

Interspecies Reproduction: Xenogenic Desire and the Feminist Implications of Hybrids

This spring, our bees didn't make it. This had been their third winter, and it was a really long, cold, snowy one: not ideal bee weather. We felt some hope briefly in mid-April that the colonies might have survived, when we saw some bees looping around the hive entrances. But several weeks later, when the bluebirds were staking out their nest boxes, the peach trees had begun to blossom, and the weather had finally climbed into the 60s, my husband taped up the cuffs of his trousers (so no bees would crawl in), lit the smoker to calm the bees, and opened up the hives -- to find frames golden with honey but tenantless, except for a sprinkling of dead bees.

I'd been doing a lot of thinking about bees this spring—or to be more precise, about *the birds and the bees*—because I was teaching a “Gender and Science” doctoral seminar in the English department focused on reproduction. We'd read Adele Clarke's *Disciplining Reproduction* and learned about the practices linking animal breeding and human reproductive medicine. We'd learned in particular about the rich history of animal agricultural practices upon which zoologist Walter Heape and Physiologist FHA Marshall pioneered the new field of the reproductive sciences as an area of practice linking the “prior proto-scientific efforts of the rural gentry in England, especially in the area around Cambridge” to emerging research in biology and medicine. (Clarke 2007, 318) We'd read Sarah Wilmot's “Between the Farm and the Clinic” with her caution lest we “miss the history of reproductive technologies that lie between traditional breeding programmes and the new recombinant DNA techniques.” (303) We read Sarah Franklin's *Dolly Mixtures* and Daniel Kevles's *In the Name of Eugenics* and Evelyn Keller's *Refiguring Life*, and talked about the ways that national ambitions were articulated through the

construction (and destruction) of reproductive genealogies. Last but not least, we read fiction: Margaret Atwood's *Oryx and Crake* and the first two volumes of Octavia Butler's *Xenogenesis* trilogy, *Dawn* and *Adulthood Rites*. During three hour classes in the overheated women's studies seminar room (jokingly dubbed the 'hot flash' room) we talked about fertility and infertility, artificial insemination, gene splicing, stem cell therapies, and what are now the old standards in ART: IVF, egg and sperm donation, and surrogacy.

Then, with thoughts of Atwood's pigeons, rakunks and Crakers, and Butler's gene trading Oankali and sexually mediating Ooloi swirling in our heads, we ventured into a very different setting: the Center For Reproductive Biology and Health, where my students would complete one of the seminar's main projects: an ethnographic observation of the bench scientists at work there.

Why would I add such a project to a doctoral seminar in English? First, because students who want to write about fiction and science fiction dealing with assisted reproduction, hybrid sexuality, interspecies reproduction, and genetic modification can write with more authority when the those scientific and medical interventions are put in their historical and current contexts. I do the same thing when I teach graphic medicine—comics that address issues of medicine, illness, caregiving, and disability. Then I encourage the students to learn to make comics, in order to have an understanding of the cartooning process. But that's another story, one I can discuss if you like in the question period. Second, I include it because students who are interested in science studies as an area of theoretical involvement need to see biological and reproductive science as actually practiced, with all the nuances that complicate and

unsettle the seamless narrative of scientific discovery. Third, I include this ethnographic experience because reproductive scientists who are aware of, and in conversation with, scholars interested in the literary, social, philosophical, ethical and historical understandings of reproduction learn to think of the experimental results they get in new way, and even to conduct different kinds of experiments. (See the work of Scott F. Gilbert, who has collaborated with Donna Haraway, Anne Fausto-Sterling, and Alice Dreger, for an inspiring example.) For that reason, the graduate students in my course, and the graduate students and post-docs in the lab meet together for a final seminar where they discuss together their shadowing experiences.

But let me back up to describe the setting where my students will be doing their ethnographic research. The CRBH is a postgraduate research unit whose scientists are trained in physiology, stem cell biology, and molecular endocrinology, among other scientific disciplines. They conduct experiments in reproductive biology and fertility: on the “regulation of biological clocks, ovarian biology, . . . ovarian function and follicle development, and molecular endocrinology.” Their model animal is not, of course, the human being: they work on mice, rats, chickens, pigs and cows. In fact, the center director, Dr. Joy Pate, Professor of Reproductive Physiology and C. Lee Rumberger and Family Endowed Chair in Agricultural Science, specializes on the function of the corpus luteum in the cow. Housed in the College of Agricultural Sciences at Penn State University, the Center for Reproductive Biology and Health has two intertwined missions: the improvement of fertility and the development of effective and safe contraceptives in humans and the effective management of fertility and reproduction in “agriculturally important animals.”

