

THE HOLIDAY ISSUE

bon appétit

*The Future of the
Food & Ingredients*

*Experimental Recipes
Around the World*

**Lovely Grub:
Are Insects The Future
Of Food?
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Lovely Grub: Are insects the future of food?

Emily Anthes braves locusts, beetles, mealworms and more as she asks whether eating insects is the answer to feeding ever more humans and livestock.

BY EMILY ANTHES

AT FIRST MY MEAL SEEMS FAMILIAR, like countless other dishes I've eaten at Asian restaurants. A swirl of noodles slicked with oil and studded with shredded chicken, the aroma of ginger and garlic, a few wilting chives placed on the plate as a final flourish. And then, I notice the eyes. Dark, compound orbs on a yellow speckled head, joined to a winged, segmented body. I hadn't spotted them right away, but suddenly I see them everywhere — my noodles are teeming with insects.

I can't say I wasn't warned. On this warm May afternoon, I've agreed to be a guinea pig at an experimental insect tasting in Wageningen, a university town in the central Netherlands. My hosts are Ben Reade and Josh Evans from the Nordic Food Lab, a non-profit culinary research institute. Reade and Evans lead the lab's 'insect deliciousness' project, a three-year effort to turn insects — the creepy-crawlies that most of us squash without a second thought — into tasty, craveable treats.

The project began after René Redzepi (the chef and co-owner of Noma, the Danish restaurant that is often ranked the best in the world) tasted an Amazonian ant that reminded him of lemongrass. Redzepi, who founded the Nordic Food Lab in 2008, became interested in serving insects at Noma and asked the researchers at the lab to explore the possibilities.

The Food Lab operates from a houseboat in Copenhagen, but Reade and Evans are in the Netherlands for a few days, and they've borrowed a local kitchen to try out some brand new dishes. I, along with three other gutsy gastronomes, am here to taste the results.

We take our seats at a long, high table as Reade and Evans wheel in a trolley loaded with our meals. We each receive a different main course. I get the Asian-style noodles and fixate on the bug I can see. "That's a locust," Reade says. "[It] was alive this morning. Very fresh." But he's much more excited about another,

