

ARTICLE

Solitary But Not Alone: Materialising Boundaries at a Distance with a Leafcutter Bee's Nest

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(Received 01 December 2023; revised 29 March 2024; accepted 29 March 2024)

Abstract

More-than-human refusal, as an expression of agency, plays an active role in constructing boundaries. In this article, I address what kind of environmental education is made possible by the productive constraints of respecting more-than-human boundaries and refusal. This is intertwined with how humans can practice being attentive to the intra-actions of more-than-humans when they are not physically present, are only speculated to be present or are present through artifacts. I rhizomatically analyse my relationship with a leafcutter bee (*Megachile* spp.) nest as a situated example of practicing a relational ethic of care. Through queering the boundary between myself and the leafcutter bee, nature becomes not something that *I* (human) experience, but as something *we* (*bougainvillea-leafcutter bee-nest-human assemblage*) produce through our human-and-more-than-human relationality. Rather than seeing limited proximity as prohibitive, environmental education can use this productive constraint to know-with more-than-human others in a way that disrupts the nature/culture binary — to blur the boundaries between humans and more-than-humans without violating the agency asserted by more-than-humans.

Keywords: New materialism; multispecies; boundaries; refusal; relationality

Staying with (the middle/the trouble/the insect)

In environmental education, the philosophies of new materialism and posthumanism are being used to address the current ecological crisis brought about from unchecked colonialism and anthropocentrism (Clarke & Mcphie, 2020; Hohti & MacLure, 2022; Jukes & Reeves, 2020). Several pedagogies have been proposed as ways we can (re)think our relationship with and the agency of more-than-humans others, such as common worlds (Pacini-Ketchabaw et al. 2015; Taylor, 2017), place-responsive (Jukes & Reeves, 2020) and assemblage pedagogies (Mannion, 2020). These pedagogies, often examined through post-qualitative research styles, engage with the agency of a situated, material ecology. MacLure's approach to post-qualitative research (2013) is particularly influential in how I attempt to foreground materiality and engage with unstable, ever-shifting data assemblages that decenter humans as the primary locus of concern. In this materialisation of post-qualitative research, the indeterminacy or voids of data are treated not as weaknesses that require an asterisk when they are reported, but as surprises that defy presupposition of what we think may be the results of a study. In working with more-than-human others, this dynamic theoretical assemblage allows for messy interactions in which there isn't always a "correct" approach under the complex entanglements we (inclusive of human and

more-than-humans¹) find ourselves in. However, this is where I employ a critical perspective and take up the call from Rautio (2013) “to find practices worthy of cultivation” (p. 394) in entangling with the more-than-humans in my life.

The relationship between humans and insects is multifaceted and ever-changing (Duffus et al., 2021). Humans can interact with insects as a food source or a pest, a thing of beauty or a pollinator for crops, or (most likely) some combination thereof — the dynamic between humans and insects cannot be generalised and summarised into neat categories in light of the varied, often species-specific reactions between humans and insects. Recognising these varied entanglements of our lives is especially crucial in the age of the Anthropocene, which implicates human exceptionalism, capitalism and extractivism — cultivated by a relatively small proportion of people that will not experience its most disastrous effects — in radically altering the environment (Haraway, 2016; Lewis & Maslin, 2015; Liboiron, 2021; Pacini-Ketchabaw et al., 2015). Insects are affected by the Anthropocene, with reports of decreasing numbers of insects (Sánchez-Bayo & Wyckhuys, 2021; Wagner, 2020) and species extinctions (Finn et al., 2023) that could have devastating effects on the lives of multiple species (Raven & Wagner, 2021). Environmental education is poised to address this by teaching students an ethic of care in a multispecies world, or as defined by Maria Puig de la Bellacasa (2017), the “thick, impure, involvement in a world where the question of how to care needs to be posed” (p. 6). The crises of the Anthropocene will not be resolved by human removal. An ethic of care encourages humans to “stay with the trouble” (Haraway, 2016, p. 4) and take responsive action, even when it is imperfect. This ethic relies on engaging with boundaries, or the differentiating process through which humans and more-than-human others are constituted.

The new materialist conceptualisation of more-than-human agency provides space for queering multispecies boundaries without leaning too heavily on anthropomorphism (not that anthropomorphism should be wholly avoided or endorsed — for a more nuanced discussion on its utility, see Bennett, 2010, pp. 98–100). Agency is not something innate in itself, but a performance that happens relationally (Barad, 2007; Jukes & Reeves, 2020; Rautio, 2013; Tynan, 2021). This highlights the capacity of more-than-humans, such as plants, animals, dust, or other things, to be active participants in worldbuilding practices, even if they do not do so through any recognised human linguistic tradition. Following this idea, humans are no longer the sole taxonomists of boundaries between themselves and more-than-human others, as those others also have a say in how their boundary is constituted.

