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From Mother/Fetus to Holobiont(s): A Material Feminist Ontology of the Pregnant Body

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Abstract

In Karen Barad's agential realism, the "fetus" does not preexist as an object with a distinct agency that interacts with the "mother." Meanwhile, recent scientific studies reveal the vital roles symbiotic bacteria play in human reproduction. Drawing on material feminist theory, this article offers an alternative ontology of the pregnant body represented by the *motherfetus*, which collapses the material distinction between the "maternal" and the "fetal" embedded in the Cartesian mother/fetus dualism regularly reiterated by scientific, popular, and feminist discourses. The article deconstructs pregnancy, which is typically known as a bidirectional exchange of substances between the parent and offspring, and reconstitutes it into a symbiotic process sustained by networks of commensal microbacterial activities. The idea of *holobiont reproduction* challenges some of the basic concepts associated with pregnancy and childbirth such as the difference between a fetus and an infant and the gender of the gestational parent. This article offers the motherfetus-holobiont as a boundary-breaching cyborg figure that opens up new possibilities for scientific and feminist studies of the pregnant body.

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*The cyborg, like the mother-fetus rethought,
may push scientific medicine to tolerate
ambiguity, admit subtle shading, and replace
antagonistic opposition with mutual interest.
—Emily Martin (1998, p.138)*

*This chapter is an argument for pleasure in the
confusion of boundaries and for responsibility
in their construction.
— Donna Haraway (1991, p.150)*

Abortion and childbirth are rarely discussed together in feminist scholarship, perhaps understandably so. Termination of pregnancy by choice does not seem directly relevant to the feminist critique of overmedicalization of obstetrics, while a pregnancy carried to term has little to do with protecting abortion rights. Although health care and abortion politics seem unrelated as feminist research areas, they share a strong interest in strengthening the agencies of pregnant persons and restoring their control over their bodies. Feminist scholars have argued that the overuse of technological interventions minimizes gestational parents' involvement in childbearing and undermines their subjectivities (Davis-Floyd, 2004; Katzman, 1991). The high rate of cesarean section in the United States reflects obstetricians' prioritization of extracting the fetus from its parent, which, as I discuss below, is normalized by the binary thinking of the Western philosophical tradition. Feminist scholars who have analyzed photography of fetuses that appear to be free-floating in space and sonographic images of the "unborn child" are similarly critical, arguing that these visual representations push the pregnant person into the background and render their presence imperceptible (Hartouni, 1998; Morgan, 1996; Oaks, 2000; Petchesky, 1987; Stabile, 1992). Visualizing the "independence" of the fetus predisposes the viewer to regard it as a patient of its own right. Moreover, fetal imaging bolsters antiabortionists' rhetoric of "fetal personhood," against which feminist scholars have argued tirelessly for decades to support reproductive

rights.

Pushing against the personification of the fetus, feminist theorists have proposed a variety of ways to reconceptualize fetal relationships, reestablish the pregnant person's agency, and strengthen abortion rights (Casper, 1994; Morgan & Michaels, 1999; Hird, 2007; Browne, 2015). While many have argued that the fetus cannot be regarded as an independent person because its existence relies on its relationship with the gestational parent, most have fallen short of revoking the Western notion of "corporeal autonomy" (Addelson, 1999, p. 33). In other words, while maintaining that a fetus is not a fully autonomous agent morally, psychologically, or socially, feminist theorists have for the most part left untouched the notion that the fetus is physically distinct from the host. This, I feel, has hindered feminists' ability to fundamentally shift the ontological divide between the "mother" and the "fetus."

The idea of fetal corporeal independence, which underpins both medicalized childbirth and antiabortion arguments, has been upheld by Biological sciences that presume Maternal and Fetal substances to be exclusive of each other.¹ Scientific theories that pit the Fetus against the Mother have been widely accepted because they appear to be the "natural" order of things, according to the Cartesian binarism that counterposes the self against the other and when the Fetus is coded *male* after the sperm. Recognizing that this habitual dichotomizing and gendering inhibit thinking about pregnancy differently, this article explores an alternative ontology of the materiality of the pregnant body.²

A material feminist counterargument to maternal/fetal corporeal independence, and the theoretical foundation of this article, is offered by Karen Barad (2007), who takes issue with the fundamental assumption that the fetus exists as an essential being with its own substance, qualities, attributes, and relations. Denying the existence of separate individual entities that preexist their "interactions," Barad holds that "distinct agencies do not precede, but rather emerge through, their intra-action" (p. 33). In agential realist terms:

The fetus is not a preexisting object of investigation with inherent

properties. Rather, the fetus is a phenomenon that is constituted and reconstituted out of historically and culturally specific iterative intra-actions of material-discursive apparatuses of bodily production (p. 217)

If this is so, then the fetus as a phenomenon can also be *unconstituted* under a different material-discursive practice. Building on Barad's insight, this article attempts to replace the binary-laden *mother/fetus* with a nondualist *motherfetus*, which refuses to make a distinction between the Maternal and Fetal organisms by foregrounding symbiosis as the material basis of a pregnant body.

