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**Making insects tick: responsibility, attentiveness and care in edible insect farming**

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**Abstract**

Insects are increasingly promoted as a sustainable and nutritious source of protein, with 'edible insect' sectors emerging in many countries not traditionally associated with their consumption. A number of studies have examined the attitudes of potential consumers to eating insects but the understandings and practices of farmers have largely been ignored. This paper expands nature-society scholarship's engagement with the edible insect sector by investigating how farmers make sense of their responsibilities to insects through their everyday practices. Drawing on a qualitative study of the UK's edible insect farmers, the paper contributes to wider ongoing debates within STS and animal studies around multispecies companionship involving apparently 'awkward' creatures, and around the relationship between 'care' and 'ethical regard' in more-than-human relations. Such debates are especially pertinent here, as insects have often been understood as lacking sentience and beyond moral considerability, resulting in their exclusion from animal welfare codes and regulation. Insect farmers are therefore faced with questions not only about how to care for their 'mini livestock' but also whether to care. Following an outline of the UK's edible insect production sector, and framed by a discussion of literature on awkward creatures, attentiveness and practices of care, the paper reports on: (1) the relationship between sentience and farmers' constructions of insects' moral significance; (2) farmers' motives for, and approaches to, becoming attentive to their insects; and (3) how farmers respond to the actions of insects. It concludes by reflecting on the nature of attentiveness encountered in edible insect farming, arguing that it offers a promising yet unstable basis for the development of harmonious more-than-human relations.

**Keywords**

Insects, Entomophagy, More-than-human geographies, Care, Attentiveness

**Highlights**

- Edible insect farming in the UK sits outside of animal welfare legislation; farmers develop ways of navigating insects' ethical ambiguities.
- Uncertainties around insect sentience mean that this is an unstable grounding for the development of insect welfare codes.
- UK edible insect farming is characterised by 'tinkering' practices, where farmers attempt to respond to insects' perceived needs and wants.
- These tinkering practices point towards an 'ethos of care' in insect farming, where farmers learn to become 'response-able'.

**Introduction**

Insects (van Huis et al., 2013) have long been on the culinary margins for much of the world's population. Although regularly consumed by 2bn people globally (van Huis et al., 2013), entomophagy (the consumption of insects as food), remains limited outside Africa, Asia and Latin America. In the context of prominent debate around conventional livestock's role in future food systems (e.g. Steinfeld et al., 2006), new geographies of insect production and consumption are opening up, as they are increasingly promoted in countries such as the UK as a nutritious (Rumpold and Schlüter, 2013) and environmentally sustainable (Alexander et al., 2017; van Huis et al., 2013) 'alternative protein' (Akhtar and Isman, 2018: 267). Despite such promises, a recent paper in this journal noted that some proponents of alternative proteins 'have explicitly tried to distance themselves from insect-based approaches, often citing the ethical ambiguity of slaughtering insects for food' (Sexton et al., 2019: 48). Within a rapidly expanding literature on Western entomophagy (e.g. House, 2019a; 2019b; Sogari et al., 2017; Verneau et al., 2016), some studies have begun to research how consumers perceive the ethics of using insects as food (House, 2019c; Elorinne et al., 2019). However, the ethical ambiguity of insect *production* has, as yet, been little-explored.

This paper addresses this issue by investigating how edible insect farmers in the UK make sense of their responsibilities to insects. The paper contributes to wider ongoing debates within geography, animal studies and STS around multispecies companionship involving ostensibly 'awkward' (Ginn et al., 2014: 113) creatures, and around the relationship between practices of 'care' and the notion of 'ethical regard' in more-than-human relations (Pitt, 2018: 255). Insects, recently attracting increasing attention across animal studies and STS (key contributions include Beisel, 2015; Beisel et al., 2013; Ginn et al., 2014; Lorimer, 2007; Bingham, 2006; Sexton et al., 2019; Shaw et al., 2013; Shaw et al., 2010; Del Casino Jr, 2018; Wilkie, 2018; Bear, 2019; Phillips, 2014; 2020; Jones and Beynon, 2020; I discuss the contributions of such literature in a subsequent section), have often been presented as 'other' (Looy et al., 2014: 132), and at 'empathetic distance' (Beisel et al., 2013: 6) from humans. Alongside this, their ontological difference can be 'positive' (Bingham, 2006: 4927), fostering fascination (Beisel et al., 2013: 8) and 'curiosity' (Lorimer, 2014: 197).

UK insect farmers currently have considerable freedom over their approaches to the rearing and slaughter of 'minilivestock' (DeFoliart, 1995: 310), as insects sit outside the sorts of legislation and codes that inform animals' treatment in other livestock sectors. For Röcklinsberg et al. (2017: 376) this lack of codification provides an 'opportunity to be pro-active and craft practices and policies that at the outset attend to ethical issues.' However, there is little consensus amongst the UK's edible insect farmers about what the 'ethical issues' are, or whether they matter. Because of questions over insect sentience (see Pali-Schöll et al., 2019) – defined by Singer (1995: 8-9) as 'the capacity to suffer and/or experience enjoyment') – their insects are frequently dismissed as beyond 'moral obligation' (Loo and Sellbach, 2013: 13). A starting question for farmers thus regards not *how* to care, but *whether* to care for their animals (Gjerris et al. [2015: 349] claim that ethical issues tend to be 'left out of the considerations' of insect production).

In what follows, I examine how these farmers think about and characterise their responsibilities towards the creatures they rear. I approach this in relation to recent discussion around the emergent and fluid nature of 'care' in human-animal relations (e.g. Greenhough and Roe, 2011; Giraud and Hollin, 2016; Law, 2010). Most specifically, I respond to Beisel et al.'s (2013: 8) question: 'What kinds of companionship and care do insects evoke in humans?' In doing so, I join others in viewing care as

something that 'cannot be reduced to a universal set of principles,' and which instead 'involves "tinkering" with existing socio-technical infrastructures' (Giraud and Hollin, 2016: 29). This tinkering builds on practices of 'attentiveness – of attending to the non-human other, of becoming response-able to them' (Krzywoszynska, 2019: 664). However, as Krzywoszynska (2019: 662) notes, 'how attentiveness may arise, and what work attentiveness may be able to do as a catalyst for and conduit of more-than-human ethics, has not been sufficiently explored'.

This paper addresses Krzywoszynska's (2019) concern, exploring the emergence of attentiveness amongst the UK's edible insect farmers and how this relates to the development of 'response-able' (Haraway, 2008: 71) farming practices. I begin with an overview of insects-as-food and associated practices of entomophagy, prior to outlining the methodology that underpins the research. Reporting on one of the first qualitative studies of edible insect farmers outside of the regions where they have a longer history of consumption, I then discuss recent research on human-insect relations from geography and animal studies, framing this in relation to conceptualisations of more-than-human care. This forms the backdrop to three empirical sections, which investigate: 1) farmers' constructions of insects' sentience and its relation to moral significance; 2) farmers' motives for, and approaches to, becoming attentive; and 3) how farmers respond to the actions of insects. Through these three sections, I illustrate the emergence and nature of caring relations in insect farming, highlighting tensions between claims around insects' moral insignificance and practices that respond to perceived insect desires. As such, the paper contributes to ongoing debate around the constitution and role of care in more-than-human relations.

**Farming Insects as food**

Although the range of insect-based products available in the UK continues to grow[1], these often rely on imports, especially from Thailand and the Netherlands. Dossey *et al*'s (2016: 136-139) survey of insect farming enterprises identified 17 in Europe, but only two were in the UK (neither reached commercial stage and have both subsequently gone out of business). The UK's first fully-operational commercial edible cricket farm opened in 2017 (though closed less than a year later). In this sense, compared to North America and Western Europe, the UK's edible insect farming sector has been slow to develop. At the time of writing, five farms producing insects for human consumption in the UK have a public profile (e.g., with a website or Twitter feed), though not all of these are yet trading; the author knows of three further farms that are in the process of establishing themselves (or diversifying their existing insect production to contribute to the human food market). The existing UK farms are generally on a relatively small scale. As yet, most produce from these farms is sold either online (as dried insects or in powdered form), or at events such as food festivals and farmers' markets (often as a component of products such as cakes). One farm specialises in selling live insects for home cooking, while another currently focuses on outreach work around sustainable food, using its produce in edible

[1] They include cricket-based protein bars, roasted crickets and cricket-enriched bread. These are largely sold online, though the supermarket Sainsbury's began selling roasted crickets in 2018, while Selfridges started selling 'cricket cookies' in 2019. Insect-based food is also available in restaurants including Grub Kitchen (St Davids, Wales) and Archipelago (London, England), and has recently been incorporated into lunches in some Welsh schools in an insect-based bolognaise product (Jones and Beynon, 2020).

insect workshops and demonstrations. Around six further farms, not considered in this paper, are being established with a view to supplying the aquaculture industry with insect-based feed.

