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Insects as food in the Netherlands: Production networks and the geographies of edibility

Jonas House*

Department of Geography, University of Sheffield, Winter Street, Sheffield S10 2TN, UK
Sociology of Consumption and Households Group, Wageningen University, De Leeuwenborch (Building 201), 6706 KN Wageningen, Netherlands

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ABSTRACT

A nascent subfield within food geographies research investigates edibility, or how things 'become food'. In the context of efforts to create more sustainable foodways in Europe and the US (the 'West'), this question is pertinent. One proposed contribution to these efforts is the Western adoption of insects as human food. Related scientific and commercial activity in the Netherlands has been prominent in this area. This paper draws on research with people involved in the development of a Dutch edible insect network, and with the production, supply and consumption of a range of insect-based foods. It explains how this network arose out of the interaction between heterogeneous, mutually-influential actors, and acts to delimit the 'horizon of possibility' for insect-based foods. The paper then presents a case study of a range of insect-based foods, arguing that the food products themselves, and their edibility, can similarly be understood as a network effect. Agency in both the design of foods and the construction of edibility is conceptualised as distributed, multiple and contingent. The paper also discusses the disjuncture between edibility (in principle) and routine consumption (in practice): new foods may be successfully positioned as 'edible', but this does not mean that people will eat them. Implications for debates on the conceptualization of edibility are discussed.

1. Introduction

How do "things become food" (Roe, 2006a, p. 105)? Within the rich geographic literature around food, a nascent subfield has emerged which engages with this question in particular, investigating and elucidating the constitutive geographies of 'things becoming food' (e.g. Bennett, 2007; House, 2018a; Probyn, 2011; Roe, 2006b, 2006a; Sexton, 2016, 2018; Waitt, 2014). In this literature, which I term the *geographies of edibility*, the principal analytic focus is the concept of the in/edible: the "cultural categories of what can and cannot be eaten" (Long, 2004, p. 32).

The positioning of particular foods as in/edible is a relational process, which in broad terms is negotiated through mutually implicated practices of production and consumption. However, it involves a heterogeneous range of elements including – inter alia – discourse, technology, sites and modes of food production, provisioning and consumption, legislation, interpersonal relations, the taste and materiality of food, and its visceral, non-discursive or immaterial attributes (e.g. Evans and Miele, 2012; House, 2018b; Krzywoszynska, 2015; Longhurst et al., 2008; Probyn, 2011; Roe, 2006b, 2006a; Sexton, 2016, 2018; Smith, 2012; Vialles, 1994; Waitt, 2014; Waitt and Phillips, 2016). These points are reflected in accounts of the wax and wane of food which do not deal explicitly with the notion of edibility, such as in Houlihan's (2003) account of tripe in northern England. Houlihan demonstrates how the edibility of tripe was to a large extent temporally bound, and connected to contemporary industrial labour relations, food supply infrastructure, and family eating practices.

Historical examples from Europe and the US (the 'West') reflect the situated and constructed nature of changing edibility, and that it is liable to change over time (e.g. Mennell, 1996). Things may 'become food' for relatively long periods, such as sushi (House, 2018b), avocado (Charles, 2002), or sugar (Mintz, 1985), or for much shorter ones, such as organ meat (Wansink, 2002), tulip bulbs (Vorstenbosch et al., 2017), or dogs (van Es, 2000).

In the context of current debates around the sustainability of food, and efforts to make improvements in that direction, understanding how edibility may be deliberately constructed is a salient concern. Research in this area is still relatively limited, but has explored efforts to construct the edibility of new 'alternative proteins' including plant-based products (Sexton, 2016, 2018), genetically modified food (Roe, 2006b), and insects (House, 2018a; Sexton, 2018; Stock et al., 2016; Yates-Doerr, 2015). Prominent focuses within this work are the manifold

* Address: Sociology of Consumption and Households Group, Wageningen University, De Leeuwenborch (Building 201), 6706 KN Wageningen, Netherlands.
E-mail address: jonas.house@wur.nl.

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strategies employed to construct edibility and the ways in which these may not, despite the best efforts of those involved, be successful.

The present paper seeks to extend and enrich these debates. It explains and analyses one such proposed solution to the unsustainability of current Western meat consumption: efforts in the Netherlands to encourage the use of insects as human food, and the production of insect-based foods in the same region. The context in which such foods were created is explained in terms of a network of actors, both human and more-than-human (Latour, 1996; Whatmore, 2006), which has shaped the 'horizon of possibility' for insect-based food – what insect-based foods *are*, or *can be*. This is argued to have implications for the production and consumption of insect-based foods, both in the Netherlands and beyond. The paper examines a case study of a range of insect-based foods, suggesting that the production of these foods, and of their edibility, can also be understood as resulting from interactions within a network of heterogeneous actors.

The paper has two central arguments. The first is that edibility is a *network effect* (Law, 1992). To conceptualise edibility in this way directs attention to the way in which its constituent elements – the kind of things listed in the discussion of literature above – are related to each other, are interdependent, and are mutually constitutive. That is to say, it is not that edibility simply represents the outcome of the successful arrangement of heterogeneous entities into a particular constellation (although in one sense, it certainly does). Rather, through their involvement in the construction of edibility, these entities affect and shape each other. This argument also entails a move away from seeing the construction of edibility as chiefly the responsibility of entrepreneurial strategy (e.g. Sexton, 2018; cf. House, 2018b), and towards a view of edibility as *co-produced* by a diverse range of actors. Edibility in this account is situated and contingent: it does not entail general acceptance of insects, although this may be the aim.

The second main argument is that edibility and consumption are *not the same thing*: it is possible for a food to be positioned as 'edible' without anyone actually eating it. The analysis illustrates a fundamental tension, in which socio-material arrangements and network connections necessary for the construction of edibility may in fact work against the routine consumption of the foods in question. Connections between edibility and routinisation are discussed towards the end of the paper.

2. Insects as food

The idea that insects should be adopted as a human food source in the West is not a new one (e.g. Holt, 1885; DeFoliart, 1992; Meyer-Rochow, 1975), but its recent prominence can be attributed to a report published in 2013 by the Food and Agriculture Organisation of the United Nations (FAO), entitled *Edible Insects: Future Prospects for Food and Feed Security* (van Huis et al., 2013). Synthesising global knowledge around insect consumption ('entomophagy'), the report argued for Western use of insects as a new, sustainable protein source in both human food and animal feed. The principal grounds for this were environmental and nutritional: in both senses, insects compare favourably with conventional meat animals. The global prevalence of entomophagy was cited as a strong indicator of insects' appropriateness as human food.

The report was downloaded 2.3 million times in 24 h. It sparked a wave of media interest (Smith and Pryor, 2014a, 2014b), academic research, and – perhaps unsurprisingly – significant commercial interest. A plethora of start-ups and small businesses have since appeared in Europe and the US, marketing whole insects or foods containing insects as a processed ingredient (for examples, see Engström, 2018).

However, the wave of new commercial endeavours following the report were established in the context of a pre-existing network of research, policy and business activity in the area. While defining an absolute origin of this network is likely to be rather difficult (cf. Latour, 1996) – one could, for example, identify the earlier pieces advocating Western consumption of insects as foundational – it evidently began to assume a more formalised character in around 2006.