This project comes at a timely moment, when some biological scientists are revisiting individualist assumptions long adhered to and moving toward a more ecological framework to study living things. The realization that the human body relies on millions of microbes to cofunction supports the conceptualization of the pregnant body as a *holobiont*, or an integrative symbiotic system (Gilbert and Tauber, 2016). In this article, I first provide examples of the traditional Scientific construction of fetal corporeality, followed by an overview of the emerging nonindividualistic way of organizing biology. The main section of the article taps into the latest Scientific revelations regarding the role of symbiotic microbes in human reproduction to show how pregnancy can be viewed not as a bidirectional exchange between the Mother and the Fetus, but instead as a process integrated in a larger symbiotic circulation of matter. I then challenge the binary distinctions between *before* and *after* "birth" and redefine the liminal state from around the third trimester to the first birthday as *holobiont-in-becoming*. These exercises will ultimately dissolve the material distinction between the gestational parent and the Fetus, making it more difficult to make claims about an independent fetus or to negate the benefits of natural birth.³

Furthermore, this work troubles the highly gendered conception of the pregnant body. Feminist scholars have for the most part—like the Scientific approaches in which they intervene—long taken for granted that pregnant people are all women and therefore "mothers" (and not

fathers or some other relation), and thus that the constituency represented by pregnant persons is indeed women. While acknowledgement that not all women are mothers is fairly commonplace, the fact that not all pregnant or potentially pregnant persons are mothers or women has yet to transform our language and conceptual frames substantively. I endeavor here to problematize the separation of pregnant body and fetus and at the same time to loosen the grip of gender on our imaginings of pregnancy.⁴ Overall this article aims not to offer the mother/fetus as a feminist panacea, but to release feminist theory from dualist binds so that reproductive science and politics can be explored in new ways. The conclusion section will offer some thoughts on how focusing on the biology of pregnancy as the process of developing a new holobiont from a parent holobiont enables the transgression of gender binary and heterosexuality with which human reproduction has been imbued.

Fetal Corporeality as a Phenomenon

For many years scientific theories have taken for granted that an entity referred to as the Fetus preexists while remaining oblivious to the effect of their assumptions on authenticating a hegemonic referent called the Fetus. Although scientist rarely acknowledge it as such, a genetically pure, original, and independent Fetus is a hypothetical entity rather than something that precedes its scientific accounts. Typically, Scientific accounts portray the Mother and Fetus as rivals, although collaborative models are not uncommon. Either way, Scientific theories predicated on a materially isolatable conceptus that is *distinct* from the parent have engendered the phenomenon scientists call the Fetus.

Mother/Fetus: Oppositional Dualism:

An antagonistic relationship between the Mother and Fetus, which I name “Mother/Fetus” here—mirroring the self/other dichotomy in Cartesian dualism—is a common trope for theories in multiple scientific

fields. In evolutionary medicine, Wenda Trevathan (2010) hypothesizes that miscarriages and pregnancy complications result from competition over resources between the Mother, who is trying to balance her overall reproductive success, and the Fetus, which is resolved to survive for its own sake. The Embryo/Fetus is often assigned the masculine task of overcoming the odds, as represented in Harvard anthropologist Peter Ellison's (2009) portrayal of the Embryo's perilous journey, which involves "overriding" the "mother's reproductive system" that normally leads to menstruation, "establish[ing] a connection with its mother's blood supply in order to obtain food and oxygen," and "evad[ing] its mother's immune system." (pp. 19–20). Immunologists have puzzled over how an Embryo carrying different human DNA, like a transplanted organ, can attach itself to the uterine wall and grow without prompting rejection from the host's immune defense system (E. Martin, 1998). A 2012 *Slate* article titled "Your fetus is an alien: So why doesn't a pregnant woman's body attack it?" cites Yale School of Medicine's Harvey Kliman, who uses marriage as a metaphor for a successful pregnancy. According to him, "Each side has its own agenda. Yet, the key to a successful union — whether it be mother and fetus, or husband and wife—is compromise" (Epstein, 2012). As Emily Martin (1998) has pointed out, Scientific accounts of implantation reflects "a masculinist bias" that "divide[s] the world into sharply opposed, hostile categories, such that the options are to conquer, be conquered, or magnanimously tolerate the other" (p. 132).⁵ An imagined opposition defines the Mother/Fetus.