Although entomophagy is widespread in some countries, much of this relies on insects' 'wild harvesting' (Glover and Sexton, 2015: 14) rather than farming. There are regional and species-specific exceptions - for instance, Dossey et al. (2016: 140) estimate that there are around 20,000 'small to medium' cricket farms in Thailand - but farming insects for human consumption, particularly at a large scale, remains relatively undeveloped globally in comparison to other livestock sectors. As a corollary, the formal and informal knowledge networks (e.g. Sligo and Massey, 2007) and communities (Nerbonne and Lentz, 2003) found in other livestock sectors are largely absent here, and in contrast to other insect-husbandry practices, such as beekeeping (see Adams, 2018), there are no clubs for practitioners, resulting in relatively little sharing of 'good practice' between farmers. There is some networking of insect producers at a national level (e.g. the North American Coalition for Insect Agriculture, and the UK's Woven Network[2]) and regional industry bodies (e.g. the International Platform of Insects for Food and Feed [IPIFF] in the European Union). However, IPIFF's focus is on larger-scale producers and on lobbying at European level, rather than the networking of small-scale or start-up farmers. Until recently, there have also been few formal guides to rearing insects as food at a commercial scale (see van Huis and Tomberlin, 2017b), with participants in this study often referring to their use of online forums and YouTube videos (often aimed at those who farm insects to feed their pet reptiles and suchlike) when starting up.

Although the sale of insects in the European Union (EU) is subject to the Novel Foods Directive, and insects sold as food must meet the same food hygiene regulations as any other animal-based food product, edible insect farming is generally subject to considerably less regulation than other livestock sectors (see Lotta, 2019). This began to change in 2018, when formal requirements for edible insect production were introduced in Thailand (Thailand National Bureau of Agricultural Commodity and Food Standards, 2018) and Finland (Evira [Finnish Food Safety Authority], 2018). These remain the exception to the rule, and the full implications of their implementation has yet to be assessed. Nonetheless, the Finnish guidelines in particular offer challenges to the sector's future development, particularly through suggesting that the 'five freedoms' of animal welfare should be extended to insects (a perspective mirrored in recent IPIFF [2019] guidelines) – despite uncertainties around their experience of pain or stress and ambiguities around the nature of 'optimum' temperatures, lighting and so forth. While no similar guidance has been introduced in the UK, the IPIFF and Finnish examples point to the development of a more standardised approach in the future, drawing on values and practices associated with other livestock sectors. This is in marked contrast to Röcklinsberg et al's (2017) call to be more proactive and creative in the development of ethical approaches to insect farming and these recent developments suggest a need for relative urgency should other countries wish to follow a different path.

[2] The Woven Network was launched in 2016, to connect 'businesses, researchers and others involved with insects in the human food chain in the UK and beyond', and identifying 'key barriers and opportunities for addressing challenges facing' the sector (Woven Network, 2019).

**Methodology**

The paper draws on a total of 13 semi-structured interviews with individuals involved in the farming of insects for human consumption in the UK. At the time of conducting the fieldwork, these encompassed all the UK's current or recent (within the past two years) edible insect farming enterprises. 12 interviews were with insect farmers, one of whom was interviewed twice[3]; the producer interviews were augmented by a further interview with a representative of the industry body Woven[4]. Five farmers dealt exclusively with crickets, four with mealworms and two with a combination of species. The interviews lasted between one and four hours. Four were carried out on-site in cricket farms, four in person in 'neutral' locations, such as cafes, and the remainder over the telephone or Skype.

The interviews followed standard practice: they used an interview guide, but enabled participants to raise additional themes and to vary the thematic order. The interview guide involved six broad themes: personal background and motivation for farming; farm design; running an insect farm; insect farming best practice; views on the edible insect sector; and future plans. A large segment of each interview focused on the design and running themes, which encouraged participants to speak about, for instance, their daily routines, insect lifecycles, sources of advice, and how they learn to respond to insects. As such, while it was not always possible to visit farms and observe everyday farming practices (in some cases because the farms no longer existed), the interviews were designed to encourage participants both to discuss and reflect on their attitudes, and to detail what they might have viewed as more mundane aspects of their farming practices (following Hitchings [2012]). The on-site interviews, conducted in part while touring the production facilities, used the same topic guide but discussion was additionally prompted by the presence of insects, farming technologies and suchlike. All interviews were audio recorded with participants' permission and were subsequently transcribed fully. Following transcription, interviews were coded using NVivo 11; 'in vivo' coding was adopted to build categories around participants' own words. Pseudonyms are used throughout the paper to protect the identity of participants where possible. The wider project also included interviews with those involved in farming insects as aquacultural feed. At the time of conducting the research, most of those companies were focused on research and development, rather than insect production per se, so they have not been analysed for this paper.

References to 'farmers' and 'farms' in the paper should not be taken to imply large-scale production facilities, nor the professional identity of participants. Most participants were part-time farmers, farming insects alongside other jobs and responsibilities. Three participants had a background in entomology, but the majority had no formal training in rearing insects (see Wilkie [2018] for further detail on who farms insects in Europe and North America). Farms, meanwhile, range from rooms in participants' houses and large garden sheds, to relatively large-scale barns. In most cases, the participants hoped to expand in the future, although some explicitly set out to develop small-scale businesses, challenging the prevalent agri-food model.

[3] An initial phone interview resulted in an invitation to visit the farm, where an extended interview was conducted whilst touring the facility.

[4] Following this initial interview with a Woven representative, I became a Director of the Woven Network. Only two of the interviews took place following this appointment; those participants were informed of my dual roles, and that the research was independent of Woven.

**Awkwardness, attentiveness and more-than-human ethics of care**

The interdisciplinary field of animal studies has recently taken what might be termed an awkward turn. Having focused for much of the past two decades on relationships between humans and ostensibly 'familiar subjects' (Lorimer, 2014: 195) such as warm-blooded mammals, recent scholarship has turned to beings that appear harder to engage or empathise with. These have been referred to as 'awkward creatures' – awkward in that they 'bite, or sting, or…fascinate but also repulse us' and 'tend not to fit off-the-shelf ethics' (Ginn et al., 2014: 113). These include cold-blooded aquatic creatures (Bear, 2011; Atchison, 2019), slugs (Ginn, 2014), ticks (Bull, 2014) and, most pertinently here, insects (Beisel et al., 2013). Lorimer (2007: 920) argues that insects hold 'radical alterity to humans in terms of size, ecology, physiology, aesthetics, and modes of social organisation'. Perhaps in part because of this, they have, along with other invertebrates (Moore and Wilkie, 2019), 'received scant attention in social sciences' (Phillips, 2020: 59), including animal studies.

Insects have, nevertheless, increasingly attracted social scientists' attention, especially when they appear as pests (Davis and Nichter, 2015; Shaw et al., 2013; Shaw et al., 2010). Here, political ecologists, along with STS scholars and historians, have highlighted the agential properties of insects (Mitchell, 2002), which are portrayed as 'unruly' (Biehler, 2009: 1015) and 'noncompliant' (Haraway, 2008: 85). Such work has shown how this apparent noncompliance – rendered, as Haraway notes, all the more problematic through multiplicity - raises practical problems for their management. Shaw et al. (2013), for instance, show how mosquitoes' vitality exceeds the technologies that have been designed to control or eradicate them.

