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EDITORIAL

Welfare of farmed insects

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Abstract

When discussing insect welfare, the distinction is often made between nociception and pain, the first being a reflex response, while the second refers to a negative emotion perceived by the brain. There is some evidence that insects can experience emotions. Anthropomorphism may influence opinions on the question of how smart animals are. For insects, the precautionary principle is often used: give insects the benefit of the doubt and regard them as 'sentient beings'. Considering the large number of farmed insects needed for food or feed, some articles discourage the consumption of insects, and favour plant-based diets. However, the protection of food plants also involves the killing of huge numbers of insects. I conclude that in insect farming we need to treat insects as sentient beings.

Introduction

For most of my life I have been involved in controlling insects using an integrated pest management approach in different parts of the world. During this period nobody has ever asked me about insect welfare. However, in the last decade of giving presentations on insects as food and feed, there has been an increasing number of questions on insect welfare. Why? Is it because an association is being made with livestock production, where consumers demand improvements in animal welfare in animal-production systems (Broom, 2010), or is it because insects are considered as animals able to experience emotions? According to Horvath *et al.* (2013), the issue has been overlooked.

Nociception and pain

One of the main questions often asked is: Can insects experience pain? This question was addressed by Eisemann *et al.* (1984) in a mini-review. They mentioned the often-cited example of their observation of a locust which continued to feed whilst itself being eaten by a mantis. In this discussion the distinction is made between 'pain' and 'nociception'. Nociceptors are nerve fibres that respond to potentially damaging levels of heat, cold, pressure, or chemicals. Elwood (2011) considered nociception an involuntary rapid reflex response, lacking the negative emotional response or feeling associated with pain. The sensation of pain is only created when the signals reach the brain and a serious threat is perceived. Eisemann *et al.* (1984) reasoned that insects have a pre-programmed behaviour which mediates reflexive avoidance behaviour, i.e. protective reflexes without the involvement of a sensation of pain. Pain experience has also been associated with the complexity of the brain, measured by the number of neurons present (Roth and Dicke, 2005). The number of neurons in the brain of the bee, considered to have an impressive behavioural repertoire, is 960,000 (Menzel and Giurfa, 2001), compared to 75 million for a mouse (Herculano-Houzel *et al.*, 2006) and 16 billion (Herculano-Houzel, 2009) for humans. The estimated number of neurons in the brains of a mealworm was estimated to be only 25,000 (Scherer *et al.*, 2017). However, Klein and Barron (2016) found it inappropriate to focus on neuron number alone, because, although insect brains are small, their functional organisation is very efficient. They conclude, from the perspective of functional neurobiology, that insects have the capacity of subjective experience (Barron and Klein, 2016).

Are insects 'sentient beings'?

Sentience has been defined as the capacity to feel, perceive or experience subjectively. According to Knutsson and Munthe (2017) there is no certainty about whether insects have sentience. Withdrawal responses and associative learning of invertebrates are not sufficient evidence for inferring conscious affective states (Mason, 2011). Perry *et al.* (2016) performed motivation experiments with bumblebees. They were able to demonstrate that rewarding the bees with a sweet sucrose solution induced a positive emotional state, in which bees would fly faster to ambiguous

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cues. This was considered analogous to human emotions, which bias decision-making under ambiguous conditions (Mendl and Paul, 2016). The behavioural changes of the bumblebees shown by Perry *et al.* (2016) ended when fluphenazine, an antagonist of dopamine, was applied topically. Dopamine plays a major role in the motivational component of reward-motivated behaviour.

Sherwin (2001) discusses the widely-held believe that invertebrates do not experience negative mental states such as pain, distress, and suffering. He applies the notion of 'argument-by-analogy' used for vertebrates, meaning that if an animal responds like humans to the same stimuli, it is presumably having an analogous experience. However, he believes that this notion should also be applied to invertebrates, as in many examples they show similar responses: e.g. in short- and long-term memory; in age effects on memory; in complex spatial, associative, and social learning; and in behavioural and physiological responses indicative of pain. Sherwin (2001) also counters some of the arguments used by Eisemann *et al.* (1984) such as the mantis eating the non-reactive locust, indicating that this behaviour could be a strategy for avoiding death.