Mother-Fetus: Relational Dualism:

As researchers came to realize that immunological mechanism in pregnancy cannot be fully explained by the self/nonself model, they have introduced less combative and more amicable expressions. The field of immunology has been exploring various theories that view the immune system as an information-processing mechanism that recognizes elements and shapes its own reactions accordingly (E. Martin, 1990; Tauber, 2000; Weasel, 2001). Feminist scholars have taken a particular

interest in highlighting the role of the parental immune system in integrating the fetal cells into the host tissue (E. Martin, 1998; Howes, 2007). Moira Howes (2008) has searched for ways in which reproductive immunologists construct a mutual Mother-Fetus relationship. She has found some evidence that the tendency to presuppose schism is dissipating. She writes:

Immunologists occasionally describe maternal-fetal immunological relations using terms that suggest positive, neutral, non-antagonistic interactions. Terms such as maternal-fetal “bi-directional traffic,” “dialogue,” and fetal trophoblast “migration” emphasize normal communication or at least neutral interaction. Such terms contain the beginnings of a relational immunological model of maternal-fetal contact (pp. 262–263).

Despite some of these positive language shifts, Howes still required some “determination” to “draw this emerging model” from reproductive immunology papers. “This,” she notes, “is because there are no explicit theoretical models or experimental practices built around beneficial relations” (p. 263). In other words, reproductive immunologists are struggling to articulate a theoretical framework that is not bound by the self/nonself model.

Howes, whose objective is to reconstruct immunological reactions during pregnancy from a feminist perspective, maintains that “the exchange of immune cells and biochemicals between mother and fetus is routine and the relationship between them is beneficially interconnected and dynamic” (p. 264). Meanwhile, Scott Gilbert (2014) asserts that host activities and fetal development are coordinated by information exchange:

The mother influences the fetus, providing it with nutrition, oxygen, antibodies, and hormones for its growth. The fetus reciprocally influences the mother, changing her blood circulation, immune responsiveness, and metabolism, while prodding her with hormones to retain pregnancy. The physiology of the mother changes as the pregnancy continues, with both the mother and the

fetus producing hormones and other growth factors to influence the other's survival and development. (p. 1)

The mutuality expressed in these descriptions are welcome from a feminist perspective in that they equalize power and agency, which have tended to be granted to the fetus and denied to the pregnant person. These perspectives also encourage thinking in a nonhostile mode. However, Mother-Fetus relational dualism stops short of discarding the idea of two separate entities.

Mother-Placenta-Fetus: Feminist Triangulation:

Feminist scholars who refute fetal personhood based on legal, philosophical, and social analyses rarely attend to the materiality of pregnancy. Myra Hird (2007) and Maria Fannin (2014) are the exceptions in that they attempt to restore the agency of the pregnant parent, whom they assume to be a woman/mother, by bringing attention to Scientific accounts of the physiological processes of pregnancy that support association rather than conflict between the two parties. Unlike scholars who attempt to demonstrate the fetus's dependence on the gestational parent through social or psychological arguments, Hird turns to physiological reliance, including the DNA that the Fetus inherits and materials such as oxygen, nutrients, and immune cells that are passed on through the placenta. She argues that the act of "gifting" or "corporeal generosity" is central to the parental-fetal relationship. In the same spirit, Fannin's article, "Placental Relations," focuses on the placenta as the site where reciprocally productive exchanges are mediated between the pregnant person and the Fetus. In essence, Hird and Fannin attempt to neutralize the active role assigned to the Fetus in conventional Scientific discourses and emphasize mutuality and partnership.

While the placenta is often considered a "lifeline" and filtering organ, it has also been understood to be an organ that separates the Mother and Fetus. Ironically, the placenta's purported role as the anatomical barrier between two organisms came into the spotlight when the organ "failed" to protect the offspring from the harm of thalidomide, a

medication doctors prescribed for morning sicknesses in the early 1960s (Martin & Holloway, 2014). By drawing attention to the placenta as the “mediator,” Hird and Fannin inadvertently reproduce the duality between the Mother and Fetus and reaffirm their separate existence. Although their attention to the physiology of pregnancy as well as exposing us to the dynamic of the mutual Maternal-Fetal relationship are productive, their feminist work still supplements the iterative intra-action that generates the Fetus as a phenomenon. In the following sections, I examine a paradigm shift beginning in the life sciences and then apply it to merge the Mother and Fetus, while also renouncing the gendering of reproduction.