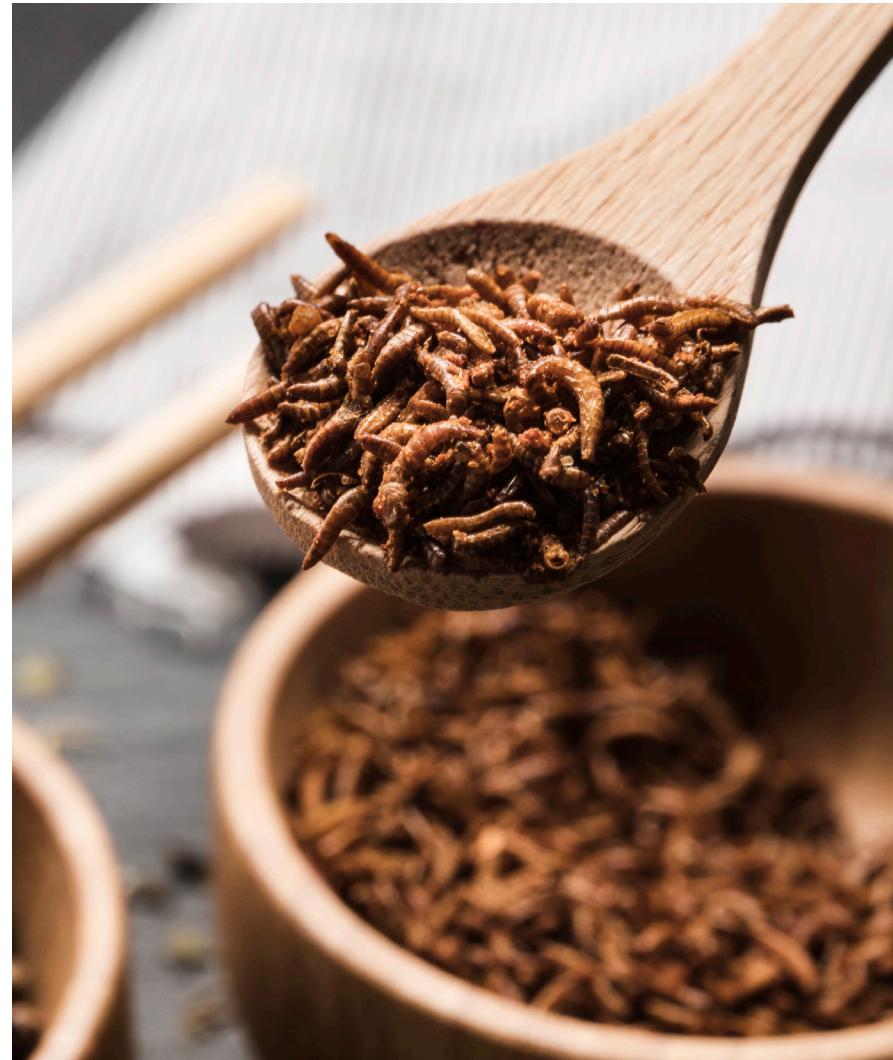


Image by Freepik.com. Fresh locusts served in a bowl

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I believe you're the first human being on the planet to have ever been served anything cooked with this,

Reade tells me.

hidden ingredient: fat extracted from the larvae of black soldier flies (or, to put it less delicately, maggot fat). The whole dish has been stir-fried in it.

But not to worry: "I've eaten some of it myself, an hour ago. I'm still alive."

I inspect my plate.

Reade urges us to begin: "Eat before it gets cold."

The next morning, Reade and Evans join 450 of the world's foremost experts on entomophagy, or insect eating, at a hotel down the road in Ede. They are here for Insects to Feed the World, a three-day conference to "promote the use of insects as human food and as animal feed in assuring food security".

The attendees are all familiar with the same dire facts. By the year 2050, the planet will be packed with 9 billion people. In low- and middle-income countries, the demand for animal products is rising sharply as economies and incomes grow; in the next few decades, we'll need to figure out how to produce enough protein for billions more mouths. Simply ramping up our current system is not really a solution. The global livestock industry already takes an enormous toll on the environment. It's a hungry and thirsty beast, gobbling up land and water. It's a potent polluter, thanks to the animal waste and veterinary medicines that seep into soil and water. And it emits more greenhouse gases than planes, trains and automobiles combined.

The insect authorities assembling in Ede believe that entomophagy could be an elegant solution to many of these problems. Insects are chock-full of protein and rich in essential micro-nutrients, such as iron and zinc. They don't need as much space as livestock, emit lower levels of greenhouse gases, and have a sky-high feed conversion rate: a single kilogram of feed yields 12 times more edible cricket protein than beef protein. Some species of insects are drought resistant and may require less water than cows, pigs or poultry.

Insect meal could also replace some of the expensive ingredients (e.g. soybeans and fishmeal) that are fed to farm animals, potentially lowering the cost of livestock products and freeing up feed crops for human consumption. As an added bonus, bugs can be raised on refuse, such as food scraps and animal manure, so insect farms could increase the world's supply of protein while reducing and recycling waste.

Officials at the United Nations Food and Agriculture Organization (FAO) became interested in the role of insects in food security about a decade ago, after documenting the significant part that insects play in Central African diets. Since then, the FAO has been commissioning

studies, issuing reports and arranging small meetings on eating insects. The gathering in Ede, jointly organised by the FAO and Wageningen University and Research Centre, is the culmination of all these efforts – the first major international conference to bring together entomologists, entrepreneurs, nutritionists, chefs, psychologists and government officials. They are here to discuss how to expand the use of insects as food and feed, particularly in the Western world, and to lay the foundation for an edible insect industry – to review the science, identify the obstacles and talk about how to move forward.

Over the next three days, they will lay out their vision for the future. It is ambitious and optimistic. They will speculate about creating an insect aisle at the supermarket and fast-food restaurants that serve bug burgers. They will imagine putting packages of 'beautiful, clean' shrink-wrapped mealworms on display at the meat counter, alongside the skirt steak and chicken wings. And they will dream about a world in which forests are thick, land is fertile, the climate is stable, water is clean, waste is minimal, food prices are low, and hunger and malnutrition are rare.

This conference, they hope, will be the beginning of it all. The experts assembled in the darkened auditorium are fired up, ready to give the world the gift of six-legged livestock. Are we ready to receive it?

Turning to insects for nourishment is not a novel idea – the Bible mentions entomophagy, as do texts from Ancient Greece and Rome. But insect eating never became common in Modern Europe. The reasons are unknown, but the spread of agriculture – and, in particular, the domestication of livestock – may have made insects, and undomesticated plants and animals in general, less important as food sources. The advent of agriculture may have also contributed to a view that insects were primarily pests and that insect eating was primitive. What's more, Europe's temperate climate makes wild harvesting less practical than in the tropics, where insect populations are larger and more predictable.

