REVIEW ARTICLE

How Bizarre, How Bizarre, How Bees Are: Domus and Umwelt in the Multispecies Entanglements of Humans and Honeybees

Jessica Jack
Department of Archaeology and Anthropology, College of Arts and Science, University of Saskatchewan

ABSTRACT
Relationships between humans and honeybees are complex because they are deeply entangled. These entanglements take on many forms, such as those present in the honeybees' self-centered worlds—*umwelt*—as well as the intersections in their mutually constituted lived world, or their domus. As honeybees are involved in pollinating up to 85 percent of the world's agricultural crops, understanding these entanglements is a vital component of environmental anthropology. To highlight these interconnected relationships as they apply to commercial beekeepers, this paper explores the case study of an Australian almond farmer named Mark deCaux who has incorporated beekeeping into his agricultural practices to ensure his crops are adequately pollinated. Since adopting beekeeping, his crops have grown his apiary to a commercial-sized practice. Through the lens of his experiences, the concepts of umwelt and domus emphasize the intricate negotiations between humans and honeybees that constitute their mutually entangled relationships.

Keywords: environmental anthropology, umwelt, domus, multispecies entanglements, honeybees, sociality, agriculture

FLYING BY: INTRODUCTION

"We've got some bees under a dog. Under a dog and next to a chair! That's different," says Mark deCaux, an Australian apiarist also known to his YouTube followers as the Bush Bee Man (deCaux 2020d). Mark is "rescuing" a hive of bees that have made their home in someone's backyard pond pump, a common occurrence on his channel that is full of the interactions between humans and honeybees as he has deeply entangled himself with *Apis mellifera*, the Western or European Honeybee. It was to these same entanglements which bee-focused author Sue Hubbell was referring when she said, "I like pulling on a baggy bee suit, forgetting myself and getting as close to the bees' lives as they will let me, remembering in the process that there is more to life than the merely human" (1988, 7). Her process of remembering and Mark's observations of the human elements of the bees' chosen hiding spot highlights the complex relationships we humans have with our honeybee compatriots. Both Sue and Mark approach these entanglements between humans and honeybees in their daily work, pointing to the plethora of relationships that form and reify the connections between us and these industrious insects.

Both human and bee lives are deeply interconnected for many reasons, the least of which is that pollinators like bees are involved in 85% of the world's commercial crop production and

some crops like almonds are entirely dependent on bee pollination (Klein et al. 2007; American Beekeeping Federation n.d.). To explore these entanglements, I turn to the concepts of *domus* and *umwelt* to dig into the myriad ways in which both honeybees and humans construct and reify the intertwined relationships that they have shared for tens of thousands of years (Abou-Shaara 2020). In recent times, these relationships have grown and transformed under the influence of industrial farming (Bartlett et al. 2019). To gain a deeper understanding of the current impacts of these multispecies entanglements between humans and honeybees, I explore the case study of Mark, The Bush Bee Man, who has taken up beekeeping to pollinate his crops and has since grown his apiary to a commercial-sized practice (deCaux n.d.). In doing so, I will use the concepts of domus and umwelt to highlight the multispecies entanglements between humans and honeybees in the context of modern Western agriculture and commercial beekeeping practices.

BUILDING THE HIVE: DEFINITIONS

To examine the entanglements between humans and honeybees, I must define my terms. The first central concept of this paper is umwelt. Umwelt is a German word used by Jakob van Uexküll to describe the mix of perception and action that creates an animal's "self-centered world", made of their perceptor and effector worlds (Uexküll 1992, 320). Others have used the term to refer to the "intimate worlds" of animals (Bubenik 2007), their "meaningful environments" (Koutroufinis 2016), or their "environmental carriers of significance" (Van Dyck 2012). To understand how this term is useful, I borrow from Clint Westman and colleagues who explain that, because moose have very different connections between "mind, body, and environment", their umwelten, the plural of umwelt, radically differs from ours and results in the moose inhabiting very different worlds than we do, even if they are within a shared domus (2020, 11). Extending this concept to honeybees, their umwelten are likely to be even more different than ours. This is because bees are not mammals but insects that are colonial organisms; they can fly, and they are very small in comparison to us, so the scale of their environments are quite different than ours. Understanding the umwelten of honeybees without the participant observation of walking among their hives and attempting to observe both the effector and perceptual worlds of bees in person is difficult, so its application in a research paper is limited. Including the case study of Mark and his apiary videos is my attempt to address that shortcoming. Regardless of that limitation, I will endeavour to explore the applications of umwelt to honeybees in a theoretical and academic but removed way, perhaps recalling the armchair anthropologist forebears whose early contributions helped form this discipline.