Moving beyond the Self/Other in Biology

The whole dear notion of one's own self—marvelous old free-willed, free-enterprising, autonomous, independent, isolated island of a Self—is a myth.
—Lewis Thomas (1974, p. 142)

New ways of thinking about life and bodies are arising in the biological sciences. There are constant pushes and pulls whereby new findings challenge assumptions about what organisms are or do, but scientists try to interpret them in conventional frameworks.⁶ Nonetheless, we may be able to renew our understanding of human existence with repeated exposure to a novel concept and accept an alternative materiality as a reasonable form of life. In this section, I examine chimerism and symbiosis as possible sources of iterative intra-actions that would lead to a rearrangement of substances and discourses around the physiologically autonomous “self.”

Chimerism:

Chimerism has the potential to overturn our belief that each person must be made of a singular set of human DNA. People who are “true” chimeras harbor more than one genetically distinct cell populations as a

result of having absorbed a paternal twin that died *in utero*. Chimeras may live a perfectly normal and healthy life only to discover their genetic compositions when they fail a paternity or maternity test, a case in which the genes in their blood samples do not match the DNA of their children. These chimeras carry one twin's DNA in their bloodstream and the other twin's genes in their reproductive cells (Vergano, 2015; Edwards, 2015). Because the "naturalness" of a singular identity is so engrained in our culture, media stories of chimeras tend to report them as curious cases in which a person is living with a "stranger within" or has a "dual identity" rather than as people who happen to possess two sets of DNA (A. Martin, 2007, p. 217). When the discourse of chimeras finally breaks away from the cultural grasp of individualism, chimerism may help propel "a radical reevaluation of the boundaries of self and other" (p. 222).

Fetomaternal microchimerism, which is common during pregnancy, refers to the presence of the Fetus's DNA in the gestational parent's body and vice versa. Microchimerism can last for decades, which means that the cells belonging to the "other" multiply and live on in the "wrong" body long after the pregnancy has ended. Cells containing the offspring's DNA, some suppressing diseases and others contributing to ill health, have been discovered in parents' organs decades after pregnancy (Boddy et al., 2015; Martone, 2012). Alas the romanticization of microchimerism in the media as an eternal bond between the mother and child reinforces the gendered and essentialist discourse that presumes all women to identify with motherhood and all "mothers" to be women. Still, as Aryn Martin (2010b) suggests, chimerism and microchimerism can help us see that the single-genome self is a myth by showing that multiple DNAs can participate in the "mutual constitution of different bodies and persons." A pregnant body can be regarded as a boundary-breaching chimera supported by plural genomes.

Symbiosis:

Scott Gilbert and Alfred Tauber have been among the leading philosophers of biology attempting to disrupt and make obsolete the

atomistic conception of an organism that consists of a unique genome and a distinct body. They have been able to develop their nonindividualist paradigm of life forms from scientific studies utilizing new technologies that enable detailed analyses of microorganism DNA. Metagenomic sequencing can provide insights into how microbes and larger organisms live in intermingled relationships, and research using this technique has grown exponentially since the beginning of the twenty-first century. Maureen O'Malley and John Dupré (2010) argue that “metagenomics is a scientific approach that vindicates pluralism and has profound implications for fields within and without life sciences” (p. 183).

More than half of the cells that comprise the human body belong to bacterial symbionts inhabiting the airways, skin, mouth, gut, and reproductive cavities (Sender et al., 2016).⁷ Human lives are supported by multiple species and genomes with which reciprocities are common. Trillions of bacteria find their habitats on the human body and many feed on the food eaten by the host. These include more than 150 species of resident microbes in the gut that participate in metabolic functions, trigger various gene expressions, destroy organisms that might become an irritant or pathogen for the human, and provide yet unknown services (Gilbert et al., 2012). Microbes also help modulate immune-system reactions and prevent undesired inflammatory responses (Mor & Kwon, 2015). Experiments using “germ-free” mice show that microbes are also critical to the complete development of immune, digestive, and neurological systems (Gilbert et al., 2012).⁸ Researchers have also found that changing the gut microbiota can induce different behavioral traits in mice (Smith, 2015) and that the bacterial composition in the mice’s guts alters the early-life programming of brain circuits related to stress response, motor activity, anxiety-like behavior, and cognitive functions (Heijtz, 2016). Human studies suggest that microbes stimulate cells in the gut to produce large quantities of the neurotransmitter serotonin as well as prompt immune cells to produce cytokines, or cell-signaling molecules, which can influence neurophysiology (Smith, 2015).