Nevertheless, entomophagy remains common in some parts of the world: at least 2 billion people worldwide eat insects, according to the FAO. Yellow jacket wasp larvae are popular in Japan, cicadas are treasured in Malawi, and weaver ants are

devoured in Thailand. Termites, a food favourite in many African nations, can be fried, smoked, steamed, sun-dried or ground into a powder. The list of edible insect species is at 1,900 and growing.



Laura D'Asaro's first brush with entomophagy came in Tanzania. In the summer of 2011, D'Asaro – a tall, freckled Harvard student with a relentlessly cheerful disposition – had gone to East Africa to take classes in Swahili. One day, she came across a Tanzanian woman standing by the side of the road, selling fried caterpillars out of a big basket. D'Asaro, an on-again off-again vegetarian, wasn't sure she wanted to eat an insect, but curiosity trumped apprehension. "When else am I going to try fried caterpillar?" she wondered. So she tried not to look too hard at the brown, inch-and-a-half long caterpillar as she placed it in her mouth and chewed. She was pleasantly surprised – the texture and the taste reminded her of lobster.

When the summer ended, D'Asaro returned to the USA and moved on with her college life until, two years later, she stumbled across an article on a newly released FAO report called Edible Insects: Future prospects for food and feed security. As she read about the benefits of bug eating, she thought back to her time in Tanzania. "All these things clicked," she recalls. "It made me reconsider why I was vegetarian and made me realize that insects could be this more sustainable protein that I'd been looking for pretty much my whole life."

D'Asaro decided to start a company to introduce insects to American diners and enlisted two of her college classmates, Rose Wang and Meryl Natow, to join her. They began ordering boxes of bugs from pet food companies and playing around in the kitchen, making wax-worm tacos and smothering crickets in soy sauce. "We were immediately very impressed with the taste of it all," D'Asaro says. They partnered with a Boston-area chef and started developing recipes. But when they shared samples with friends, or bravely brought some of their new dishes to potluck dinners, it did



not go well. "People seemed very frightened."

They had run smack into what may be the biggest hurdle in expanding insect cuisine: getting people to eat it. Some foods, like chocolate, sell themselves. Insects are not one of those foods. "Insects," says Paul Rozin, a psychologist at the University of Pennsylvania, "are disgusting. Things that are disgusting are offensive because of what they are. It's not that insects taste bad. It's that the idea of an insect is upsetting to people."

Rozin, who is known as 'the father of disgust in psychology', has come to the conference in Ede to present his work on consumer attitudes toward insects, and he outlines the challenges that entomophagic entrepreneurs will face. At one point during his talk, he clicks forward to a slide that displays two photos, side by side: a cockroach and Adolf Hitler. "In my research on disgust," he tells the audience, "these are my two best stimuli. Because they reliably produce negativity."

Insects are so repellent that most Americans, at least, don't want to consume anything that bugs have ever touched. In the 1980s, Rozin conducted a study in which he invited volunteers to try two different kinds of juice and rate them on a 200-point scale. Then, he briefly submerged a dried, sterilised cockroach in one of the glasses of juice and a birthday candle holder in the other. The participants were asked to evaluate each juice again; their ratings of the 'cockroached' juice plummeted, by 102 points on average. The candleholder, by contrast, produced a ratings drop of a measly three points.

Why do we find insects so disgusting? The answer, Rozin says, is simple: because they're animals. As a general rule, most of the foods that humans find disgusting are animal products and most animal products are disgusting; even the most insatiable carnivores eat only a

small fraction of the species that exist on the planet. In some ways, roaches are no different to gorillas, gerbils or iguanas, or any other creatures that we don't routinely eat. In other ways, though, they're much worse. Many insect species are found on, in or around waste, and they're commonly associated with dirt, decay and disease, all of which can significantly up the yuck factor.

D'Asaro and her partners realised that they'd need to ease consumers into the idea of bug gastronomy, so they abandoned the idea of serving whole insects and decided to work instead with cricket flour, which could be invisibly incorporated into familiar foods. They decided to launch their company, which they named Six Foods, with a product Americans already love: chips [crisps]. They created 'Chirps', a triangular chip made of black beans, rice and cricket flour, which is lightly spritzed with oil and then baked. Chirps are high in protein and low in fat and taste similar to tortilla chips, D'Asaro says, although the cricket flour adds a slightly nutty, savoury flavour. Six Foods plans to begin shipping them in October 2014.

