Ethical considerations for invertebrates
Commentary on **Mikhalevich & Powell** on *Invertebrate Minds*

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Abstract: Mikhalevich & Powell (2020) have built on the discussion about which species deserve inclusion in animal ethics and welfare considerations. Here, we raise questions concerning the assessment criteria. We ask how to assess different species for their ability to fulfill the criteria, which criteria are most important, how we quantify them (absolute or on a continuum), and how non-animals such as fungi and plants fit into this paradigm.

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Mikhalevich & Powell (2020) (M&P) build on a growing discussion about the inclusion and exclusion of specific animals in ethics and welfare considerations. M&P examine consciousness/sentience, cognitive ability, emotion, and the experience of pain to argue that invertebrates, specifically arthropods, should be provided with ethical consideration if they meet the same criteria as protected vertebrates. Invertebrates are often unfairly categorised as 'a lower class of life' or 'simpler' than vertebrates (Browning and Veit 2020) due to their smaller brain sizes and instinctual behaviours. Decades of research, however, indicate that many arthropods show evidence of self-awareness (Briffa and Twyman 2011), cognition (Chittka and Niven 2009), and other complex behaviours. Arthropods are thought to be sentient (Barron and Klein 2016; Klein and Barron 2016), able to experience emotion (Bateson et al. 2011; Mendl et al. 2011), to exhibit behavioural differences in personality (Kralj-Fišer and Schuett 2014), and to perform cognitively demanding tasks such as arithmetic (Howard et al. 2019a; Howard et al. 2019b); they are even able to learn to play 'soccer' (Loukola et al. 2017).

We are inclined to agree with recent commentaries from Vonk (2020) and Levy (2020), however, who argue that cognitive complexity, intelligence, and sentience are not the only criteria for whether a species should be provided with ethical and welfare consideration. None of

the traits mentioned are absolutes; they vary along a continuum. Their presence or absence should neither automatically qualify nor disqualify invertebrates for ethical consideration.

1. Variability in testing. One difficulty in the criteria M&P set out for ethical consideration is that they are not easy to assess. Several arthropods have shown evidence of complex cognitive ability, among others bees (specifically honeybees and bumblebees; Avarguès-Weber and Giurfa 2013; Dyer 2012; Dyer and Chittka 2004; Loukola et al. 2017; Srinivasan 2010) and ants (Cammaerts and Cammaerts 2019a; Cammaerts and Cammaerts 2019b; Cammaerts 2020). The greater accessibility for testing of some arthropods than others complicates the issue.

Social insects such as honeybees, bumblebees and ants, because of their hive environments and foraging lifestyles, are easier to test for learning and cognition than solitary species. Social insects often work for the hive and so do not lose motivation when satiated; they are thus ideal species for studying invertebrate cognition. The relative ease of testing these species may result in other arthropods being overlooked, even though they may have similar levels of self-awareness, cognitive ability, emotion, and pain or discomfort.

Observations of behavioural responses are also influenced by our own human perception of these behaviours. Larger invertebrates inevitably form the basis of most behavioural and physiological analyses because they are easier to manipulate and observe. It is not known how much their behaviours can be extrapolated to all invertebrates. M&P, citing Birch (2017), suggest that we apply the Animal Sentience Precautionary Principle, which advocates that welfare principles be applied to an entire Order where there is reliable scientific evidence of sentience in one of the species in that Order. Precautionary principles are not intended to remove all possibility of risk (COMEST 2005); they depend on the degree of threat — in this case, the likelihood that a species experiences pain, discomfort, or distress.

2. Which criteria matter? M&P review the evidence of cognition, sentience, emotion, and the experience of pain in arthropods to argue for their inclusion in animal ethics and welfare. Questions arise: (i) where do we draw the line on these criteria? and (ii) how many of these criteria does an animal need to satisfy to receive ethical consideration? Bees show a range of complex behaviours and cognitive abilities including facial recognition (Avarguès-Weber et al. 2010; Chittka and Dyer 2012; Dyer et al. 2005), numerical ability (Bortot et al. 2019; Howard et al. 2018; Howard et al. 2019b; Howard et al. 2019c; Howard et al. 2019d; Howard et al. 2020), and relational learning (Avarguès-Weber et al. 2011; Giurfa et al. 2001; Howard et al. 2017a; Howard et al. 2017b). They also demonstrate subjective experience, evidenced by individual differences in learning ability (Dyer et al. 2019; Howard et al. 2019a). Thus, they achieve some of the criteria set out by M&P but may fail at other important criteria such as the experience of pain (Groening et al. 2017), which has not been conclusively proven or disproven. We therefore need to consider what allows an invertebrate to be given ethical consideration. Is it intelligence? Is it the ability to experience pain? Is it evidence of self-awareness? Following that is the question of how we quantify these criteria, and the level to ascribe as sufficient to merit ethical consideration. Primate researchers have long experienced difficulties in quantifying intelligence and cognitive abilities, with the diversity and extent of key behaviours being assessed (Reader et al. 2011). Even with these assessments, however, judgements need to be made as to which traits are most important; and poorly studied species will tend to be ranked lower due to lack of observation. M&P argue

for an absolutist approach which implies that any evidence for cognition, sentience, pain etc., should be taken as arguing for an inclusion in animal welfare, but these traits are part of a continuum, not a binary classification.

3. Other considerations: Organisms without brains. Another consideration for the criteria on which M&P base their arguments is how to interpret and apply ethical considerations when fungi and plants exhibit similar behaviours. Extensive research into slime moulds has shown that they have the ability to perform tasks which would be considered 'higher learning' in vertebrates. Slime moulds are able to navigate mazes (Reid et al. 2012), solve problems (Reid et al. 2016), and use speed-accuracy trade-offs (Latty and Beekman 2010). Plants also exhibit information acquisition, memory, learning, decision making, and reaction to damage (Calvo Garzón and Keijzer 2011; Garzón and Keijzer 2009; Parise et al. 2020). Under some of the criteria set out by M&P, certain fungi and plants should also be eligible for ethical consideration. At which point do we determine whether a species is deserving of protection?

4. Conclusions. M&P have argued that arthropods and other invertebrates should be provided with animal ethics protections. Here, we have raised questions about how to assess different species for their ability to fulfill the criteria, which criteria are most important, how we quantify them, and how non-animals such as fungi and plants fit into this paradigm. As research continues to reveal the complexity of invertebrate brains and behaviour, we will need to consider how their welfare fits into research and everyday life.

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