the GOI without losing its ability to infect the plant for successful gene expression. The next generation of vectors were based on plant viruses with single-stranded RNA (e.g. tomato bushy stunt virus (TBSV) and tobacco mosaic virus (TMV)) (19). These viruses are more diverse, have a larger packaging capacity, and can also better tolerate gene substitution or insertion (19). Development of “deconstructed” viral vectors fairly recently has made transient gene expression by agroinfiltration even more efficient. “Deconstructed” viral vectors are constructed by removing the viral components which are not essential for the functioning of an expression vector. This reduces the size of the replicon* and allows for the insertion of larger transgenes (21). Two of the prominent deconstructed viral vector systems are the MagnICON system and the DNA replicon system derived from bean yellow dwarf virus (BeYDV) (21). Both systems offer high transgene yield, but the latter has a broader host range and allows for the production of proteins with a maximum of 5 heterosubunits (vs. the two produced by MagnICON) (21, 22). Beyond these two systems, there exist other methods of constructing deconstructed vectors for agroinfiltration (21). The details of how these systems work are beyond the scope of this review and readers are directed to this review article by Peyret and Lomonosoff for further information (21). As the type of plant virus on which the vector is based affects its ability to infect different plant species, future research

could focus on the construction of a vector that would eliminate this issue and increase the efficiency of transgene expression in host plants.

Selecting & Growing Plants for Agroinfiltration

Growth conditions and the age of plants in which transient systems are developed result in variability in the amount of target protein produced by the plant. Research has shown that temperature, light intensity, the supply of fertilizer, plant inoculation age*, and incubation time after leaf infiltration are important factors for ideal plant growth and protein expression (23). Consistency of these factors is crucial as even the slightest of changes can produce drastic differences in the amount of protein produced (23). It has also been reported that 6-weeks old plants grown under ideal conditions (varies between plant species) yield the largest amount of recombinant protein (18). Plants older than six-weeks yield a higher amount of biomass but these plants have already begun flower production and this compromises the amount of protein produced (23). Future research could focus on using gene editing or modifying techniques to stably produce transgenic plants that will develop faster and will be able to yield, upon infiltration, high amounts of recombinant proteins at an earlier age.

Agroinfiltration can be performed on most plants, but not all plants are suitable for recombinant protein production. Tobacco and *N. benthamiana* are commonly used for transient expression of proteins because of their ability to rapidly yield a high amount of proteins (24). However, most tobacco and *N. benthamiana* plants contain high levels of phenolics and toxic alkaloids, which complicate the purification process of pharmaceutical proteins produced in these plants (24). Alternatively, lettuce has been shown to produce a similar yield of pharmaceutical proteins as tobacco and *N. benthamiana* and a limited amount of phenolics and alkaloids (24). This makes lettuce a better host plant for the production of pharmaceutical proteins, as secondary steps are not required to purify the protein. Regardless, *N. benthamiana* and tobacco remain the most popular for development of transient expression systems with the aim of recombinant protein production (See Table 1). This is most likely due to the fact that lettuce was only recently optimized for vacuum infiltration (24), and other plant species, such as tomato and