In some ways, however, Chirps are a Trojan horsefly, a way to sneak bugs into American diets and transform sceptics into insectivores. Six Foods hopes to eventually introduce products in which the critters aren't so hidden. "That's our ultimate goal," D'Asaro says. "Where you can go to the store or a restaurant, and you can get a beefburger or a chicken burger or what we call an 'ento' burger. But we're just not quite there yet in society."

D'Asaro isn't the only one hoping we get there: in the past few years, there's been an explosion in businesses trying to put the 'meal' into mealworms. A Belgian outfit called Green Kow makes carrot-mealworm, tomato-mealworm and chocolate-mealworm spreads. Ento, based in the UK, sells mealworm and cricket pâtés at food festivals and last year created a pop-up restaurant devoted to insect cuisine. In the USA, Chapul and Exo sell protein bars chock-full of cricket flour, while New Generation Nutrition, in the Netherlands, has experimented with a falafel-like chickpea and buffalo worm patty.

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Then there are the companies that are raising insects for animal feed, such as Agriprotein, which is based in South Africa and building “a damn big fly factory”, as co-founder David Drew puts it. The plant is scheduled to open next year and will produce 24 tons of larvae and 7 tons of maggot meal, or MagMeal, every day. Agriprotein plans to create nine more of these factories across the globe by 2020. Enviroflight (in the USA), Ynsect (in France) and Protix (in the Netherlands) have also built large-scale insect production facilities.

Representatives of many of these enterprises have made their way to Ede, carting along product samples or prototypes to display in a large foyer at the conference hotel. During coffee and lunch breaks, participants can ponder whether they prefer miso made with grasshoppers or silkworms, buy a plastic container of freeze-dried mealworms for €3.50, or lean against the enormous sacks of black soldier fly meal stacked up at the back of the room. These businesses may one day be competitors, but for now, they've got an industry to build, so the atmosphere is one of camaraderie and collaboration. They trade strategies and suggestions and commiserate about the obstacles ahead.

Many companies have arrived at the same conclusion as Six Foods – that it's best not to confront consumers with insects too directly. That often involves processing and disguising the bugs, but it can also mean doing a little clever rebranding. Take waxworms, which live in beehives and eat honeycomb. By all accounts, they're delicious: buttery, with a taste reminiscent of bacon. But the word ‘worm’ can be a deal-breaker for diners, so Six Foods has re-christened them ‘honey bugs’. Ento calls them ‘honeycomb caterpillars’. Florence Dunkel, an entomologist at Montana State University, recommends borrowing from their scientific name, *Galleria*

mellonella. “We say ‘We're having *Galleria quesadilla*,’ and it sounds much more exotic,” she tells the audience at one presentation. “It's very romantic.” Dunkel also suggests using the euphemism ‘land shrimp’ for insects.

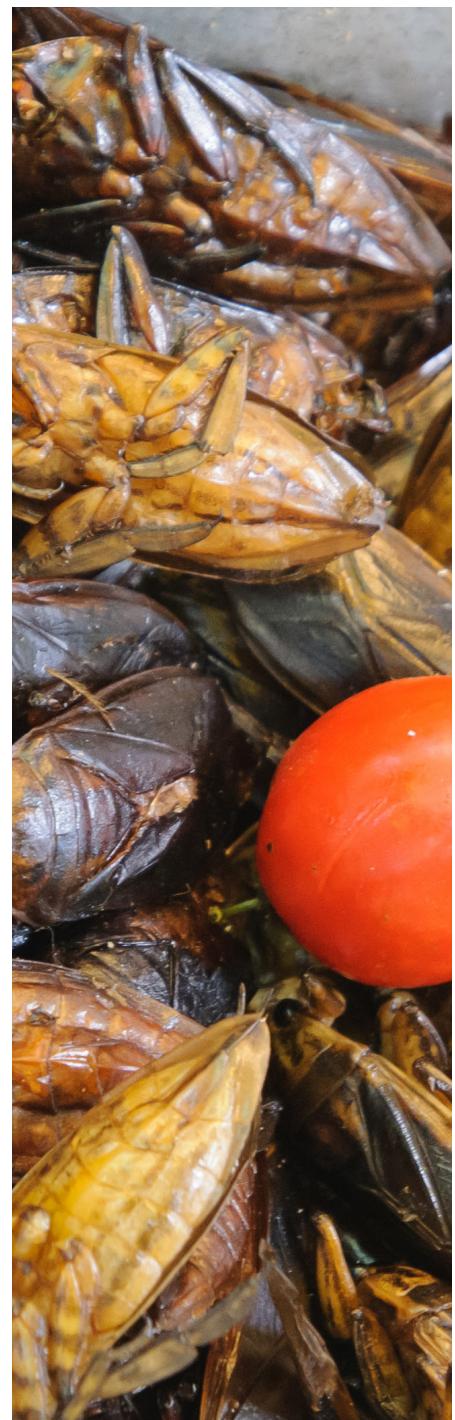
The arthropod advocates know they have some convincing to do, but they are optimistic. In consumer surveys, many people report that they'd be willing to try insects, at least in some form. When Rozin conducted an online survey of several hundred Americans, he found that 75 per cent said they'd rather eat an insect than raw goat meat, and 53 per cent reported that they'd rather eat an insect than endure ten minutes of moderate pain. “So this isn't the worst thing in the world,” Rozin reassures the audience during his talk. “It's just something you'd rather not do.”