We know that animal agricultural and breeding practices have been essential to the development and consolidation of the human reproductive sciences. Yet since better baby contests and other explicitly eugenic attempts to improve the “human stock” were backed away from—at least publically—in the wake of World War II, the role of the animal sciences in the development of the biomedical, social and historical shaping of human reproduction has received scant attention by feminists, who have tended to frame reproduction as a woman's issue, or at best an issue that should also include men. (I am thinking here of Cynthia Daniels' important work on male reproductive vulnerability.) A notable exception is Michelle Murphy's important focus on attempts to control reproduction as central to the history of feminism, reflecting her understanding that “technoscience and the politicization of living-being have been defining features of late twentieth-century feminisms.” Murphy's stress on the militarization and economization of fertility, as part of an industrialized biomedicine, illuminates reproduction as “an overdetermined and distributed process that divergently brings individual lives, kinship, laboratories, race, nations, biotechnologies, time, and affects into confluence.”(8) Despite the valuable work of Adele Clarke, Sarah Franklin, and Nelly Oudshoorn, the feminist theoretical analysis of reproduction has only quite recently begun to consider how reproductive practices entangle humans and animals. That is why, after they have spent much of the semester studying reproduction from a feminist perspective, I send my students off to the lab, to observe and converse with scientists whose research engages in precisely that crossover between animal breeding and human reproduction. So, my students went to the lab, hoping to deepen their engagement with the literary and

theoretical texts they were writing about. And (free from teaching for a week) I went back to thinking about our bees.

Why had their hives emptied? Why had they failed to thrive? I thought of Roald Dahl's wonderful little story about bees, "Royal Jelly." Do you know it? Albert Taylor, a fanatical beekeeper, and his rather cowed wife Mabel, have a baby girl who is failing to thrive. At six weeks old the child weighs two pounds less than she did at birth. Yet doctors can find nothing wrong with her, to Mabel's despair. Fertility had been a problem for the couple; it took them nine years to conceive the child, and if it dies, Mabel exclaims, she'll die too. Yet the doctors dismiss her worries with platitudes. Things come to a crisis one night, and Albert sends a weeping Mabel to bed, promising to take care of the evening feeding.

Remarkably, over the next several days, the baby experiences a dramatic turnaround in her health, nursing vigorously and gaining prodigious amounts of weight. At last, it becomes apparent (to her mother and to the reader) that her bee-enthusiast father has been covertly feeding her royal jelly in her bottles of formula. Albert explains the wonders of royal jelly to his wife in a passage so full of alarming enthusiasm and entomological accuracy that it is worth looking at closely (and it's on your handout):

"The bees want a new queen. So they build an extra-large cell, a queen cell we call it, and they get the old queen to lay one of her eggs in there. The other one thousand nine hundred and ninety-nine eggs she lays in ordinary worker cells. Now. As soon as these eggs hatch out into larvae, the nurse bees rally round and start pumping in the royal jelly. All of them get it, workers as well as queen. But here's the vital thing, Mabel, so listen carefully. . . . The worker larvae only

receive this special marvelous food for the *first three days* of their larval life. After that they have a complete change of diet. What really happens is that they get weaned . . . After the third day they're put straight away onto more or less routine bees' food . . . and then about two weeks later they emerge from their cells as workers."

"But not so the larva in the queen cell! This one gets royal jelly *all the way through its larval life*. The nurse bees simply pour it into the cell, so much so in fact that the little larva is literally floating in it. And that's what makes it into a queen!"

. . . . And what makes it more marvelous still is the absolutely enormous difference between a queen and a worker when they grow up. The abdomen is a different shape. The sting is different . . . [and] The queen has fully developed sex organs. The workers don't. And most amazing of all, Mabel, the queen lives for an average of four to six years. The worker hardly lives that many months. And all this different simply because one of them got royal jelly and the other didn't!"