The other major concept central to this paper is that of domus. Here I borrow from Marianne Lien and John Law, who define domus as "a fragile assemblage of animate beings and inanimate things that loosely holds together and mutually constitutes the conditions of existence of its component parts" (2016, 16). David Anderson and his colleagues summarize this approach to domus as "a synonym for the assemblage where human-animal relationships are housed and performed" (2017, 400). They go on to elaborate that a useful ecological approach to domus "might focus on how the attention of many different species, and the artefacts of that attention, come to work together in a particular setting", which they call "a co-specific domus" (Anderson et al. 2017, 401). Within these three theoretical explanations of domus are the useful ingredients for applying this concept to the entanglements between honeybees and humans.

Research and media attention in the last decade has highlighted the fragility of the

human-honeybee domus because of neonicotinoid insecticides and colony collapse disorder (Suryanarayanan and Kleinman 2013; Thomson et al. 2013; Vanengelsdorp et al. 2017; Ellis 2019). Animals, humans, and nonliving aspects of their surroundings like rocks and wind are all implicated in these entanglements, recognizing the complexity of these relationships that extends beyond anthropocentric considerations of humans as masters, of bees as mindless drones in service of humans needs, and of things as tools suited only to manipulation by intelligent humans (Boddice 2011; Giraud 2019; Rülke et al. 2020). Finally, Anderson and colleagues' "co-specific domus" highlights the role of attention, calling to mind the observer effect in physics that dictates that observation, or "the artefacts of attention", paid to something results in changes to that thing (Dirac 1987, 3). As I will illustrate in this paper, the concept of domus paired with umwelt is a useful tool for examining the entangled relationships between humans and honeybees.

A VOICE FOR THE BEES: CASE STUDY

To understand the relationships between Mark and the bees, it is important to contextualize his environment. Mark hails from Australia's Riverland, a region of South Australia. Originally occupied by Australian Aboriginal groups since time immemorial (Westell et al. 2020; Flinders University 2020), European settlers colonized the area in the late nineteenth century (Murray-Darling Basin Authority 2010). The area has a warm, Mediterranean-style climate that has contributed to the current primary industry of wine production, almond growth, and the farming of stone fruit (Renmark Paringa Council n.d.; South Australian Centre for Economic Studies 2012). Changing the zone's water flows through irrigation was the key to the economic success of the region, without which large-scale fruit and nut farming would be impossible (Department of Primary Industries and Regions 2017). Water is also vital to keeping the pollinating bees that many of these industries rely on alive and happy (Casey 2018), so irrigation is also key to any Riverland apiarist. The mild winters with an average temperature of 16.2°C make keeping bees easier than in more temperate climates but the scorching summers, with an average of 32.5°C yet often reaching into the 40s (Destination Riverland 2021), present unique challenges for both humans and bees alike. Yet, bees are a major aspect of the Riverland economy with more than 2,000 beekeepers and 68,000 hives in South Australia contributing more than $101 million in both bees themselves and in bee by-products yearly (Department of Primary Industries and Regions 2020). The environment in which Mark and his bees are making their livings bears the mark of human development and design, making it an attractive area in which to consider the entanglements between humans and these insects.