The conference-goers seem to find comfort in telling and re-telling the story of sushi – a strange, foreign dish that showcased raw fish (raw fish!) and yet became not just acceptable but trendy in the West. “There's no question that food preferences can change,” says D'Asaro, whose words tend to come rushing out in an enthusiastic tumble. “I mean, there are 450 people here who believe in the future of insects as food. So I think it's going to happen, it's going to happen now, and I would certainly – I mean, I am putting my money on it.”

The entomophiles are not just putting their money where their mouths are – they're putting their mouths where their money is. There is audible excitement on the first morning of the conference when the organiser, entomologist Arnold van Huis, announces that each day's lunch will feature at least one insect snack. That day, it's miniature quiches sprinkled liberally with dried mealworms. They don't look particularly appetising to me, but I'm in the company of true believers. It's easy to get caught up in their passion and energy, their conviction that ‘land shrimp’ are the key to fixing food.

I put a mealworm quiche on my plate. I don't want to miss my chance to help save the world.

Noodles Eating Insects Gustav Almestål
© Gustav Almestål



Adrian Charlton is a major buzzkill. A biochemist at the Food & Environment Research Agency in the UK, Charlton is one of the scientists working on PROteINSECT, a €3 million, EU-funded project that launched last year. The team, which includes researchers in seven countries and three continents, is trying to nail down the nitty-gritty details involved in turning insects into animal feed. The scientists are testing different methods of fly farming, conducting livestock feeding trials and analysing the environmental impact of insect factories, among other things. Charlton is heading up the safety and quality analyses, and he's here at the conference at 9.00am, the day after we've all chowed down on mealworm quiche, to warn us that "not all insects are safe".

Whether they're used in animal feed or human food, insects present a slew of hazards. Bugs scooped up from the wild may be covered in pesticides or other contaminants, but even raising insects in industrial, indoor facilities won't necessarily eliminate the risks. One of the benefits of insects is that they can be raised on waste, but food scraps may be contaminated with fungus, some species of which produce nasty toxins. Animal manure may contain disease-causing bacteria, such as *Salmonella* and *Campylobacter*, as well as antibiotics or other drugs given to livestock. Heavy metals such as arsenic, cadmium and lead can also accumulate in animal manure and agricultural waste – and then in the bodies of insects that feed on it. "We know in some cases insects will tolerate much higher levels of metals than mammals," Charlton warns. "And therefore that's a risk in terms of using them as a feedstock."

In his initial tests, Charlton has found that some flies raised on animal and food waste have cadmium levels higher than limits set by the EU. Other researchers have also documented elevated levels

of lead in dried grasshoppers from Mexico and dangerous levels of fungal toxins in the mopane caterpillar, which is eaten in many parts of Africa. "This is not all speculation," says Charlton.

Insects also have their own pathogens: viruses, bacteria and fungi that colonise their tiny bodies. Although there's still a lot to learn about these microorganisms, some could potentially pose risks to humans or livestock.

Then there's the allergy question. Insects are arthropods, and several other arthropods – most notably shrimp – can cause severe allergic reactions. One of the major triggers of shellfish allergies is a muscle protein called tropomyosin. The protein sequence of tropomyosin is similar in insects and crustaceans, and people with shellfish allergies may also react to insects.