I term this network the 'Dutch edible insect network'. Although its actors were – and are – primarily based in the Netherlands, it also involves Belgian universities, businesses and governmental agencies, and the FAO, a global NGO headquartered in Rome. It is also shaped by academic and less formalised knowledges about insects from all over the world. The decision to term this network 'Dutch' is thus a heuristic one. In addition to signifying the territorial location of primary actors, the designation follows a popular understanding of the Netherlands as playing a key role in the area (e.g. Anderson, 2015; Jansson and Berggren, 2015), self-identification of the Netherlands as a forerunner and advocate for sustainable protein sources including insects (e.g. Green Deal, 2018; Willemsen, 2015), and the substantial financial and institutional support provided by the Dutch government (addressed below). Although I will also explain, for example, how developments in Belgium act (and are acted upon) within the network, I continue to use the designation 'Dutch' for the sake of clarity. In what follows I also employ the term 'European edible insect network', to indicate the broader context in which the Dutch network is situated, and is a constituent and influential part.

This following analysis is divided into two sections. In the first section, I explain the development of the Dutch edible insect network. I conceptualise its development as the weaving together of heterogeneous elements in alignment towards a common project, the establishment of insect-based food in the Netherlands and across Europe.[1] The process by which these heterogeneous actors become recruited or 'enrolled' to the project can be understood one of *translation*, in which their diverse interests are translated in accordance with a unifying idea (Latour, 1996).

In the second analytic section, I apply these insights to a case study of a specific range of insect-based food in the Netherlands and Belgium. I explain how the Dutch edible insect network has shaped the horizon of possibility for these foods, and suggest the conceptual account of the network itself can be fruitfully extended to an analysis of the foods' development. This entails a view of food production as the achievement of a "hybrid collective" (Callon, 2004, p. 4) rather than an individual entrepreneur (Drakopoulou Dodd and Anderson, 2007), and of the development of foods (as with other innovations) as a distributed, negotiated process, rather than as involving the linear diffusion of a stable artefact (e.g. Akrich, 1992; Håkansson and Ford, 2002). Drawing on research with consumers of these foods, I analyse how the foods were successfully positioned as edible, and how their edibility was shaped by the complex and contingent processes of production, supply, and consumption. I then discuss how the achievement of edibility does not necessarily entail consumption of foods so positioned, drawing out implications for the edible insect sector and future research on the geographies of food.

3. Methodology

As part of a larger project investigating public acceptance of insects as food in the Netherlands,[2] this paper focuses on evidence from semi-structured interviews with six individuals involved in some way with the development of an edible insect sector in the Netherlands. Interviews were conducted during 2016 and 2017, and participants included a scientist at the Netherlands' Wageningen University and Research Centre; a scientist at a Dutch insect farm; the owner of a Dutch insect farm; a civil servant working for the Dutch food safety authority; a product development manager at Damhert, a Belgian manufacturer of insect-based foods; and a category manager at Jumbo, a Dutch

[1] The same argument applies to the related but distinct goal of facilitating and creating insect-based animal feed, discussion of which is beyond the scope of the present paper.

[2] Other aspects of the project are discussed elsewhere (House, 2016, 2018a, in press).

supermarket chain who sold those insect-based foods.

Participants were recruited purposively via email or existing contacts. Recruitment was principally oriented to two main questions: the genealogy of the insect-based products discussed below, and the more general question of why certain species are used for human food applications and not others.

Not all attempts to organise interviews were successful. For example, some individuals involved with insect breeding did not respond to interview requests, and some requests to be put in touch with actors in the supply chain for insect-based foods were refused. However, development of the paper's argument proceeded iteratively alongside the identification and interviewing of participants, with each informing the other. Thus, while the participants are not fully representative of the Dutch edible insect network, I would suggest their accounts are sufficient to address the central questions which motivated the research. As part of the iterative identification of relevant participants, a North American insect-based food producer was also interviewed: the objective was to investigate the determinants of species choice in that context.

The paper also draws on semi-structured interviews with 40 consumers of a range of insect-based convenience foods in the Netherlands, all of whom had voluntarily purchased the foods and were recruited via in-packet flyers. Interviews typically lasted for 45–60 min, and were conducted in a location of participants' choosing (usually cafés). These interviews sought to understand how the insect-based foods were (or were not) integrating into people's diets. Participants were questioned about when, where and why they had bought and eaten the products, and whether/why they had (not) done so again. Interviews also involved broader discussion about participants' diets. This covered general practical aspects of shopping, cooking and eating, consumption of meat alternatives, and consumption of culturally unusual foods.

All participants provided informed consent, and interviews were recorded and transcribed. Coding and analysis of interview material was conducted using NVivo 11 software. All participants were anonymised. The research project under which interviews were conducted was granted ethical approval from the author's university.

4. The Dutch edible insect network

Starting in around 2006, circuits of exchange between academia, policy and business in the Netherlands began to formalise into an edible insect network, with the shared goal of encouraging and facilitating insect consumption in the Netherlands and elsewhere in the West. The constitution of this network, and the ongoing mutual influence of its component parts, has led to a small number of species becoming relatively fixed as 'the' food insect species. This, I will suggest, has significant implications for the extent to which they are consumed. I explain the academic, governmental and commercial components of the Dutch edible insect network, before turning to a discussion of the legal and normative stabilisation of key insect species.

4.1. Academic interest

The Netherlands' Wageningen University and Research Centre (WUR) is a long-standing hub of research and advocacy relating to entomophagy. Academics at WUR – particularly the entomologists Arnold van Huis and Marcel Dicke – became increasingly interested in the subject throughout the 1990s and 2000s (van Huis et al., 2014). In 2006, Wageningen hosted the six-day City of Insects event: its exhibitions and activities included opportunities to learn about, and try, entomophagy (WUR, 2013). In 2009, Marcel Dicke gave a talk entitled (after Holt, 1885) 'Why not eat insects?' at TED Amsterdam. The following year he repeated the presentation at TEDGlobal, attracting significant global media attention (e.g. GrrlScientist, 2010), and by 2011 Dicke and van Huis were writing on the subject in the US popular press (Dicke and Van Huis, 2011). Such efforts intensified media interest in entomophagy within the Netherlands (van Huis et al., 2014), furnishing a discursive context in which related commerce and research developed. They also helped to bring the topic to global attention (van Huis et al., 2014).

Broader academic interest in the subject was also burgeoning during this period (e.g. Paoletti, 2005; Verkerk et al., 2007), and in 2008 a PhD project on insects as food and feed began at WUR (Oonincx, 2015). Since 2003 the FAO had also been engaged with the topic, holding a workshop focused on entomophagy in 2008 (Durst et al., 2010). Exchange between WUR and FAO paved the way for the landmark report on the subject discussed above (van Huis et al., 2013).[3]

At WUR in around 2006, plans were conceived for a large cross-departmental research project on entomophagy, involving collaboration with commercial insect breeders. The Dutch government offered their "verbal support" (WUR, 2014, n.p.) and reportedly were also involved with the development of the proposal.[4] The project was aligned with contemporary developments within the government itself.