Mark fits these common themes of the Riverland very well. He is a large-scale almond farmer who experimented with beekeeping to pollinate his crops and uploaded videos about his bee adventures to his YouTube channel because, as he argues, "the bees need a voice" (deCaux 2019a). His operation has grown from a few bee boxes to hundreds of hives accompanied by an increasing variety of processing equipment for cleaning, maintaining, sorting, and storing the bees and their valuable by-products of honey and wax. He has an earthy sense of humour and, when on camera, is always chunnering to himself about the chaos of his life with the bees. While Mark's videos are intended to spread information to viewers about how beekeeping works and how they can tend to their own hives, the sheer breadth of his videos (to date, 273 videos in 4 years) give viewers a chance to analyze the relationship he demonstrates with his bees and the worlds in which they both live. As a result, I have chosen him as a representative case study for this paper because his life in

these YouTube episodes contains many important elements for understanding the concepts of umwelt and domus. This methodology is limited, as there is much curation between Mark's actual field experiences with the bees and the final videos that are released for the public to view, removing contextual information and other potentially important aspects of his beekeeping. The videos I review for this paper are but a fraction of his actual life with the bees and are thus no substitute for direct participant observation. As such, I do not imagine that Mark's intention was to showcase the entanglements between humans and honeybees, but as he often says, "Well, good golly gosh, let's give it a try," (deCaux 2017).

EXPLORING INNER WORLDS: UMWELT

At first, it seems tricky to apply the concept of umwelt to honeybees. The life-span of the majority of *Apis mellifera* bees is quite short in comparison to human lives – a few weeks to a few months for workers, up to a year for drones, and up to five years for queens. The individual honeybee perceptor worlds, an important component of umwelt, could be described in many sensory mediums. These include, but are not limited to: the feelings of air currents; the genetically programmed language of pheromones; the sensations of rising and falling temperatures; the tastes of nectar, of pollen, and of the regurgitation of fellow bees; and the rhythms of performance and sleep that dictate the patterns of their lives (Chittka 2017). Umwelt could also include the bright, loud, smoky intrusion of the beekeepers as they inspect the hive and address any issues they perceive. Individual honeybees perceive a vast array of information, all of which are useful for the purposes of survival and productivity that can be seen in the example of bees pollinating Mark's almond crops. The perceptor worlds of individual honeybees, and, therefore, their umwelten, are complex indeed.

Moving away from individual bees, the concept of umwelt changes in application to the collective organism that is the hive. *Apis mellifera* are eusocial, meaning that colonies are created by a single egg-laying female bee, the queen, with the worker and drone bees hatching from eggs laid by the queen (University of Florida n.d.). Many of the activities that are central to the lives of honeybees could be seen as resulting from the hive as a whole rather than the activities of individuals. One aspect of the umwelt of bees is what Mark calls their "song". Mark is often sent to relocate nests of bees that have been built in places inconvenient for humans, such as backyards, utilities boxes, and neglected cars (deCaux 2020e). Capturing the queen is a necessary part of such relocation efforts because, without her, the bees will try to return to the place from which they were moved where the queen remains. In order to tell if the queen has been captured among the other thousands of bees, Mark listens to the "song" they make, or the tone of the hum made through the concert of thousands of flapping wings and vibrating bodies. This song, the product of the collective hive, changes when the queen is among the other bees (Michelsen et al. 1986; Boucher and Schneider 2009). It is a part of both their perceptor and effector worlds, as the bees perceive their queen is among them through scent, sound, or touch and react by changing their activities to reflect her presence among them. By sharing this information with each other, the worker bees that make up the majority of the hive can act in concert to protect the queen and ensure the continued survival of the hive as a whole (Bencsik et al. 2011; Slone et al. 2012). Thus, honeybee umwelt is both individually constituted, such as the focus on the queen bee, and made of the group or hive, who act in response to the presence of the queen.