Such gut-brain connections shatter mind/body dualism. The

classic idea that genetic identity is inherited from parental chromosomes and remains unaltered throughout life no longer holds water once we recognize that our genetic expressions depend in part on the activities of microsymbionts. Scientists are beginning to recognize that evolutionary selections of organisms must have involved the symbionts and their DNA as much as the host's genetic characteristics (Theis et al., 2016). The recognition that humans rely on microbes for survival troubles the long-held paradigm that upholds the *individual* organism, which was believed to function, develop, and reproduce as an independent "self" distinguishable from "others." As Gilbert, Sapp, and Tauber (2012) contend, the discovery of symbiosis throughout the animal kingdom is "fundamentally transforming the classical conception of an insular individuality into one in which interactive relationships among species blurs the boundaries of the organism and obscures the notion of essential identity" (p. 326).

Holobiont is the term biologists use to refer to a comprehensive unit of a symbiotic system consisting of a host organism and numerous symbionts. As Gilbert and Tauber (2016) explain:

What had been previously described as "individual organisms" are, in fact, multi-species/multi-lineage "holobionts," composite organisms, whose physiology is a co-metabolism between the host and its microbiome, whose development is predicated upon signals derived from these commensal microorganisms, whose phenotype is predicated on microbial as well as host genes, and whose immune system recognizes these particular microbes as part of its "self." (p. 840)

The idea that a human being is a holobiont, or an integrated organism comprised of both host elements and a persistent yet constantly evolving population of symbionts, opens the door for thinking about pregnancy and the pregnant body as a symbiotic process and system. In the next section, I turn to showing ways to reconfigure the pregnant body as a nonindividualist, nondichotomous *motherfetus*.

Congeeing the Motherfetus-Holobiont

Matter is not a fixed essence, rather, matter is substance in its intra-active becoming—not a thing but a doing, a congealing of agency.
—Karen Barad (2007, pp. 183–184)

Before a mammal becomes pregnant, “she is already a symbiotic community, a holobiont, composed of numerous species most of them bacteria” (Gilbert, 2014, p. 1). Building on this notion, I offer the term *motherfetus*—in contrast to *mother/fetus* and *mother-fetus*—to represent a nondualist ontology of pregnancy in which the material distinctions between the Mother and Fetus are erased. In order to congeal the motherfetus, I enlist recent scientific studies as material-discursive apparatuses to reconstitute the pregnant body as a phenomenon generated via symbiotic relations.

What becomes pregnancy must emerge from a symbiotic system. After the sperm (and occasionally embryos created by *in vitro* fertilization, or IVF) are introduced to a host-holobiont, the complex processes that establish a pregnancy require various kinds of support from resident microbes. A number of recent studies have revealed that bacteria are regularly present in the uterus, fallopian tubes, around the ovum, and in the placenta, and are thus likely to be part of a normal pregnancy (Reid et al., 2014). For example, Gil Mor and Ja-Young Kwon (2015) hypothesize that certain bacteria contribute to creating a favorable tissue homeostasis or equilibrium around the uterine wall where the fertilized ovum implants. Although infectious bacteria’s negative roles in failed cases of fertilization, implantation, and pregnancy have been studied for therapeutic purposes, research on bacteria’s regular participation in initiating and maintaining pregnancy has barely begun. Gregor Reid and colleagues (2014) expect, however, that more about how commensal bacteria facilitate reproduction will be discovered.

Bacteria are essential participants in the continuation of pregnancy, as they metabolize nutrients and alter the blood being

circulated within the holobiont (Gilbert, 2014). The gut microbiome of the pregnant host changes dramatically during pregnancy to support its progressive stages. For instance, during the third trimester, when more nutrients are required to facilitate exponential growth, the gut microbial community transforms so that more glucose is released into the bloodstream (Hellman, 2010). Also, some *Lactobacillus* species of bacteria that produce an acidic environment become prevalent in the vagina during pregnancy and prevent pathogens from spreading to the uterus (Gilbert, 2014). Researchers are trying to understand the exact mechanism that causes these shifts in the microbiota. They believe the trigger to be hormonal changes, which themselves are products of intricate interactions within the holobiont.

As Gilbert declares, “the fetus survives and develops in a network of symbiotic relationship provided by the pregnant mammal” (2014, p. 2). The participation of bacteria compels us to reconceptualize pregnancy not so much as a collaborative process between the Mother and Fetus, but as the integration of the fertilized egg into a holobiont. A holobiont by definition defies the self/other binary: the understanding that many of our “personal” traits are defined by microbial activities interacting with the host genome has weakened the notion of a totally independent organism around which the “self” is built. At the inception of pregnancy, the fertilized egg joins other microsymbionts in interacting with one another as well as the host. In a sense, gametes are not very different from numerous substances that are introduced to a holobiont and engaged, or not, by the host and its symbionts. The point is that the Fetus never exists as an *independent* entity because its physicality is inextricable from microbial activities. As a kind of a symbiont, the agency that a Fetus has, if any, is limited to its actions within the holobiont. The material basis of a unique individual fetishized by antiabortionists is no longer supported by this Scientific account.