A further small but developing literature in geography and animal studies has begun to approach insects less as pests and more as 'companions' (Beisel et al., 2013). This literature encompasses contexts ranging from beekeeping to laboratory work, emphasising the nonhuman 'labour' (Phillips, 2014: 157) performed by insects alongside their often-ambiguous relationships with humans. In two ethnographic studies of beekeeping, Maderson and Wynne-Jones (2016: 93) speak of the 'intimate and caring relations' beekeepers have with their bees while Phillips (2014: 157), building on Bingham (2006), finds that some beekeepers express a 'sense of attachment' to their animals and articulate 'enthusiasm and concern' for them; 'the ways of insects, so different from human experience,' she argues, 'add challenge and fascination.' Lorimer (2007: 920) calls this a 'feral charisma,' where 'wildness and chaotic characteristics' are celebrated by some people, who 'rejoice in their alterity.' Alongside such unexpected affinities, however, 'togetherness can be sometimes a question of alien-ness, disconnection, detachment, or withdrawal' (Ginn et al., 2014: 114). Beekeepers spoke, therefore, of how certain practitioners engage in 'rough' treatment of their bees (Phillips, 2014: 155), while in scientific practice, argue Beisel et al. (2013: 6), the 'empathetic distance [and] alien form' of insects 'expunges their dissections of violence and their deaths of sacrifice'.

This literature implies that creatures such as bees occupy an ambiguous status, charismatic and fascinating, yet combining bodily and social difference, alongside apparent empathetic distance. On this basis, bees, and by implication insects more broadly, are problematic candidates for participating in caring relations. However, recent work on care focuses not on concepts of 'moral standing' (e.g. Singer, 1975) or on following codes of practice but on developing an ethic of 'response-ability' (Haraway, 2008: 71). This shift draws on feminist reworkings of the conceptualisation of care where,

for instance, Gilligan (1982) contrasts masculine and feminine conceptions. The former, she argues, is centred around 'rights and rules,' while the latter is concerned with 'the *activity* of care' (p. 19, emphasis added). Schrader (2015: 668) builds on such definitions, referring to the former as '*caring for*,' which is 'goal-oriented' and defines the recipient 'through a lack of ability or autonomy,' and the latter as '*caring about*,' which is rooted in '"an opening to become with those with whom we are not yet"' (Haraway, 2008: 93, cited in Schrader, 2015: 668) – a move away from assuming one knows the subject(s) of care prior to caring about, and where care, as involving attentiveness and attunement, is relational and mutually affective.

Viewed thus, care can be understood as practice rather than as a code or goal. Haraway's ethic of response-ability, therefore, 'encourages a practice of making oneself available to respond without knowing ahead of time which phenomena will call one's attention or what form the response should take' (Martin et al., 2015: 635). A corollary of such perspectives is that care is not necessarily rooted in intent as Mol et al (2010) point out, the best intentions may not result in positive outcomes. Moving the focus away from intent, Puig de La Bellacasa (2017:154) views care as rooted in the emergence of obligations, where particular actions 'create and re-create demands and dependencies, they become necessary in a specific world to subsist and thus somehow *oblige* those who inhabit that world,' regardless of whether ethical thought or intention were involved. As such, an 'ethos of care' (p.18) '*creates* its ethics' (p.166, emphasis added) rather than simply following codes or conventions.

Central to interpretations of care-as-practice is the development of 'a generous sensibility towards others' (Pitt, 2018: 257), with 'attentiveness' to those others as a central 'tool' (Krzywoszynska, 2019: 662). Such generous sensibilities are often viewed as more significant than the resulting outcome: 'You do your best,' according to Mol et al. (2010: 13), and if an attempt to care appears unsuccessful, you 'try again, try something a bit different, be attentive'. Care, they say, involves 'persistent tinkering in a world full of complex ambivalence and shifting tensions' (p.14). As a result, caring is also 'ongoing. It has an implicit temporality and situatedness' (Krzywoszynska, 2016: 293). However, Pitt (2018: 258; see also Ginn, 2014) recently questioned the 'logic that connecting with nonhumans leads people to value them.' She argued that 'it is not clear that closeness is an inevitable source of care, or that spatial proximity overcomes separation by difference.' If, as Pitt (2018: 260), argues, attentiveness involves 'knowing what another needs' (p. 260), how might care emerge when needs are far from clear (cf Pali-Schöll et al., 2019: on the uncertainties around the welfare requirements of insects)? Her arguments are developed by Krzywoszynska (2019), who contrasts the pervading marginalisation of soil in Western agriculture in favour of a focus on chemical additives as producers of fertility with an emerging rediscovery of soil biota and processes. There, 'a dialogue around what may count as "needs" of soils, and how to adapt human practices to those needs, is only starting to take shape' (p. 671) Attentiveness might direct concern to identifying needs, but such identifications could be contradictory. Further, attentiveness may serve multiple purposes. While the ethics of care literature promotes attentiveness as an opening to response-able practice, it may also operate as a route to manipulation. Krzywoszynska (2019: 672) holds that 'the reason for attending to the needs of other entities is to better satisfy the needs of the primary object of care,' but as Wadiwel (2016) has shown, attending to the actions and preferences of animals can be used to introduce 'technologies of violence' (p. 210) that can render animals as co-creators (p. 221) of the practices and technologies that come to kill them (see also Giraud and Hollin [2016] on the relationship between care and control). In contexts such as livestock farming, the relationship between caring, controlling and killing is always in tension (Convery et al., 2005; Wilkie, 2005; 2010; Riley, 2011; Holloway et al., 2014; Bear

and Holloway, 2019), and it would be naïve to assume that attentiveness, or even openness to difference, equates to response-ability. It is not surprising on that basis that Krzywoszynska (2019: 662) suggests that the role of attentiveness as 'a catalyst for and conduit of more-than-human ethics' requires further examination.

The ethics of care, therefore, opens up alternative ways of thinking about insects and their relations with humans, focusing on their enrolment and participation in knowledge-practices, as opposed to prioritising pre-ordained versions of 'right' and 'wrong' ways of treating them. This is not to say that the ethic of care simply replaces other ethical framings. Law (2010: 69) develops the concept of 'choreography of care' to capture such multiple framings, viewing veterinary care as 'the art of holding all those versions of care in the air without letting them collapse into collision'. As I show in this paper, while insect farmers may develop forms of care that rest on attentiveness and experimentation, they often do this in the knowledge of more instrumental versions of ethics that might view insects as morally insignificant (Gjerris et al., 2016). Different ethical framings, therefore, can coexist in everyday practices, though not without tension.

**Growing insects well**

> There's one thing growing insects, there's another thing growing them well.
>
> (Geoff, cricket and mealworm farmer)

Practitioner literature often portrays insect farming as 'easy' (Gates, 2017: 24; Gordon, 2013: 15) in comparison to other forms of livestock farming. It is said to require little skill, previous experience, or knowledge about the insects themselves. Geoff, as the above quote illustrates, felt uncomfortable with such claims. He had learned the hard way, after his farm was struck by densovirus shortly after its establishment, killing a large proportion of his crickets. Cricket farming, he had discovered, was *not* easy. Geoff's perspective also stemmed from his previous employment, where he had reared a variety of insects for laboratory use for around two decades. Musing on why some UK start-up farms had failed to reach a commercial stage, he commented that 'some people think it's just like falling off a log'. These farmers, he felt, had prioritised business plans over learning 'about what makes insects tick'.

Whatever the veracity of Geoff's critique, his understanding of the multiple connotations of 'growing them well' serves to illustrate the themes that will be explored in the next two sections. First, he took an instrumental perspective, arguing that any notion of insect welfare was ambiguous at best, and questioning their ability to experience pain. Second, his goal was to produce as efficient a system as possible, summing up his central aim as 'making sure you can keep your insects alive to the point where you can gain remuneration from them.' His approach, therefore, was characterised by goals around (for instance) mortality rates and reducing the need for his intervention in tanks. Third, his farming was overtly experimental, involving comparisons of different feed, temperatures, housing and so forth, accompanied by detailed record-keeping; it was an explicitly responsive approach – though not necessarily 'response-able'.

Over the next three sections, I expand on these themes, in exploring shifting notions of 'care' and responsibility in insect farming. I begin in the next section by examining how farmers frequently contextualised their approaches with reference to notions of pain and sentience, questioning the

moral significance of their minilivestock. I show that this is an unstable grounding, with inherent uncertainties making farmers feel the need to find other ways of developing and justifying their practices.