"It's pretty hard to believe," she said, "that a food can do all that." (Dahl [1945] 1990, 226-227)

This royal jelly is more than just a food supplement that turns a baby afflicted with "failure to thrive" into a baby "fat as a puppy," "a nipper that'll win first prize in any baby show in the entire country." (Dahl 234) It is also a fertility tonic. Over a year before his daughter was born, in the course of his scientific reading, Albert came across an experiment in which fertility had been returned to "a male rat which hitherto had been unable to breed." (Dahl 229) Inspired, he transferred the technology from animal to

human, and administered royal jelly to himself. Not only had royal jelly created the turnaround in their baby's health, but it also brought them their baby in the first place, giving Albert the fertility that had made the baby's conception possible in the first place. In so doing, it also turned both him and his daughter into hybrid beings: both bee and human. We realize this when first we see Albert through Mabel's eyes:

Looking at him now as he buzzed around in front of the bookcase with his bristly head and his hairy face and his plump pulpy body, she couldn't help thinking that somehow, in some curious way, there was a touch of the bee about this man. She had often seen women grow to look like the horses that they rode, and she had noticed that people who bred birds or bull terriers or Pomeranians frequently resembled in some small but startling manner the creature of their choice. But up until now it had never occurred to her that her husband might look like a bee. It shocked her a bit. (Dahl 228)

"Royal Jelly" closes with an image that is something of a set piece in stories of hybrid reproduction, appearing in *Frankenstein*, *The Island of Doctor Moreau*, and *Brave New World* as well as Doris Lessing's wonderful dystopian social parable *The Fifth Child*. This is a scene in which the monstrous, scientifically engineered baby [monster] appears to us from the perspective of its horrified mother. "The woman's eyes travelled slowly downward and settled on the baby. The baby was lying naked on the table, fat and white and comatose, like some gigantic grub that was approaching the end of its larval life and would soon emerge into the world complete with mandibles and wings." (Dahl 130)

Hmm--I might just write something about "Royal Jelly," I thought this spring as my students were off shadowing the CRBH scientists. I started looking into it, only to

discover (to my chagrin) that I had already done so, in an article I published in *Cultural Studies* and, later, in my book *Liminal Lives*. I became interested in “Royal Jelly” as long ago as 1984, in connection with the Warnock Report, the committee established in 1982 by the Human Fertilization and Embryology Authority. For those of you who may not remember what this report entailed, let me refresh your memory by citing the official website of the Human Fertilization and Embryology Authority.

In 1982 a committee was established to inquire into the technologies of in vitro fertilisation (IVF) and embryology. This was in response both to concern at the speed with which these technologies were developing, and also to the 1978 birth of Louise Brown in 1978, the first baby to be born using this technology.

The role of the committee was to develop principles for the regulation of IVF and embryology. The committee was chaired by the philosopher Mary Warnock, who would later become Baroness Warnock. The committee concluded that the human embryo should be protected, but that research on embryos and IVF would be permissible, given appropriate safeguards. The committee proposed the establishment of a regulatory authority with the remit of licensing the use in treatment, storage and research of human embryos outside the body. This body would later become the Human Fertilisation and Embryology Authority. The findings of the committee were published in what is now referred to as the Warnock Report in 1984. In many ways, the Warnock report formed the basis for the Human Fertilisation and Embryology Act.

<http://www.hfea.gov.uk/2068.html>

What interested me in 1984 was the curious fact that the *Warnock Report on Human Fertilization and Embryology* had stipulated that although “trans-species fertilization” was routinely incorporated into ART, still “the development of any resultant hybrid should be terminated at the two cell stage.”(71) Within the decade, the United States Human Embryo Research Panel of the National Institutes of Health (also called the Muller panel) expressed a very similar attitude toward interspecies reproduction. They ruled that although such cross-species fertilization practices were routine (as tests of sperm viability for example), any fertilized eggs created by that practice should not be “permitted to develop, nor is it likely that they would do so, due to the wide evolutionary distance between the two species.”(Muller 42) Just to hammer the point home, the Muller panel went on explicitly to oppose the deliberate creation of inter-species embryos:

“It is theoretically possible to make chimeras between human embryos and closely related primates, such as chimpanzees but . . . the fetus would have cells derived from both species in all tissues. . . . it might be possible for the chimeric fetus to have large parts of the brain and/or gonads derived mostly from human cells, a situation that would, from a medical and ethical standpoint, be totally unacceptable.” (43)

It roundly condemned any plan to gestate a human foetus in a non-human animal: “The Panel finds it repugnant to experiment with such *relating* between a human fetus and a nonhuman gestational mother.” (96) “*Relating*”-- I thought then---*a fascinating term to use to describe the ontological novelty of a primate fetus possessing a human brain or human gonads*. The affective charge of those decisive pronouncements caught my interest all those years ago, because it reminded me of the signal insight in Freud's 1925

essay "Negation": "the subject-matter of a repressed image or thought can make its way into consciousness on condition that it is denied." I began to think that these government panels were doing some pretty interesting ideological work: simultaneously shoring up the boundaries of the human, and (in a truly Latoureaan fashion) proliferating some very interesting hybrids.