4.2. Policy interest

In July 2009, the Dutch government laid out a strategic plan for the Netherlands to become a world-leader in sustainable food production and consumption within fifteen years (Ministerie van Landbouw, Natuur en Voedselkwaliteit, 2009), and announced €6m of funding for research and knowledge exchange in the area (Rijksoverheid, 2010a). In 2009–2010, a number of related government initiatives were launched. Some were targeted at consumers (Rijksoverheid, 2010a), while many focused on the sustainability of the production and supply of food (Rijksoverheid, 2009b, 2009c). The development of sustainable protein sources was a particular focus (Rijksoverheid, 2010a, 2010b).

It was in this context that the WUR project – 'Sustainable production of insect proteins for human consumption' (SUPRO2) – was awarded in 2010, with funding of €1m. Project research investigated the nutritional and safety aspects of insects as food (Klunder et al., 2012; van Broekhoven, 2015; Yi, 2015), as well as their sustainability (Oonincx and de Boer, 2012) and consumer acceptance (Tan, 2017). Project stakeholders, including researchers, business and government representatives, met around every six months. From the outset, the project had substantial involvement from the burgeoning Dutch edible insect sector.[5]

4.3. Commercial interest

In the Netherlands in 2006–2007, Ruud Meertens, a breeder of grasshoppers for animal feed, came together with 'innovator' Marian Peters and poulterer Jan Ruig, and the three of them decided to commercialise insects for human food (van Huis et al., 2014). Mealworm producer Van de Ven was known personally to Meertens due to their geographical proximity, and expressed interest in joining.[6] Ruig suggested that a minimum of three insect species would be necessary for the commercialisation efforts (van Huis et al., 2014); consequently, the insect breeding company Kreca was contacted and agreed to produce the lesser mealworm for human consumption.[7] Together these parties formed VENIK, the Verenigde Nederlandse Insectenkwekers (Dutch Insect Breeders' Association) (van Huis et al., 2014).

WUR's Arnold van Huis was involved in some VENIK meetings from the outset, having become acquainted with them following Kreca's involvement in the City of Insects event. A senior project member from WUR reports that SUPRO2 was "also on behalf of the insect industry," referring to VENIK, who were present at, and chaired, all project

[3] Interview, WUR scientist.
[4] Interview, WUR scientist.
[5] Interview, WUR scientist.
[6] WUR scientist, personal communication, 2nd Feb 2017.
[7] WUR scientist, personal communication, 2nd Feb 2017.

stakeholder meetings.[8] Thus, the science and business sides of the Dutch edible insect network developed alongside each other, as part of a circuit of exchange. SUPRO2 was planned to begin with a broad species focus, to be narrowed as the project progressed. The species ultimately focused on corresponded with those that VENIK had been producing for human food (see the project literature cited above).[9] This emphasis has been reflected in ongoing academic research in the area (e.g. Azzollini et al., 2016; Hartmann and Siegrist, 2017; Hustinx-Broekman, 2017; Miglietta et al., 2015; Rumpold et al., 2014; Siemianowska et al., 2013; Stoops et al., 2016; Wynants et al., 2017). It may, I would suggest, be acting to normatively stabilise these species vis-à-vis human food applications.

4.4. Species selection

The early activities of VENIK's founding members established the first three insect species to be reared in the Netherlands for human consumption: the migratory locust (*Locusta migratoria*) – usually referred to, one assumes for PR purposes, by the taxonomically proximate designation of 'grasshopper' – the mealworm (*Tenebrio molitor*), and the lesser mealworm (*Alphitobius diaperinus),* which are both species of beetle larvae. From around 2007, VENIK began selling these species (whole and freeze-dried) to the Dutch public via Ruig's company (Kreca, 2011; van Huis et al., 2014). It was not until later that these began to be incorporated into different product types and sold elsewhere.

The locust and mealworm were not so much 'selected' as appropriate species for human food production as directed by existing socio-material arrangements. The locust was the only species that its breeder produced (Meertens Insectenkwekerij, 2010), and the mealworm was the species which its breeder specialised in (Van de Ven, 2009). Both companies had a history of producing its respective species for animal feed (i.e. for zoo animals and 'exotic pets' such as reptiles, birds and spiders).[10] As a result, the requisite technology and expertise had been developed around particular species.

Kreca, who provided the lesser mealworm, produced fourteen species (van Huis et al., 2014), and thus had more wide-ranging production capabilities. However, the lesser mealworm was chosen for its high protein content and for practical reasons, including ease of rearing, relative fecundity, reliable reproductive rate, and short lifecycle.[11] The selection of this species was thus primarily technical and instrumental rather than culinary, a point which has significant implications for its consumption.

The physiology, materiality and behaviour of the lesser mealworm has facilitated its 'enrolment' into human food production practices (Callon, 1984). This enrolment was not solely the responsibility of human actors, but was shaped by the diets of the reptiles and birds for which the insects were initially produced (cf. Callon, 2004). The selection of this insect was not directly determined, but was shaped by the pre-existing socio-material entanglements that provided the context of its choice. Indeed, these points apply equally to the grasshopper and the mealworm, whose selection was shaped by the 'heaviness' of the norms, expertise and technology within the insect rearing networks in which they were respectively situated (Håkansson and Ford, 2002).

These three species were the only insects reared for human consumption in the Netherlands until 2013, when a new company, DeliBugs, began producing the house cricket (*Acheta domesticus*) for human food.[12] Kreca, which had been rearing the insects since the 1980s (van Huis et al., 2014), began producing a food-grade version in around 2015.[13] The cricket is more difficult and thus more expensive to rear than mealworms and lesser mealworms, but has other reported benefits, such as superior taste (e.g. Hofsink, 2015) and versatility. Breeders can manipulate the taste profile and protein content of crickets by altering their substrate, which is made easier by the species' omnivorousness.[14]

A crucial aspect of the four main species' selection is their *affordances* for food production (Gibson, 1986; see also Bennett, 2007; Roe, 2006a). Mealworms and lesser mealworms remain within their substrate during rearing, and are thus easier for humans to manage and to enrol into food production networks.[15] "Behavior", as Gibson (1986, p. 135) argues, "affords behavior": in this context, the erratic and energetic behaviour of certain species – particularly grasshoppers, but also crickets – makes them more difficult to manage during rearing. This has a direct impact upon the amount of human labour necessary to rear and slaughter them, which in turn impacts upon the cost of their production, their retail price, and subsequently their viability as a food ingredient.[16] Mealworms and lesser mealworms afford easier integration into food applications due to their physiology and behaviour. Crickets are more difficult to rear but assimilate the flavour properties of their feed, a balancing of physiological and behavioural characteristics that provides a crucial affordance for the human food producer.[17]

In a manner of speaking then, certain species 'resist' enrolment into the agri-food network (cf. Latour, 2000), while others collaborate in their enrolment. The intersecting *Umwelten* of different organisms – the aggregates of their respective affordances – "determine their possible interactions within an ecological complex" (Lorimer, 2007, p. 916; von Uexküll, 1957). In this case, that complex involves humans and technological artefacts, and pertains to the broader project of the construction of edibility. The extent to which particular species may 'become food' is influenced by the affordances of those species. Crucially, however, the affordances that ease the production of certain species are not necessarily still affordances in the rather different context of their consumption.