Attending to more-than-human refusal

An ethic of care can be exercised through respecting the refusals of the more-than-human others in our lives. Boundaries are emergent through intra-actions between humans and more-than-humans and refuse simple biological classification as being a result of *either* nature or nurture, but by a fusion of both (Tuana, 1983). Refusal is a way for more-than-humans to performatively enact boundaries, it “is not just a no, it is a performance of that no, and thus an artistic form” (Tuck & Yang, 2014, p. 814). This refusal is a way more-than-humans express agency in how they are constituted. For example, some environmental education programs might foster interest in animals by allowing participants to get as close as possible to them, through petting zoos or encountering them in their “natural” habitats. Some species and individual animals have an appropriate temperament for this kind of activity and seek out, or are receptive to, intra-actions with humans, while others aren’t suited for these close encounters. Applying an ethic of care, in

¹I intentionally use “more-than-human” instead of other similar terms (nonhuman, nature, agents and other-than-humans) to break from deficit thinking about anything that isn’t human. This foregrounds the capabilities of more-than-humans that humans do not possess and is inclusive of any previous, current or future in/animacy status. I am cautious of reproducing binaries by referring to humans and more-than-humans, but may use this phrasing to highlight that I am not speaking of humans only.

this example, could be critically examining what humans hope to gain or understand through these intra-actions and if there are alternate ways to achieve this understanding. Given that one way human dominion over nature can be asserted is by (un)intentionally ignoring more-than-human boundaries, how does this desire for (human) closeness affect how we approach more-than-human entanglements? What kind of environmental education is made possible by the productive constraints of respecting more-than-human boundaries? How can we practice being attentive (van Dooren et al., 2016) to the intra-actions of more-than-humans when they are not physically present, are only speculated to be present, or are present through artifacts?

This article sprang from a chance encounter with a leafcutter bee (*Megachile* spp.)² nest and our intra-actions took the form of a rhizomatic assemblage (Deleuze & Guattari, 1987), with its lack of a beginning or end and its unpredictable expansion through lines of flight. In this article, I will describe the post-qualitative approach I took to working with more-than-human agency and the relational ethics of care involved in getting close with more-than-humans. I will discuss how data happened when the nest and I intra-acted — or when I made time to be attentive to the nest and the nest expressed its agency with me. Data was not limited temporally or spatially and included dreaming-with and crafting-with this nest. Performing a rhizoanalysis was appropriate for this data because of its non-linear, non-representational and non-hierarchical nature. The capacity of rhizoanalysis to disrupt hierarchies is crucial to this project, as my goal is to disturb the ideas of human dominion over nature and hyperindividualism by queering the boundary (Barad, 2011) between myself and the leafcutter bee's nest).

The practices of attentiveness and restraint I am cultivating rely on a foundation of agency, of taking seriously the ways in which intra-actions constitute the boundaries between humans and more-than-humans. In my work with the leaf-cutter bee nest, I wanted to think with performativity theory (Butler, 2009) about how precarity and performativity are intertwined in our intra-actions with more-than-humans.³ At the time, I thought this may be a salient theoretical choice because of the precarious position solitary bees occupy due to environmentally extractive human practices (Kline & Joshi, 2020; Russo et al., 2021). I struggled with the human-centeredness of Butler's iteration of this theoretical perspective until I stumbled across Karen Barad's article, "Nature's Queer Performativity" (2011), which takes a posthuman twist on performativity. Barad (2011) calls into question the way boundaries materialise through performativity, while de-centering humans:

all bodies, not merely human bodies, come to matter through the world's performativity — its iterative intra-activity. Matter is not figured as a mere effect or product of discursive practices, but rather as an agential factor in its iterative materialisation, and identity and difference are radically reworked. (p. 125)

Queering the boundaries between human and more-than-human, in my case, means I, as a human, am not attempting to assimilate into the leafcutter bee's (nest's) world or homogenise our experiences. It is the immanent process through which relationality and ethical obligations to these "queer critters" (Barad, 2011, p. 126) are made apparent. These boundaries may be multiple and indeterminate because they can form and re-form during each intra-action. Moreover, boundaries can form as a result of more-than-human performance of refusal. Working in

²Confirmation of genus *Megachile* based on geographical distribution and morphological characteristics observed of a single bee that emerged from the nest received through personal communication (15 November 2023) from entomologists Evan Waite and Alex Morphey. A particular species cannot be confirmed more rigorously because the bee flew away. However, the focus of this paper is concerned with the intra-actions between humans and more-than-humans, and a precise species identification does not change the findings of this study.

³I share my decision-making path through Butler to Barad in an effort to not erase the process of "trying on" different theories, as I see it as an important step in my research.

multispecies assemblages requires tools such as “the art of attentiveness” (van Dooren et al., 2016, p.17) that involve not just noticing that a boundary has formed, but also responding to it.

Bianco (2017) also grapples with this boundary blurring in their becoming-honeybee, stating that denying the reality of human-bee relations, “is to negate the anthropocentric power structure of humyn [*sic*] consciousness” (p. 35). Queering the boundary between myself and the bee nest makes possible a different way of experiencing and practicing ethical response-abilities. As Lloro-Bidart (2018) discusses, these affective relations are a way of extending a nuanced more-than-human ethics, exemplified in my case by refusing to exert my power as a human to categorise the leafcutter bee as wholly good (because of its pollination), nor bad (because of its destruction of plant leaves).