In that original essay, I described Dahl's "Royal Jelly" as a representation of the anxiety about interspecies reproduction, an emotion that I argued was foundational both to the Warnock Committee's and the Muller Panel's focus on the creation of hybrid embryos and the transfer of human embryos into non-human uteri. What were the origins of the Muller Panel's obsession with the notion of gonads and brains in which both human and nonhuman cells were mixed? Racial theories of the seventeenth, eighteenth and nineteenth centuries, which mingled race and species because of the preoccupation with issues of origin and hierarchy, often imagined life as a 'chain of being' on which the species and the races were arranged in hierarchical order. Seventeenth and eighteenth-century naturalists toyed with the notions of apes becoming human, and speculated on the intellectual and biological significance of imagined ape-human sexual encounters, finding them a productive source of social satire and critique. The European discovery of the great apes in the seventeenth and eighteenth centuries spawned numerous stories about ape-human hybrids, and Rousseau even went so far as to suggest that a cross-breeding experiment could conclusively decide whether or not apes were human: if the issue was fertile, his argument went, the apes' humanity would have been demonstrated.

This notion that race and reproduction are inextricably wound together, connected and co-constructing in political, social, philosophical and scientific thought, has been

described as the “race/reproduction” bind of the late nineteenth and twentieth centuries: whenever reproduction was in question, so was race, and vice versa. (Weinbaum 2004) I argued that the issue was broader still: the era was characterized by a set of entanglements we might term the “race/species/reproduction bind.” Victorian discourse of race mingled inter-racial and interspecies boundary crossings, imagining a great Chain of Being in which “predictably the African was placed at the bottom of the human family, next to the ape, and there was some discussion as to whether the African should be categorized as belonging to the species of the ape or of the human.” (Young 1995, 6-7) The definitive test of species membership was, of course, reproduction: if two beings could produce fertile offspring, they were judged to be of the same species. Questions of interspecies reproduction and inter-racial sex were thus “at the heart of Victorian race theory,” which as Robert Young has argued transmuted “into expressions of the clandestine, furtive forms of what can be called *“colonial desire”*: a covert but insistent obsession with transgressive, inter-racial sex, hybridity and miscegenation.” (Young 102, xii) And just as the boundary-constructing concept of race is overshadowed by a desire to transgress those racial boundaries, so too the taxonomic impulse that has given us the concept of species has as its transgressive underside the impulse to cross species, as can be seen at its wildest in the contemporary craze for hybrid taxidermy (as in Rachel Poliquin's *Frozen Zoo*).

Scaling up a bit to recognize the existence of a race/species/reproduction entanglement, I argued that we can extend Young's formulation of “colonial desire” and theorize the existence of what we might call ‘xenogenic desire’—a covert but insistent obsession with transgressive interspecies sex, hybridity, and interspecies reproduction or

xenogenesis. *That term first acquired prominence, of course, in the novels my students read just this semester: Dawn and Adulthood Rites, the first two volumes of Octavia Butler's Xenogenesis trilogy. It's worth remembering that Haraway described this science fiction vision of interspecies reproduction as being "about miscegenation, not reproduction of the One."* Yet the articulation and production of xenogenic desire—the fear/wish of interspecies reproduction—played out differently in modern and postmodern literature, I argued then. I traced that xenogenic desire from *Frankenstein*, *The Island of Dr. Moreau*, and Roald Dahl's "Royal Jelly" to Doris Lessing's *The Fifth Child*, and Octavia Butler's *Xenogenesis* with its gene-trading Oankali and its reproductive mediators the Ooloi.. While all of these works portray the xenogenic birth as monstrous, it seemed to me then that their representations of interspecies pregnancy reflected the changing biomedical construction of the reproductive body as its technologies of intervention shifted from the surgical, to the reproductive technological, and finally to the genetic (as deployed by Octavia Butler's gene-trading Oankali.) My conclusion in that article was a bit of a peroration. I cautioned against embracing the hybrid or affirming xenogenic desire "unless we are satisfied that we are not obscuring the persistence of gender hierarchies (even into the realm of the posthuman), and that we are not silencing or objectifying the reproductive experiences of women, in all of their variety, multiplicity, and diversity." (Squier 378) I still agree with that peroration, and yet I see these texts somewhat differently today, as a result of fifteen years spent engaging not only with human reproduction, ART, and stem cell research, but also with animal breeding and research into reproduction more broadly construed.

