Scottish Animal Welfare Commission

Principles for ascribing sentience to animals and case study of the evidence for sentience in cephalopods

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Introduction

1. The Scottish Animal Welfare Commission (SAWC) was established by the Scottish Animal Welfare Commission Regulations 2020, made under section 36 of the Animal Health and Welfare (Scotland) Act 2006. The function of providing advice on the protection of wildlife under section 23 of the Wildlife and Countryside Act 1981 has been assigned by Ministerial declaration.

Further information on the Commission, including reports and minutes of previous meetings, is published when available; see https://www.gov.scot/groups/scottish-animal-welfare-commission/

2. SAWC's terms of reference are to focus on the welfare of wild and companion animals in Scotland while also providing scientific and ethical advice to the Scottish Government. The Commission will only consider areas that are within the normal current remit of the UK Animal Welfare Committee and the UK Zoo Expert Committee where these relate to the overall responsibility to consider the welfare needs of sentient animals in all areas of Scottish Government policy or at the specific request of the Minister. The Commission will not consider matters that are reserved to the UK Government, including the welfare of animals used in scientific procedures.

The Commission will provide written reports and opinions to Scottish Ministers giving practical recommendations based on scientific evidence and ethical considerations on the welfare of sentient animals in Scotland, and the impact of policy on welfare.

Scope

(i) to provide a study of the evidence and thought processes underlying the ascription of sentience; (ii) to apply these principles to the case of cephalopods.

Part of the work of SAWC has been the development of a definition of sentience, which we published online on 10th February 2021.

SAWC defines animal sentience as: ‘the ability to have physical and emotional experiences, which matter to the animal, and which can be positive and negative’.

Determining whether an animal is sentient is complex and relies on balancing the weight of evidence from neurological, behavioural, anatomical, physiological and cognitive studies. We consider that the animals for which the threshold for evidence of sentience has been exceeded, and thus for whom a consideration of animal welfare is important, include: vertebrates (mammals, birds, fish, reptiles and amphibians), and cephalopods (e.g. octopus and squid) and is likely to include decapod crustaceans (e.g. crab and lobster).

As a further continuation of these ideas, this document sets out an approach for justifiably ascribing sentience to some animals, followed by a case study for one group (cephalopods) to demonstrate the application of scientific evidence to the assumptions of sentience.

Part 1

Principles for ascribing sentience to animals

Background: Why ascribe sentience?

The need to determine which species are sentient is a welfare issue, an ethical issue, and a policy issue. Sentience is a capacity by which animals can have experiences that matter to the animal (e.g. suffering), and promoting animal welfare means increasing positive experiences and reducing negative experiences. We have a moral obligation to treat sentient animals as sentient in order to prevent or reduce unnecessary suffering and human activity should consider the impact on animals who are potentially sentient. In some cases, this should be ensured by governmental policy. Indeed, modern policy and legislation designed to protect the welfare of animals in Britain and Europe are predicated on an acceptance, underpinned by scientific opinion, that many animals are sentient (Radford, 2001). Increasingly, the debate now focuses on which animals meet the relevant threshold, and how that threshold is defined and met.

Defining sentience

The SAWC defines animal sentience as an ability to have physical and emotional experiences. These experiences matter to those animals, positively or negatively. There may be a variety of experiences in different animals.

This definition means sentience is not a particular cognitive process or behaviour per se. However, sentient animals may have different cognitive and emotional capabilities, which means that they have different needs and wants. Cognitive and behavioural capacities may also facilitate evidence of sentience (e.g. demonstrating goal-directed learning).

Ethical considerations

Our ethical duty to minimise unnecessary suffering implies a requirement to determine, robustly and fairly, which animals are sentient. Avoidable ignorance, metaphysical uncertainty or excessive scepticism are not, in themselves, valid excuses for causing suffering. We should not require impossible “proof” of sentience and avoid over-simplistic categorisations that deny sentience unscientifically (e.g. unthinking presumptions that only certain taxa can be sentient).