These four species – which I term the 'Big Four' – now represent the 'industry standard' food insect species in the Netherlands, and indeed across Europe. Their central position, I would argue, derives chiefly from the developments outlined above. However, their positioning within legislation and regulatory discourse has also been important in shaping the horizon of possibility for insect-based food, both within and beyond the Netherlands.

4.5. Legislation and regulatory discourse

A substantial influence on edible insects in Europe has been their position within European law. Until 2015, insects for human consumption fell into a legal grey area, in which no specific EU regulation dealt explicitly with them. Despite the lack of explicit regulation for food insects in the EU, general legislation such as the General Food Law (regulation EC No 178/2002) still applied, as did various regulations

[8] Interview, WUR scientist.

[9] Interview, WUR scientist.

[10] Interview, WUR scientist.

[11] Interview, scientist at a Dutch insect farm.

[12] Interview, Dutch insect breeder. Western companies also produce the banded cricket (*Gryllodes sigillatus*), but for present purposes it is not necessary to distinguish between cricket species.

[13] WUR scientist, personal communication, 2nd Feb 2017. It is unclear whether this development relates to a circuit of influence between Europe and the US, following the cricket's prominence in US edible insect production. In 2012, the first major US insect-based food – the Chapul cricket-based protein bar – was launched, itself a result of the global reach of Marcel Dicke's 2010 TEDGlobal presentation (Wilkey, 2012). The use of crickets reflects the prescriptive influence of existing socio-material assemblages seen in the Netherlands. Crickets were one among a limited range of species for whom an animal feed supply infrastructure had already been developed in the US (also for exotic pets), and were seen as a more palatable alternative to species such as cockroaches (Interview, North American insect-based food producer). Thus despite post hoc rationalisation regarding crickets' suitability as human food (e.g. Bennington-Castro, 2017), their selection was from a limited range of alternatives, shaped by existing socio-technical arrangements.

[14] Interview, Dutch insect breeder.

[15] Interview, scientist at a Dutch insect farm.

[16] Interview, scientist at a Dutch insect farm; interview, Dutch insect breeder.

[17] Interview, Dutch insect breeder.

regarding the rearing and supply of insects (Federal Agency for the Safety of the Food Chain, 2014).

Under EU legislation (EC No 258/97) during this period, insects broadly fitted within the definition of 'novel food', defined by the European Food Safety Authority as "food that European citizens have not consumed to a significant degree prior to May 1997" (European Food Safety Authority, 2016, n.p.). For novel foods to be brought to market, they had to either be supported by a full risk assessment or by a demonstration that they had a history of safe use as a "traditional food" outside of Europe (European Food Safety Authority, 2016).

However, when insects came to the attention of the European Commission in around 2011, it became apparent that the wording of the novel food legislation – which dealt with products obtained *from* animals, but not *whole* animals – did not fully account for food insects (Gleadle, 2011). As a corrective, new EU novel food regulations were announced in 2015, which came in to force on January 1st, 2018 (EC No 2015/2283). Those involved with the production and supply of food insects in Europe are now required to submit applications to have specific insects permitted for sale, via either the 'novel' or 'traditional' route (for a detailed discussion see Belluco et al., 2017). Prior to 2018, it was the prerogative of individual member states to decide whether to permit the sale of food insects. In certain states, such as the UK, sale of insect-based food was tolerated (Gaffey, 2015); in others, such as Italy, it was forbidden (Rettore, 2016). The relatively formalised context of regulatory permissibility in the Netherlands and Belgium played a significant role in the stabilising of the Dutch edible insect network.

In around 2010–2011, VENIK contacted the Dutch food safety authority (NVWA) to discuss regulatory requirements, and were asked to provide information about the safety of the species, which at the time was (and indeed, still is) limited. The NVWA also considered whether insects were a novel food, and their subsequent regulatory position.[18]

A temporary period of regulatory tolerance was agreed, whose boundary was the 2018 introduction of the revised Novel Food regulation.[19] This tolerance – which did not prescribe the insect species that may be used – was predicated on VENIK members' adherence to a 'standard control regime', incorporating general EU legislation regarding the production and supply of food (cf. Federal Agency for the Safety of the Food Chain, 2014). Specific food safety criteria for insect products were also established, including that insects must be prepared according to approved procedures (e.g. Hazard Analysis and Critical Control Point [HACCP]) and methods (i.e. blanching and drying), and must be labelled clearly due to potential allergenicity. The NVWA also requested that VENIK began to draft a hygiene code for the industry.[20] Dutch regulatory tolerance enabled the continued production of food insects in the Netherlands for both domestic use and international resale (e.g. Kreca Ento-Food, 2017), and led to the presence of various insect-based foods in shops and restaurants in the country (e.g. Stevens, 2017). However, compliance with procedures to ensure food safety is expensive (e.g. Vandeweyer et al., 2017), which has ramifications for their feasibility as food.

Dutch regulatory tolerance was by no means a foregone conclusion. There remains a general lack of evidence regarding the food safety of insect species, and there are indications that the Big Four may have similar allergenic properties to house mites and crustacean species (Hustinx-Broekman, 2017). The context of permissibility in which Dutch insect producers continue to operate (and which due to exports, has a considerable geographic spread), was originally a relational achievement between governmental organisations: the Ministry of Economic Affairs (EZ), who promotes new protein sources, the Office for Risk Assessment and Research (BuRO), who carries out independent risk assessments, and the NVWA, who enforces food law. The tolerance period represents a balancing of interests. VENIK had provided the NVWA with assurances that insect consumption, in a global sense, was demonstrably prevalent and safe, despite lack of scientific data on the subject; further, the presence of a Dutch edible insect sector was in harmony with the contemporary governmental objectives around sustainable food production (particularly in the EZ). Thus, despite limited safety data, the decision was for regulatory permissibility rather than the precautionary principle (the more conventional standpoint of risk managers). Such tolerance is, of course, responsive, and would be revised should safety incidents occur. None has yet been reported, and the tolerance remains.[21]

Despite a lack of explicit legal prescription of permitted species in the Dutch context, regulatory discourse may have acted to further stabilise the centrality of VENIK's three original species in the Dutch edible insect network. In October 2014 the Dutch food safety authority produced an advisory report, in which the risks of the three species VENIK were selling to the public were assessed based on the available evidence (Bureau Risicobeordeeling and Onderzoeksprogrammering, 2014). This was not a legally-binding document, but summarised the state-of-the-art in relevant scientific research and set out recommendations regarding safe processing, possible allergen risks, and daily consumption limits. Although the document's formal role was limited to an advisory one, there are indications that it may be being used in a more directly prescriptive capacity, particularly when taken alongside a slightly earlier ruling from the Belgian food safety authority, the Federal Agency for the Safety of the Food Chain (FASFC).