A method for mapping the contours of these boundaries is by getting close to our more-than-human collaborators. Closeness can be achieved through multiple means — affective and embodied alike. In an embodied, material sense, this closeness can be seen in physically approaching something or being approached by something, getting a magnified view of something, or touching another. I want to take a moment to focus on touch, since it is a common tool used in environmental education for children to develop a sense of closeness to animals, whether it’s an aquarium touch pool (Biasseti et al., 2020) or a class pet (Tammi & Hohti, 2020). In the case of the class pets, Tammi and Hohti engage with the ethics of touch and how an event in which a gerbil asserts its boundary through biting can be an opportunity for learning our abilities to respond to such assertions. An unexpected negative experience has the potential to educate children about the limits of how close they can get and how to stay attentive to the behaviours of more-than-humans. In a highly entangled network of competing needs and desires, there is no guidebook for perfect ethical action. The limits of closeness are often unknown until they are transgressed. Therefore, it is vital to develop a sensibility for responding to the noninnocent actions of more-than-humans.

This article addresses closeness and refusal as ethical considerations for environmental education. In intra-acting with the nest, it expressed overwhelming affect with me that I was not permitted to transgress the nest’s boundaries to peek inside. This limit of how close we could get to each other made possible different routes of multiplicity. The leafcutter bee nest was not just an amalgamation of bougainvillea leaves stuck together — it was always multiple, becoming my model of the nest and my speculative narratives about it as part of the nest-assemblage. This was enabled by the nest unexpectedly asserting its boundary with me through its affective refusal of my entry into the nest. Rather than seeing limited proximity as prohibitive, environmental education can use this productive constraint to know-with more-than-human others in a way that disrupts the separation of nature and culture. When faced with refusal, encouraging students to seek closeness to multispecies networks in different ways — through arts-based explorations, embodiment, or speculative narrations — can provide them with an open-ended means for exploring how to engage in an ethics of care with more-than-human others.

Care-fully attending to more-than-human refusal has implications for environmental education, as this could materialise as becoming-with the more-than-human other within an immanent ontology. It is a movement away from an *a priori* conception of nature — nature not as something I experience as a fully-formed, pre-existing entity, but as something *we* (humans and more-than-humans alike) contribute to the production of. This anti-hyper-individualist move is significant because although leafcutter bees are a solitary species — meaning they don’t aggregate in large, social structures like honeybees (*Apis mellifera*) — this doesn’t mean they are alone, as they are always in relation to plants, other leafcutter bees, different species of bees and humans.

Data acts

As this was a post-qualitative inquiry, the leafcutter bee’s nest and I intra-acted in an emergent and unexpected way. Our relationship unfolded as a result of our doing research differently by work/think/playing together (Hughes et al., 2017). This research-play wasn’t always light and

positive, but was characterised by periods of tumult and self-doubt. Although I strove to practice relationality and not extract knowledge from this bee's nest that it was unwilling to share with me, I couldn't help but wonder if I was practicing relationality or theorising with this nest in the "right way." By engaging with different texts on relationality (Lloro-Bidart, 2018; Tuck & Yang, 2014; Tynan, 2021), I learned how to let the agency of the leafcutter bee's nest direct our work together and determine our relationship not rooted in categories, but in ways of being-with each other. Because of this, "data" could happen at any time, regardless of if I was trying to make data happen or not. I experienced this data assemblage like acts in a play, although these acts didn't end in resolution, nor did they remain singular and intact. Instead, I experienced this data as a rhizome, in which the intensities of each act would simmer until lines of flight (Deleuze & Guattari, 1987) ruptured the stability of the rhizome and altered relationality with the nest. Following the diffractive reading done in Murriss and Bozalek (2019), I use these Deleuzian concepts alongside Baradian concepts, such as intra-action, because of their shared relational ontology. Another rhizomatic quality of this inquiry was the production of maps, which resulted from my material engagements with the nest and becoming-close to it through the labour and bougainvillea leaves of the nest. This map creation is an exercise in what Masny (2013) highlights a key aspect of rhizomatic work, that it "focuses on what it produces and how it functions as a way to conceptualise research-as event" (p. 345). Framing the data assemblage as acts, as in events of action, also foregrounds the idea of performativity in the mutual constitution of more-than-human and human.

Act 1: Disturbance

In Summer 2021, I thought there was a piece of debris from a monsoon in the windowsill outside. When I removed it with a skewer, the dried brown leaves gave way to the brilliant pink of bougainvilleas, inviting me to stop the task I was completing and sit with this thing⁴ for a while (Figure 1). It provoked a memory of something I had read about the structure of leafcutter bee nests because of the way its circles of leaves were pasted together to form a long, segmented tube (Butler, 1965; Sheffield et al., 2011). I am a PhD student studying animal behaviour and have researched honeybees for 5 years. Along the way, I have collected some knowledge about solitary bees, or bees that do not aggregate in large, social enterprises like honeybees. I set the nest in a jar and watched as a single leafcutter bee emerged from her cell. Having learned about solitary bee nest construction, I knew that there could be other bees developing in the nest, so I waited for the others to emerge. None emerged and the nest was too fragmented to be returned to the windowsill where I found it, so it remained in the jar and joined me at my desk.