In ascribing sentience, we should use criteria which we would want others to apply to ourselves, defining “others” in sufficiently generic ways. We should determine practically what evidence is sufficiently convincing to affect our decisions or legislation, in a sufficiently open-minded, but not overly credulous, way. The strength and weight of evidence we consider convincing should depend on multiple factors, including the potential severity of the interventions under question (e.g. if the animals are sentient, what suffering could be caused), and their benefits to sentient animals (e.g. the benefits of biomedical research to vertebrate patients). In practice, we should err on the side of caution in avoiding suffering, except where this disproportionately increases the risks of suffering for other sentient animals.

Evidence relevant for ascribing sentience

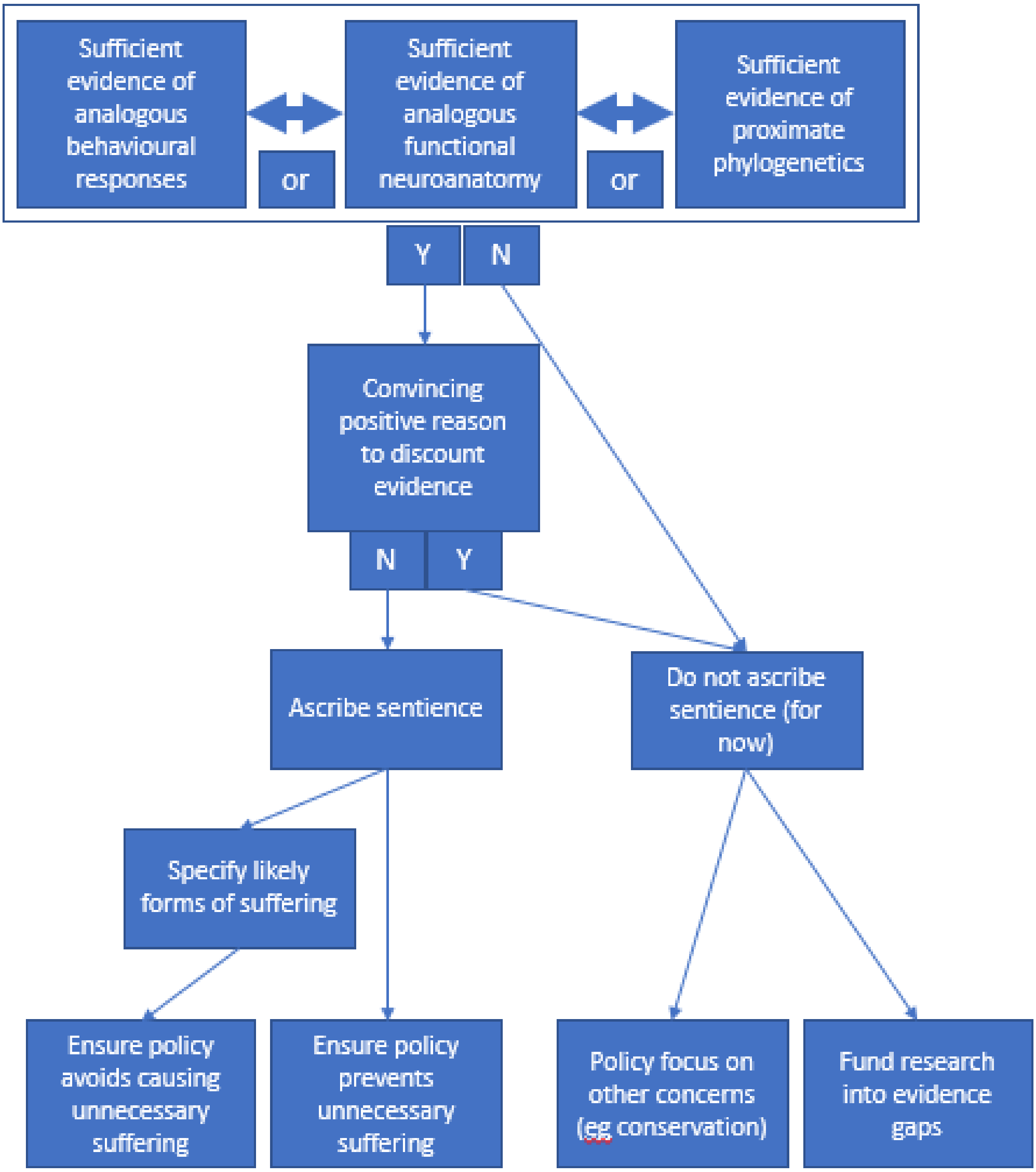
A key question is how to evidence that an animal has passed a threshold where it should be considered sentient? Many scientists consider that we can never be completely sure that an animal is or is not sentient, but only formulate our best belief through the accumulation and review of evidence. This is a critical approach that considers the strength of evidence in proportion to our confidence that an animal has a feeling. Where the evidence is stronger, we should generally be more confident. A multifactorial, rather than a linear approach has been suggested to understand interspecies variation in states of consciousness (Birch et al, 2020). An alternative approach, based on philosophical thinking, suggests that animal emotions can be directly assessed, through observation and measurement of 'whole animal expressivity' (a process of Qualitative Behavioural Assessment or QBA; Wemelsfelder, 2007). This process considers it is possible to gain a direct window on animal sentience, rather than inferring feelings from other measures.