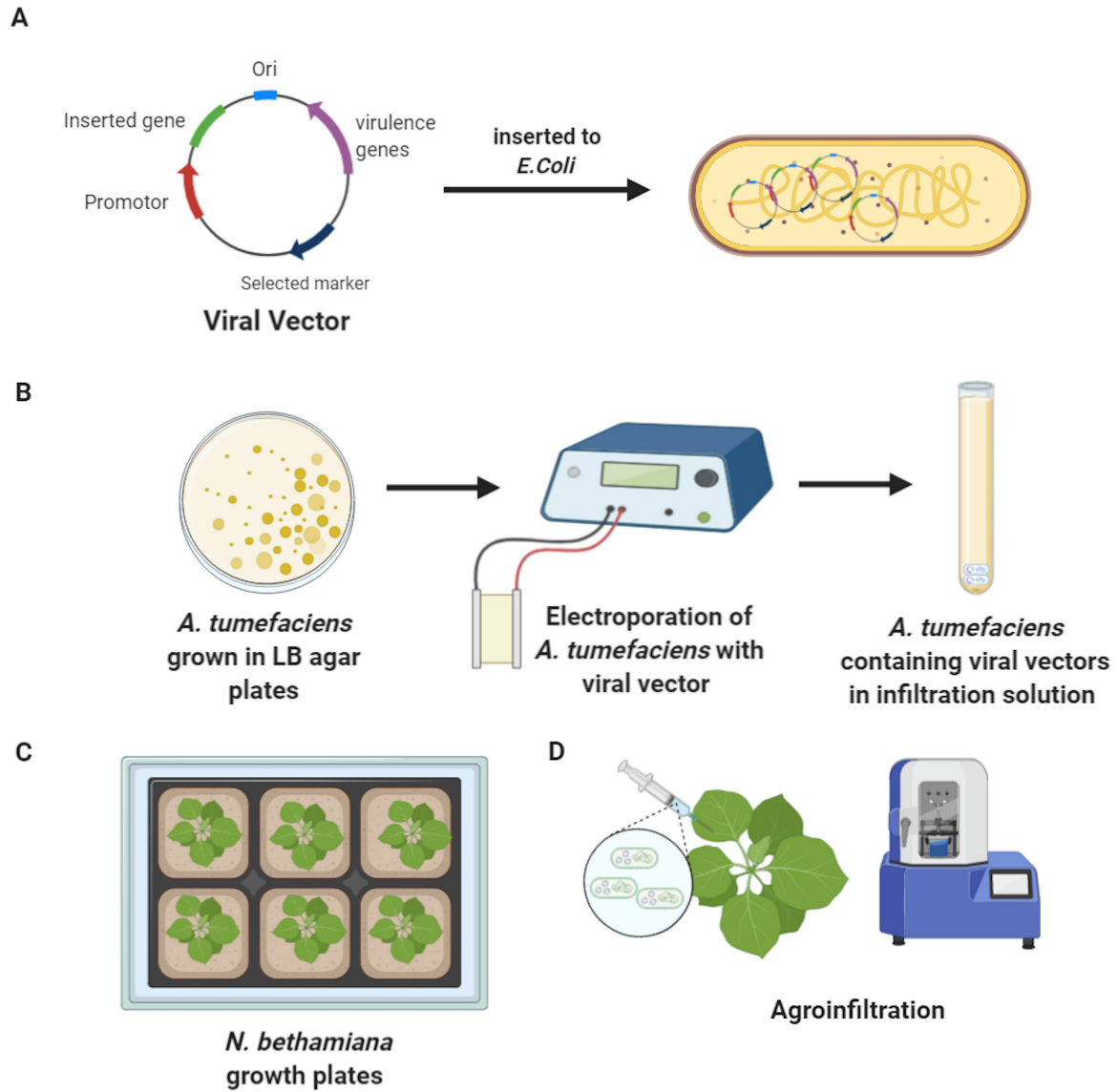


Figure 2. Agroinfiltration in Steps

Agroinfiltration is done in four steps. A. Vector (usually based on plant viruses) is constructed to carry GOI. Vectors are cloned in *E. coli* bacteria (also grown in agar plates; not shown) due to its rapid growth rate and ability to express proteins at high levels (47,48). B. *Agrobacterium tumefaciens* are grown in LB agar plates (usually at 27 °C) (47). Using electroporation, vectors extracted from *E. coli* are inserted into *A. tumefaciens*. The *A. tumefaciens* is then introduced into the infiltration culture, containing a mixture of chemicals, including acetosyringone, functioning to ensure efficient gene expression and high protein yield in host plants. C. *N. benthamiana* or other plant species is grown for agroinfiltration in a controlled environment. Optimized growth conditions vary from one plant species to the next. D. When plants are ~6-weeks old, *A. tumefaciens* is introduced into plant cells via syringe or vacuum infiltration.