Act 2: Construction

In October 2021, I was assigned a class activity to gather performance data on Indigenous narratives by peeking into the data. I had an initial anthropocentric desire, driven by what knowledge I wanted to extract, to peek into the bee nest I gathered that summer by dissecting it open. For clarity, peeking inside would involve me taking a small pair of scissors and cutting the nest open. This would sate my curiosity about the contents of the nest and reveal if there were any bees remaining inside that did not complete their development into adult bees. After consideration of how I could enact a more posthuman and new materialist ethic, I practiced the "art of attentiveness" (van Dooren et al., 2016, p. 17) as I sat with this nest multiple times, each time returning in an attempt to ask its consent for me to look inside of it. I use the term "consent" here because, although it could not express in human language agreement for me to cut it open, I was attuning myself to the agency this nest had producing affects within me and the

⁴In the *Vibrant Matter* (Bennett, 2010, p. 3) sense, in which a thing is never just an inert object, but a lively agent.



Figure 1. a) A piece of the leafcutter bee nest made of bougainvillea petals, b) the entire nest in a glass jar with a newly emerged leafcutter bee and c) the nest under my windowsill. Note the dried, brown appearance of the nest under the window contrasted with the shocking bright pink when removed.

ethico-ontological consequences of proceeding with the actions I intended if the nest did not agree to them.

I felt an overwhelming affect that I was not granted permission to look inside of it in this way. Taking my cue from how the practice of respect was developed in the 4 R's of Indigenous Story Work (Archibald & Parent, 2019, pp. 5–7), I respected the autonomy of the nest by deeply listening to it and not disturbing it any more than I already had by removing it from its place of residence. (Additionally, the idea of reciprocity that Archibald and Parent describe acted as a motivator for me to share the story of this leafcutter bee's nest and my continued intra-actions with it.) Tuck and Yang (2014) have written about pedagogies of refusal — how the refusal to be object/subject-ified “turns the gaze back upon power” (p. 817) that acts as the knowledge-creator. Refusal changed my relationality with the nest in several ways: 1) by accepting the refusal of the nest to become a research subject, it became my research collaborator — one that expressed equal agency over the research process as myself and 2) refusal prompted me to think with the nest for how else I could peek inside of a nest and resulted in my creation of a model (Figure 2). The role of affect in refusal opens possibilities for more-than-humans that are not present or are only

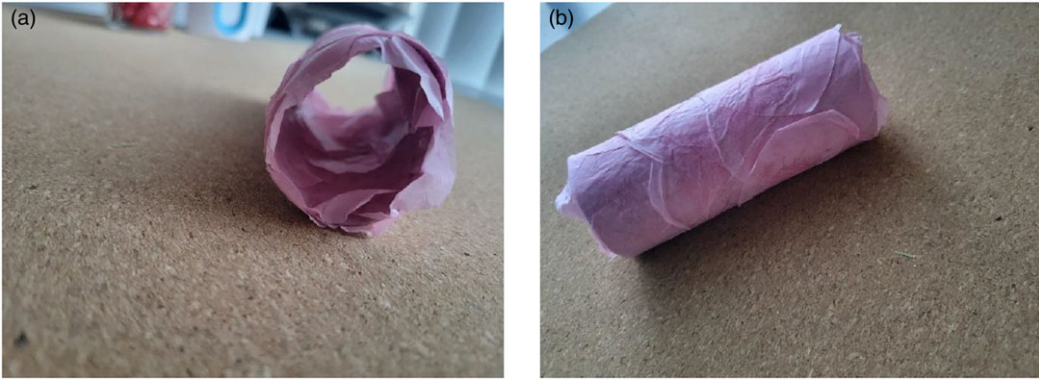


Figure 2. a) and b) Various angles of the nest model (toilet paper roll, tissue paper and glue).

speculated to be present to express agency over the research process. It led the nest and I to co-create performance-theory-art, through which I embodied the bee in her process of building a nest. I gathered my materials — an empty toilet paper tube, scissors, pink tissue paper and glue — and set about creating my model.

Because I was not able to become close to the bee nest in the way I originally intended, I became close to the bee through the labour of creating these nests. The embodied process of delicately cutting out circles of paper and pasting them in place was a way for me to intimately get to know the way a leafcutter bee constructs her nest.

Act 3: Leaves

The next act of my assemblage saw a flurry of thoroughly embodied rhizoanalytic activity (Sellers, 2015). A provocation to analyse my data with the nest saw me climbing into planters, collecting bougainvillea leaves fresh from the plant and rotting on the ground and tracing these materials was a different way for me to know with the leafcutter bee (Figure 3).

I found myself drawn not to the nest as a whole, pre-existing entity in itself, but as a collection of pieces which needed to be processed by the bee. I honed in on the materiality of the leaves for creating the nest — the substrate that the leafcutter bee intra-acted with to build the place to lay her eggs. Becoming attentive (Barad, 2011; van Dooren et al., 2016) to the bougainvillea leaves in this way was another rhizomatic entry point for me to think with leafcutter bees. The contrast of crumbling, dry leaves with the soft, supple texture of fresh leaves attuned me to the way these bees intra-act with the leaves as a building material. Time's impact could be seen on these leaves, with the older leaves becoming dried out and a less vibrant pink. The ability of the leafcutter bee to build her nest relies on the bougainvillea plant staying alive and maintaining a supply of flexible leaves, since the brittle leaves that had fallen off the plant are unsuitable for creating the cylindrical shape of the nest. The cycles of life and rot, homebuilding and familial care and pink as a vital, serious colour all became points of relationality that unexpectedly emerged from our intra-actions in this rhizoanalysis.

