Pain sentience criteria and their grading
Commentary on **Crump et al** on *Decapod Sentience*

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Abstract: On the basis of the target article by Crump and colleagues, we suggest a more parsimonious scheme for evaluating the evidence for sentience. Since some of the criteria used by Crump et al. are not independent and some are uninformative we exclude some criteria and amalgamate others. We propose that evidence of flexible learning and prioritization, in conjunction with relevant data on brain organization, is sufficient for assigning pain-sentience to an animal and we suggest a scoring scheme based on four criteria.

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The target article by Crump et al. is an important contribution to animal welfare research, updating, qualifying and extending the criteria of Smith and Boyd (1991). Crump et al.'s review of the literature on decapods' reactions to harm and tissue damage is crucial for welfare considerations concerning decapods (as well as other groups).

The target article reveals the dearth of evidence so far for aversive and aversion-ameliorating learning, for prioritizing aversive and appetitive stimuli, and even for the basic neuroanatomy of nociception/pain in decapods. The scarcity of data forces the authors to rely on correlative evidence. On the basis of their list of criteria Crump et al. suggest a grading scheme for estimating sentience. Although they recognize that the multiple criteria do not have equal weight, they seem to use the criteria additively in order to avoid the use of a scoring scheme where weights would be arbitrary.

The grading scheme suggested by Crump et al. has additional problems, however. Not all the criteria are informative, and some are not independent. First, we suggest that criterion 1 (Nociception) should not be included in the list because the question asked is whether

nociception or the feeling of pain (which necessarily involves nociception) can explain the behavior and internal state of the animals. Since specific receptors mediate signal transduction in all living organisms, it is self-evident that nociceptors will be present in all animals with nociception. Second, criterion 4 concerning response to modulators of nociception is also redundant (although there is little evidence for it in decapods because of the lack of relevant research). All animals, sentient or not, are likely to respond to inhibitors of nociception (analgesics), as well as to other modulators. We expect that additional research will reveal a universal response to specific analgesics and other modulators in all animals with nociceptive reactions.

> **1. Nociception**
>
> **2. Sensory integration**
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> **3. Integrated nociception**
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> **4. Analgesia**: (a) endogenous (b) exogenous
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> **5. Motivational trade-offs**
>
> **6. Flexible self-protection**
>
> **7. Associative Learning**
>
> **8. Analgesia preference**: (a) self-administer (b) location (c) prioritised
>
> **Crump et al.'s 8 criteria**

Criteria 2 (sensory integration) and 3 (integrated nociception) are necessary conditions for criteria 5 (motivational trade-offs), 7 (associative learning) and 8 (analgesia preference) and plausibly also for criterion 6 (flexible self-protection) (although this is less clear, as it depends on the plasticity of the pain-protecting behavior). Since we believe that 3 is present whenever 2 is present, we suggest joining these two criteria into one (see Table 1, below). Even without direct evidence for 3, if 2 is in place, then 3 can be assumed. Flexible learning and flexible prioritization, tradeoffs and protective behavior require integrative brain areas that receive stimuli via nociceptors. As the authors note, however, there is unfortunately a dearth of studies on the prioritization and learning capacities of decapods (and many other animal taxa). Hence, in the absence of research on tradeoffs, learning and prioritization, criteria 2/3 are indicative of flexible and sophisticated tradeoff, learning and prioritization. This suggests that fulfillment of criteria 5/8c [prefer analgesics over other needs when injured], 7/8a,b [learned self-administration of analgesics when injured, and preference for location of analgesics] (we see 8a,b as a special case of 7 and 8c as a special case of 5) is likely, although current brain data are less convincing than behavioral data.

We therefore suggest excluding criteria 1 (nociception) and 4 (analgesia), as they are always necessary and hence not informative. A specific localized self-protective behavior (criterion 6) is difficult to evaluate because it is not clear how localized it should be for it to clearly indicate a representation of a body image. In conjunction with good evidence for the amalgamated criterion 2/3, however, criterion 6 may be considered a good indicator of feeling pain. Hence, in our opinion, evidence of prioritization and learning of aversive stimuli and their predictors should be given maximal scoring weight, depending on the type of learning involved. As we have suggested elsewhere (Ginsburg and Jablonka 2019), open-ended associative learning (in this case of composite predictors of aversive or aversion-ameliorating stimuli or actions) – which requires multimodal discrimination, motivational

tradeoffs, instrumental goal-directed conditioning, trace conditioning and second order learning – is a very strong indicator of sentience, accompanied invariably by integrative brain areas that support it. Such learning has been shown to be possible (in humans) only when there is conscious awareness (as noted also in the target article). On-line updating and prioritizing requires the same functional cognitive-affective architecture (Ginsburg and Jablonka 2019 pp. 354, 365-366). Although studies of associative learning in decapods are still limited (few studies of discrimination learning and trace conditioning have yet been conducted), the existing evidence points to flexible associative learning capacity in the groups that have been studied.

Hence, we suggest in Table 1 a scoring scheme that uses 4 major criteria with the following scoring: criteria 5 and 7/8 should be given maximal weight (+++), and when there is high evidence for it (H) should be considered as a maximally probable marker of pain. Criterion 6, when highly reliable (H), is given medium-high weight (++), although in conjunction with criterion 2/3 it could be given high weight (+++) and can be seen as a good indicator of feeling pain. With medium reliability (M) the attribution of sentience is somewhat less certain. When learning or prioritizing evidence is lacking, criteria 2/3 should be given intermediate weight (+), so sentience is deemed plausible but not certain.

Table 1: Suggested scoring scheme for probability of sentience

Criteria / Group	Supporting integrating brain areas (2/3)	Motivational tradeoffs (5/8c)	Localized self-protective behaviors (6)	Associative Learning of pain and analgesics (7/8a,b)	Feels pain?
True crabs	H+		H++	H+++	Yes
Anomuran Crabs	H+	M+++	M++		Yes
Astacid lobsters/ crayfish	H+			M++	Very probable
Spiny lobsters	H+			M++	Very Probable
Caridean shrimps	H+		M++		Probable
Panaeid shrimps					???

Our conclusions are based on the information reviewed in Crump et al. and on their evaluation of the behavioral data. Although we use only some of their criteria, our conclusions are very similar. According to the four criteria we chose, and our suggested scoring, the evidence for sentience is strong for true crabs and anomuran crabs, substantial for astacids and spiny lobsters, and probable but less substantial for caridean shrimps. As Crump et al. point out, Panaeid shrimps have hardly been studied, so we know little about their nervous system and behavior. The correspondence between our conclusions and the conclusions reached by Crump et al. on the basis of their additive 8 criteria is encouraging and supports the welfare conclusions they reached. Furthermore, the approach can be generalized to support the attribution of other aspects of sentience to these and other taxa.

References

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