The Möbius strip may be helpful here to reinforce nondualist thinking. The three-dimensional figure-eight with a single continuous surface that appears to be two opposite sides of a ribbon has been

utilized by feminist theorists Elizabeth Grosz (1994) and Ann Fausto-Sterling (2000) as a metaphor to dissolve the binary configurations of mind/body and gender/sex, respectively. The Möbius strip can be a metaphorical figure to blur the boundary between the Mother and Fetus. The seamless transition from the outer side of the ribbon over to the inner side visualizes the material flow within a nondualist motherfetus. Because the strip cannot be divided into two parts, it thwarts the idea of “bi-trafficking” or the passing of substances back and forth between two individuals. Instead, all “exchanges” that sustain pregnancy are part of a multidirectional, multigenomic, and multireciprocating circulatory network that maintains a holobiont. Meanwhile, the centrality of gender and sexual reproduction subsides as microbes and circulations take the center stage in this material feminist account of the pregnant mammal’s body.

Reconstituting Birth: A Holobiont-in-Becoming

Going from the maternal environment to the outside world is not merely leavening a symbiotic support system and gaining “independence.” There is no such thing as “independence.” It’s mutual dependency all the way down, and birth is the exchanging of one symbiotic system for another
—Scott Gilbert (2014, p. 5)

This last section discusses how symbiotic relations extend to the postnatal period. As I have argued elsewhere, obstetrics is rooted in a masculinist and dualist Western philosophical tradition; the mind/body dualism allows physicians to concentrate on the physiological aspects of pregnancy while ignoring its psychological and social dimensions (Takeshita, 2017). When it comes to childbirth, the focus is on the extraction of the Fetus from the parent, after which the separation of two independent organisms is deemed complete. If we regard the pregnant body as a holobiont, however, birth for the offspring is a process of leaving “one symbiotic association and forming another” (Gilbert, 2014, p.

2). Birthing may be a decisive change, but in a larger scheme of things, it is only one part of generating a second holobiont from a mother/fetus.

As Aryn Martin has suggested, the human body's "borders are permeable, blurry, and change overtime" (A. Martin, 2010a, p. 46). Before being exposed to the external environment at all, the fetal-symbiont gets primed to become a future holobiont. Bacteria from the pregnant host's oral cavity move into the gut of the fetal-symbiont, as do immune cells, both of which will serve as the initial building blocks of a future symbiotic system.⁹ Once the amniotic sac breaks, millions of bacteria migrate onto the newborn and start establishing an ecosystem. Although the initial exposure has the largest impact on its composition, it will take months before the infant's microbiome resembles that of an adult and the offspring thus becomes a comprehensive holobiont. Infancy is a liminal phase during which the first encounter with the environment and the subsequent development of the digestive, neurological, and immune systems lay the foundation for the holobiont-in-its-becoming.

During the last decade, scientific studies on microbial changes during pregnancy and infancy have multiplied exponentially (Nuriel-Ohayon et al., 2016). One of the consistent findings is that whether the infant is born vaginally or surgically significantly affects the initial composition of microbial residents in the newborn (Johnson & Ownby, 2017). In most studies of microbial populations during pregnancy, the vaginal microbiota shifted to a dominant population of *Lactobacillus*, which not only contributes to keeping pathogens away from the uterus as mentioned above, but also helps the infant digest milk and prevents deadly sepsis in newborns (Panigrahi, et al., 2017). Studies have found that the gut of a vaginally born infant is often colonized by a diverse bacterial population, with a significant presence of *Lactobacillus*. *Bifidobacteria*, also a common symbiont transmitted to the neonate in the birth canal, has been found to keep pathogenic bacteria away and help induce and sustain the immune system as well as produce essential vitamins that the infant needs. They might even influence brain formation, since *Bifidobacteria* in the gut "help tighten the linking of the intestinal

epithelial cells, which might be essential for the cognitive health of the infant” (Gilbert, 2014, p. 4). Specific *Bifidobacteria* appear to form colonies in vaginally born neonates within three days. Breast milk, as we already know, contributes to the formation of the new symbiotic community by supplying it with nutrients, immune cells, and advantageous microbes. It also contains complex sugars that are not digestible by the infant itself but that help bacterial symbionts thrive. One of these sugars, *oligosaccharides*, serves as food for the beneficial *Bifidobacillus*. A strong mutual relationship between breastfed infants and *Bifidobacillus* is quite evident.