*Making insects count? Pain, sentience and moral worth*

It is not surprising that most of the participants in this study made some reference to the moral standing of their insects. At the centre of much debate around insects' ontological ambiguity are questions around sentience; for Singer (1975), 'sentience – in the sense of consciousness, awareness, or at best, the ability to suffer or feel pain – should be the distinguishing criterion for moral standing' (Gjerris et al., 2016: 105). Even if this definition of sentience – and its connection to moral standing – is accepted, there is disagreement within scientific literature over whether insects do feel pain. Indeed, according to Gjerris et al. (2016: 106), 'there is probably a large majority opinion, which holds that some invertebrate groups, such as insects, are not capable of suffering'. Although thus excluded from 'the policeable sphere of care' (Johnson, 2015: 300), as previously noted, the 'five freedoms' of animal welfare (freedom: from hunger and thirst; from discomfort; from pain, injury and disease; from fear and distress; and to express normal behaviour (Farm Animal Welfare Council, 2009) are increasingly promoted as a basis for responsible insect farming (van Huis and Tomberlin, 2017a; Evira [Finnish Food Safety Authority], 2018); IPIFF (2019) encourages 'all insect producers to embrace' and commit to its interpretation of the five freedoms by 2020.

Some farmers engaged with such debates because of concerns about 'what the consumer would want' (Julia, mealworm farmer), while for others it was more a desire to, as Mol et al. (2010) put it, 'do your best' for the insects. Most commonly farmers discussed their understandings of insects' (lack of) ability to feel pain, using this to justify their approaches to both rearing and killing (see Bear, 2019) and, mirroring the wider debates around sentience, often relating pain to moral standing. In this section, I explore such arguments, looking at how moral significance was acknowledged or denied by farmers, but also at some of the problems they found in applying such labels through their everyday farming practices.

Most farmers felt that their insects could not feel pain. Tony, a mealworm farmer, put this especially strongly:

> if they have any pain response at all, they don't have the cognitive architecture to have any awareness of that, so I don't think they're moral agents. I think of them like a plant with legs. So in terms of the kind of ethical concerns around it, it would be more to do with the economies of the environment in which they're raised, the labour practices, the energy costs of their growth and shipping...

Developing ethical farming practices, in other words, would have little to do with the animals themselves, mirroring literature on the challenges faced by insect farming (Rumpold and Schlüter, 2013), where any conception of ethics relates most frequently to sustainability and access to food. Other farmers expressed more nuanced views. Siobhan (cricket farmer), for example, felt conflicted as a result both of ongoing scientific debate and her interpretations of this in relation to her own observations of cricket cannibalism:

> they would just eat each other when they're still alive. And the one being eaten like didn't notice. And I read all stuff that they don't feel pain, and if they don't feel pain then I suppose you might not notice if you're being eaten. And I've read that, but I've also read things that say there's not conclusive evidence to say that they don't.

Geoff and Jim, meanwhile, differentiated between experiences of pain and stress:

> most insects in the wild are starving, like most predators are starving. … So do they feel stressed? Yes, under certain circumstances. But I think that stress is maybe acquiring resources, things like that. I think the thing is that if you think of anything that might be detrimental to production, could it be construed as a stressor – simple access to food and water, things like that. Remove those and you remove most of the stressors. (Geoff, cricket and mealworm farmer)

> I don't think or I don't really believe that insects feel pain in any way that we would understand pain, but I think they can still be stressed. (Jim, cricket farmer)

For Geoff, insect farming was always going to involve some level of stress for the crickets, but a life without stress would be impossible in any context; he felt that his farming system removed many of the stressors found 'in the wild' and that his insects, as a result, were living 'in a de-stressed state'. Certain levels of stress could be justified, therefore.

However, Geoff and Jim differed in their responses to the potential presence of cricket stress. For Geoff, his concerns were instrumental. Speaking of his crickets, he said he had 'absolutely no feeling for them whatsoever… I think you'll struggle to find anybody who'll say that there's any emotional attachment to them.' Any changes he made, therefore, were to improve his farm, rather than resulting from 'caring about' (Schrader, 2015: 668) the crickets. In contrast, Jim felt the need to act in the face of uncertainty, for instance in the killing process using $CO_2$ as an anaesthetic on his crickets prior to refrigeration in order to reduce the potential stress of cooling. As he put it, 'the only reason I'm doing it is with insect welfare in mind' (see Bear, 2019 for further discussion of approaches to insect death)

Other farmers felt similarly to Jim. Mike (mealworm farmer), for instance, argued that, 'The jury is still out on whether insects feel pain in the same way that we do. But because the jury is still out you have to be cautious about that.' Siobhan (cricket farmer) articulated her perspective in relation to 'respect': 'even if there was conclusive scientific evidence […] to say that they didn't feel pain, I still think that we should have respect for anything living.' Such attitudes mirror calls to adopt the 'precautionary principle' (e.g. van Huis and Tomberlin, 2017a; Cooper, 2012; Eisemann et al., 1984) around insect pain, the logical extension of which is the aforementioned development of welfare codes to insect farming (Evira [Finnish Food Safety Authority], 2018; IPIFF, 2019).

However, some farmers felt that welfare codes, or even attempts to identify and deal with pain, were abstracted from their everyday experiences of farming. Jim (cricket farmer), for example, felt that, even if insects *could* experience pain, this would be hard for farmers to identify:

> I mean it wouldn't be able to show that it was in pain really anyway I wouldn't have thought. I don't think that's a good test of whether it's actually in pain or not; it's whether you can look at it and it looks like it's in pain, because you wouldn't be able to tell I don't think.

In his view, implementing welfare codes would serve limited purpose, as identification of insect pain would be too open to interpretation, as well as varying between species. Others drew attention to the difficulty of attending to the welfare of individual animals. According to Tony (mealworm farmer), for instance, 'You can only look at them collectively. So you can look at percentage of deaths, or you can look at growth rates or reproductive rates. But you don't really get any information at all by looking at individual animals.' Geoff, meanwhile, stated that 'when you've got crickets, you're dealing with units in the million…they are just commodities.' As a result, the individual animals are subsumed within the mass (cf Buller, 2013), with indicators such as mortality rates being a more common reference point than experiences of individual animals. In this sense, it made little difference whether a farmer was dealing with a few tanks of insects in a garden shed or with tens of tanks in a warehouse or barn; at each scale, it is often difficult to see beyond the mass unless focusing on, for example, an escapee or when observing an individual tank at length.

In this section, I have begun to show some of the tensions that exist around grounding care for insects in an ethic centred on sentience. Scientific uncertainty around insects' ability to feel pain, combined with the scale and density of insect farming, works to encourage more instrumental approaches to insect ethics, where they can either be discounted as morally insignificant or where 'caring for' (Schrader, 2015) them is driven by a desire to produce efficient farming systems. However, attempts to codify welfare in relation to pain have proved problematic because of the difficulty (impossibility, even) of identifying the feelings of the animals, whether through scientific study or farmers' observations. In the next sections, therefore, I explore how farmers' curiosity around insect behaviour has led them to experiment (or 'tinker' (Mol et al., 2010; Krzywoszynska, 2016; Giraud and Hollin, 2016) with their farming systems in an effort to 'care about' (Schrader, 2015: 668) the minilivestock.

*Becoming attentive? Observing and learning with insects*

Caring about crickets and mealworms on the basis of their questionable sentience and uncertain ability to experience pain is, as the previous section demonstrated, problematic. However, as various authors (Mol et al., 2010; Krzywoszynska, 2016; Giraud and Hollin, 2016; Schrader, 2015) have argued, 'care is not possible when the practitioners care more about adhering to the rules and procedures than they do about doing the right thing' (Krzywoszynska, 2016: 294). It might, therefore, be understood and practiced more constructively as responsive, situated and emergent. Alongside this, caring involves 'creating the space to affect and be affected,' which, in turn, enables animals to '"speak back" in ways that reshape their environment' (Giraud and Hollin, 2016: 30). However, as noted in the introduction, the alien form, social organisation in dense collectives, and short lifespans of insects can serve to 'create ethical distance' (Phillips, 2014: 155). In this section, I look at instances where insect farming opened up, or closed down, opportunities to be affected, and at how and why some farmers have developed attentive and responsive approaches to their insects.

