**Pain in Pleocyemata, but not in Dendrobranchiata?**

Commentary on [**Crump et al.**](https://www.wellbeingintlstudiesrepository.org/animsent/vol7/iss32/1)on *Decapod Sentience*

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**Abstract**: Crump et al.’s contribution to assessing whether decapods feel pain raises an important question: Is pain distributed unevenly across the order? The case for pain appears stronger in Pleocyemata than in Dendrobranchiata. Some studies report pain avoidance behaviors in Dendrobranchiata (Penaeidae) shrimp, but further studies are needed to determine whether the chemicals used are acting as analgesics to relieve pain, or as soporifics to reduce overall alertness. If the latter, the most farmed shrimp species may not require the same level of protection as crabs, crayfish, and lobsters.

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More than 160 billion Pacific whiteleg shrimp were harvested for food last year (Albalat et al., 2022). If in the process they felt pain, then extensive reform of one of the world’s largest food animal industries is necessary. If the shrimp did not feel pain, but other decapods—perhaps crabs—did, then policy makers should concentrate efforts on protecting the decapods most at risk of suffering.

Crump et al. make a significant contribution to this question. They present a plausible theory of sentience, identify a set of criteria to recognize it, and provide a comprehensive survey of the relevant studies. Their work lays critical foundations on which others will build.

The findings of the target article suggest a positive, tentative, answer; yes, some decapods probably feel pain. This assessment is far from conclusive, however, as the authors point out, because empirical investigations of the possibility of invertebrate sentience are just beginning. Crump et al. are cautious about their judgments and couch them in probabilistic terms (with levels of confidence from Very High to Very Low).



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| **1. Nociception**  |
| **2. Sensory integration** |
| **3. Integrated** **nociception** |
| **4. Analgesia**: (a) endogenous (b) exogenous |
| **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**

 **Table 1** (from Crump et al. 2022)

 Confidence: Very High (VH), High (H), Low (L) Very Low (VL)

The findings raise the possibility that pain in decapods is not evenly distributed. As illustrated in Crump et al.’s Table 1, the case for pain is strongest in true crabs and hermit crabs (infraorders Brachyura and Anomura), followed by crayfish (Astacidea), and spiny lobsters (Achelata). The case for pain in true shrimps (Caridea) is somewhat weaker. These five infraorders belong to the largest of the two decapod subfamilies, the Pleocyemata, a subfamily of roughly 14,500 species. The second, smaller, subfamily, the Dendrobranchiata, has less than 500 species. Crump et al. mention only two studies focused on the Dendrobranchiata (Penaeidae) shrimp: Taylor et al. (2004), who experimented with the above-mentioned intensively-farmed whiteleg shrimp *Litopenaeus vannamei;* and Puri & Faulkes, (2010), who worked with the equally important aquaculture species, *L. setiferus*. Based on Crump et al.’s survey, roughly 20 of the 15,000 total decapod species have been examined for the possibility of pain.

Any inferences drawn from such a narrow knowledge base are preliminary, but might the Pleocyemata experience pain and the Dendrobranchiata not? In Crump et al.’s Table 1, the top five rows represent five orders of Pleocyemata; the bottom row contains the Dendrobranchiate shrimp, or Penaeidae. In the top rows, the authors express 20 judgments of medium (M), high (H) or very high (VH) confidence that the Pleocyemata meet various pain criteria. In the bottom row they express high confidence for only one of the criteria for the Dendrobranchiata, and medium confidence for another. They have low confidence in the rest of their judgments about Dendrobranchiata. A low confidence judgment, however, “implies only that the scientific evidence one way or the other is weak, not that the animal fails or is likely to fail the criterion.” So we cannot infer from Table 1 that the Dendrobranchiata are likely not to feel pain. Table 1 only shows that the Dendrobranchiata have not been much studied.

The authors might still be over-estimating the case for pain in Dendrobranchiata (Comstock 2022). The two traits that receive a high and a medium vote of confidence are Criteria 1 and 4. Criterion 1 is the possession of nociceptors. Yet as Crump et al. point out, even if an animal has nociceptors, that fact is not sufficient to conclude it is sentient. Nociception is not pain. But the situation may be worse for the Penaeidae because the authors’ high confidence level that Penaeidae have nociceptors is not borne out by any of the studies they cite and is questioned by three of them (Puri and Faulkes, 2010; Sneddon et al., 2014; Walters, 2018). With respect specifically to the Penaeidae, the evidence Crump et al. offer seems to be that “nociceptors are widespread across the animal kingdom” and “decapod crustaceans” are “a sister group” to insects, known to have nociceptors. Yet Puri and Faulkes (2008) found no behavioral evidence of nociception in *Litopenaeus setiferus,* and no neurophysiological evidence of nociceptors for extreme pH in the animal’s primary exploratory organ, the antennae (2010). Parenthetically, Puri and Faulkes (2010) also found no nociception for extreme pH in two Pleocyemata species, swamp crayfish (*Procambarus clarkii*), and grass shrimp (*Palaemonetes* sp.). This suggests that Crump et al. may need to revise downward their confidence level that the Penaeidae have nociceptors.

Crump et al. express medium confidence that the Penaeidae meet Criterion 4 and possess endogenous neurotransmitters modulating pain or respond to local anesthetics. Taylor et al. (2004) lend support. They applied a topical anesthetic, lidocaine, before ablating the eyestalks of 15 *Litopenaeus vannamei*. After ablation, non-treated animals swam erratically, recoiled, seemed disoriented, and self-groomed injured parts. Treated animals did not exhibit these avoidance behaviors. The results suggest an anesthetic response.

However, it is unclear whether lidocaine acts as an analgesic or a soporific. When Parodi et al. (2012) treated *L. vannamei* with eugenol (the active ingredient in clove oil, used to treat toothaches in humans) or lemon verbena oil (*Aloysia triphylla*), the animals became immobilized. Both chemicals induced loss of equilibrium, an effect similar to that observed by Taylor et al. Once the animals were transferred to a tank without the chemical, they returned to normal upright posture within 5 minutes (Parodi et al., 2012). Did eugenol relieve their pain or their proprioception? In another study, Wycoff et al. (2018) found that eugenol slows the heart rate and activity of *L. vannamei*. Within 2 minutes of being injected, shrimp failed to respond to pinches with their characteristic (nociceptive) tail flip. As eugenol’s mechanism of action is not well understood, these results would also be consistent with general paralysis. Further studies are needed to determine whether the chemicals are truly acting as analgesics and relieving pain by, for example, blocking signals from tissue damage, or acting as soporifics and relieving stress by, for example, reducing overall alertness. Meanwhile, Criterion 4 might merit less than medium confidence.

The framework proposed by Crump et al. seems to have an important weakness. It does not provide a way to distinguish between negative evidence and lack of evidence. For example, evidence for pain in Pleocyemata gets weighted with a (positive) confidence judgment, but evidence against pain in Dendrobranchiata receives a "low confidence" judgment. This is misleading because “low confidence” is the *same* judgment used when no evidence is available. The model needs a way to indicate (negative) evidence when an animal does not satisfy this or that criterion. A better framework might be to provide -- for each criterion for each species -- a positive (+) or negative (-) score and a zero score (0) for absence of evidence.

Whether decapod crustaceans feel pain matters morally, scientifically, and economically. Justice requires that we consider the needs of any animal that suffers (Birch, 2017; Birch et al., 2021; Conte et al., 2021; Passantino et al., 2021). If there were strong evidence that Dendrobranchiates do not feel pain, policy makers would need to know that, so as to focus attention on decapods that do.

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