That's not to say that all these potential dangers will turn out to be actual dangers, or that they're insurmountable. But right now, there's very little data. "We need to know a lot more, really – that's the bottom line," says Charlton.

Given that, Charlton says, it makes sense for legislators to take a cautious approach. In the EU, companies that want to introduce edible insect products may be subject to the Novel Food Regulation, which applies to any food that wasn't 'used for human consumption to a significant degree' in Europe before the law was enacted in 1997. Any of these so-called 'novel' products or ingredients must undergo a thorough safety assessment, and then be approved by food safety regulators, before being placed on the market. The situation in the USA is similar: companies can sell whole insects as long as they are clean, wholesome and raised specifically for human consumption, but if they want to use a novel insect-derived product (e.g. protein powder) as an additive, they may need to petition the Food and Drug Administration to designate the ingredient as safe.

The Novel Food Regulation sounds straightforward enough, but in practice it's caused profound confusion. Owing to what many people consider to be an oversight, the law currently applies to ingredients that are 'isolated' from animals but not animals that are eaten whole. And yet, some national food authorities have rejected whole-insect products, and future versions of the novel

food regulation may encompass them. Meanwhile, some companies are already selling products that may be forbidden under the current regulation, without any apparent consequence. These and other ambiguities can leave companies in an uncomfortable grey area, unsure of whether they are actually allowed to sell their products.

Getting insects into animal feed could prove even tougher than getting them onto people's plates, thanks to rules enacted in response to the outbreak of mad cow disease in the UK in the 1980s and 1990s. The disease spread as the remains of sick animals were processed into feed for other livestock. To combat this problem, the EU instituted a series of new policies, including a ban on feeding 'processed animal proteins' to farmed animals. There are some exceptions for fishmeal and fish feed, but as the law currently stands, insect meal is a non-starter. Another problem for would-be insect farmers is a law that forbids 'farmed animals' – a category that includes insects raised for food and feed – from being reared on certain kinds of waste, including manure.

The restrictive (and sometimes confusing and contradictory) regulatory system is the target of particular scorn at the conference, where the heads of various insect enterprises point out that these policies were developed before bugs were on the agricultural and gastronomic radar.

"Insects will be allowed to be fed to chickens in Europe," David Drew, of Agriprotein, says in his talk. "It's just a mistake – let's be honest... At the time the legislation was created, there was no insect feed. Otherwise, it would be there in the legislation. It's absolutely absurd that the natural food of chickens, which is maggots...is banned, and fish, which they've never eaten, is permitted."

The audience breaks into a hearty, spontaneous round of applause, but Drew isn't done yet. "It's a bit like banning giant pandas from eating bamboo. It just ain't right."

But while the entrepreneurs seem to be growing restless – some have brought products to display at the

conference that they're not yet allowed to sell – some scientists are worried about moving too fast. “Until we know more, then the legislation shouldn't change to allow insects into the food chain,” says Charlton.

When I catch up with him a few weeks after the conference, Charlton makes clear that he's not trying to shut the bug businesses down or keep insects out of animal feed forever. “I actually do think that this is a good idea,” he says. “It just needs the data behind it to prove that.”

I ask him whether I was foolish to eat the mealworm quiche. “It depends how cautious you are and how adventurous you feel,” he says diplomatically. “I guess I'm more of an evidence-based person.”

Eating the mealworm quiche had given me a good sense of what the insectivores are up against. The dish tasted perfectly fine – the mealworms had a slightly nutty, toasted flavour and gave the quiche an extra crunch – but it still made my stomach turn. After taking a few bites, I found myself pushing the quiche to the side of my plate. I pulled a piece of bread off the top of my insect-free cheese sandwich and used it to cover the quiche; I didn't want to look at the worms while I was eating the rest of my lunch.

But I'd survived the quiche, as well as the maggot fat at that first tasting by the Nordic Food Lab. Over my week in the Netherlands, I'd tried other delicacies: locust tabbouleh; chicken crumbed in buffalo worms; bee larvae ceviche; tempura-fried crickets; rose beetle larvae stew; soy grasshoppers; char-grilled sticky rice with wasp paste; buffalo worm, avocado and tomato salad; a cucumber, basil and locust drink; and a fermented, Asian-style dipping sauce made from grasshoppers and mealworms.