Some of the farmers found themselves holding ostensibly contradictory attitudes to their insects. Faced with seething masses of crickets or mealworms, a number of them commented on the lack of individual difference. For Julia (mealworm farmer), 'they all look the same,' while Siobhan (cricket farmer) 'would never be able to identify any individual […] Identical, yeah, there's not, unlike mammals that quite often have an odd distinguishing slightly different coloured leg or something. They don't, they all are just identical'. Jim (cricket farmer) described his crickets as 'fairly predictable,'

while Gregory (cricket farmer) went so far as to describe them as 'little machines,' which 'all react the same'. This sort of predictability is not suggestive of a care ethic that emerges from 'a recognition that we cannot know all the possible variables, and that therefore we may not be able to foresee all the possible outcomes' (Krzywoszynska, 2016: 293). However, farmers responded to the apparent predictability in a variety of ways.

The first approach was to look for any divergence from predictability, using this as an indicator of poor farming practice. For instance, Jim (cricket farmer) spoke of having two cricket tanks 'that have as far as I can tell identical conditions' but that when he came to harvest them:

> it's amazing how big a difference you can get sometimes in the weight of crickets that you can get out of what would appear to be exactly the same container. But that shouldn't be the case. They should be a lot more predictable than that. And that's because I've done something wrong, something's not right, and it's all down to the rearing conditions. For example, when I was in that shed there were hotspots.

In contrasting examples, other farmers found themselves drawn in through fascination, making them question their assumptions about predictability. Siobhan (cricket farmer), for example:

> spent a lot of time just watching them, I was totally fascinated, couldn't stop watching their behaviour. And I … literally recorded everything I was doing. And each day things were changing… if they'd bred, what they ate, what they didn't eat, anything, any change each day I just recorded, not knowing at that stage what was important and what wasn't important. So I just put it all, just made notes.

Her record-keeping contrasted markedly with Geoff's in the previous section; while his was often goal-oriented and directed to assessing his own practice, Siobhan was attempting to find a way to attend to her crickets' needs. While there is ultimately an instrumental rationale to her approach, in that she hoped it might lead to more efficient farming, her primary concern was to produce what she referred to as 'high welfare crickets' and, in the absence of consensus over what this might consist of, she wanted to work it out for herself.

Despite having referred to crickets as 'machines', Gregory (cricket farmer) felt, similarly to Siobhan, that 'you've got to watch individuals. I sit and watch them all the time.' He continued:

> sometimes they do quite strange behaviour and you think these guys might be a bit more intelligent than they're given credit for. I've seen them block off entrances to food sources, some of the larger ones, block them, I've seen them knock smaller crickets off things. There's definitely some more going on there I think than people realise.

Observing his crickets in such ways has led him to change his attitude to the worth of individuals. As he put it, he has gone 'go to ridiculous lengths to save one baby pinhead [cricket] that's fallen behind the back. It's ridiculous. I've taken 20 minutes to get hold of one and just get it up and put it back in […] because I just can't bring myself to leave it, I don't know why that is and maybe I'll get over that, but they're living animals.'

In a similar way to Pitt's (2018: 266) study of more-than-human relations in community gardens, the relationships illustrated in this section vary from the instrumental, where notions of care are rooted in 'goals selected by humans' (especially in the case of Geoff), to more 'interdependent' relations,

where ‘mutual benefits for humans and nonhumans’ are recognised (such as in the case of Siobhan). While the motives of these three farmers for spending time watching their crickets and becoming aware of less-than-predictable characteristics might differ, they were united in building on their observations to bring about changes in their farming practices. I discuss such responsive practices in the next section.

*Making insects happy: tinkering and empathy*

Regardless of their attitudes to insect sentience or even predictability, all the farmers discussed their practices as involving ‘trial and error’ (Jim, Siobhan [cricket farmers] Tony, Mike [mealworm farmers]) (or in similar terms such as ‘experimenting’ (Patricia, mealworm farmer) and ‘tweaking’ (Jim, cricket farmer)) (see also van Huis and Tomberlin (2017a); De Goede et al. (2013)). Trial and error – or ‘tinkering’ (Mol et al., 2010; Krzywoszynska, 2016; Giraud and Hollin, 2016) is re-cast by Mol et al. (2010: 13) as ‘attentive experimentation’ – attentive in that it is not random but builds on an openness to, and engagement with, ways of being that might not have been anticipated. In this section, I explore some aspects of this experimentation, focusing on farmers’ attempts to establish, and respond to, insect ‘preferences’.

That farmers might experiment with different aspects of their farming systems should not be surprising, especially from a rational perspective of trying to maximise the efficiency of production. The lack of established standardised approaches, and of easily obtainable ‘expert’ advice, also increase the need for experimentation, while concurrently complicating any assessment of its success:

> through the trial and error process you have either continual improvements or setbacks. So you have to measure yourself against yourself really because there’s no other standard. That’s just kind of how it works. (Mike, mealworm farmer)

Some of the trial-and-error related specifically to more ostensibly anthropocentric concerns – around ‘bringing the costs down’ (Jim, cricket farmer), for instance. In other cases, the farmers’ approaches could be interpreted as finding ways of responding to insects. In learning to respond, most of the participants referred to the animals’ ‘preferences’ – often expressed in relation to what crickets and mealworms ‘like’, and even what makes them ‘happy.’ This might appear surprising in the context of the earlier discussion around insect sentience, and caution should certainly be taken in interpreting the terms too literally. In some instances, being ‘happy’ could be viewed as shorthand for remaining alive and displaying no obvious signs of stress or disease. As Gregory (cricket farmer) put it:

> I just want to keep them happy. They seem happy to me if they’ve got water and they’ve got food and they’ve got access to the opposite sex. They seem to have a shortened but pretty happy life as far as I’m concerned.

Here, happiness is not so much an emotional state as ‘getting by’, continuing to survive in the circumstances into which they have been introduced – and Gregory’s explanation is very close to more established codifications of farm animal welfare.

A contrasting view was put forward by Jim (cricket farmer), who cautioned against ‘just doing things because you *think* that that’s what the cricket would like’. For him, it was important not to make changes to farming methods on a hunch but rather to respond directly to cricket behaviour. This form

of experimentation was important as 'there's…so little research' into the best ways of rearing crickets; 'it's probably safer just to treat the cricket as its own sort of litmus test', working out 'whatever conditions they're thriving in terms of their growth rate and not having cannibalism'. This appears quite an instrumental perspective, one which is quantified relatively easily. However, as Gregory and Jim noted, visual inspection of cricket tanks can be misleading:

> hens or chickens will be unhappy and they'll suffer, but they won't start eating each other, whereas crickets will, so if they're too tightly packed in they're going to solve that problem for themselves. So to a certain extent it manages itself and you can't really keep them too unhappy, because they just deal with it. (Gregory, cricket farmer)

> If you've done something wrong you'll see it because you'll have dead crickets at the bottom of the enclosure [but] they will probably have been eaten by the other crickets before you'd even realised. (Jim, cricket farmer)

Again, understanding the animals at even the most basic levels of whether or not they are alive can be challenging. Jim, nonetheless, spoke of his hope that he could 'get to know [the crickets] better,' feeling that he did not at that time 'understand fully the[ir] needs and wants'.

Others, through their practices of experimentation, were beginning to feel that they had some sense of their insects' preferences. Tony (mealworm farmer), despite his argument that insects (and mealworms specifically) are not sentient, discussed the impact of their substrate and feed:

> Stick them in the wheat bran and they're happy. We do also put slices of apple in there. It's mostly as a moisture source…but they seem to like the apple… if the humidity's right you don't need the apple, and the humidity is right because it's regulated, but I put the apple in there anyway because they like it**.**

Asked if he has tried anything else, he responded, 'I've tried every fruit you can think of…apple's their favourite and that's what they get.' The typical rationale for including apple in a mealworm tank is to provide the appropriate level of moisture; Tony, in contrast, was effectively giving his mealworms what he perceived to be a treat – something they liked rather than needed. Other farmers had also experimented with different feed. Siobhan (cricket farmer), for instance, had tried a range of diets for her crickets and found:

> dark leaves they really like... They don't like tomatoes and things like peppers... So I've avoided that, so things like aubergines, potatoes. Potatoes they're not particularly interested in. Yeah, so it's more green and leafy is their favourite and broccoli.