In May 2014 the FASFC announced that the production and sale of ten insect species for human consumption would be tolerated in Belgium, provided that other more general standards and procedures were met (Federal Agency for the Safety of the Food Chain, 2014). These included "the application of … good hygiene practices … traceability … obligatory notification … labelling … and the implementation of [a] HACCP based self-checking system" (Federal Agency for the Safety of the Food Chain, 2014, p.5). The ten species had been identified following an investigation into which insects were commercially available as food in Belgium, of which six species "appeared to be regularly offered for human consumption".[22] They included the Big Four, as well as morio worms (*Zophobas atratus morio*),[23] and wax moth larvae (*Galleria mellonella*). The FASFC statement noted that its ruling was subject to a safety assessment by an internal scientific committee (Federal Agency for the Safety of the Food Chain, 2014); this assessment was published in September 2014, confirming the tolerance of the ten species (Scientific Committee of the Federal Agency for the Safety of the Food Chain and Superior Health Council, 2014). Less than two weeks later, the sale of two ranges of insect-based food was announced in the country (Hope, 2014).

Two points are worth noting about the FASFC's safety assessment. Firstly, among the studies cited, the SUPRO2 research is prominent. This suggests that the constitutive circuit of exchange between policy, academia and business from which the research derived had implications for the establishment of food insects in Belgium. Secondly, the safety assessment cites a 2012 study from the NVWA, whose title is identical to that published in 2014 (Bureau Risicobeordeeling and Onderzoeksprogrammering, 2014). This suggests that the NVWA/BuRO investigation had been underway for some time, and that in-progress findings were shared with their Belgian counterparts, implying another point of exchange and mutual shaping in the network.[24]

[18] Interview, NVWA employee.

[19] In effect the tolerance period has been extended. Under the revised Novel Food regulation (EC No. 2015/2283), any species already legally sold as food prior to 2018 may continue to be sold without specific approval until 2nd January 2020.

[20] Interview, NVWA employee.

[21] Interview, NVWA employee.

[22] Email enquiry to FASFC, 14th Feb 2017. Author's translation.

[23] Also known as 'superworms', this species is related to mealworms and lesser mealworms, but larger.

[24] I was unable to obtain formal confirmation of this point.

5. Insect-based convenience foods

At the time of research, perhaps the most prominent insect-based food in Europe was the Insecta range of insect-based convenience foods. Produced by the Belgian functional food company Damhert Nutrition, this range included products such as burgers, nuggets and schnitzel, which were very similar in appearance, taste and texture to vegetarian convenience foods.[25] Indeed, they were sold in the same section of Dutch supermarkets as vegetarian products (more on which below).

5.1. Production

The idea of producing an insect-based product range was reportedly conceived at Damhert in 2012, and was considered harmonious with their commercial positioning as a pioneer in functional foods and vegetarian products. Product development was a two-year process (2012–2014). The first year involved the identification of a supplier of insects, and then a production partner to manufacture the foods (a Dutch company with experience of producing vegetarian convenience foods). Identifying a production partner who was both willing and able to work with insects was reportedly difficult.[26] The second year was spent in product testing. When the products were ready, a Dutch retailer was identified.[27]

Each of these stages shaped Insecta in important ways, and contributed to how the products' edibility was constructed. I frame my account of this thematically rather than chronologically, by looking at species selection, product form, and retail.

5.1.1. Species selection

Species selection for Insecta was shaped by the dynamics of the Dutch edible insect network, which affected what was available and legally permissible at the time of product development. Damhert's insect supplier was Kreca (now Protifarm), who produced all Big Four species. These were the ones tested for product development, with mealworms and lesser mealworms ultimately being decided upon. These were reportedly deemed the tastiest species by internal tasting panels, due in part to their lack of hard shells, which were found to create a less pleasant end product. Fortuitously, these species were also substantially cheaper than crickets or grasshoppers.[28] Thus although the two "best" species were selected for use in the Insecta products based on the key criteria of taste and price, they were chosen from a small list of alternatives, whose legality and feasibility was prescribed by network dynamics.

Damhert sought to include the highest feasible proportion of insects in the products. To include less than 10% was seen as not "being honest" about creating an insect-based product. Different quantities of insects were tested, and the figure of 14% was eventually alighted upon. In addition to the key considerations of taste (not too strong) and price (not too expensive), this was partially due to the insects themselves: quantities of more than 20%, it transpired, were difficult to digest.[29] Thus, the materiality of the insects, by acting upon the taste buds and digestive systems of their human eaters, limited the range of and extent to which the insects were enrolled in the production of foods (cf. Bennett, 2007). It also affected the form of the resulting foods.

5.1.2. Product form

The form of the product range was shaped by a number of factors. The insects themselves had a role to play: test products involving whole insects were found to be too close to rotting meat in appearance (Cardinaels, 2014), engendering an affective response – the 'yuck factor' – which directed product development to the use of grinding. Indeed, an employee at Kreca has also opined that mealworms are "not attractive" as food (quoted in Nooteboom, 2015, n.p., author's translation).

The Insecta products were deliberately not modelled on insect-based dishes from elsewhere in the world. Instead, insects were to be integrated into product types familiar to consumers in Belgium and the Netherlands. The target market segment was 'flexitarian' consumers: those who are deliberately looking to reduce their meat consumption for environmental reasons, but who do not object per se to the consumption of animals.[30]

The form of the foods was also affected by pre-existing expertise and business networks. Given their prior experience with vegetarian convenience foods, the production partner already had expertise with producing suitable recipes, and they also had a network of existing suppliers.[31] The pre-existence of expertise and ingredient supply networks are of course hugely useful in developing a new product, where starting completely anew may not be feasible. Yet the 'heaviness' of such networks acts upon and shapes the production process (Håkansson and Ford, 2002). Thus the recipes (and consequently the taste) of Insecta were affected by the production partner's earlier activities: they were not designed with a totally 'blank canvas'.[32]

Within Damhert itself product development involved a "really big group of people," among whom were internal taste panels, industry experts, and a research and development department, all of whom exerted an influence on the creation of Insecta.[33] Development of the range was also affected by feedback from the Dutch supermarket who arranged to stock Insecta.[34] Thus the products were not fixed, radiating out in a linear direction from the supplier, but rather shaped, and indeed *designed*, during the process of diffusion (cf. Bijker, 1995).

5.1.3. Retail

In the Netherlands, Insecta products were stocked in branches of Jumbo, a national supermarket chain. Trialled initially in a handful of stores in late 2014, they were rolled out across all 550 branches nationwide during 2015. By 2016 the number had been reduced to a relatively small proportion of branches, and their sale now appears to have ended.

The fact that Insecta were sold in Jumbo at all was the result of a number of contingent factors. The individual at Jumbo's headquarters primarily responsible for arranging the sale had been interested in the topic of insects as food for some years, yet was only able "to do something about it" relatively recently, having attained a position of appropriate seniority and the support of a sympathetic colleague in a different part of the company. Around the same time, the owner of fifteen stores in the north of the country had also decided to start selling insect-based foods, which had directed discussion to the subject within the relevant echelons of the firm and led to the development of a

[25] The range can be viewed at https://web.archive.org/web/20170107180119/http://www.damhert.be/en/shop/insecta.