Whereas in Act 2, I became close to the bee's nest through understanding the labour that goes into building the nest, closeness was developed in Act 3 through an intra-action with the leaves that make up the nest. This was a way of my becoming attentive to another species in our multispecies assemblage: the bougainvillea. The leaves perform the role of a structure protecting leafcutter bee eggs because of their intra-action with the leafcutter bee. However, not all leaves on this plant were equally represented in the nest. The bougainvillea has two types of leaves: the



Figure 3. Bougainvillea flowers, fresh and decomposing, collected during class and the knife on my carabiner I used to slice a small branch of fresh flowers from the bush.

flexible pink leaves surrounding the small white flowers and the large, tougher green leaves. There is a selective relationship happening between the bee and the bougainvillea that determines which leaves will perform the role of the nest.

Act: Lacuna

Although I am at a place where I have worked with the leafcutter bee nest enough that I have insights to share, I want to state that this research is still open to future co-creation, as the relational process of becoming human-bee-nest-bougainvillea assemblage doesn't have a defined end point. As Koro and Wolgemuth (2022) put it: "Maybe the aim isn't to produce knowledge so much as it is to produce ourselves each time differently" (p. 7). I went through multiple rounds of (re)producing myself as I became with this bee's nest. The nest still sits on my desk in the glass jar I placed it in back in 2021. It constantly reminds me to consider the multiple ways that more-than-human others may express agency. The nest also anchors how I think about the ethics of getting to know more-than-human others. What is our responsibility to these more-than-humans, especially with regards to sharing their stories and respecting their agency? What scale of action matters and how do we deal with competing responsibilities? How can we remain attentive and responsive in these relationships and not fall into a standard method that collapses the differences between the various others we work with? I continue to see this nest as a collaborator and will work with her as long as she is willing to teach, refuse and intra-act with me.

Discussion

Closeness and productive constraints

Here, I (re)turn to the ideas of closeness and productive constraints. Closeness — physically getting closer to — can be a powerful means for environmental education to shift the perspectives of people who have been submersed in a culture that prizes human dominion over “the natural world”. However, this type of closeness isn’t always appropriate. We must rethink what it means to get close to the more-than-human others we live with and the plural, speculative possibilities that are created by more-than-human refusal of this closeness. Tuck and Yang (2014) discuss refusal as a “starting place for other qualitative analyses and interpretations of data” (p. 812) and can present as refusing to collect and code data, particularly data that reduces Indigenous people to the suffering inflicted by a colonial system of power. Refusal, in my intra-action with the nest, manifested as an affective force that halted my action and made me question what knowledge or relationship I was seeking with the leafcutter bee’s nest by cutting it open. However, refusal could present in a variety of ways: an animal receding from touch or declining to exit their hiding place or a plant or stone remaining just out of our reach — an overall defiance of expectations.

Rather than seeing this refusal as a negative, stymying obstacle to researching with more-than-human others, we can take it as a productive constraint — a limit that allows us to generate a different relationality to more-than-human others. The productive constraint of refusal kept me in the middle of my data. My original intent of looking inside of the bee’s nest had a defined endpoint. My previous research question was “what is inside of this nest,” so my work with the nest would have ended after I cut it open and poked around inside. By refusing to participate in research answering that question, the nest caused a proliferation of other questions and alternate methods for exploring them. I still wanted to peek inside the nest, so I made my own version of it from a toilet paper tube and tissue paper. The nest’s refusal made me reckon with its agency to direct my research and how to put ethical perspectives into practice. If multispecies researchers and environmental educators take seriously the agency of more-than-humans, then we should be prepared to respond to the unexpected, affective ways that they may express refusal.

Boundary formation and multiplicity

There was a multiplicity of boundaries I played with in this exploration: the nature/culture binary, the boundary between my identity and the leafcutter bee’s nest’s identity and the boundary that was imposed by the nest about how I was permitted to intra-act with it. Going through the experience of boundary constitution with the nest altered how I constituted my identity in relation to it. This is where I thought with “Nature’s Queer Performativity” (Barad, 2011) the most, as it provoked me “to embrace a commitment to being attentive to the activity of each critter in its ongoing intra-active engagement with and as part of the world it participates in materialising” (p. 127). What “queer critter” (p. 126) was I intra-acting with anyways? There was only one leafcutter bee that emerged from the nest on our initial meeting, and, without cutting the nest open, I could only speculate that there were others within the nest. The critter turned out to be the nest itself, and the (speculated) absence of the bees that normally inhabit it. The uncertainty of knowing if there were other bees in the nest, but responding to the nest’s refusal to be opened, was an exercise in restraining that hunger to answer questions and amass knowledge. I dug into the problematic dualistic thinking of the nature/culture binary as the intra-actions between the nest and I disrupted the neat lines the binary attempts to draw between the world of humans and everything else. It can cause discomfort to constitute an inanimate thing as agentic — as capable of affecting others — since things that are not alive are usually seen as lively. Yet this is a vital task for understanding the intertwined roles we play in the lives of more-than-human others and vice versa.