Fifteen years ago, “Royal Jelly” seemed to me a horror story of hybridity and interspecies reproduction, a kind of entomological *Frankenstein*, its monstrous larval baby a product of her father's deranged dabbling in bad science. Today, reading it through the lens of my graduate seminar on reproduction, I see the story rather differently, influenced by three areas of research we have covered in the seminar. These areas are: 1) Epigenetics, particularly nutritional epigenetics and its analyses of metabolism (Landecker 2011); 2) Feminist new materialism, and its reconceptualization of feminism's primary categories of gender, sexuality, and reproduction; and finally 3) Ecological developmental biology, especially its systems-based understanding of development as an interchange between organisms and their environmental contexts. (Gilbert and Epel 2009; Gilbert, Sapp and Tauber, 2012). I want to talk about each of these areas a bit, and then about the alternative perspective each suggests on “Royal Jelly.”

Let's begin with nutritional epigenetics. The field of epigenetics studies how genotype leads to phenotype, or how among all the possibilities possessed by a totipotent cell—a fertilized egg, for example—a specific individual emerges. This modern biological theory resurrected “the old term for embryological growth and differentiation” to provide an alternative model of development.ⁱ That old term, epigenesis, held that an organism comes into being as its parts interact with one another, rather than being preformed as a static entity (think: homunculus). In the 1940s, embryologist C.H. Waddington incorporated that interactionist understanding of development and proposed a new field that would study the relationship between the complete hereditary information of an organism (the genotype) and the organism's actual properties—its

metabolism, morphology and behavior (the phenotype). Epigenetics explored development not only at the cellular level, but also at the level of whole organisms, and even of populations. Waddington even developed a visual image, known as the epigenetic landscape, to represent how those developmental trajectories could be calculated and predicted, through a process of probabilistic mapping. (I'm currently working on a book about this iconic image, and I'd be happy to talk more about that project during the Q and A.)

The field of epigenetics has been increasingly narrowed from its initial form when it emerged in the 1940s through its operationalization in scientific research in the 50s, 60s and on. In recent years, epigenetics has become a major focus of medicine, as physicians try to understand how mechanisms of gene regulation can be targeted to improve treatments. To the dismay of some scientists and philosophers, epigenetics is now primarily understood as the study of gene expression, and the questions it asks about environmental influence focus generally on the ways that genes can be turned on or off by the influences of chemicals outside or above the DNA, through processes called cell methylation and histone modification. What's interesting about nutritional epigenetics, however, is that it takes this idea of exploring the environment's effect on development, and goes micro. Rather than thinking of food as the fuel for the whole body-as-machine, as calories that must be taken in in order for an organism to get larger and do physical work, nutritional epigeneticists research food on the molecular level, studying the part it plays in a broader complex of relationships that shape an individual's growth and development in relation to the other biotic and abiotic entities with which it interacts at the micro and macro scale. "Food has become environment," to borrow Hannah

Landecker's phrase; what we eat becomes the epigenetic (outside the gene) environment in which metabolism (and hence development) occurs. (Landecker 2011, 167)

If we think about "Royal Jelly" from this perspective, the becoming-bee of Albert and his baby daughter makes concrete one of the classic examples of nutritional epigenetics: the developmental effects of royal jelly. This powerful protein-rich food is only produced when the hive senses the need for a new queen, and it enables the bee larva to delay metamorphosis into an adult bee so that it can grow large enough to produce the ovaries required for reproduction. "Thus, the queen does not achieve her large and fertile status due to genetic predisposition, but from nutritional supplementation." (Gilbert and Elpel 2009, 20). One of the most significant effects of the new nutritional epigenetics has been what Landecker calls the "experimental formalization of food." This is the process by which industrial processors formulate food to meet specified nutritional requirements, so that animal feeds are created that range from "so-called 'natural' ingredient diets," to "'Purified' diets," to "'chemically defined' diets made from synthesized compounds. A similar kind of "formalization of food" occurs in the new field of nutraceuticals, new experimentally-produced and heavily marketed foods intended to produce health effects, and thus seen as analogous to pharmaceuticals. Viewed from this perspective, Roald Dahl's "Royal Jelly" is uncanny because it anticipates the marketization of nutrition as part of the drive for optimization. It directs our attention not on the horrors of hybrid reproduction, but on the image of a society driven by the purported promises of nutrition as an aspect of epigenetic medicine, both human and veterinary. Dahl gives us a prescient vision of such a society:

