What is the current state of evidence for farmed insect sentience?

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Summary

The importance of welfare considerations for farmed animals can be affected by several factors. Cognition refers to mental processes including memory, learning, and problem solving, whereas sentience is the ability to have subjective feelings and experiences.[1] Despite the growth of insect farming, there has been little research into farmed insect cognition. Conclusions regarding farmed insect sentience remain even less clear. Nevertheless, some have advocated for a "precautionary principle," that unless farmed insects can be concluded not to be sentient, their welfare should be considered.[2] This is based on the idea that "when faced with such little research, we cannot assume that absence of evidence, is evidence of absence."[3] Increased understanding of farmed insect sentience may rely on further research, which is theoretically and methodologically appropriate to address this question.

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[1] Proctor (2012)
[2] Birch (2020)
[3] Lambert et al. (2021), p.8

Our Assessment

At present, there is insufficient evidence to conclude the presence of sentience in farmed insects. However, the scale of insect farming is considerable. We believe that conducting further research into the sentience of commonly farmed insects could be an effective strategy for highlighting potential animal welfare concerns in a rapidly developing industry. In the face of insufficient evidence, we adhere to the precautionary principle on this topic, assuming sentience in farmed insects until evidence confirms otherwise.

Importance

Farming insects for nonhuman animal feed and human consumption has been increasingly studied as a cost-effective and environmentally friendly alternative to traditional animal protein sources,[4] such as chickens, pigs, and fishes. Despite the relative novelty of insect farming, an estimated 1–1.2 trillion insects (largely comprised of crickets, mealworms, and black soldier flies) are slaughtered, sold live, or pre-processed annually.[5] Insects account for the majority of farmed invertebrates. Other commonly farmed invertebrates include decapod crustaceans (e.g., crabs, lobsters, and shrimp), with an estimated 253–605 billion farmed a year as of 2017.[6] The farming of octopuses (a cephalopod mollusk) is less common—the world's first commercial octopus farm is set to open in 2023.[7]

The scale of invertebrate farming motivates the consideration of these species' sentience and capacity to suffer. Sentience can be defined as the capacity for both positive and negative subjective feelings and experiences.[8] Of relevance to farmed invertebrate welfare are subjective experiences of pain, suffering, and stress. A recent report[9] that reviewed the evidence of sentience in cephalopod mollusks and decapod crustaceans resulted in such species being officially recognized as sentient in U.K. government policy

[4] van Huis (2020); van Huis & Oonincx (2017)
[5] Rowe (2020)
[6] Fishcount (n.d.)
[7] Marshall (2021)
[8] Proctor (2012)
[9] Birch et al. (2021)

under the Animal Welfare (Sentience) Bill.[10] This review will focus on evidence for sentience in farmed insects due to the fact they have not received this degree of attention and the vast numbers in which they are farmed.

Determining Sentience in Farmed Insects

There is considerable disagreement concerning the likelihood of sentience in insects and the appropriate methods for determining so. Some have adopted an "argument by analogy" approach, supposing that the potential for suffering can be determined by looking for behaviors in insects that would suggest conscious pain in humans.[11] Others question this approach. For example, the case for conscious pain in insects may be challenged by the simplicity of their central nervous systems, including their brains, relative to mammals.[12] However, such anatomical differences do not necessarily mean that insects do not experience suffering comparable to mammals—cephalopods and crustaceans have an advanced visual system that evolved independently from visual ability in humans.[13] Selective pressures may similarly have resulted in the capacity for suffering in insects, serving the same function as it does in vertebrates.

The case for conscious pain in insects may be supported by anatomical and functional similarities to mammals. The capacity for conscious pain is strongly associated with nociceptors: receptors specialized for detecting damage that send signals to the central nervous system and result in reflex withdrawal (a process known as nociception).[14] Evidence for nociception similar to mammals has been reported in a wide range of insects, although it is argued that this system may be more specialized in mammals with evolution of the central nervous system.[15] This is further complicated by the fact that nociception in humans does not always go hand in hand with the negative emotions we

[10] Benyon & Goldsmith (2021)
[11] Birch (2020)
[12] Adamo (2016)
[13] Elwood (2011)
[14] Reichling et al. (2013)
[15] Sneddon (2018)

associate with conscious pain.[16] Direct anatomical comparisons between species may therefore be limited in their current capacity to quantify suffering in farmed insects.