The leafcutter bee nest was never just a singular entity — it was always multiple. It had multiple identities, contained multiple individuals within it (possibly) and had multiple points of relationality. The nest was not a simple object with a single relationship to its surroundings (including myself). It was not an “innocent” more-than-human other (Hohti & Tammi, 2019, p. 174), nor a destroyer of leaves (from the bougainvillea’s perspective), but a complex mattering that exercises its agency through affective refusals. In becoming attentive to the nest — the labour that goes into making it and the qualities of the leaves used, I saw, in Massumi’s words, “the potentially creative power of life enveloped in the visible corporeal form” (p. 83, 2014). The refusals, rather than acting as a destructive obstacle in my research, worked to open a space of multiplicity. Boundaries between the nest and I were dynamic and changed throughout our time together. This less stable conception of the nest allowed me to stay “in the middle” (Deleuze & Guattari, 1987, p. 25) of my theorising with it, rather than arriving at a fixed endpoint.

Refusing finality

Although the bee’s nest and I have reached a stable plateau, the nature of a rhizome is that stability is temporary and could shatter at any moment. I won’t speak on behalf of the bee’s nest, but I refuse to conclude this piece and hope to be invited back to tangle with it further. For now, I will offer suggestions for enacting practices of alternative closeness in education based on our experience together. This work addresses closeness as an ethical consideration for environmental education (Lindgren & Öhman, 2019; MacLure et al., 2018; Tammi & Hohti, 2020; Taylor, 2018). In intra-acting with the nest, it impressed upon me an overwhelming affect that I was not permitted to transgress its boundaries to peek inside. This limit of how close we could get to each other made possible new routes of multiplicity. The leafcutter bee nest was not just an amalgamation of bougainvillea leaves stuck together — it was always multiple, containing myself, my model of the nest and my speculative narratives about it as part of the nest-assemblage. This was enabled by the nest unexpectedly asserting its boundary with me. Rather than seeing limited proximity as prohibitive, environmental education can use this productive constraint to know-with more-than-human others in a way that disrupts the separation of nature and culture. For example, the consent and refusal practices of animals could be foregrounded in settings where there are class pets. These consent and refusal practices would not be conceptualised as something that solely humans could express and would require that students become attentive to the behaviours or other ways that a class pet could refuse interaction. Another example could come in the form of trash around schools. Snack wrappers and empty water bottles might refuse containment within trash cans. This could become a lesson on trash ecology, or what happens to trash when students are done with it. Becoming close to a landfill may not be a possibility, so alternate ways of becoming-close to trash could be enacted by following the ecology of trash on a school campus. I hope that these suggestions of alternate ways to become close to a more-than-human other contribute to the already-present-and-growing use of new materialism and posthumanism in environmental education.

Acknowledgements. I would like to thank Dr. Gro Amdam, Dr. Mirka Koro and Daniel Bisgrove for the support and helpful comments in preparing this manuscript. I am grateful for the help of Evan Waite and Alex Morpheus in identifying the genus of the leafcutter bee. A special thanks to the leafcutter bee and her nest.

Financial support. This research received no specific grant from any funding agency, commercial, or not-for-profit sectors.

Ethical standard. This article does not contain any studies involving human participants performed by the author. This work is exempt from IACUC review due to their regulations regarding invertebrates. However, the research was still conducted humanely and ethically.

