

COMMENTARY

GASTROPODS AND BIVALVES: “BENEFIT OF THE DOUBT” DOES NOT MAKE THEM SENTIENT

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The recent publication by Acosta-Salmón et al. (2026) gave us pause to reflect. This commentary presents information relevant to some of the assertions made in that article. This commentary is not an assailing of those authors; rather, it seeks to inform readers to provide important information for those not familiar with the subject at hand.

In their study of the use of magnesium chloride (MgCl₂) as a relaxant during surgery for pearl implantation in milk conch (*Macrostrombus costatus*) and queen conch (*Aliger gigas*), the authors draw several parallels with vertebrate medicine with respect to “bioethical advancement in pearl aquaculture” and advocate for “the broader integration of veterinary anesthesia principles into invertebrate welfare practices.” The authors placed their results and discussions in the context of ethical standards for invertebrate welfare by stating in their introduction that “it is likely that similar considerations will, in the future, extend to other invertebrates (e.g., crustaceans, bivalves, and gastropods).”

Acosta-Salmón et al. (2026) noted that molluscs (other than cephalopods) lack a centralized brain, but then stated that “growing evidence, particularly from cephalopods, indicates complex neural processing and behavioral responses consistent with pain-like states.” They then invoked the precautionary principle to conclude “it is ethically prudent to assume that conch may experience pain and to adopt an ethical framework for anesthetic protocol selection that prioritizes both immobility and the attenuation of nociceptive signaling.” With this, and their discussion of the distinction between nociception and pain perception, they repeated the same errors made in many recent articles on invertebrate welfare [summarized in Browman et al. (2019) and Diggles et al. (2024)].

Nociception is not pain. The International Association for the Study of Pain (2020) defines pain as “An unpleasant sensory and emotional experience associated with, or resembling that

associated with, actual or potential tissue damage.” Thus, a gastropod or bivalve can only experience pain if they are conscious sentient beings (Humphrey 2025), which requires that their noncentralized nervous system and associated neurobiology is capable of generating an emotional pain response. Evidence of such is lacking.

Diggles et al. (2024) present several reasons why skepticism should be applied to claims for sentience and pain in these taxa. Ignoring the current debate regarding cephalopods for a moment [and the associated attempts to ban cephalopod farming, see Crump et al. (2022) and Gleadall et al. (2025)], gastropods and bivalves also react in response to visual, chemical, noxious, and other environmental cues (Walters 2018, Selbach et al. 2022) with stereotypic escape responses and avoidance swimming triggered, for example, by discrete chemosensory and mechanical stimuli (Stephens & Boyle 1978, Wilkens 1981). Even then, adaptive “more than a reflex” responses to noxious stimuli occur without brain involvement in not only molluscs (Walters 2022) but most, if not all, aquatic taxa, including amphibians, an indisputable fact that has been known for over one and a half centuries (Klein 2018). Importantly, these avoidance responses do not signal pain, even though they are often misconstrued as such.

In addition, aquatic molluscs are physiologically very distinct from vertebrates. For example, the hemocytes circulating in the hemolymph are capable of responding to and mediating neuronal immunomodulation by controlling the expression of specific neurotransmitter receptors on cell surfaces and modulating their binding sensitivities (Liu et al. 2016, Malagoli & Ottaviani 2017). Second, aquatic molluscs have relatively loose cellular communications such that gills can be removed and the gill tissue will keep functioning in a petri dish of seawater for days (Van Winkle 1972, Axiak & George 1987). Likewise, clams continue to function with severe lesions including digestive tubule and intertubular tissue necrosis (Costa et al. 2013), and pearl oysters tolerate large tissue excisions, probably because this reflects adaptation to recovery from damage by natural predators (Acosta-Salmón & Southgate 2006). Although these

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circumstances might be seen by a human as “painful” through an anthropomorphic lens, the behavior of the affected molluscs is, in fact, normal (Bowmer et al. 1994, Pires et al. 2022).

Various criteria for identifying sentience in invertebrates have been proposed (e.g., Birch et al. 2021). Following recent studies of the neurobiology of these organisms, some of these criteria, such as motivational trade-offs (Walters 2022), are being reclassified as innate neural mechanisms rather than indicators of sentience (Brembs 2026). In other words, these neurobiological discoveries explain how what appears at face value (under an anthropomorphic lens) to be conscious decisions based on a trade-off are actually not that at all. Virtually all organisms react to their surroundings, and these recent attempts to adjust the definition of sentience misinterpret many well-known aspects of invertebrate biology.