Figures generated using BioRender & Adobe Illustrator.

Arabidopsis, were only optimized for syringe infiltration (18). Since *N. benthamiana* remains a popular plant for agroinfiltration, future experiments could be designed to edit the genome of the plant to prevent the expression of phenolics and toxic alkaloids without altering its ability to produce recombinant proteins.

Preparing the Infiltration Culture

Ensuring the preparation of the ideal culture for infiltration is critical as it directly affects the degree of transient expression (18, 25). The ideal culture for infiltration varies depending on the vector used and the plant species that is to be infiltrated. It has been shown that the inclusion of acetosyringone* in the culture medium improves plant transformation frequencies (26). The concentration of *Agrobacterium* in the culture medium is also critical as too much can cause tissue necrosis and cell death (17). A study carried out by Chen *et al.* determined that the optimal concentration, measured in terms of OD₆₀₀*, required for maximum delivery of transgene in *N. benthamiana* plants without causing necrosis is OD₆₀₀ = 0.12 per *Agrobacterium* strain (17). Their results suggest that by using consistent culture media, culture time, and temperature, the desired concentration of *Agrobacterium* can be obtained (17). Optimal *Agrobacterium* concentration to allow for maximum transgene transmission without causing harm to the plant tissue varies between plant species and has to be optimized for each (11, 18).

Introducing Gene of Interest into Plant Cells

The final step in agroinfiltration is the process of infiltration itself. As described above, the flexibility of syringe infiltration allows for multiple assays* to be performed in a single leaf. For example, different concentrations of *Agrobacterium* can be injected into a single leaf to determine the optimal concentration required for maximum gene transfer (23). Other parameters that can be determined for a new protein being harvested in a plant using the flexible nature of syringe infiltration include optimum growth conditions and organelles in which expression of genes or accumulation of protein is favored (23). Upon determination of these factors, syringe infiltration can be used to infiltrate the entire leaf area of several plants to rapidly obtain sufficient recombinant protein for its biochemical characterization, preclinical functional studies, as well as for

developing its purification schemes (23). However, syringe infiltration will not produce large-scale protein for commercial purposes, and as discussed above, vacuum infiltration is used instead for that purpose. Vacuum infiltration is scalable, more robust, and can infiltrate plants more rapidly and has been used to produce sufficient virus-like particles (VLPs)* for clinical trials in humans (23, 37, 45, 46).

Applications of Agroinfiltration

Agroinfiltration can be used to analyze biotic and abiotic stresses (27), induce or suppress gene silencing (28), gene-for-gene interaction studies (14, 29), analysis of bacterial/viral gene expression in plants (14, 15, 29), and production of recombinant proteins (12). This section will focus on the application of agroinfiltration in molecular pharming.

Agroinfiltration has been used to harvest many recombinant proteins in plants over the years. In 1999 Vaquero *et al.* was the first to use agroinfiltration to create a transient expression system for the production of a molecular farming product—chimeric antibody (30). Since then several companies have adapted the agroinfiltration-based transient expression system described by Vaquero *et al.* (1999) and developed platforms in tobacco for rapid vaccine manufacturing (31). The potential of a rapidly scalable transient expression system was validated by the production of ZMapp, a combination of three monoclonal antibodies for the treatment for Ebola hemorrhagic fever (32). ZMapp was transiently expressed in tobacco and was the only relief available against the symptoms caused by the viral infection (33). Companies such as Medicago and iBio/Caliber Therapeutics have developed transient expression systems in tobacco and related plants for the production of influenza vaccines (31). Medicago's platform is based on the infiltration of *N. Benthamiana* for the production of VLPs that can act as effective vaccines (34). **Table 1** summarizes some of the different pharmaceutical proteins that have been produced via transient expression of genes in plants using agroinfiltration.