In Mexico, in 1953, a group of enlightened physicians began prescribing minute doses of royal jelly for such things as cerebral neuritis, arthritis, diabetes, autointoxication from tobacco, impotence in men, asthma, croup, and gout. . . . A waiter in the Café Jena, also in Mexico City, reported that his father, after taking minute doses of this wonder substance in capsule form, sired a healthy boy at the age of ninety. A bullfight promoter in Acapulco, finding himself landed with a rather lethargic-looking bull, injected it with one gram of royal jelly (an excessive dose) just before it entered the arena. Thereupon, the beast became so swift and savage that it promptly dispatched two picadors, three horses, and a matador . . . (Dahl 229-230)

Notice, here, the off-shore testing of this wonder supplement, which parallels the off-shore testing of pharmaceuticals that has had such profound gendered, raced, and classed effects.

The second set of developments that shifts my understanding of “Royal Jelly” is the broader perspective on embodiment that has emerged in the writings of some feminist new materialists, who have argued that feminist theory enriches itself by a serious encounter with embodied life at all scales, from the molecular to the organismic to the geologic and cosmic. Elizabeth Wilson has taught us to think about the gut as the site of complexly interwoven material-social processes productive (and reflective) of psychological states and social relations. That focus on the gut certainly illuminates “Royal Jelly.” If we approach the tale as a narrative of development, we are encouraged to see in this story of infant feeding as a reframing of the social relations necessary to support growth. Attending to the struggle over feeding the baby—a medicalized and

explicitly biological process—we also necessarily are drawn into discussion of the gender differential between Albert and Mabel that the act of infant feeding exposes. Mabel appears as petitioner to the controlling (and repressive) physician, while Albert is empowered by his vernacular agricultural expertise and self-taught scientific expertise to generate his own solution to a problem framed as scientific, yet still accessible to a masculine hobbyist. More than merely a question of the gendered relative access to scientific and medical authority, however, this question of nutrition expands beyond the mother/child dyad or the mother/father/child triad, even beyond the society and nation that monitor and calibrate infant development.

Dahl's story illuminates the fact that species other than the human are also involved in human development. Though Dahl invented this portrait of the transformative effects of royal jelly on a human baby (no doubt extrapolating from contemporary apiculture), recent studies have demonstrated that bacterial cells in the gut can influence the development of the vascular and immune systems, and in a well known recent experiment the presence of a specific bacterium (*B. thetaotamicron*) has been shown to predispose mice to extreme obesity. (Gilbert and Epel, 110-111) What are the implications of this broader construction of the social realm? There is a politics—and indeed a biopolitics--that extends beyond the human to incorporate biotic and abiotic objects, not just bees, but even the flowers whose pollen feeds the hive and the soil in which those flowers grow.

Finally, this new strand of feminism draws on the work of biologist Lynn Margulis to broaden our understanding of reproduction, no longer limiting it to the mammalian xygote-based model and an understanding of sexuality and gender that are

reductively binary and parochially human. Margulis's effect on our understanding of the relationship between reproduction and evolution is transformative. Once we understand "that species evolve by subsuming the genetic material—the gene sequences—of other species," then—as Robert Markley puts it—we understand evolution "not [as] a tale of self-fashioning adaptation or a cause-and-effect response to environmental stimuli, but [as] a matter of existing life forms—the thousands of archaea that have taken up residence in the digestive systems of animals, for example—adopting as well as adapting to their environments in order to ensure the survival of their species." (Cole, Landry, Boehner, Nash, 2011, 98.) Able now to understand reproduction far more broadly, as a set of practices that operate on multiple scales, from the bacterial to the mammalian, and in a range of temporalities, we can now appreciate the reproductive enhancement produced nutritionally as royal jelly capacitates Albert's sperm into potency, and the species transformation that occurs when, after being fed royal jelly, the baby turns from the "gigantic grub that was approaching the end of its larval life" into what Albert calls "our little queen." (Dahl 236)