For these, and other reasons presented in Diggles et al. (2024), invoking the precautionary principle to extend “the benefit of the doubt” on sentience to lower vertebrates and invertebrates is not scientifically justified. The main issue here is that by invoking the precautionary principle to extend sentience to gastropods, this would (under the assumed future scenario) invite legitimate questions regarding why bivalves and other shellfish are not treated the same way, resulting in a risk of bans on the consumption, for example, of fresh, live oysters in those jurisdictions with strong animal welfare legislation (Diggles et al. 2024). Unless there is arbitrary decision-making, these sorts of potentially unintended consequences would in fact be logical outcomes of such a process, demonstrating how the slippery slope of the precautionary principle (or “benefit of the doubt”) can neutralize everything, including common sense (Diggles et al. 2024).

A significant proportion of research into invertebrate sentience over the past decade has been funded as part of campaigns by organizations that support and advocate for animal welfare and animal rights. A prominent example is Open Philanthropy (now Coefficient Giving), which has a stated aim (published on their website <https://coefficientgiving.org/funds/farm-animal-welfare/>) to:

“support efforts to end factory farming and improve the lives of animals confined on factory farms”

This mission statement has two objectives which are incompatible, as the primary animal rights objective makes the secondary animal welfare objective redundant. If factory farms are shut down, there are no lives left to improve.

Following the Effective Altruism (EA) approach, their objective is to “expand the moral circle” to include invertebrates and lower vertebrates under animal welfare legislation, specifically to morally transition these animals from “resources” to “sentient beings.”¹ Effective Altruism’s position is that although there are billions of farmed terrestrial vertebrates on Earth, there are trillions of insects, fish, crustaceans, and molluscs in culture or in capture fisheries.² Thus, by targeting the latter animal taxa, funders and advocacies that embrace EA can point to how their funding of research into the welfare of invertebrates (including insects), and their support of concomitant advocacy and lobbying efforts, yields the highest return on investment by targeting the highest numbers of animals that are allegedly suffering.³

Because only sentient conscious animals are covered by welfare legislation in most jurisdictions (Browman et al. 2019), establishing that invertebrates are sentient has been a key

objective of EA activism. Sentience is essential for expanding the moral and legislative circle to achieve the *a priori* target of trillions of affected beings, which is why EA-aligned animal rights groups have targeted establishing sentience–consciousness–pain–suffering in these animal groups.

A significant percentage of research in this field over the past decade has, therefore, been funded and driven by animal rights activism, which is not necessarily in the best interests of animal welfare⁴ or food security (Diggles et al. 2024). This is especially so when these very same groups have also funded on-the-ground activism, media campaigns, and litigation against industry to the tune of many hundreds of millions of US dollars and are themselves heavily invested in the development of artificial meat products.^{5,6} The likely outcome of many of these activist campaigns (e.g., opposition to the use of ice slurry for shrimp harvest in favor of electrocution), if they were to be successful, would be to force industry to harm animals⁴ and infringe evidence-based animal welfare regulations (Weineck et al. 2018).

We support aquatic animal welfare using functional criteria (Diggles et al. 2024) and based on the results of Acosta-Salmón et al. (2026) and others support the use of magnesium chloride as a relaxant during surgery for pearl implantation whenever it results in improved postoperative survival and growth. Nevertheless, we also note that previous work in this field suggests little observed benefit from the use of a wide range of anesthetics in bivalves (Mamangkey et al. 2009). Magnesium chloride has long been used as a muscle relaxant in many animal species due to its effects at neuromuscular junctions (synapses between motor neurons and muscle), specifically by competing with calcium at calcium-dependent voltage-gated channels on the postsynaptic (muscle) side of these synapses. It can also affect other types of ion channels, however, including action potentials along axons of afferent neurons in molluscs (Butler-Struben et al. 2018). In fact, magnesium chloride can be used to broadly affect excitability of nerves and muscles in most, if not all animals with nervous systems; however, the exact mechanisms of its action in most invertebrate species are unknown. Hence, its efficacy as a muscle relaxant tells us nothing about the existence of pain in molluscs.