Philosophical and ethical considerations

Nature is often arranged from lower to higher organisms with primates and humans at the top. When everything revolves around humans, we call it anthropocentrism. Humans are considered the most unique and highly-evolved animals on the planet. The effectiveness of human communication is often mentioned as evidence of this. However, is this true? For example, Con Slobodchikoff, who has studied prairie dogs for 30 years, showed that these dogs have a 'complex communication system that borders on language' (Anonymous, 2019). Another problem with showing effective communication is that tests are conducted in the expectation that animals will perform in a similar way to humans (Lockwood, 1987). We must also bear in mind that insects have a much broader complex array of communication systems than humans, that are not only auditory and visual, but also tactile, chemical (smell and taste), visual and vibrational. Because we consider ourselves the planet's preeminent species, we may underestimate the abilities of animals. Which is why De Waal (2017) wrote a book entitled 'Are we smart enough to know how smart animals are?'

Mather (2011) mentions three different philosophical attitudes towards dealing with invertebrates: (1) contractarian, i.e. not needing to concern ourselves with their welfare; (2) utilitarian, i.e. focussing on gains and losses in our interactions with invertebrates – consider the importance of the 99% of animals that invertebrates represent (e.g. ecosystem services of insects); and (3) rights-based, i.e. concentrating on animals' essential needs. If invertebrates are 'sentient beings', the last approach may be appropriate, and research should be conducted on the extent to which their natural behaviour and needs are enabled in captivity.

Gjerris *et al.* (2016) discusses ethical considerations when using insects as food and feed: environmental impact, human and animal health, social acceptability, animal welfare, and animal ethics. They stress that the issue is becoming increasingly important as insects are being farmed as 'mini-livestock' in order to meet the demands of nutrition, food safety, feed efficiency transformation, and sustainability. Lockwood (1987) proposes the following ethical approach to insects:

> We ought to refrain from actions which may be reasonably expected to kill or cause nontrivial pain in insects when avoiding these actions has no, or only trivial, costs to our own welfare.

Cautionary principle and recommendations

A number of publications favour the use of the cautionary principle, giving invertebrates the benefit of the doubt and regarding them as 'sentient' (Knutsson and Munthe, 2017). This means that, when farming them, steps to minimise pain should be adopted. This is also valid for invertebrates that are used in laboratory experiments (Cooper, 2011). Within this precautionary principle it is possible to have a hierarchy in the moral status of edible insect species. To establish this for each species would require quite a lot of research (Monsó, 2018). Further study is also needed on other insect welfare issues such as health, farming systems and humane methods of killing (Horvath *et al.*, 2013; IPIFF, 2019; Pali-Schöll *et al.*, in press; Röcklinsberg *et al.*, 2017).

In order to reduce the suffering of insects, Knutsson (2016) recommends not using insects as food and feed, and where it is done, their suffering should be kept to a minimum. His arguments are: (1) the large number of insects required per meal; (2) insects being killed such that they suffer; and (3) much death and suffering due to their short lives and high mortality. The large number of insects required to produce food is also reason enough for Scherer *et al.* (2017) to discourage insect eating. The authors integrated animal welfare into a life-cycle sustainability assessment allowing for comparisons among animal products. For insect welfare reasons, Knutsson (2016) favours plant-based diets instead. However, in contrast, Fischer (2016) considers that in order to produce plants for food, billions of insects have to be killed by insecticides. For that reason, he recommends that vegans eat insects instead.

Hakman *et al.* (2013) recommended in a report to the Dutch government that killing methods for insects should be quick and effective. The methods proposed were freezing (insects

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are cold blooded), heating (cooking or blanching), and shredding. The Council of Animal Affairs of the Netherlands wrote a report entitled 'The emerging insect industry: invertebrates as production animals' (RDA, 2018). The council concludes that there are enough arguments to ask the relevant parties to attach a moral value to invertebrates and act accordingly. The International Platform of Insects as Food and Feed, representing the interests of the insect production sector to EU policy makers, states that all insect producers should abide by high standards of animal welfare and ensure insect well-being (IPIFF, 2019).

Conclusions

Insects deserve our respect (Van Huis, 2014). They have a history on our planet of 480 million years compared to only 0.8 million years for *Homo sapiens*. There is increasing awareness that insects provide crucial ecosystem services (Dangles and Casas, 2019). Anthropomorphism probably often plays a role in judging how sentient animals are (Urquiza-Haas and Kotrschal, 2015) and the distinction between the human and animal mind may be an experimental artefact (Spence *et al.*, 2017). Considering the possibility that insects are 'sentient beings', it is recommended to treat them as such.

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