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Briffa, M

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Sentience in decapods: an open question

Commentary on **[Crump *et al.*]** on *Decapod Sentience*

Mark Briffa
School of Biological and Marine Sciences, University of Plymouth

Abstract: Crump et al.'s framework is a powerful tool designed to assist decisions on the ethical treatment of decapod crustaceans. However, the question of whether decapods are sentient (i.e., whether they feel), remains open, perhaps indefinitely. More optimistically, we might design experiments that distinguish among different levels of awareness, sometimes viewed as components of sentience. We should strike a balance between assuming that all organisms are sentient and making unnecessary anatomical assumptions about sentience. Refining current experiments may provide concrete insights about awareness in Decapoda and other taxa.

Mark Briffa, is Professor of Animal Behaviour, University of Plymouth, UK. He teaches evolution, animal behaviour and marine biology and does research on contest behaviour and animal personality in hermit crabs and sea anemones. **Website**

1. A framework to assist ethical decisions. Crump et al.'s (2022) framework concerning sentience in decapods is motivated by the need to treat animals ethically. It addresses the epistemic component (Birch 2017) of the precautionary principle: taking into account what we know about their anatomy and behavior, how credible is it that decapods could be sentient? Their tentative answer is that some decapods might feel pain.

The framework has practical utility but, it is important not to lose sight of how it should be used scientifically. It is not designed to answer conclusively whether decapods are sentient. Rather, it summarizes, using a graded scale, the accumulated pieces of evidence (a mixture of neurological prerequisites and behavioral signs) that are viewed as *compatible with the possibility* that decapods are sentient. The risk is that this is interpreted – especially outside the scientific community – to mean that sentience is the best explanation for decapod behavior (or the behavior of any organism). In fact, this has not been established at all. From a purely curiosity-driven perspective, the question remains open.

If we assume that ethical expediencies such as those underlying Crump *et al*.'s framework have really answered the question of decapod sentience we risk stifling further research into an especially fascinating set of questions. To show that this is still an open question. I will discuss a few concepts that are central to the decapod sentience framework.

2. The definition and scope of sentience. This is perhaps the trickiest aspect of animal sentience – what does it actually mean? Often it is defined as the ability to experience feelings (e.g. Smith & Boyd 1991, Birch *et al*. 2021, Crump *et al*. 2022, and by this journal, a "journal on animal feeling"). But there are also wider definitions, encompassing various levels of awareness (e.g. Broom 2007 [cf. Broom 2016], Elwood 2022a). Crump *et al*. do not include awareness in their narrower definition of sentience, but they have also broadened the definition in another way by including sensory experiences under the umbrella term "feelings."

The meaning of "experiences" here is not fully resolved. But simply having a sensory channel – a change in cell membrane polarity on the arrival of a photon for example – is not the same as having feelings. There certainly might be feelings associated with the detection of light, but the fact that we can observe a behavioral response to light does not mean that feelings must have been involved. In most cases the relations between stimuli and behavior (or other biological responses) can be explained in simpler ways without recourse to feeling (Briffa 2022, Elwood 2022b).

A second problem with opening up the scope of sentience to include any animal that can respond to stimuli is that this would mean that all animals are sentient – which is exactly what is advocated by the cellular basis of consciousness (CBC) theory (see the commentary of Reber et al. 2022). As with all theories, we need evidence, provided by hypothesis-driven tests, before we can decide whether we should accept them.

Nor does extending "sentience" to all organisms solve the problem of defining it. Although there is general acceptance that sentience is about feelings I think we still lack a clear definition (which would also have to include a definition of "feelings"). I have proposed a starting point (Briffa 2022) whereby sentience could encompass feelings as well as the two higher levels of awareness described by Broom (2007): assessment awareness (insight) and executive awareness (hypothesizing about the future). In contrast, perceptual awareness (detecting stimuli) and cognitive awareness (using stored information) seem to describe basic cognitive functions common to all animals (Shettleworth 2001). As such they do not relate to the functions that most people would recognize as sentient.

3. Criteria for sentience: Assumptions versus evidence. I am accordingly unsure that I would go as far as Reber *et al*., equating sentience with the ability to respond to stimuli. Rather (once we have first agreed on a definition of sentience), I would prefer to derive some predicted indicators of sentience – behavioral or other biological properties, for which feelings or higher levels of awareness would be the simplest valid explanation – and then look for evidence of those indicators in any study species of interest. For this reason, although I think that assumptions about the ability to detect and respond to stimuli are too loose, I think another one of Crump *et al*.'s assumptions is too restrictive. Their criteria for sentience, developed from Smith and Boyd (1991), actually contain a mixture of signs of sentience and prerequisites for sentence, the latter based on assumptions about the neural machinery that would be required to generate it. Crump *et al*. assume that certain brain regions within a centralized nervous system have to be present because information gathered across different channels cannot be integrated in their absence. The ability to integrate different information sources certainly seems like a prerequisite for sentience); but the assumption that specific brain structures are needed to achieve this seems unnecessary.