As I have mentioned, perception is one of the key ingredients in a creature's umwelt (Uexküll 1992) and in humans, the experience of perception is modulated by a person's

cultural orientation (Kawahara et al. 2017). Though direct comparisons between humans and non-humans are not always possible (Smart 2014), the similarities between humans and other animals make the exploration of non-human cultures an important aspect of understanding the relationships between humans and honeybees (Smart and Smart 2017; Hartigan 2014). One aspect of honeybee culture visible in the experiences of Mark is the phenomenon of social learning (Hartigan 2014, 13). Honeybees engage in social learning based on their self-centered worlds of nectar and pollen collection, warning others of danger, and supporting their hive mates in the maintenance and growth of the hive. One example of this is honeybees transmitting information to each other through forms of physical communication that humans call "dancing" (Raffles 2010, 175). Different types of dances communicate different messages, and these messages can cause not only individual bees, but sometimes a whole hive, to change their behaviours (Raffles 2010, 179). Honeybee dancing is an example of umwelt because it demonstrates the connection between what the bees perceive, i.e., food, danger, or humans, and their effects, such as the physical movements necessary to transmit their perceptions to other bees. The self-centered world of honeybees contains a culture of communication and learning.

The learning that leads to honeybee communication in Mark's hives, like their singing and their dancing, includes him in ways that are both peripheral and central to the bees' umwelten. While honeybees are concerned with the collection of both pollen and nectar to feed their hive, Mark is sometimes the one supplying those food sources when they are not available from his almond trees or the surrounding vegetation (deCaux 2020b; 2021). When the bees are learning and transmitting information about where these food sources are, Mark must take care to ensure that the food he provides matches the bees' umwelt by putting them in places that the bees can find, ensuring they fall within the limitations of the bees' perceptor worlds.

Another aspect of the bees' perceptor world is their reaction to risk. When the bees perceive danger, they transmit this to each other by butting their heads against other bees and by patterns of vibration (Srinivasan 2010). Often times, this danger is Mark opening the hive to do routine maintenance (deCaux 2019d), meaning he is a part of both perceptor and effector worlds of the bees and is a constituent part of their umwelten. These interactions between Mark and the bees is also an example of the co-created domus, as both groups work with and around each other in their daily activities. This means that, though the concepts of domus and umwelt are separate, in reality they work together to influence and co-create each other.

Comparing the honeybee umwelt to how honeybee lives are perceived by humans reveals further entanglements between the two species. Donna Haraway notes that in many aspects of Western writing and thinking, animals "are not allowed personal pronouns such as *who*, but must be designated by *that*, *which*, or *it*" (2008, 206). Whether or not we discuss non-humans as being a "who" or an "it" often turns on whether we see them as a "means to the purposes of the [human] other", which is often the case for domesticated animals (Haraway 2008, 206). The other option is whether the animals "can be somebody, ends not means", which Haraway suggests is only available for wild animals (2008, 207). In this context, I argue that honeybees in a commercial setting occupy an uncomfortable middle ground, that 'betwixt and between' liminality that is so often of anthropological interest. This liminality is a result of the differences between the bee population's umwelt and human perceptions about the purposes of bees. For the bees, their umwelt is likely to be bees reacting to bee stimuli and making decisions for the good of themselves and their hive. Humans see bees

differently, such as their roles as pollinators, producers of honey and wax, or as potential nuisances or sources of physical harm. It may therefore be easy to assume that humans see bees as an "it", but the reality, as is often the case in anthropology, is more complex.

It is undeniable that, for agriculturalists like Mark, the honeybees serve as a means to an end. That is the reason he began his beekeeping – to pollinate crops (deCaux 2019e; 2019b) and, now that his beekeeping has reached a commercial scale, to sell the bee by-products of honey and wax (deCaux 2020a). Were it not for this productive outcome, he may see bees in much the same way as do many of his neighbors in the Riverland, who often call him to extricate nests of bees from inconvenient locations. If he did not perform these removals, the bees would likely be destroyed by pest removal services or killed by those who made the call, reduced to an "it" of tiny bodies littering the ground. In some views, using bees to pollinate large-scale crops already renders bees an "it" in the Marxist sense, used for their labour to produce profit. This objectification is especially poignant when combined with the other "biophysical barriers" inherent to industrial-scale farming, such as soil erosion, the demand for irrigation, and the increased risks of infectious disease, that serve human capitalist needs at the expense of other organisms (Ellis et al. 2020, 439). Thus, the honeybee umwelten and domus is not only shaped by the perceptions of Mark and his beekeeping practices but are also co-created by the economic need for Mark to support himself and his family, by the environmental stresses created by the large-scale farms so predominant in the Riverland, and, by extension, the entire edifice of capitalism that drives human demand and consumption for these products. For people who do not come into regular contact with farmed bees or the pollination in which farmed and wild bees engage in, the lack of bees in their own umwelt may contribute to this association of bees as an "it". Without that close contact and intimate understanding of the inner lives of bees, it may be easy for the average human on the street to objectify these tiny, often unobtrusive creatures (Nimmo 2015). In their role as pollinators, bees are transformed into Haraway's "it", changing their umwelt by placing them in the service of human farming activities and, ultimately, the cycle of profit inherent to capitalism.