The composition of the initial bacterial community is critical, as the microorganisms assist in the development of the tissue that makes up the skin and the linings of internal cavities, the balancing and function of the intestines, the production of blood vessels, and the priming of the immune system (Heijtz, 2016). Gilbert (2014) notes that “the process of [bacterial] colonization in neonates appears to involve many of the same molecules that are usually used to attack bacteria” (p. 4). In other words, how someone’s immune system reacts to the same microbes may depend on the initial context in which they were introduced. Although studies are still in the preliminary stage, a simple way to understand this is that if a certain microbe is registered during the early period of immune development, it will be recognized as one of the symbionts, whereas if the encounter occurs after a certain period of initial programming, the same microbe may not become fully incorporated into the holobiont. Infants who lacked certain commensal bacteria during the primary programming phase of the immune system can develop allergic reactions to otherwise unharmed molecules.

Increased risks of childhood obesity and chronic immune disorders, including asthma, allergy, and inflammatory bowel diseases, are associated with surgically delivered offspring, who are found to be colonized by bacterial populations that resemble that of the mother’s skin and the general hospital environment rather than the vaginal microbiota (Kuhle et al., 2015; Sevelsted et al., 2015). It may take over a year for a

diverse microbial community similar to that of a vaginally born counterpart to colonize the gut of an infant born by C-section (Gilbert, 2014). Meanwhile, surgically delivered infants, as holobionts-to-be, are likely to be missing out on *Lactobacillus*'s digestive assistance and the traits and functions of a diverse range of bacteria, including *Bifidobacillus*. A few physicians have started experimenting with "vaginal swabbing" to see if the composition of microbiota in cesarean-born babies can be upgraded by swiping the neonate's mouth and body with a gauze that was placed inside the vagina prior to delivery (Dominguez-Bello et al., 2016). Preliminary studies have found that swabbed surgically delivered newborns obtained some microbes resembling those of their vaginally born cohorts, which might give them a stronger foundation compared to nonswabbed counterparts. "Perturbations" of microbiota can also be linked to antibiotics prescribed to the pregnant person, the newborn, or the breast-milk supplier as well as "maternal stress" that changes the composition of the vaginal bacteria during pregnancy (Heijtz, 2016). In other words, a number of procedures practiced in hospital births can change the course of the holobiont-in-becoming.

Birthing is only one of the steps in the yearlong process of transitioning a symbiotic resident into an all-encompassing holobiont with a complete microbiota. The holobiont-in-becoming spans the *in utero* state throughout the newborn and the liminal infant phases, during which a symbiotic community is seeded, developed, and established. One might imagine this process as the Möbius strip parting into two around the time of "birth." The strip can be abruptly torn or deliberately teased apart, allowing material circulation—the migration of immune cells, microbes, nutrients, and hormonal signals—to continue while it slowly splits. Gradual rather than abrupt separation from the parent holobiont appears to promote the robustness of the new holobiont-to-be. Experts now recommend immediate skin-to-skin contact for the infant after birth, which has been found to have various benefits, including exposure to bacteria on the parent's skin, enhanced thermal regulation, higher blood glucose levels, and enhanced cardiorespiratory stability. Babies

immediately placed on the childbearer's chest also cried less and had an easier time establishing breastfeeding (Crenshaw, 2014). Vaginal birth, immediate skin-to-skin contact, and breastfeeding also seem to help the parent adjust to the new relationship with the offspring, who transforms from an internal to an external symbiont to which the post-partum body continues to respond. Parents who have a C-section, on the other hand, generally have a more difficult time breastfeeding and bonding with their babies due to missing out on the synchronized turn of events that triggers physiological responses, including the surge of milk ejection stimulating oxytocin, also known as the "love hormone" or "cuddle chemical" (ibid.). Proclaiming the benefits of vaginal birth and denouncing the adverse effects of surgical delivery, childbirth advocates are protesting hospitals and doctors that discourage or simply do not allow parents who have had a C-section in the past to give birth vaginally in subsequent pregnancies (Pratt, 2013).¹⁰ Overall, the alternative ontology of the pregnant body validates the holistic-midwifery model of care (Davis-Floyd, 2009; Gaskin, 2010).