The final set of developments that shifts my reading of this story is the emergence of a new scientific synthesis of ecology, developmental biology, and evolution that views developmental symbiosis, or co-development, as a central life strategy. This has been outlined most powerfully by biologists Scott F. Gilbert and David Epel in their 2009 textbook, *Ecological Developmental Biology: Integrating Epigenetics, Medicine, and Evolution*. Gilbert and Epel map a range of such strategies, collaborations at the micro and macro scale, that extend from parasitism (think: tapeworm) to mutualism (the oxpecker and the rhinoceros) to endosymbiosis (the incorporation of one species within

another so that each species thrives: think of the gut flora that enable us to digest our food.) The often cited example of this is the “life cycle symbiosis” of pollination which relies on the symbiotic relationship between the apple tree and the bee. What difference does the new synthesis of ecological developmental biology make to my reading of Dahl's “Royal Jelly?” And how does it reflect the understanding of reproduction that I've gathered over the years of my collaborative gender and science graduate seminar? Let me detail a couple of responses.

First, it transforms the story from a mordant fantastic fable of scientific over-reaching to a cautionary exploration of the effects of the human disregard for the philosophical implications of contemporary science. Albert and Mabel each, in their own way, conceive of the baby as a being whose body boundary it is their responsibility to manage, under the supervision of their physician. And yet this attitude toward their baby flies in the face of a more porous and interactive view of identity and the world that characterized Albert from his earliest childhood. As Dahl tells us,

All his life Albert Taylor had been fascinated by anything that had to do with bees. As a small boy he used often to catch them in his bare hands and go running with them into the house to show to his mother, and sometimes he would put them on his face and let them crawl about over his cheeks and neck, and the astonishing thing about it all was that he never got stung. On the contrary, the bees seemed to enjoy being with him. They never tried to fly away, and to get rid of them he would have to brush them off gently with his finger. Even then they would frequently return and settle again on his arm or hand or knee, any place where the skin was bare.

His father . . . said there must be some witch's stench about the boy, something noxious that came oozing out through the pores of the skin, and that no good would ever come of it, hypnotizing insects like that. But the mother said it was a gift given him by God, and even went so far as to compare him with St. Francis and the birds. (Dahl 214)

If Albert's harmony with the bees reflects any religious or philosophical perspective it is neither Wiccan nor Christian, but rather Buddhist: the appreciation of interdependency that in Buddhism is called "interdependent co-origination." (Squier 2011) This harmony enables a sophisticated agricultural husbandry as well. By age fourteen, Albert is not only keeping five hives, engaged in a form of apiary reproductive technology: "he was practicing the delicate and complicated business of rearing his own queens, grafting larvae into artificial cell cups, and all the rest of it." (Dahl 214) If we consider what the villagers call the "strange sympathy between the boy and his bees" from the perspective of ecological developmental biology, it is revealed to be one of the oldest survival mechanisms: symbiosis. As Gilbert and Epel point out, "Alliances are strange and wonderful things in the living kingdom. We 'become with' the world, and that is our enormous responsibility." (Gilbert and Epel 2009, 417)

Understanding reproduction in this new way, as an entangled developmental system, we will now notice how "Royal Jelly" traces the same technological and epistemological transfer from agriculture to human biomedicine that Adele Clarke identified in her pathbreaking study, *Disciplining Reproduction*. We can also venture to identify the source of "Royal Jelly's" uncanny, *unheimlich*, tone: the persistent taboo against discussing sexuality or reproduction that delayed for so long the consolidation of

the reproductive sciences. The taboo, in particular, against viewing sexuality and reproduction as processes that entangle human beings with the other species who share the earth. There are profound ontological and ethical implications if we ignore the taboo and adopt this new view of reproduction. It challenges our notion of individuality: "Our self becomes a semi-permeable self." (Gilbert and Epel 2009, 404) And with it goes the obsession with self-possession, autonomy, and competitive optimization stretching from the early days of eugenics to our current era of optimization, an obsession that leads Albert to predict their daughter—fed on royal jelly—will be able to "win first prize in any baby show in the *entire* country." (Dahl 234) From this perspective, the development of their baby looks like just one of many examples of the interspecies cooperation found in nature. As Gilbert and Epel explain, "ecological developmental biology suggests that the internal, cooperative embryonic mode of evolution be seen between species":