In these instances, the insects were provided with what farmers perceived they *wanted*, rather than what farmers thought would produce 'good' insects for human consumption, or what would lead to healthy insects. Despite these various attempts to work out what the insects 'like' or what makes them happy, Jim (cricket farmer) suggested a more pragmatic approach:

> what is best for you as the farmer is in many cases the same as what's best for the cricket. So if you're not doing it right for the cricket then, or the mealworm or whatever you're producing, then they will suffer and your output will suffer.

In other words, if good yields were being achieved, and mortality reduced, it could be assumed that the crickets' needs were being met. Gregory (cricket farmer) also expressed a similarly instrumental

perspective through his argument that it is difficult to maintain unhappiness in insects, not only because of ambiguity around their emotional development but also through their propensity to eat each other if they become too crowded.

There were tensions between these perspectives, however. Jim (cricket farmer), for instance, spoke of how increasing the temperature in his farm to 35 degrees Centigrade would enable his crickets to 'grow faster, mature faster,' which could be beneficial for his farm's efficiency, but commented that this could introduce 'heat stress related problems', potentially raising mortality rates, while also consuming more electricity for the heating of his barn. Geoff (cricket and mealworm farmer) similarly aimed to keep his barn at a temperature 'suboptimal for crickets but optimal for humans', as he found it hard to work in the temperatures he felt would be ideal for his insects. In his warm barn, he said, crickets 'are pinging everywhere' and 'you really need to have a room temperature where you can calm them down a bit,' though equally 'they do love it warm'. Similar tensions appeared in relation to their feed, where what is considered a 'good' insect for human consumption might differ from a high-welfare insect. In Geoff's case, he did not want to feed them:

> …anything that's going to be laid down as fat unnecessarily… I wanted to get them on a high protein diet that was a little bit lacking in carbohydrate and naturally in oils, so that it might push them to slightly higher protein. Even if it just means that they're not laying down as much fat. But the trouble is you see you're trying to create as healthy an insect as possible, and healthy insects run to fat.

This was one of many instances where Geoff found that the actions of insects did not neatly conform to his attempts to manipulate them, where trying to produce an end-product that would be desirable to consumers because of its nutritional composition diverged from the insects' own food preferences. Such experiences drove him to further tinker with his approach.

In this section, I have shown some of the ways in which farmers learned to respond to their insects. The motives for, and outcomes of, such attentiveness varied considerably. For some farmers, learning to read their insects helped, as they saw it, provide the animals with better lives. Moving beyond instrumental approaches, they attempted a more empathetic (cf Donald, 2019) form of engagement, focusing on desires alongside needs. In some cases, any potential improvement in the lives of the insects was incidental, with the focus being on farming efficiency and so forth. In other cases, the attempt to provide them with better lives was unexpected, as the farmers had previously dismissed their sentience or moral significance. This did not necessarily result in rationales for different modes of care to 'collapse into collision' (Law, 2010: 69); rather it acted as a continuing incentive or provocation for them to continually reassess their approaches to farming and the nature of their relationships to the insects.

**Conclusions**

This paper has expanded the engagement of social sciences, animal studies, and animal geography in particular, with the emerging entomophagy sector, shifting the focus from the consumption of insects and the institutional arrangements that surround the sector. There are undoubted similarities between insect farming and other forms of livestock production – most notably producing animals to be consumed by humans and navigating an awkward relationship between care and killing. The paper

has also emphasised some of the divergences, where farmers operate largely outside formal codes or legislation around how their mini-livestock should be treated – or 'cared' for. In these conclusions, I briefly outline three key areas of contribution made by the paper, building especially on those divergences, and suggest potential routes for further research.

First, the paper has expanded nature-society scholarship's engagement with the emerging insect-as-food sector. For instance, despite geography's long-standing interest in agricultural practices (Bear and Holloway, 2015), and the changing agro-food system more broadly (Winter, 2004), it has been slow to examine practices associated with the alternative protein movement, with research on edible insects focusing on their governance and on attitudes to consumption. Engaging with production practices and understandings of farmers will be increasingly important as the industry develops, as it is likely that consumers will express interest in the provenance of these novel foods in a similar way to so many other foods. Indeed, the oft-discussed 'yuck factor' (Belluco et al., 2017: 804) associated with edible insects may make consumers even more concerned about their origins. Further, their positioning as an animal-based food that may be acceptable to meat-eaters and vegetarians alike (House, 2019c) is likely to raise questions over production practices and claims around welfare (e.g. Gildea, 2019). As noted earlier, edible insect farming is in its infancy in the UK, but it is considerably more established in other countries, such as the Netherlands, France, Thailand and Canada, where farming often takes place at greater scales. Future research would usefully develop the themes raised here, examining the impact of different scales and spaces of farming, and associated technologies, on the types of human-insect relation that emerge. For instance, a French mealworm farm (Ynsect), widely promoted as becoming the 'world's biggest insect farm' (Frangoul, 2019) makes significant use of automation technologies along with sensors that 'collect data to control such factors as humidity and temperature to optimize the environment for healthy growth' (Ynsect, 2020). While that farm focuses on production for aquaculture and pet feed, similar scaling and technologization could reasonably be expected in the human food sector. As has been seen in other sectors (see Holloway et al., 2014 on automation and data-capturing technologies in dairy farming), such technologies can affect not only how a 'good' or 'normal' animal might be defined (e.g. in relation to bodily characteristics, nutritional profiles or fecundity) but also perceptions of farming skills, as well as affecting the nature and spatialities of farmer-animal relations. Indeed, Ynsect states an objective of ensuring 'homogeneity by life stage' (Ynsect, 2020); targets, and the nature of insects themselves, appear pre-defined in their publicly-available information, implying an approach of 'caring for' as opposed to 'caring about' them (Schrader, 2015). Future research would usefully explore the place of, and possibilities for, a renewed focus on attentiveness in such facilities. What role does it play in determining how best to produce (even care for) insects? How do technologies affect the nature and role of attentiveness?

Second, the paper has developed the scope of social science – and especially geographical –studies of insects more broadly. While these creatures, as noted in the introduction, have attracted increasing scholarly attention, they remain somewhat under-represented in the increasingly expansive bestiary of animal studies, with focus tending to rest on warm-blooded mammals to the detriment of those ostensibly more 'alien' in appearance (Bear and Eden, 2011; Ginn, 2014). Here, I have presented examples of individuals who aim to foster insect life – albeit with the ultimate purpose of death – in a variety of spaces, ranging from garden sheds to large barns. They are not alone; insects are farmed for multiple purposes such as medical research and as fishing bait, in settings ranging from highly controlled lab environments to fishing tackle shops and the back rooms of houses. They are also set

against each other; ladybirds, for instance, released in greenhouses to attack plant-harming aphids. Most social science research on insects to date has focused on their eradication but insect production is common. How are they treated in these different settings and in relation to these different purposes? How are they controlled? What are the domestic politics that surround insects-in-the-home? Further, as this paragraph illustrates, it is all-too-easy to refer to 'human-insect' relations, yet these are highly variable, as are the creatures (both human and non) within that phrase (see also Kellert, 1993). Future work would further engage with the species differences subsumed within the category 'insect'.