The Motherfetus-Holobiont as a Queer Feminist Figure

Drawing on agential realism, this article has reworked the material-discursive apparatus of bodily production that engenders a phenomenon we generally understand as the pregnant body. It has congealed the motherfetus-holobiont from scientific literature, human flesh, and microorganisms to invalidate the dualist ontology of sexual reproduction. I propose that holobiont reproduction is a boundary-blurring cyborg (Haraway, 1990). As a cyborg, the motherfetus is not innocent: it is a creature with an agenda to disrupt the constriction of binary thinking and negate fetal corporeal independence for feminist gains. As a cyborg, the motherfetus is not meant to be a feminist solution to the entangled politics of reproduction. I am cognizant that while cyborg figures embody the pleasure of breaching dualisms, they can also betray us, which in the case of the motherfetus might include cooptation by antifeminist

discourses. Still, whether as a mainstream scientific object, a biopolitical subject, a self-identification for pregnant people, or an agent for change, I believe that holobiont pregnancy holds more promises for feminist theory than the timeworn archetypes do.

As Myra Hird (2004) argues, the symbiotic life form offers “a potent lens with which to explore particular boundary transgressions associated with queer theory including autonomy of the self, embodiment and sexual difference” (p. 85). Bacteria-supported reproduction enables the decoupling of gender and reproduction by situating microbials as the primary agents of what used to be considered either a Fetal or Maternal function. Although the term seems to leave the gender of the parent intact, the motherfetus-holobiont ultimately displaces the sexed physiology of reproduction and helps bypass the burdened trope and construction of the maternal body. Consequently, it liberates women from obligatory childbearing by offering the possibility of a trans-pregnancy.

As a phenomenon, the motherfetus-holobiont is not a fixed or a universal materiality. Instead, it is expected to morph through further material-discursive rearrangements into varied shapes and meanings, perhaps the likes of a fatherfetus or an artificial womb. In essence, this cyborg figure queers reproduction and moves pregnant bodies into a more fluid space that opens the door for alternative approaches to scientific and feminist studies.

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Notes

¹ In line with the writing protocols of this special edition on “Science out of Feminist Theory,” I capitalize “Mother,” “Fetus,” “Embryo,” and so forth to refer to hegemonic accounts of particular objects of Science. Capitalized words such as “Maternal” and “Fetal” signify the materiality of these entities that are produced through the legitimizing apparatus of Science and accepted as “official knowledge” or “actually existing.” Within quotations, I have left the words “fetus” and “mother” lowercased as they are used in the original documents. Otherwise, lowercased “fetus” and “mother” represent the ideas of them referenced in discourses other than official Science.

² My focus on the reproductive body should not be interpreted as a biological determinist argument or romantic embracement of motherhood. The Biological processes I describe are not meant to be “natural” or Scientific Facts; instead they are natureculture or co-constructions of Biology and meaning.

³ By “natural” birth, I mean a vaginal birth achieved through physiological processes without biomedical interventions (see Takeshita, 2017).

⁴ I thank Banu Subramaniam and Angie Willey for encouraging me to explore this dimension of the motherfetus.

⁵ See Zenclussen (2013) on Scientific accounts of how Maternal and Fetal immune systems learn to *tolerate* each other.

⁶ For instance, the understanding that human beings cannot function without microsymbionts has not entirely suppressed the impulse to redefine biological individuality. Biologists and philosophers of biology are now involved in debates about what defines biological “individuality” when symbiotic microbes are taken into consideration in various domains

including evolution, ecology, immunology, development, physiology, and the cognitive sciences (Pradue 2016).

⁷ Until recently, the often-quoted ratio between microbial cells to human cells in a human body was ten to one. This is now believed to have been greatly overestimated. Sender, Fuchs, and Mil (2016) have revised the ratio to about 1.3 to one. A model human—a twenty- to thirty-year-old man, 70 kilograms, 1.7 meters—is estimated to be composed of 30 trillion human cells (most of them blood cells) and 39 trillion bacterial cells.

⁸ Mouse studies do not necessarily translate to humans. However, these experiments show what is possible in the animal kingdom and the potential for finding similar bacterial functions in the human host.

⁹ For instance, if the pregnant person receives a whooping-cough vaccination during the third trimester, antibodies that prevent the disease will become integrated into the newborn's growing symbiotic system (Gall et al., 2011).

¹⁰ Cesarean section rates in the United States have been around 30% for the last couple of decades, although the rate varies widely by individual physicians and hospitals. Repeated abdominal surgery increases health risks for the parent. Vaginal birth after Cesarean (VBAC), however, is often discouraged by lawsuit-averse physicians, hospital policies, and insurance companies. In sum, many Americans are deprived of the right to choose how they give birth (see Morris, 2013).

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