References

- Archibald, J., & Parent, A. (2019). Hands back, hands forward for indigenous storywork as methodology. In *Applying indigenous research methods*. (1st ed., pp. 3–20). Routledge. DOI: [10.4324/9781315169811-1](https://doi.org/10.4324/9781315169811-1).
- Barad, K. (2007). *Meeting the universe halfway: Quantum physics and the entanglement of matter and meaning*. Duke University Press.
- Barad, K. (2011). Nature's queer performativity. *Qui Parle*, 19(2), 121–158. DOI: [10.5250/quiparle.19.2.0121](https://doi.org/10.5250/quiparle.19.2.0121).
- Bennett, J. (2010). *Vibrant matter: A political ecology of things*. Duke University Press.
- Bianco, M. (2017). Turning Homo Apis: From specio-mimetic performance to bio-concrete form. *Performance Research*, 22(2), 31–39. DOI: [10.1080/13528165.2017.1315944](https://doi.org/10.1080/13528165.2017.1315944).
- Biasseti, P., Florio, D., Gili, C., & De Mori, B. (2020). The ethical assessment of touch pools in aquariums by means of the ethical matrix. *Journal of Agricultural and Environmental Ethics*, 33(2), 337–353. DOI: [10.1007/s10806-020-09823-2](https://doi.org/10.1007/s10806-020-09823-2).
- Butler, G.D. (1965). *Distribution and host plants of leaf-cutter bees in Arizona*. College of Agriculture, University of Arizona.
- Butler, J. (2009). Performativity, precarity and sexual politics. *Revista de Antropologia Iberoamericana*, 4(3), i–xiii.
- Clarke, D.A.G., & Mcphie, J. (2020). Tensions, knots, and lines of flight: Themes and directions of travel for new materialisms and environmental education. *Environmental Education Research*, 26(9–10), 1231–1254. DOI: [10.1080/13504622.2020.1825631](https://doi.org/10.1080/13504622.2020.1825631).
- Deleuze, G., & Guattari, F. (1987). Introduction: Rhizome. In *A Thousand plateaus: Capitalism and schizophrenia* (pp. 3–25). University of Minnesota Press.
- Duffus, N.E., Christie, C.R., & Morimoto, J. (2021). Insect cultural services: How insects have changed our lives and how can we do better for them. *Insects*, 12(5), 377. DOI: [10.3390/INSECTS12050377](https://doi.org/10.3390/INSECTS12050377).
- Finn, C., Grattarola, F., & Pincheira-Donoso, D. (2023). More losers than winners: Investigating Anthropocene defaunation through the diversity of population trends. *Biological Reviews*, 98(5), 1732–1748. DOI: [10.1111/BRV.12974](https://doi.org/10.1111/BRV.12974).
- Haraway, D.J. (2016). *Staying with the trouble: Making kin in the Chthulucene*. Duke University Press.
- Hohti, R., & MacLure, M. (2022). Insect-thinking as resistance to education's human exceptionalism: Relationality and cuts in more-than-human childhoods. *Qualitative Inquiry*, 28(3–4), 322–332. DOI: [10.1177/10778004211059237](https://doi.org/10.1177/10778004211059237).
- Hohti, R., & Tammi, T. (2019). The greenhouse effect: Multispecies childhood and non-innocent relations of care. *Childhood - A Global Journal of Child Research*, 26(2), 169–185. DOI: [10.1177/0907568219826263](https://doi.org/10.1177/0907568219826263).
- Hughes, H.E., Bridges-Rhoads, S., & Cleave, J.V. (2017). Work/think/play in qualitative and postqualitative inquiry. *Qualitative Inquiry*, 24(9), 1–4. DOI: [10.1177/107780041773349](https://doi.org/10.1177/107780041773349).
- Jukes, S., & Reeves, Y. (2020). More-than-human stories: Experimental co-productions in outdoor environmental education pedagogy. *Environmental Education Research*, 26(9–10), 1294–1312. DOI: [10.1080/13504622.2019.1699027](https://doi.org/10.1080/13504622.2019.1699027).
- Kline, O., & Joshi, N.K. (2020). Mitigating the effects of habitat loss on solitary bees in agricultural ecosystems. *Agriculture*, 10(4), 115–128. DOI: [10.3390/AGRICULTURE10040115](https://doi.org/10.3390/AGRICULTURE10040115).
- Koro, M., & Wolgemuth, J. (2022). Methodologies for the apocalypse: Unthinking the thinkable. *Qualitative Inquiry*, 00(0), 1–8. DOI: [10.1177/10778004221142805/FORMAT/EPUB](https://doi.org/10.1177/10778004221142805/FORMAT/EPUB).
- Lewis, S.L., & Maslin, M.A. (2015). Defining the anthropocene. *Nature*, 519(7542), 171–180. DOI: [10.1038/nature14258](https://doi.org/10.1038/nature14258).
- Liboiron, M. (2021). *Pollution is colonialism*. In *Pollution is colonialism*. Duke University Press.
- Lindgren, N., & Öhman, J. (2019). A posthuman approach to human-animal relationships: Advocating critical pluralism. *Environmental Education Research*, 25(8), 1200–1215. DOI: [10.1080/13504622.2018.1450848](https://doi.org/10.1080/13504622.2018.1450848).
- Loro-Bidart, T. (2018). Cultivating affects: A feminist posthumanist analysis of invertebrate and human performativity in an urban community garden. *Emotion, Space and Society*, 27, 23–30. DOI: [10.1016/j.EMOSPA.2018.02.006](https://doi.org/10.1016/j.EMOSPA.2018.02.006).
- MacLure, M. (2013). Researching without representation? Language and materiality in post-qualitative methodology. *International Journal of Qualitative Studies in Education*, 26(6), 658–667. DOI: [10.1080/09518398.2013.788755](https://doi.org/10.1080/09518398.2013.788755).
- MacLure, M., Mills, T., & Strom, K. (2018). Encounters and materiality in intimate scholarship: A conversation with Maggie MacLure. In K. Strom, T. Mills & A. Ovens (Eds.), *Decentering the researcher in intimate scholarship: Critical posthuman methodological perspectives in education*. Emerald Publishing Limited.
- Mannion, G. (2020). Re-assembling environmental and sustainability education: Orientations from new materialism. *Environmental Education Research*, 26(9–10), 1353–1372. DOI: [10.1080/13504622.2018.1536926](https://doi.org/10.1080/13504622.2018.1536926).
- Masny, D. (2013). Rhizoanalytic pathways in qualitative research. *Qualitative Inquiry*, 19(5), 339–348. DOI: [10.1177/1077800413479559/ASSET/IMAGES/LARGE/10.1177_1077800413479559-FIG1.JPEG](https://doi.org/10.1177/1077800413479559/ASSET/IMAGES/LARGE/10.1177_1077800413479559-FIG1.JPEG).
- Massumi, B. (2014). *What animals teach us about politics*. In *What animals teach us about politics*. Duke University Press. DOI: [10.2307/j.ctv11hpmt7.3](https://doi.org/10.2307/j.ctv11hpmt7.3).
- Morris, K., & Bozalek, V. (2019). Diffraction and response-able reading of texts: The relational ontologies of Barad and Deleuze. *International Journal of Qualitative Studies in Education*, 32(7), 872–886. DOI: [10.1080/09518398.2019.1609122](https://doi.org/10.1080/09518398.2019.1609122).
- Pacini-Ketchabaw, V., Taylor, A., Zarabadi, S., Ringrose, J., Pacini-Ket, V., & Blaise, M. (2015). Learning with children, ants, and worms in the Anthropocene: Towards a common world pedagogy of multispecies vulnerability. *Pedagogy, Culture & Society*, 23(4), 507–529. DOI: [10.1080/14681366.2015.1039050](https://doi.org/10.1080/14681366.2015.1039050).
- Puig de la Bellacasa, M. (2017). *Matters of care: Speculative ethics in more than human worlds*. University of Minnesota Press.