With signals coming from outside the embryo, the game of embryonic induction is played between organisms. Symbiotic bacteria help form our guts and immune systems; predators, competitors, and food change developmental trajectories by the evolved mechanisms of developmental plasticity; signals from the warmth of the sun or from the number of hours the sun is above the horizon determine the sex of some vertebrates and the pigmentation of others. In some cases, the induction is reciprocal, allowing each organism to find its place within the ecosystem as it develops. (Gilbert and Epel 407)

I said at the outset that when the students in my reproduction class went off to observe the bench scientists, I stayed at home thinking about the collapse of our bee hives. Yet in a sense, I was addressing the same issue, and pondering the same philosophical

implications, that the students were confronting in the Center for Reproductive Biology and Health. If scientists increasingly understand that we come into being through a relationship with other beings, a relationship not antagonistic but intra-active in the sense that Karen Barad defines the term, then our reproductive success depends on such an interactive process as well. As Donna Haraway observed in *When Species Meet*, a passage that also appears, wonderfully, in the conclusion of *Ecological Developmental Biology*, "Organisms are ecosystems of genomes, consortia, partly digested dinners, mortal boundary formations." (Gilbert and Epel 2009)

Haraway's comment applies directly to the stakes in coming to this broader understanding of reproduction. The peroration with which I ended my earlier paper assumed that the crucial boundary was the one between women and men. Yet under the influence of new materialism, I join other feminist scholars in directing our attention to the problems caused by a much more widespread, more potentially mortal boundary formation: that between humans and all other species.

Why is this so crucial? Let's return one last time to my bees. Current research into colony collapse disorder suggests it is the classic 'wicked problem,' explicable only as the result of a combination of factors including: the use of agricultural insecticides, particularly neonicotinoids; the 'industrialization' of the bee population and the production of a larger, more uniform bee through the introduction of factory produced artificial honey combs that have larger cell spaces that encourage the production of larger larvae and thus larger bees; the narrowing of the bee genetic pool due to the increasing reliance by the beekeeping industry on domesticated standardized hives; the impact of predatory mites (both the varoa destructor and the nocema mite) on bee colonies; and the

massive temperature shifts linked to global warming. When a hive fails to thrive, the bees die or disappear, and the process of pollination that depends so centrally on the bee is disrupted. Nutritional collapse for the bees means a fertility crash for the bees, and then for the apple blossoms, and the apples. And that, finally, means a nutritional collapse, and thus a fertility crash, and finally increased mortality, for animals and people as well.

Now the situation of Albert and Mabel's little baby in "Royal Jelly," dependent on the bees for nutrition that prevents her from starving, suddenly seems not far-fetched but very real, and very relevant. As "Tangerine and Cinnamon," a food blogger from South Africa put it recently, "a world without bees, is a world which will struggle to feed itself."

DRAFT

NOTES:

ⁱ As Lynda Van Speybroeck explains, "Whereas *preformation*—claiming that all the characters of the adult organism are present in the fertilized egg and only needed to unfold or grow—stressed the static aspects of development, *epigenesis* presented the old term [dating back to Aristotle] for embryological growth and differentiation, thereby focusing on the interaction of the constituents of the zygote." Linda Van Speybroeck, "From Epigenesis to Epigenetics: The Case of C.H. Waddington" *Ann. N.Y. Acad. Sci.* 981: 61-68 (2002), 67. Van Speybroeck is citing Waddington's 1939 *An Introduction to Modern Genetics* (London: George Allen & Unwin Ltd., 1956), 29. See also Maienschein, Jane, "Epigenesis and Preformationism", *The Stanford Encyclopedia of Philosophy* (Spring 2012 Edition), Edward N. Zalta (ed.), URL =

<<http://plato.stanford.edu/archives/spr2012/entries/epigenesis/>>. As Maienschein explains, Epigenesis and Preformation are two persistent ways of describing and seeking to explain the development of individual organic form. Does every individual start from material that is unformed, and the form emerges only gradually, over time? Or does the individual start in some already preformed, or predelineated, or predetermined way? The questions are part metaphysical: what is it that exists — form or also the unformed that becomes the formed? And they are partly epistemological: how do we know — through observation or inference? The debate has persisted since ancient times, and today plays out as genetic determinists appeal to the already "formed" through genetic inheritance, while others insist on the efficacy of environmental plasticity. Nature or nurture, epigenesis or preformation, genetic determinism or developmental free will, or is some version of a middle ground possible? These are the terms of this perennial discussion, and the underlying assumptions shape debates about when life begins and have profound bioethical and policy implications.