Yet Mark does not see the bees as an "it", as his close interactions with them have led to a complex, anthropomorphized relationship with the honeybees that includes the numerous complexities of his impacts on the honeybee umwelten. He genders the bees, referring to them as "the girls", "ladies", or "chicky-babes" with great regularity (deCaux 2020c). While it is true that most honeybees are females, the cultural implications of gender hint at the complex relationships between utility and autonomy in Mark's approach to the bees. These complex relationships carry further into Mark's perceptions of the bees; even though they produce for Mark by pollinating his trees, he sees the bees as autonomous beings that are definitely not within his control. Mark sees "the girls", as he calls them, as independent animals full of agency and personality in many of his videos. They may swarm, which involves the queen leaving with some or all of her bee children and find a preferable place to live (deCaux 2019c). They have their own personalities or dispositions, often defined by how much they tolerate the presence of humans. If they react with hostility to Mark's intrusion into their hives, he often refers to them as "toey", meaning "nervous, anxious, or worried" (Merriam-Webster 2021). If they are calm when Mark is working with the hive, they are "chilled out" and "cool", ascribing a group personality to the hive as a whole (deCaux 2020c). Of course, these attributions of personality cannot be separated from the fact that Mark is making these judgments based on how easy it is for his human self to intrude on the

bee's homes and disturb their contents for the purposes of continued commercial success. This distinction of animals as either a means or an end is not a clear binary when it comes to honeybees but falls on a spectrum of intermingled closeness and productivity. This spectrum is partially the result of the differences between honeybee and human umwelten, creating this push and pull of utility and agency present in the relationships between Mark and the bees. The difference between how bees are situated in the lives of the farmers who use them for pollination and how humans anthropomorphize bees demonstrates the complexity of entangled multispecies relationships.

CREATING OUTER WORLDS: DOMUS

To further understand the relationships between humans and honeybees, it is worth investigating what constitutes the honeybee domus. At the most fundamental level, the domus of an individual honeybee begins with the cell made from wax, where bees begin their lives as eggs, developing into larvae after a three day gestation period (Crane 1999, 20). These cells are the foundation of the domus because each cell is affixed to hundreds of other similar hexagonal cells in what is called a "comb". There are different types of combs that have multiple uses: brood comb is where eggs are laid and new bees are reared; honey comb is where concentrated nectar is stored, dehydrated, and aged into sweet honey; combs that hold pollen; and some combs are left strategically empty to act as insulation for the hive. In a commercial beekeeping operation like Mark's, the building and maintenance of comb is managed by the use of vertical frames that are hung within a hollow box, known as the Langstroth hive (Crane 1999, 422). Already the intersection between humans and honeybees in the creation of their shared domus is evident – Mark provides the frames, protected by a home of wooden boxes, in which honeybees are encouraged to build their comb and thus their home. In nest rescue operations, this relationship is even more direct as Mark will cut out existing pieces of comb and affix them to empty frames using rubber bands. The bees will gradually attach the comb to the frame with more wax and then will chew through the rubber bands and remove them from the hive, leaving them just outside the hive entrance (deCaux 2020). The small, jumbled pile of rubber strands is a visual representation of the multispecies entanglement at work in the co-creation of honeybee domus.