- Rautio, P.** (2013). Children who carry stones in their pockets: On autotelic material practices in everyday life. *Children's Geographies*, 11(4), 394–408. DOI: [10.1080/14733285.2013.812278](https://doi.org/10.1080/14733285.2013.812278).
- Raven, P.H., & Wagner, D.L.** (2021). Agricultural intensification and climate change are rapidly decreasing insect biodiversity. *Proceedings of the National Academy of Sciences of the United States of America*, 118(2), 1–6. DOI: [10.1073/PNAS.2002548117](https://doi.org/10.1073/PNAS.2002548117).
- Russo, L., de Keyser, C.W., Harmon-Threatt, A.N., LeCroy, K.A., & MacIvor, J.S.** (2021). The managed-to-invasive species continuum in social and solitary bees and impacts on native bee conservation. *Current Opinion in Insect Science*, 46, 43–49. DOI: [10.1016/J.COIS.2021.01.001](https://doi.org/10.1016/J.COIS.2021.01.001).
- Sánchez-Bayo, F., & Wyckhuys, K.A.G.** (2021). Further evidence for a global decline of the entomofauna. *Austral Entomology*, 60(1), 9–26. DOI: [10.1111/AEN.12509](https://doi.org/10.1111/AEN.12509).
- Sellers, M.** (2015). . . working with (a) rhizoanalysis . . . and working (with) a rhizoanalysis. *Complicity: An International Journal of Complexity in Education*, 12(1), 6–31.
- Sheffield, C.S., Ratti, C., Packer, L., & Griswold, T.** (2011). Leafcutter and mason bees of the genus *Megachile* Latreille (Hymenoptera: Megachilidae) in. *Canadian Journal of Arthropod Identification*, 18, 1–107. DOI: [10.3752/cjai.2011.18](https://doi.org/10.3752/cjai.2011.18).
- Tammi, T., & Hohti, R.** (2020). Touching is worlding: From caring hands to world-making dances in multispecies childhoods. *Journal of Childhood Studies*, 45(2), 14–26.
- Taylor, A.** (2017). Beyond stewardship: Common world pedagogies for the Anthropocene. *Environmental Education Research*, 23(10), 1448–1461. DOI: [10.1080/13504622.2017.1325452](https://doi.org/10.1080/13504622.2017.1325452).
- Taylor, C.A.** (2018). Each intra-action matters: Towards a posthuman ethics for enlarging response-ability in higher education pedagogic practice-ings. In V. Bozalek, R. Braidotti, T. Shefer & M. Zembylas (Eds.), *Socially just pedagogies : Posthumanist, feminist and materialist perspectives in higher education*. Bloomsbury Publishing.
- Tuana, N.** (1983). Re-fusing nature/nurture. *Women's Studies International Forum*, 6(6), 621–632.
- Tuck, E., & Yang, K.W.** (2014). Unbecoming claims: Pedagogies of refusal in qualitative research. *Qualitative Inquiry*, 20(6), 811–818. DOI: [10.1177/1077800414530265](https://doi.org/10.1177/1077800414530265).
- Tynan, L.** (2021). What is relationality? Indigenous knowledges, practices and responsibilities with kin. *Cultural Geographies*, 28(4), 597–610. DOI: [10.1177/14744740211029287](https://doi.org/10.1177/14744740211029287).
- van Dooren, T., Kirksey, E., & Münster, U.** (2016). Multispecies studies: Cultivating arts of attentiveness. *Environmental Humanities*, 8(1), 1–23. DOI: [10.1215/22011919-3527695](https://doi.org/10.1215/22011919-3527695).
- Wagner, D.L.** (2020). Insect declines in the anthropocene. *Annual Review of Entomology*, 65(1), 457–480. DOI: [10.1146/ANNUREV-ENTO-011019-025151](https://doi.org/10.1146/ANNUREV-ENTO-011019-025151).

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