Finally, the paper has contributed to debates around the nature and practice of care involving more-than-human relations. All the farmers who participated in this study spoke of practices that could be described as 'attentive'; they experimented, or 'tinkered' (Mol et al., 2010) partly in response to the actions and responses of the insects in their farms. In some instances, attentive experimentation was a clear driver for the 'ethos of care' (Puig de La Bellacasa, 2017: 18) that developed; particularly where farmers felt uncertain about the needs of insects, the 'relations of ethicality' (Puig de La Bellacasa, 2017: 218) that emerged were rooted in observing insects and their responses to farming practices. However, to view attentiveness as the sole catalyst for 'more-than-human ethics' (Krzywoszynska, 2019: 662), even in those situations, would be overly simplistic. Learning to care went beyond the immediacy of (often attentive) farming encounters to encompass 'multiple temporal and spatial elements' (Johnson, 2015: 310), including scientific discourses, practitioner blogs and videos (often relating to different scales of farming in diverse locations), and emerging 'best practice' guidance from NGOs and governments. Awareness of, and engagement with, such elements sometimes preceded encounter with insects themselves and informed subsequent practice, particularly in relation to the widespread debate around insect sentience and experience of pain. In other cases, insect encounters drove subsequent exploration of literatures, formal guidance and so forth, resulting both in a deeper interest in insect behaviour and a questioning of other sources. Forms of attentiveness also emerged from more instrumental concerns, where learning-to-respond focused on improving the efficiency of farms, or on changing the nutritional profile of the end-product. Being attentive here may have had the inadvertent effect of producing a better life for the insects. 'Caring about' and 'caring for' are, therefore, not necessarily binary approaches; actions that could be construed as 'caring' may emerge from a disregard for any intrinsic value of the non-human life at stake. Beyond that extreme, the approaches to attentiveness that have been illustrated here were often characterised by multidirectionality, focused not only on needs and desires of insects but also of the farmers themselves. This was especially evident in the examples where farmers were explicit about balancing the health or welfare of their insects with their own comfort and convenience. Attentiveness there was about learning to live together, even though imbalanced and focused on the manipulation and subsequent death of insects. It should not be viewed, then, as a silver bullet for 'better relations' (Krzywoszynska, 2019: 672) between living beings. Even where attentive practices enable insects' needs to be 'known' (ibid.) (or inferred), the responses that follow may knowingly produce less-than-ideal conditions for them. As such, while attentiveness and associated experimentation may hold considerable potential, they may also be unstable grounding for the development and flourishing of harmonious relationships.

**References**


Adams EC. (2018) How to become a beekeeper: learning and skill in managing honeybees. *Cultural Geographies* 25: 31-47.

Akhtar Y and Isman MB. (2018) Insects as an Alternative Protein Source. In: Yada RY (ed) *Proteins in Food Processing.* Duxford: Woodhead Publishing, 263-288.

Alexander P, Brown C, Arneth A, et al. (2017) Could consumption of insects, cultured meat or imitation meat reduce global agricultural land use? *Global Food Security* 15: 22-32.

Atchison J. (2019) Between disgust and indifference: Affective and emotional relations with carp (Cyprinus carpio) in Australia. *Transactions of the Institute of British Geographers* 44: 735-748.

Bear C. (2011) Being Angelica? Exploring individual animal geographies. *Area* 43: 297-304.

Bear C. (2019) Approaching insect death: understandings and practices of the UK's edible insect farmers *Society and Animals* 27: 751-768.

Bear C and Eden S. (2011) Thinking like a fish? Engaging with nonhuman difference through recreational angling. *Environment and Planning D* 29: 336-352.

Bear C and Holloway L. (2015) Country Life: Agricultural Technologies and the Emergence of New Rural Subjectivities. *Geography Compass* 9: 303-315.

Bear C and Holloway L. (2019) Beyond resistance: geographies of divergent more-than-human conduct in robotic milking. *Geoforum* 104: 212-221.

Beisel U. (2015) Markets and Mutations: mosquito nets and the politics of disentanglement in global health. *Geoforum* 66: 146-155.

Beisel U, Kelly AH and Tousignant N. (2013) Knowing insects: Hosts, vectors and companions of science. *Science as Culture* 22: 1-15.

Belluco S, Halloran A and Ricci A. (2017) New protein sources and food legislation: the case of edible insects and EU law. *Food Security* 9: 803-814.

Biehler DD. (2009) Permeable homes: A historical political ecology of insects and pesticides in US public housing. *Geoforum* 40: 1014-1023.

Bingham N. (2006) Bees, butterflies, and bacteria: Biotechnology and the politics of nonhuman friendship. *Environment and Planning A* 38: 483-498.

Bull J. (2014) Between ticks and people: Responding to nearbys and contentments. *Emotion, Space and Society* 12: 73-84.

Buller H. (2013) Individuation, the mass and farm animals. *Theory, Culture & Society* 30: 155-175.

Convery I, Bailey C, Mort M, et al. (2005) Death in the wrong place? Emotional geographies of the UK 2001 foot and mouth disease epidemic. *Journal of Rural Studies* 21: 99-109.

Cooper JE. (2012) Insects. In: Lewbart GA (ed) *Invertebrate medicine.* Hoboken, NJ: Wiley-Blackwell, 267-283.

Davis G and Nichter M. (2015) The Lyme wars: The effects of biocommunicability, gender, and epistemic politics on health activation and Lyme science. In: Smith-Morris C (ed) *Diagnostic controversy: Cultural perspectives on competing knowledge in healthcare.* London: Routledge, 215-246.

De Goede D, Erens J, Kapsomenou E, et al. (2013) Large scale insect rearing and animal welfare. In: Röcklinsberg H and Sandin P (eds) *The ethics of consumption.* Wageningen: Wageningen Academic Publishers, 236-242.

DeFoliart GR. (1995) Edible insects as minilivestock. *Biodiversity & Conservation* 4: 306-321.

Del Casino Jr VJ. (2018) Social geography III: Bugs. *Progress in Human Geography* 42: 286-296.
Donald MM. (2019) When care is defined by science: Exploring veterinary medicine through a more-than-human geography of empathy. *Area* 51: 470-478.
Dossey AT, Tatum JT and McGill WL. (2016) Modern Insect-Based Food Industry: Current Status, Insect Processing Technology, and Recommendations Moving Forward. In: Dossey AT, Morales-Ramos J and Rojas MG (eds) *Insects as Sustainable Food Ingredients.* San Diego: Academic Press, 113-152.
Eisemann C, Jorgensen W, Merritt D, et al. (1984) Do insects feel pain?—A biological view. *Cellular and Molecular Life Sciences* 40: 164-167.
Elorinne A-L, Niva M, Vartiainen O, et al. (2019) Insect Consumption Attitudes among Vegans, Non-Vegan Vegetarians, and Omnivores. *Nutrients* 11: 292.
Evira (Finnish Food Safety Authority). (2018) *Insects as food: Evira Guide 10588/2/uk,* Helsinki: Evira.
Farm Animal Welfare Council. (2009) *Farm animal welfare in Great Britain: past, present and future,* London: Farm Animal Welfare Council.
Frangoul A. (2019) *A French firm that uses automation is going to build the 'world's biggest insect farm'*. Available at: https://www.cnbc.com/2019/02/21/french-firm-that-uses-automation-to-build-worlds-biggest-insect-farm.html.
Gates S. (2017) *Insects: an edible field guide,* London: Ebury.
Gildea W. (2019) *Eating insects mite not be the future*. Available at: https://theecologist.org/2019/jun/24/eating-insects-mite-not-be-future-says-growgreenteam.
Gilligan C. (1982) *In a Different Voice: Psychological Theory and Women's Development,* Cambridge, MA: Harvard University Press.
Ginn F. (2014) Sticky lives: slugs, detachment and more-than-human ethics in the garden. *Transactions of the Institute of British Geographers* 39: 532-544.
Ginn F, Beisel U and Barua M. (2014) Flourishing with awkward creatures: Togetherness, vulnerability, killing. *Environmental Humanities* 4: 113-123.
Giraud E and Hollin G. (2016) Care, laboratory beagles and affective utopia. *Theory, Culture & Society* 33: 27-49.
Gjerris M, Gamborg C and Röcklinsberg H. (2015) Entomophagy–why should it bug you? The ethics of insect production for food and feed. In: Dumitras DE, Jitea IM and Aerts S (eds) *Know your food: Food ethics and innovation.* Wageningen Academic Publishers, 423-432.
Gjerris M, Gamborg C and Röcklinsberg H. (2016) Ethical aspects of insect production for food and feed. *Journal of Insects as Food and Feed* 2: 101-110.
Glover D and Sexton A. (2015) *Edible Insects and the Future of Food: A Foresight Scenario Exercise on Entomophagy and Global Food Security*, IDS Evidence Report 149, Brighton: IDS
Gordon DG. (2013) *The eat-a-bug cookbook,* New York: Ten Speed Press.
Greenhough B and Roe E. (2011) Ethics, space, and somatic sensibilities: comparing relationships between scientific researchers and their human and animal experimental subjects. *Environment and Planning D: Society and Space* 29: 47-66.
Haraway DJ. (2008) *When species meet,* London: University of Minnesota Press.
Hitchings R. (2012) People can talk about their practices. *Area* 44: 61-67.
Holloway L, Bear C and Wilkinson K. (2014) Re-capturing bovine life: Robot–cow relationships, freedom and control in dairy farming. *Journal of Rural Studies* 33: 131-140.