The hive boxes represent another intense intersection between honeybees and humans in the creation of their domus. The protective wooden outer shell of a Langstroth hive closely replicates the preferred nesting sites of *Apis mellifera* and other types of honey bees, who prefer the safety of nesting in a cavity (Crane 1999, 21). The frames contained within that protective shell also mimic the natural tendency of some honeybee species to make their combs in vertical sheets. Yet they also differ from wild hives, as these frames have been modified for human purposes. Wild comb is affixed to its nesting site, while the Langstroth frames can be easily removed from their box for inspection, handling, or processing. The entrances to wild hives are hidden and numerous while those of the boxes are purpose-built for ease of human handling. In these ways, the construction of commercial hives represents the intersection between domus and umwelt for the bees.

The process of removing frames from the hives is disruptive, even if only for the short term. Examining this intersection raises several questions about the activities of bees, such as, how do the bees make sense of the temporary disappearance of whole parts of their hive? How do they handle the removal of the hive lid and the sudden flooding of light and air movement into their carefully tended spaces? Does the relative regularity of these

activities in a commercial beekeeping operation make these changes easier for the bees to deal with, or is it a fresh disruption each time? These are, of course, incredibly difficult questions to answer, though hearing the "voice" of the bees is an important aspect of postmodernist multispecies ethnography (Smart and Smart 2017, 54). The bees themselves make their voices heard very easily. Aside from the singing I mentioned earlier, the bees are regularly audible throughout Mark's videos; the contented hum of a happy hive, the frantic buzzing of a hive about to swarm, the intentional fanning of bees at the entrance of a hive on a hot day while they work to cool their sistren within, or the angry hiss of bees perceiving danger (Wehmann et al. 2015). Their voices are therefore present in the creation of their shared domus with humans.

Mark also partially answers these questions through his personal interpretation of how the bees react to his presence. He often speaks to the bees and sometimes speaks for them, adopting a different voice to represent the bees' contribution to this back-and-forth dialogue he holds with himself. In these conversations he will refer to the beekeepers as "polar bears". This is Mark's term for the white-clad apiarists whose physical size and power are so much greater than that of any individual bee that he imagines the experience to be as terrifying to them as would be a human encountering a wild bear in the Arctic circle (deCaux 2018). Thus, the "voices" that are entangled in the comingled and co-created domus are shared by Mark and the bees in his hives, as Mark brings these voices to life through his own vocal cords and the bees make themselves heard by humans in the course of their daily activities. Though we cannot know for sure how honeybees perceive humans and their activities within bee lives, exploring how humans think honeybees may perceive us highlights the intersection of umwelt and domus present within the lives of bees.

Within Mark's polar bear comparison lies an unspoken power dynamic because he represents humans as towering beasts capable of devouring anything (including the bees) in their path. This dynamic can be questioned because beekeepers choose to wear their bee-repelling suits, as those suits are proof that the stings of bees are at best a serious annoyance and at worst a fatal threat to the wellbeing of individual humans (Visscher 1996). This is part of the human domus, as Western approaches to the stinging honey providers we call bees "trigger our vulnerability: we want to repel and contain them. They are fascinating, but elusive, and for many of us, they are frightening" (Moore and Kosut 2013, 85). Many tools in the apiarist's toolkit embody the notion of "repelling" bees and work to create a specific kind of honeybee domus that protects this human vulnerability. Mark's videos regularly feature his bellows-type smoker (Hobbs and Roddy 1990), used to inject smoke into the hive in an effort to calm the bees (Moore and Kosut 2013, 70). Smokers ensure that the bees do not get too "toey" and start to attack the beekeepers. The head-to-toe suits worn by Western beekeepers like Mark are designed to prevent any ingress by small individual bees looking to protect their hive from these huge intruders. Hive tools, thin metal sticks with hooks on the end, are helpful in prying apart hive frames that have been attached to the box by wax but are also useful for keeping gloved hands out of the hive and away from potential stings. Though Mark does not come across as frightened of the bees in his videos, his actions do align with "repelling and containing" the threat of the bees. Despite the massive size and perceived power imbalances between humans and bees, humans and their relative fragility result in the creation of a specific type of domus regarding domesticated honeybees.