Reviews of farmed insect sentience acknowledge the lack of research on this topic. Many behavioral studies focus on cognitive ability as a possible indicator of the capacity for subjective states rather than directly assessing emotional experience.[17] Several insects have received disproportionate research attention, including fruit flies[18] and honeybees.[19] Crickets are perhaps the most studied of farmed insects.

Crickets

Crickets are the most widely farmed insects at 370–430 billion a year.[20] They have been the focus of many behavioral studies: For instance, crickets have been shown to display context-dependent learning, selectively selecting or avoiding certain odors based on light conditions.[21] While such evidence could be used to suggest the existence of more sophisticated operant conditioning, the authors argue that this is likely a product of simple classical conditioning.[22, 23] Later research[24] provided evidence of second-order classical conditioning in crickets, whereby a conditioned stimulus can indirectly be used to reinforce the properties of an unconditioned stimulus. This was observed for both appetitive and aversive stimuli. Evidence from this study also suggested common processes in the brain for both insects and vertebrates.

Evidence for emotional experience in crickets is limited. Following exposure to a mock predator, crickets have been shown to present behavioral signs of chronic stress, including reduced weight gain, increased sustained flight, and increased concentration of a stress hormone.[25] Such observations could suggest the existence of negative

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[16] Elwood (2011)
[17] Lambert et al. (2021)
[18] Ries et al. (2017)
[19] Bateson et al. (2011)
[20] Rowe (2020)
[21] Matsumoto & Mizunami (2004)
[22] Matsumoto & Mizunami (2004)
[23] Classical conditioning involves associating stimuli with involuntary responses, operant conditioning requires associating a voluntary behavior with a given consequence. For more info, see Cherry (2020).
[24] Mizunami et al. (2009)
[25] Adamo et al. (2011)

experiences in crickets, comparable to stress responses in vertebrates. Alternatively, this could reflect natural responses to the environment in the absence of conscious experience. The state of evidence of crickets is indicative of knowledge concerning other widely researched insects and provides perhaps the most insight into the cognitive abilities of farmed invertebrates. Despite this, current methods appear insufficient to determine the likelihood of their sentience.

Mealworms

Despite being the second most frequently farmed insect at 290–310 billion a year,[26] we were unable to find any research into the cognitive abilities, sentience, or capacity for suffering in mealworms (the larvae of the mealworm beetle). Of nearest relevance was evidence for numerical cognition in mature mealworm beetles,[27] though this is unlikely to provide insight into higher cognitive functions. Any existing welfare considerations for mealworms prioritize immediately observable biological function[28] or nutritional value[29] rather than the capacity for positive or negative experience.

Black Soldier Flies

An estimated 190–300 billion black soldier flies are farmed annually.[30] Despite this, very little has been reported about their capacity for cognition or sentience beyond a study on feed preferences.[31] While the authors argue for the need to investigate black soldier flies' capacity for distress and discomfort, such work has not been conducted to our knowledge. In terms of basic biological function, black soldier flies have been acknowledged as highly sensitive to external environmental factors, increasing the potential relevance of welfare considerations.[32]

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26 Rowe (2020)
27 Carazo et al. (2012)
28 Delvendahl et al. (2022)
29 Adámková et al. (2017)
30 Rowe (2020)
31 Parodi et al. (2020)
32 Shumo et al. (2019)

Generalizability

Sufficient evidence exists to draw conclusions about the sentience of some invertebrates, including decapod crustaceans and cephalopod mollusks.[33] Similarly, certain insect species, e.g., honeybees,[34] have been extensively researched in terms of cognitive abilities. It is unclear whether such findings are likely to generalize to farmed insect species, given that markers of sentience are not uniform across invertebrate taxa.[35] Research explicitly investigating the capacity for cognition and sentience in commonly farmed insects—such as crickets, black soldier flies, and mealworms—may address this concern.

To view all of the works cited in this report, see the reference list.

[33] Birch et al. (2021)
[34] Bateson et al. (2011); Perry & Barron (2013)
[35] Waldhorn et al. (2020)