[26] Interview, Damhert product development manager. A separate interviewee (Dutch insect breeder), discussing the widespread caution food manufacturers still exercise towards integrating insects into food products, suggested that it may derive from the way in which insects have historically been treated as a contaminant in health and safety regulations.

[27] Interview, Damhert product development manager. The products have also been sold in Belgian shops since their launch. As I only have data on Dutch consumers and retailers, the present analysis is confined to the Netherlands.

[28] Interview, Damhert product development manager.

[29] Interview, Damhert product development manager.

[30] Interview, Damhert product development manager. For discussion of consumers' ethical positioning of Insecta products see House (2016, in press).

[31] Interview, Damhert product development manager.

[32] It should be noted that the contingency and compromise involved in the production of Insecta is not particularly unusual in food product development. Companies must operate within the bounds of what is financially and practically achievable, and in the context of existing commercial relationships (Håkansson and Ford, 2002).

[33] Interview, Damhert product development manager. Indeed, to use the name 'Damhert' is to simplify or "punctualize" (Law, 1992, p. 385) a company which itself is a complex and contingent network of actors and interests. The extent to which the internal workings of the company affected the development of Insecta would offer a fascinating extension to the present case study, but unfortunately such data were unavailable.

[34] Interview, Jumbo category manager.

unified strategy for the launch.[35] A number of relatively senior Jumbo employees were thus enrolled to the project of insects as food. Contemporary 'buzz' around the subject (e.g. Smith and Pryor, 2014a, 2014b; van Huis et al., 2013) furnished a propitious context, a space of "interessement" in which enrolment became feasible (Callon, 1984, p. 207). Jumbo's prevailing interests as an organisation – an explicit commercial orientation as a sustainable and forward-thinking retailer[36] – translated without difficulty into alignment with the project of insects as food.

The appearance of Insecta on Jumbo's shelves arose from circuits of exchange between Jumbo and other actors within the Dutch edible insect network, as well as the products' integrability within existing socio-technical arrangements. Selection of Insecta drew in part on the trust developed in an existing business relationship between Damhert and Jumbo. It was also directed by Jumbo's need to conform with general food safety standards, applied as a standard to fresh foods in general, which confined the range of appropriate insect-based food products to those produced in the EU. An alternative range of foods[37] was sold in the fifteen northern branches, but considered less suitable for national sale due to the presence of whole insects – the predicted affective response of consumers (the 'yuck factor'), relating to the materiality of the enrolled insects, shaping which products were actually sold. Insecta products were integrated within existing distribution networks established for the sale of fish; their presence in supermarkets was thus facilitated by the prior existence of socio-technical arrangements involving both human and more-than-human actors.[38]

The actual placing of Insecta products – in the aisle with vegetarian foods and other 'meat replacer' (*vleesvervanger*) products – was an individual decision, but was bounded by the socio-material entanglements in which it was exercised (cf. Garud et al., 2010). The individual at Jumbo responsible for the placement of Insecta noted that they made this potentially "polarizing" decision because Insecta seemed a better fit with other "protein alternatives" than conventional animal-based products. Market research had also indicated that vegetarians and flexitarians may be amenable to the products.[39] The practical reality of the physical arrangement of stores – not just shelves and aisles, but the other foods sold – provided the *relational* context in which these foods were placed. They may not have been an exact fit with falafel and soy-based chicken-style pieces, but were deemed to be more coherent with such products than with chicken breasts or beef burgers.

5.2. Consumption

5.2.1. Edibility

Despite the contingencies and compromise involved during the creation of Insecta, the resulting products reached – at least for some people – the stage of edibility: they had 'become food'. However, there are two caveats.

Firstly, this population was limited, and among them only a small proportion continued to eat Insecta at least semi-regularly (discussed further below). Secondly, contra speculative arguments about the role of processed insect products as a 'gateway dish' entailing progression to acceptance of other insect preparations (see House, 2018a), there is no evidence that Insecta achieved the edibility of 'insects' in an abstract sense. Rather, edibility was bounded, pertaining to a specific product range.

Apropos of the edibility of insects in a more general sense, two rough groupings can be identified. There were those for whom the edibility of insects was *dependent* upon Insecta, and there were those for whom insects were, broadly speaking, *already* considered edible. Construction of the edibility of insects, by the supply-side hybrid collective (and in relation with consumer practices), was mostly an achievement only for the former group. For the latter group, Insecta chiefly represented a means of obtaining insect-based food. Nevertheless these are, I argue, differences of degree and not of kind: as far as Insecta represented a successful construction of the edibility of insects, it was in relation to a specific product type, processing method and insect species, and not necessarily of 'insects' more generally.[40] This point is, I would suggest, an important one, given the prevalent assumption in related research that overcoming the initial barrier to trial represents the main problem for efforts to increase acceptance of insects in general (e.g. Caparros Megido et al., 2016).

For some people, the edibility of insects derived from the form, type and placing of Insecta products. These participants reported that the edibility of Insecta was dependent upon the invisible inclusion of insects, reflecting arguments elsewhere that edibility depends on the tactical absenting of certain aspects of food (Evans and Miele, 2012; Sexton, 2016; Vialles, 1994). For example, one participant, Bianca, had not eaten a grasshopper when earlier given the chance due to its appearance, but was happy to eat Insecta products. Another participant, Patrick, mentioned that the general lack of photos or information about Insecta's arthropod contents "made a difference" to his preparedness to eat them. These points related to the explicit production strategy outlined above, which sought to mitigate the 'yuck factor'.[41] The mealworm species used for the products were in this respect the most appropriate (from the range of alternatives), due to their relative unobtrusiveness.

Various facets of the 'meat replacer' form of the foods aided the construction of edibility.[42] A prominent aspect was the perceived sustainability of the products, which were positioned as such by Damhert (the range's tagline was 'Go Green – High Protein') and in broader entomophagy discourse (e.g. van Huis et al., 2013). Protein and nutrient content were also raised by a number of consumers. Co, one of a small number of participants who made no efforts to reduce his meat consumption (see House, 2016), directly connected Insecta's protein content with its edibility. Discussing the unusualness of insects, he reported that "I'm not too fussed about trying insect products, because I know that they contain a lot of protein."

Others, for whom Insecta represented an alternative to vegetarian convenience foods, suggested the products' relatively high levels of protein and vitamin B12 were conducive to edibility. Crucially, however, these considerations were often entwined with insects' ambiguous ontological position, somewhere between 'animal' and 'vegetable' (see House, in press). The conjunction of these factors appears to have opened up a space within ethically-oriented diets for the consumption of a new animal protein product, even in cases where animal consumption was otherwise limited or precluded. This space can be viewed as a relational achievement between consumer practice and the complex supply-side interactions which shaped and positioned the foods (both literally and discursively). It indicates the final form of Insecta was not necessarily the 'correct' way to construct the edibility of insects, but a particular, situated example of how edibility may be relationally achieved.

The relational nature of Insecta's edibility was further exemplified

[35] Interview, Jumbo category manager. The stores operate on a franchise system and thus have a relatively large degree of autonomy over the products they stock.

[36] Interview, Jumbo category manager.