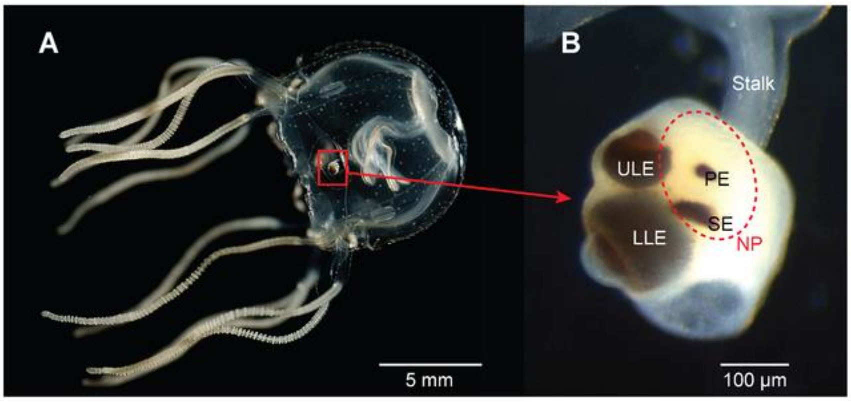

Figure 1: Cubozoan visual system (*Tripedalia cystophora*) (from Bielecki et al. 2014)
(A) Position of a rhopalium, (B) detail: Upper and lower lens eyes (ULE, LLE), pit eye (PE), slit eye (SE) and light sensitive neuropil ring (NP). PE and SE occur in pairs, either side of the lens eyes.

For example, cnidarians have a diffuse nerve net, with some regions of increased neural density and a degree of specialization (Bosch *et al*. 2017). Because they lack a centralized nervous system of the type possessed by bilateral animals, Crump *et al*. assume that they cannot integrate information. Yet cnidarians gather information through a variety of channels using complex sense organs (Bosch *et al*. 2017), and they store information (Cheng 2022); so it seems unlikely that they are not adapted to integrate the different sources of information they can access. Box jellyfish (Cubozoa) like *Tripedalia cystophora* (Bielecki et al. 2014) have 24 eyes of four different types, concentrated into four external visual organs (rhopalia; Figure 1), each containing six eyes. The different eye types within each of the four rhopalia, gather different types of visual information, used for different purposes including navigation (Garm *et al*. 2011) and regulation of swimming speed via neural integration with the pacemaker system (Garm & Bielecki 2008). Different classes of visual information are not the only sensory channel used by cnidarians. In another cubomedusoid, *Carybdea sivickisi*, successful transfer of a spermatophore during copulation involves coordinated responses to both intraspecific visual signals and tactile cues (Bosch *et al*. 2017).

Examples like this demonstrate that we should avoid overgeneralizing when deciding which types of animal might be worth investigating for signs of sentience. Rather than assuming either that all are sentient or that sentience can only be present in animals with particular neural architecture, I suggest approaching any study species of interest with a skeptical but open mind. At the same time, I agree with Comstock (2022) that we should be careful about extrapolating on the basis of disparate information from a relatively restricted range of examples to ascribe sentience to an entire taxon (e.g. Decapoda).

4. Open questions. As Crump *et al*. point out, robust deductive evidence about decapod sentience is limited. Indeed, it has been argued that the question of animal sentience should be exempted from the normal level of uncertainty (5% and less) regarded as acceptable in biology (by the target article, Birch et al. 2021 and Ng 2022). The argument for exemption is actually based on two principles, which are rarely distinguished from one another:

First, there are circumstances in which addressing a potential ethical concern is more important than satisfying our curiosity (Birch 2017). Second, in the context of curiosity-driven science there is a pessimistic view that questions about decapod sentience may not be amenable to standard scientific approaches. Regarding direct access to animal feelings, this may be true, and the best we can do is test for behavior that is consistent with pain (Elwood 2019) but consistent also with other explanations.

I am more optimistic, however, about making and testing hypotheses to distinguish between different types of awareness in decapods. Taking Broom's (2007) criteria as a starting point, we could design experiments to distinguish between patterns of behaviour predicted by perceptual and cognitive awareness versus assessment and executive awareness. Crump et al.'s target article shows that excellent model systems for addressing this open question can be found within the Decapoda.

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