Conclusion

Agroinfiltration is an important tool in the field of molecular pharming. Even though the use of

Table 1. Selected Pharmaceutical Proteins produced in Plants using Agroinfiltration

Host Plant	Target Recombinant Protein	Stage of Development
<i>N. Benthamiana</i> , Lettuce	Norovirus NVCP VLP	Preclinical (35, 36)
<i>N. Benthamiana</i>	Influenza vaccine	Phase III of Clinical Trial (37)
<i>N. Benthamiana</i>	ZMapp	Approved for compassionate use (Before clinical trial could be completed) during the Ebola epidemic in West Africa (32). Deemed safe, but not effective as other available treatments (38).
<i>N. Benthamiana</i>	West Nile Virus Domain III Virus vaccine	Preclinical (39)
<i>Raphanus sativus</i> (Radish)	Staphylococcal enterotoxin B (SEB) Virus vaccine	Preclinical (40)
<i>N. tabacum</i> cvs. Samsun and Xanthi, and <i>N. Benthamiana</i>	human IFN- γ protein	Preclinical (41)
<i>N. Benthamiana</i>	COVID-19 Vaccine	Phase I of Clinical Trial (45)
<i>N. Benthamiana</i>	Rotavirus Vaccine	Phase I of Clinical Trial (46)
<i>N. Benthamiana</i>	Norovirus Vaccine	Pre-Clinical Trial (46)

agroinfiltration has successfully generated transient systems capable of yielding high amounts of recombinant proteins, refinements have been attempted and proposed to maximize yield (42, 43). While the recent improvements in agroinfiltration have contributed to a higher yield of recombinant proteins (43), in many cases protein production following Good Manufacturing Practice regulations remains a challenge (23). Furthermore, while transient expression systems can produce a large amount of the desirable protein, they are not always efficient (38), and very few have been approved for regular use by the FDA(8). Regardless of these shortcomings, agroinfiltration remains a vital tool for biotechnologists and geneticists. While this paper focused mainly on agroinfiltration's role in the pharming, it is also an important tool for the study of plant genome and how plants interact with other organisms. Its simplicity and its ability to rapidly produce recombinant proteins at an affordable cost (39) make it a possible solution for the large-scale production of vaccines in developing countries during pandemics or epidemics (49). Future research could focus on producing transgenic plants that can express proteins of interest at an age of less than six weeks, and the development of a

vector that can successfully infect most plant species. Advancements in plant biotechnology and the field of virology will also potentially contribute to further improvement of agroinfiltration. In an animal privileged world, plants might finally be starting to get their dues, even if it is for human benefit.

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Glossary

Terms are arranged in the order of appearance in the paper.

Cell Culture Technologies

Unique technology transfer solutions to produce proteins and cells in chemically defined minimal media.

Eukaryotic-endomembrane system

A group of membranes and organelles in eukaryotic cells that works together to modify, package, and transport lipids and proteins; absent in prokaryotic cells.

Stable Integration of Genes

GOI is established into the nuclear genome by selection pressure and is inherited by offspring of transgenic plants.

Transient Gene Expression

GOI is expressed temporarily after a plasmid DNA encoding an expression cassette is introduced in a eukaryotic cell.

Biolistics

Gold or tungsten particles are coated with transgene and ballistically fired into plant cells.

Vectors

Something that carries the gene of interest(s) into the host plant.

Replicon

Self-replicating viral RNA containing viral non-structural genes. Replicons are critical for viral genome replication with genes coding for structural proteins replaced by foreign genes.

Acetosyringone

Phenolic compound released by wounded plants that attract bacteria towards them and also induces expression of certain *vir* genes.

OD₆₀₀

Optical Density of a sample measured at a wavelength of 600nm; commonly used to measure bacterial concentration as 600nm does not hinder bacterial growth.

Assays

Investigative procedures to measure the presence of a target entity in a sample or organism.

Inoculation Age

The age of the plant at which foreign genes are introduced into its cell(s).

Virus-Like Particles (VLPs)

Molecules that closely resemble viruses but are non-infectious because they contain no viral genetic material. However, they can still elicit an immune response in the human body.

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