[37] The range can be viewed at https://web.archive.org/web/20180420072818/http://www.conbuggie.be.

[38] Interview, Jumbo category manager.

[39] Interview, Jumbo category manager.

[40] A comparable example can be found in the 1960s US, when the positioning of certain raw seafood species as edible did not automatically entail the edibility of different raw species in sushi (House, 2018b).

[41] Of course, here we are dealing with those who are willing to give insects a try: for many the 'yuck factor' is sufficiently prohibitive regardless of efforts to encourage edibility.

[42] Insecta products were overwhelmingly consumed instead of plant-based convenience foods rather than meat products, calling into question the extent to which they are fulfilling their purported environmental objectives.

by the way in which the products were "punctualized" by consumers (Law, 1992, p. 385) who otherwise may not have eaten insects. That is, the heterogeneous supply-side procedures necessary to ensure the products' safety were assumed to have been fulfilled, due to the products' position on supermarket shelves. Mariska recounted the first encounter she and her boyfriend had with Insecta while shopping:

> *Are we really going to do this? Will we do this? Yes, let's just do it. Yes – are we sure? Well, if it's in the stores we probably won't die from it, so let's just eat it … And that's why we were like, 'alright, these burgers are in the stores, so they must be edible'.*

Punctualization was also evident in the group of people for whom acceptance of insects was not dependent upon Insecta. Maarten mentioned that he was interested in eating insects in general, and occasionally ate insects he found while out in the countryside. However, he was unsure about the safety of the species sold in fishing shops. Insecta were thus taken to represent a source of safe and available food insects.

For others in this latter group, Insecta had 'become food' largely because they were available and novel. These people were keen to eat insects, which was often part of an explicit general curiosity about food that reportedly led to the frequent sampling of new things. A number of people had tried both the whole insects sold in the Netherlands and one or more products from the Insecta range. Yet for these participants, the edibility of insects must still be understood as confined to the specific products available in the Netherlands. It is not possible to assume that sporadic consumption of certain kinds of insect-based food will automatically lead to the acceptability of other species or products (cf. Caparros Megido et al., 2016).

For all consumers, Insecta products represented the situated construction of the edibility of insects. It was simply that for some people, such as Maarten, this appears to have been substantially less dependent upon the specific attributes of Insecta. The groups are also not totally discrete. Bianca, for example, had happily eaten an ant while trekking through the jungle while on holiday, but would not eat a dried grasshopper upon her return to the Netherlands. Edibility is situated and constructed: acceptance of 'insects' is a misnomer. In countries where certain insect species are consumed, acceptance of insects is confined to particular species positioned as edible (Tan et al., 2015; Yates-Doerr, 2015).

Despite the varying degrees of ease by which Insecta became positioned as edible for different participants, they were in another way largely united. Overwhelmingly, they did not consume Insecta regularly. The successful construction of edibility in *principle* for a particular food does not mean that people will actually eat it in *practice* (cf. Waitt, 2014).

5.2.2. Routinisation

Consumption of Insecta products was low, and repeat consumption infrequent. The placing of Insecta products had a bearing on whether, how, and to what extent they were consumed. However, so did other aspects of the products, whose genealogy extended back into the Dutch edible insect network. These were the form, price, taste and availability of the foods.

The *form* of Insecta was, as noted, highly comparable to vegetarian convenience foods or 'meat replacers'. This 'scripting' (Akrich, 1992) was furthered by their placing among such foods. Consequently, Insecta tended to be situated as a 'meat replacer' within food provisioning and consumption practices, which positioned them as one among an extensive array of feasible alternatives. Thus framed, Insecta were assessed according to criteria that typically applied to such foods (see House, 2018a).

For example, the *price* of Insecta – at the time of research, €3,95 per pack – was higher than most comparable alternatives, and impeded repeat consumption. The relatively high price related to the insects' cost, itself shaped by species behaviour, the socio-technical arrangements of rearing, and compliance with food regulations and safety procedures.

For a third of participants, the *taste* of Insecta was judged good enough to encourage consumption. For others, who were more ambivalent, it was not. Such consumers reported finding the taste of the Insecta burger "a bit boring" or "a bit dull", which may have been related to efforts to create a versatile product without any overpowering flavours. Indeed, the general orientation of product development was to integrate insects invisibly into familiar product forms, which itself derived from available species (and the associated circuits of exchange 'further back' in the production network), pre-existing knowledges, production methods and resources, and established socio-technical arrangements. Key among this was the balancing of demands for an "honest" quantity of insects with those around price and palatability.[43] It appears the finished range reflected these compromises, in part, through its taste. Although the range did include a more heavily spiced product (see Note 25), the central principle was still of concealment rather than centrality of insect flavour, a strategy which has elsewhere been questioned (e.g. House, 2016). The latter product was also seldom available.

Indeed, the general *availability* of Insecta was limited. This was partly because it was sold only in one chain, which comprised 17.4% of Dutch supermarkets at the time of research (Distrifood, 2017). Participants reported not always shopping in the same place, due in part to the web of other social practices affecting food provisioning. Further, given Insecta's positioning as one-among-many meat replacer products, where it was unavailable alternatives were simply selected instead. Availability was also limited within stores, who could exercise a degree of autonomy in deciding which products to stock. In many stores Insecta was only intermittently available; when available, it was often only one product from the range (usually the burger). These points precluded routine integration of the foods into diets, either directly (when out of stock) or in terms of dietary variation: people tended to report that they repeatedly ate the same products only when the taste was exceptional, and/or if they were highly versatile (for example, relatively 'unscripted' chicken-style pieces rather than a more heavily scripted burger product).

6. Discussion

Developed in the context of the Dutch edible insect network, Insecta was a range of insect-based food whose edibility was successfully constructed. Edibility was nevertheless limited to a specific configuration of insects, preparation methods and other ingredients, and was constructed and negotiated through exchanges within the socio-material assemblage of the 'hybrid collective' that produced the food. Further, complexities and contingencies in the production process also impacted upon the products' consumption. A tension was evident between the network interactions necessary to create an edible product and those which would facilitate routinisation. In Callon's (1984) terms, the stage of interressement – in which consumers tentatively engaged with the edible insect project (i.e. trial consumption) – was reached; the enrolment of consumers, in which their sustained participation (i.e. routine consumption) is achieved, was not.

The success of a given initiative depends upon the enrolment of relevant actors, including users or consumers as well as a project's architects. Examples include the achievement of a working technology (Callon, 1986), the successful implementation of a regulatory measure (Shove and Walker, 2010), and the present example of 'things becoming food'. Success is not pre-determined but rather an emergent property of relations within a network of relevant actors, relating to the translation of actors' interests to the initiative's aim (Latour, 1996). If translation is successful and relevant users or consumers are enrolled, the project succeeds, as with the congestion charge in London (Shove and Walker,

[43] Interview, Damhert product development manager.