Although I found many of the dishes to be psychologically difficult to stomach, none of them

had actually tasted bad. The insects themselves were quite bland. The crickets had a slightly fishy aftertaste and the buffalo worms a metallic one. The rose beetle larvae were vaguely reminiscent of smoked ham. Mostly, the insects were carriers for whatever other, stronger flavours were in a dish.

In fact, the Nordic Food Lab's Josh Evans and Ben Reade declared their tasting a failure, largely because the star ingredients – which came from Dutch insect farms – were nearly flavourless. The insects were a far cry from the delectable specimens they'd caught in the wild during their research trips around the world.

Over the past year, they've been to five continents and discovered an astonishing world of insect flavour. In Australia, they savoured the sweet-and-sour tang of honey ants and sampled scale insect larvae, which taste like fresh mushrooms and pop softly in the mouth. In Uganda, they feasted on queen termites, which are fatty – like little sausages – with the texture of sweetbreads, the fragrance of foie gras and a delicate sweetness. In Mexico, they enjoyed escamoles, desert ant eggs with a creamy mouthfeel and the aroma of blue cheese.

Rather than carting crates of escamoles to Copenhagen, Evans and Reade hope to identify European insects that are similar to the ones they tasted on their travels or can be prepared in similar ways. (One pro tip, which they picked up from a farmer in southwestern Uganda: crickets should rest for a few minutes after being cooked.) The goal, they say, isn't necessarily to get everyone eating insects. Rather, it's to introduce diners to delicious, under-used ingredients, expand food choice and encourage people to embrace the edible resources that surround them.

They sometimes seem frustrated by what they hear at the conference, by all the talk of scaling up insect production enormously, using insects in highly processed products, and creating a global insect trade, with a few easy-to-farm species shipped all around the world. They object to large-scale insect farming partly on gastronomic grounds – in their experience, farmed, freeze-dried insects taste “like cardboard”, Evans says – but also on ecological ones, worrying that we may end up merely replacing one industrial protein-production system with another.

“Insects themselves could be the most

sustainable thing, they could have no carbon footprint at all,” Reade says. “But then if we insisted on freeze-drying them all using huge amounts of energy and sending them halfway across the planet for energy-consuming protein extraction and then decided to sell that protein in another part of the world shaped like chicken breasts in a little plastic packet – well, there's nothing sustainable about that at all.”

Indeed, just because insects have a killer feed-to-food conversion ratio doesn't mean that anything we do with or to insects will be eco-friendly. Bart Muys, an ecologist at KU Leuven in Belgium, tells the conference-goers that although insects can be reared on relatively tiny plots of land, producing insect meal requires significantly more energy than fishmeal or soymeal does, largely because the bugs need to be raised in warm conditions. The environmental impact of each production system will vary, depending on countless factors, including location, species and feedstock. The golden rule, Muys warns, is “Do not claim before you know.”

Although everyone at the conference is dreaming of a future with more insects on the menu, the exact natures of those dreams vary widely – from the chefs who want to showcase insects' unique flavours at the world's best restaurants to the businessmen who believe the best use of bugs is as a feedstock to help lower the price of beef. There's no central authority dictating the next steps; although there's talk of gathering for another conference in two or three years, all the experts and advocates will pursue their own priorities in the meantime.

The edible insect industry is still in its infancy, and it's too soon to tell how it will develop or whether it will succeed. Will we accept insect flour in our snack foods? Can we be persuaded to make waxworm tacos in our own kitchens? Will crickets become a grocery store staple? And will any of this add up to real change? Many other innovations are also being hailed as the future of food, from fake chicken to 3D printing and from algae to lab-grown meat. Whether any of them, including insects, will turn out

to make a real contribution to food security and sustainability remains an open question.

For their part, Evans and Reade reject the notion that insects will be some sort of silver bullet. Bugs, they say, will only be a real part of the solution if we are careful and thoughtful about how we inte-

grate them into the food system. In their eyes, entomophagy is about more than merely getting a precise amount of protein on a plate – it's about making sure everyone on the planet has access to food that is affordable, healthy, diverse, environmentally sound and, yes, delicious. "Insects can be a vehicle for something," Reade says. "But it has to be recognised that it's not the insects themselves

that are going to make it sustainable. It's the humans."

In summer 2014, Ben Reade announced that he'd be leaving the Nordic Food Lab and returning to his native Scotland to pursue other food-related projects. The insect deliciousness project is continuing under the direction of Josh Evans.