We reiterate earlier warnings that without application of organized skepticism, verification, and critical thinking, there is a high risk of abandoning rigorous scientific evidence with potentially significant consequences for both animal welfare and global food security (Browman et al. 2019, Diggles et al. 2024). This is why we urge caution when authors uncritically extend the “benefit of the doubt” to various invertebrate groups while at the same time drawing unsupported direct parallels between aquatic invertebrate and terrestrial vertebrate welfare. Few readers will be aware of the unprecedented extent of activist activity pervading the literature and the societal-policy-legislative sphere on this subject, especially in any publications that exclude the requirement to declare funding by nonprofit organizations and charities. This needs to be recognized by all researchers and readers whenever they read a scientific paper, news article, online post, or AI-generated search engine output that alleges pain in lower vertebrates and/or invertebrates, including cephalopod, gastropod and bivalve molluscs, crustaceans, urchins, and sea cucumbers (i.e., all those taxa classified as shellfish by the FAO).

Finally, the assertion that fish, decapods, insects, cephalopods, gastropods, bivalves, and copepods (Giske et al. 2026)

are conscious, sentient beings capable of experiencing pain and suffering can be framed using the concept of synthetic consensus. A claim enters synthetic consensus when it is repeated without verification. Each reuse increases its apparent legitimacy, regardless of the strength of the evidence (Kehl 2026). Synthetic consensus develops from this repeated production, dissemination, and citation of the assertion. Specifically, a rapidly expanding body of publications and statements repeats the proposition. This is algorithmically amplified via social media, online encyclopedias, and traditional information dissemination channels, which are all then amplified online by AI Large Language Models, exponentially increasing its apparent prominence. Network coordination arises when interconnected researchers, institutions, advocacy organizations, policy bodies, and other authors cite and reinforce one another, creating the appearance of independent convergence even where the evidential base is weak. Ultimately, there is a tendency to interpret repeated and apparently widespread agreement as evidence that the proposition is true: once fish, decapod, insect, cephalopod, copepod, gastropod, and bivalve sentience becomes treated as an established premise, subsequent authors are more likely to accept it, cite it, and build further conclusions upon it, including claims of pain, suffering, moral status, and the need for legislative protection.

It is critical that readers distinguish this synthetic consensus from independent empirical corroboration: the number of publications, citations, institutional statements, or policy references supporting the proposition should not be uncritically accepted as evidentiary strength of the claim. Rather, the reader, certification bodies, and all those institutions responsible for research and governance should ask whether independent evidence demonstrates consciousness, sentience, pain, and suffering in these taxa, and whether the evidence of those capacities is sufficient to infer a societal obligation to legislate protection. As previously pointed out by Diggles et al. (2024),

“Never before in the field of human food security, has so much been put at risk for so many, based on so few verifiable facts”

DECLARATION OF INTERESTS

This commentary was written without funding by a broad global cross-section of research scientists who work in a diverse range of fields involving research on fish and aquatic invertebrates as well as on applied aspects of fisheries and aquaculture.

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S.J. Cooke is a professor at Carleton University, Ottawa, Canada, where he leads the Canadian Center for Evidence-Informed Conservation. He has never had funding specific to the sentience–pain–suffering of animals and works primarily on the ecology, conservation, and sustainable management of wild fishes. He is involved in a number of initiatives focused on evidence-based approaches to the development of welfare guidelines for fishes.

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All the authors fish for and/or eat seafood; otherwise, there are no relevant competing interests to declare.

NOTES

¹ <https://forum.effectivealtruism.org/posts/JixMwL5fxCTuQB6D9/animal-welfare-fund-november-2020-grant-recommendations>.

² <https://forum.effectivealtruism.org/posts/Zo3uNBiZ5GN35hkfq/the-usd120-million-question-how-will-it-help-animals>.

³ <https://coefficientgiving.org/research/big-wins-for-farm-animals-this-decade/>.

⁴ <https://forum.effectivealtruism.org/posts/svjqgyFuFQ34qSgmw/animal-welfare-has-an-evidence-problem>.

⁵ <https://coefficientgiving.org/funds/farm-animal-welfare/>.

⁶ <https://nypost.com/2026/07/11/us-news/facebook-co-founder-dustin-moskovitz-funds-anti-meat-campaigns-despite-eating-meat-himself/>.

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