2010). If users are not enrolled, the project fails, as with the widely-ignored public smoking ban in Greece (Stamouli, 2017).[44]

In the present example, emergent problems in translation are chiefly engendered by the insects themselves. As Yates-Doerr (2015, p. 106) observed following lab ethnography at WUR, "insects that are easily mass-produced are not the insects people typically want to eat". Insects which are 'good for science' or 'good for entrepreneurs' are not necessarily 'good for food'. Amidst present network relations, the Big Four insect species are the point at which the "chain of translation" (Latour, 1996, p. 33) necessary to enrol European diners to the entomophagy project is broken. Under current conditions, therefore, these insects do not appear to be suitable for use as human food.

This is not an inherent property of the species in question. It derives from their articulation within the socio-material entanglements of the Dutch edible insect network. Situated instances in which these insects 'became food' indicate how the brief but propitious alignment of interests within a given set of network relations engenders the construction of edibility. The interests espoused by supply-side actors regarding insects as food – principally, healthiness and sustainability – are shared by consumers during instances of consumption.

Yet for consumers, the routine consumption of foods also involved the fulfilment of interests that diverged from the Dutch edible insect network's dominant orientation towards sustainability. These pertained to the accomplishment of enjoyable and achievable food consumption, relating to factors such as price, taste and availability. Consumers' sustainable eating objectives were often fulfilled by similarly positioned foodstuffs, such as plant-based 'meat replacer' products, which simultaneously fulfilled the more conventional food-related interests (see House, 2018a). Consumers were therefore enrolled to the consumption of different 'sustainable' or 'healthy' foods. Although interests relating to sustainability/health and enjoyable/achievable food consumption were not inherently mutually exclusive, they were generally not both fulfilled by Insecta.

I would suggest that under current network conditions, the Big Four insect species are the network entities which render these two interests irreconcilable. These species, it appears, are rather difficult to make into products that people want to eat regularly. They dominate the horizon of possibility for Western insect-based foods, but this is not because they have been independently determined to be the 'best' species for the purpose. Their dominance is the product of contingency and circumstance, and should perhaps be challenged.

These points have practical implications. For those wishing to produce and promote insects as food in the West, identification of alternative species may be necessary. I have argued elsewhere that the successful introduction of novel ingredients relates to the 'cultural intelligibility' afforded by their emplacement within a coherent framework of culinary practices, such as those associated with a particular cuisine (House, 2018a). Such positioning may help to facilitate the continued enrolment of consumers, although this would still ultimately depend upon the successful alignment of interests across the network of production and consumption (cf. House, 2018b). If suitable insect species could not be reared, for example, the 'chain of translation' would again be broken.

These arguments also have epistemological implications, particularly regarding research into Western 'consumer acceptance' of insects as food (see House, 2016). Low consumer acceptance of entomophagy in the West is not derived from intangible "cultural barriers" (Looy et al., 2014, p. 131) but rather from the specific socio-material relations that obtain in the contexts of Western insect consumption. This view involves a radical shift in emphasis regarding how we might investigate and understand 'barriers' to consumer acceptance. It is not simply that supply-side actors have yet to refine their efforts, or that consumers have yet to be 'convinced'; it is the insects themselves, and the networks in which they are involved, that are the problem. Of course, this does not imply that the insects are wilfully conspiring against their consumption. Rather, the way in which the insects are mobilised and articulated as edible within current network relations mitigates against their acceptance, which I suggest should be understood as routine consumption.

Future research should acknowledge the operation of distributed agency in the acceptance of insect-based food, which evidently involves more than convincing or educating consumers (cf. Reverberi, 2018; WUR, 2017). The success of insects as a Western food source will depend upon the alignment of actors across the production, supply and consumption of food, accounting for both the sustainable and more conventional orientations of food consumption. Orienting efforts around a suitable cuisine, rather than abstract sustainability objectives, may be a fruitful avenue of enquiry in this respect (see House, 2018a). A culinary focus may also offer a way out of the impasse highlighted above, in which efforts to achieve edibility also work to preclude routine consumption. Although the tactical absenting of animal ingredients may encourage consumption of food in certain contexts (e.g. Evans and Miele, 2012), this principle does not appear to easily translate to insect-based foods.

In highlighting the complexity and contingency at work in the construction of edibility, the present findings also have implications for research within food geographies and critical food studies more broadly. To the extent that edibility was deliberately constructed by certain actors in the Dutch edible insect network, it was only within the context of existing socio-material entanglements that decision-making agency was exercised (cf. Garud et al., 2010). Agency in the construction of edibility is distributed: the "heroic entrepreneur", acting in isolation, does not exist (Drakopoulou Dodd and Anderson, 2007, p. 349). Thus, accounts of novel food products which foreground the strategies of individual firms in the formation of edibility (e.g. Sexton, 2018) elide the constitutive role of the numerous 'unseen' actors, both human and more-than-human, which together act to position particular foods as edible. Edibility can be understood as a network effect: while human actors may exert disproportionate influence on the network and enrol other actors, these activities are dependent upon network relations with other entities. It is *together* that these entities are constitutive of edibility.

Further, edibility does not necessarily imply consumption. While on the face of it this is a rather obvious point – one may recognise Brussels sprouts as edible, for example, without actually wanting to eat them – it has significant implications for efforts to construct the edibility of *new* foods, an area of ever-increasing relevance both for those seeking to produce 'sustainable' foods and those trying to account for them theoretically. Explorations of how the edibility of potential protein sources may be constructed that do not fully engage with consumption (e.g. Probyn, 2011; Sexton, 2018; Stock et al., 2016) are thus limited, despite being analytically rich and advancing debates substantially beyond narrow, speculative research into 'willingness to eat' such foods (e.g. Gmuer et al., 2016). Edibility cannot be achieved without consumers: it is, to a significant extent, *relational* (cf. Roe, 2006a, 2006b). Thus, some investigation of the role of consumers – i.e., how, why and to what extent newly or provisionally 'edible' foods are consumed – is essential in future research on the construction of edibility.

Future geographic analysis into 'things becoming food' should also attend to the dynamic way in which edibility and routinisation are related. Edibility and routinisation may be achieved concurrently, such as when a new food is introduced into a new context along with an associated bundle of production and consumption practices in which to 'make sense' of it (e.g. House, 2018a). Yet it is clear that edibility and routinisation are distinct things. Efforts to understand the introduction of new foods – or the ways in which foods stop being eaten (cf. Houlihan, 2003) – would profit from attending to both. Future research should accommodate strategies to construct edibility, the geographic and sociological dimensions of routine food consumption, and the

[44] Thanks to Peter Jackson for bringing this example to my attention.

relationship between them.

To make such arguments is, of course, to reiterate an established principle within geography and cognate disciplines: that the study of food should account for both production and consumption, to at least some extent, if it is to lay claim a reasonable degree of analytic veracity (e.g. Goodman and DuPuis, 2002; Mintz, 1985). That point bears repeating here, I would suggest, in the context of efforts to create and to understand new, more 'sustainable' foods, and indeed in relation to efforts to understand the shifting contours of food consumption in more general terms. Edibility is a relational achievement at the confluence of production and consumption, which nevertheless does not imply that foods will be routinely consumed. Further, edibility is a quality of food – like taste (Cook, 2018) or freshness (Freidberg, 2009) – where apparently subjective and intangible qualities have direct commercial implications, as well as significance in terms of sustainability. Its complex geographies merit further investigation.

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