House J. (2019a) Insects are not 'the new sushi': theories of practice and the acceptance of novel foods. *Social & Cultural Geography* 9: 1285-1306.

House J. (2019b) Modes of Eating and Phased Routinisation: Insect-Based Food Practices in the Netherlands. *Sociology* 53: 451-467

House J. (2019c) Are insects animals? The ethical position of insects in Dutch vegetarian diets. In: Linzey A and Linzey C (eds) *Ethical Vegetarianism and Veganism.* London: Routledge, 201-212.

IPIFF. (2019) *Ensuring high standards of animal welfare in insect production,* Brussels: IPIFF.

Johnson ER. (2015) Of lobsters, laboratories, and war: animal studies and the temporality of more-than-human encounters. *Environment and Planning D: Society and Space* 33: 296-313.

Jones V and Beynon S. (2020) Edible insects: applying Bakhtin's carnivalesque to understand how education practices can help transform young people's eating habits. *Children's Geographies* DOI: 10.1080/14733285.2020.1718608

Kellert SR. (1993) Values and perceptions of invertebrates. *Conservation Biology* 7: 845-855.

Krzywoszynska A. (2016) What farmers know: experiential knowledge and care in vine growing. *Sociologia Ruralis* 56: 289-310.

Krzywoszynska A. (2019) Caring for soil life in the Anthropocene: The role of attentiveness in more-than-human ethics. *Transactions of the Institute of British Geographers* 44: 661-675.

Law J. (2010) Care and killing: tensions in veterinary practice. In: Mol A, Moser I and Pols J (eds) *Care in practice: on tinkering in clinics, homes and farms.* New Brunswick: Transcript, 57-72.

Loo S and Sellbach U. (2013) Eating (with) insects: Insect gastronomies and upside-down ethics. *Parallax* 19: 12-28.

Looy H, Dunkel FV and Wood JR. (2014) How then shall we eat? Insect-eating attitudes and sustainable foodways. *Agriculture and Human Values* 31: 131-141.

Lorimer J. (2007) Nonhuman charisma. *Environment and Planning D* 25: 911-932.

Lorimer J. (2014) On auks and awkwardness. *Environmental Humanities* 4: 195-205.

Lotta F. (2019) Insects as Food: The Legal Framework. In: Sogari G, Mora C and Menozzi D (eds) *Edible Insects in the Food Sector: Methods, Current Applications and Perspectives.* Cham: Springer International Publishing, 105-118.

Maderson S and Wynne-Jones S. (2016) Beekeepers' knowledges and participation in pollinator conservation policy. *Journal of Rural Studies* 45: 88-98.

Martin A, Myers N and Viseu A. (2015) The politics of care in technoscience. *Social Studies of Science* 45: 625-641.

Martin D. (2014) *Edible: an adventure into the world of eating insects and the last great hope to save the planet,* Boston: New Harvest.

Mitchell T. (2002) *Rule of experts: Egypt, techno-politics, modernity*: Univ of California Press.

Mol A, Mosser I and Pols J. (2010) Care: putting practice into theory. In: Mol A, Mosser I and Pols J (eds) *Care in practice: on tinkering in clinics, homes and farms.* New Brunswick: Transcript, 7-25.

Moore LJ and Wilkie RM. (2019) Introduction to The Silent Majority: Invertebrates in Human-Animal Studies. *Society & Animals* 27: 653-655.

Nerbonne JF and Lentz R. (2003) Rooted in grass: Challenging patterns of knowledge exchange as a means of fostering social change in a southeast Minnesota farm community. *Agriculture and Human Values* 20: 65-78.

Pali-Schöll I, Binder R, Moens Y, et al. (2019) Edible insects–defining knowledge gaps in biological and ethical considerations of entomophagy. *Critical reviews in food science and nutrition* 59: 2760-2771.

Phillips C. (2014) Following beekeeping: more-than-human practice in agrifood. *Journal of Rural Studies* 36: 149-159.

Phillips C. (2020) The force of Varroa: Anticipatory experiences in beekeeping biosecurity. *Journal of Rural Studies* 76: 58-66.

Pitt H. (2018) Questioning care cultivated through connecting with more-than-human communities. *Social & Cultural Geography* 19: 253-274.

Puig de La Bellacasa M. (2017) *Matters of care: Speculative ethics in more than human worlds,* Minneapolis: University of Minnesota Press.

Riley M. (2011) 'Letting them go'–Agricultural retirement and human–livestock relations. *Geoforum* 42: 16-27.

Röcklinsberg H, Gamborg C and Gjerris M. (2017) Ethical issues in insect production. In: Van Huis A and Tomberlin JK (eds) *Insects as food and feed: from production to consumption.* Wageningen: Wageningen Academic Publishers, 364-379.

Rumpold BA and Schlüter OK. (2013) Potential and challenges of insects as an innovative source for food and feed production. *Innovative Food Science & Emerging Technologies* 17: 1-11.

Schrader A. (2015) Abyssal intimacies and temporalities of care: How (not) to care about deformed leaf bugs in the aftermath of Chernobyl. *Social Studies of Science* 45: 665-690.

Sexton AE, Garnett T and Lorimer J. (2019) Framing the future of food: The contested promises of alternative proteins. *Environment and Planning E: Nature and Space* 2: 47-72.

Shaw IG, Jones III JP and Butterworth MK. (2013) The mosquito's umwelt, or one monster's standpoint ontology. *Geoforum* 48: 260-267.

Shaw IGR, Robbins PF and Jones III JP. (2010) A bug's life and the spatial ontologies of mosquito management. *Annals of the Association of American Geographers* 100: 373-392.

Singer P. (1975) *Animal liberation: a new ethics for the treatment of animals,* New York: Harper Collins.

Singer P. (1995) *Animal Liberation,* London: Pimlico.

Sligo F and Massey C. (2007) Risk, trust and knowledge networks in farmers' learning. *Journal of Rural Studies* 23: 170-182.

Sogari G, Menozzi D and Mora C. (2017) Exploring young foodies' knowledge and attitude regarding entomophagy: A qualitative study in Italy. *International Journal of Gastronomy and Food Science* 7: 16-19.

Steinfeld H, Gerber P, Wassenaar T, et al. (2006) *Livestock's long shadow: environmental issues and options*, Rome: UNFAO.

Thailand National Bureau of Agricultural Commodity and Food Standards. (2018) *Good agricultural practices for cricket farming*. Available at: http://www.bugsolutely.com/wp-content/uploads/2018/02/GAP-Guidelines-bugsolutely.pdf.

van Huis A and Tomberlin JK. (2017a) Future prospects of insects as food and feed. In: Van Huis A and Tomberlin JK (eds) *Insects as food and feed: from production to consumption.* Wageningen: Wageningen Academic Publishers, 431-445.

van Huis A and Tomberlin JK. (2017b) *Insects as food and feed: from production to consumption*. Wageningen: Wageningen Academic Publishers.

van Huis A, van Itterbeeck J, Klunder H, et al. (2013) *Edible insects: future prospects for food and feed security,* Rome: UNFAO.

Verneau F, La Barbera F, Kolle S, et al. (2016) The effect of communication and implicit associations on consuming insects: An experiment in Denmark and Italy. *Appetite* 106: 30-36.

Wadiwel DJ. (2016) Do fish resist? *Cultural Studies Review* 22: 196-242.

Wilkie R. (2005) Sentient commodities and productive paradoxes: the ambiguous nature of human-livestock relations in Northeast Scotland. *Journal of Rural Studies* 21: 213-230.

Wilkie R. (2010) *Livestock/deadstock: Working with farm animals from birth to slaughter,* Philadelphia: Temple University Press.

Wilkie R. (2018) 'Minilivestock'farming: Who is farming edible insects in Europe and North America? *Journal of Sociology* 54: 520-537.

Winter M. (2004) Geographies of food: agro-food geographies - farming, food and politics. *Progress in Human Geography* 28: 664-670.

Woven Network. (2019) *Woven Network CIC*. Available at: woven-network.co.uk.

Ynsect. (2020) *Ynsect*. Available at: http://www.ynsect.com/en/.