Fragility is an interesting concept to apply here as the relative size and strength of humans compared to any single bee renders the bee and their physical abode of the hive inherently

fragile. The combs, made of wax and honey, are soft and malleable, easily destroyed by the comparative strength of human hands and other intruders. The bodies of bees are an inevitable casualty of handling a beehive, as individual bees are often damaged or killed among the throng of bodies that the invasive human often stirs up, though this is generally accidental. Regardless of intent, beekeepers bring death to individual bees in their quest for order and pollination. Whether this death is of great consequence to the bees is an interesting question as it might be the survival of the swarm itself, and not of individual bodies, that is at stake for the bees. Indeed, the only single bee that the beekeeper takes great pains to avoid damaging is the queen. Though she is larger than her daughters and sons, she is still fragile in comparison to the huge, white-clad humans who disturb her nest. Thus, Lien and Law's definition of the domus as "fragile" plays out in the power relationships between humans and honeybees (2016, 16).

Speaking more broadly, the commercial relationship humans impose on the bees that results in their particular domus is also fragile. Changes to the environment through anthropogenic climate change (Flores et al. 2019), human-spread pathogens such as American Foul Brood and Acute bee paralysis virus (ABPV) (Poppinga and Genersch 2012; Glenny et al. 2017), and perhaps most famously, from the use of pesticides like neonicotinoids (Woodcock et al. 2017), have recently highlighted the fragility of the commercial beekeeping domus. Globally, the vitally important pollinators that have kept commercial crops viable and productive are in widespread decline, and both wild and domesticated honeybees have been deeply affected (Jaffé et al. 2010). As a result of these human effects on the global domus of bees, the umbrella term of "colony collapse disorder", used to explain the sudden decline of managed honeybee populations, is a concern for every commercial apiarist (Williams et al. 2010). Though bees have agency and will happily live out their lives without interference from humans, the aforementioned changes mean that bees worldwide, whether wild or managed, are influenced by the activities of humans and, thus, humans have a place in the honeybee domus.

INSIDE THE HIVE: CONCLUSION

Though the concepts of umwelt and domus are separate, my investigation of the multispecies entanglements that have humans and honeybees at their centre demonstrates that both domus and umwelt are always intimately connected. The complex processes of perception and effect that shape the "self-centered worlds" of umwelten influence the ways that the domus is created, and the creation of the domus shapes the way that creatures experience their umwelten. In other words, the relationship between humans and bees is highly complicated. Humans like Mark rely on the bees for their livelihood and thus support the bees with resources like food and water, but they also constrain them and kill them. Bees produce for humans by pollinating crops and making honey and wax, but they also attack them and work to their own ends which is sometimes frustrating or harmful for humans. In addition, both Mark and the bees are at the mercy of larger systems, like capitalism, that drive their engagements with one another in the specific perceptor and effector worlds that constitute their umwelten and the assemblage of relationships that comprise their domus.

Understanding the complexities contained within and arising from this intersection of domus and umwelt provides necessary insight into how and why we might change our part in these relationships. The sharp increase in the use of pesticides and other substances that are harmful to honeybees threatens their health and productivity, which could and has led to collapses throughout the natural systems in which *Apis mellifera* plays a vital role (Cilia 2019). Comprehending the inner worlds of

bees and how they connect to the outer worlds with which we are familiar could allow humans to reimagine the ways we employ bees in our industrial farming, potentially leading to higher rates of biodiversity and lowering the environmental damage caused by these farming processes (Cuthbertson and Brown 2009; Cayuela, Ruiz-Arriaga, and Ozers 2011). Investigations of honeybee domus and umwelt could even support the use of non-honeybee pollinators in farming practices by understanding when other pollinating species may be a better fit for the environment or crop (Christmann and Aw-Hassan 2012). By embracing the complex entanglements in which humans and honeybees are situated, we humans are better positioned to work with the bees at their own level and could therefore improve the quality of both their lives and ours. Ultimately, though I wish I was writing for both honeybees and humans to read, I conclude by returning to Sue Hubbell's words as our entangled relationships with honeybees should remind us "that there is more to life than the merely human" (1988, 7).

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