Methodologically (Figure 1), we can form plausible hypotheses of what animals may feel, and then use evidence to form conclusions. This process can be iterative, as we can only ever reach plausible but provisional views that we might change in light of further evidence. It should also aim to triangulate across all available evidence. As an overall scientific endeavour, this should inform both our ascriptions of sentience to particular animals, and the development of criteria and methods by which to do so.

Evidence of sentience might combine data from multiple sources, including:

1. Phylogenetic "proximity" to other species who have been deemed sentient
2. Neuroanatomical functioning
3. Behavioural indicators.
4. Qualitative Behavioural Assessment

Overview of process for ascribing sentience to nonhuman animals (Figure 1)



1. Phylogenetic "proximity" to sentient species

One approach is to consider how closely species are phylogenetically, to humans. This assumes that the evolution of sentience occurred at some point in the phylogenetic "tree" – how far back affecting how widely to ascribe sentience (e.g. Vertebrata, Nephrozoa, Animalia). However, current evolutionary thinking suggests that complex brains and high intelligence have evolved multiple times and independently (Roth, 2015; Amodio et al., 2019). Such convergent evolution suggests that it is aspects of animals' niche or lifestyle that may be associated with the evolution of neurological or cognitive capacities (Irwin, 2020), rather than phylogenetic proximity to humans. Nonetheless, in some cases, phylogenetic proximity might be a useful practical assumption (not least in a general assumption that other humans are sentient without always assessing their individual behaviour, and also to be able to generalise conclusions from scientific evidence across a clade rather than repeating every experiment for every species or individual).

2. Neuroanatomical functioning

On the assumption that sentience can be modulated in neurological structures (e.g. brains), evidence of particular neurological functions associated with affective processing may provide support for ascribing sentience. Again, the possibility of convergent evolutions would also suggest that sentience might occur in a variety of structures (e.g. a multi-layered brain cortex; Mellor 2019), since comparable functions might be achieved by different neuroanatomical structures, so the comparison is one of analogical neurological functions rather than specific structures. It is also worth noting that the capacity for sentience per se does not obviously require the degree of anatomical complexity that is exhibited in humans.

3. Behavioural indicators

Behavioural indicators also provide evidence for valenced emotional or motivational states (on the general assumption that such states affect an animal's behaviour). Some relevant behaviours represent relatively simpler responses or motivations (e.g. withdrawal, approach, and avoidance). However, these are sometimes seen as harder to differentiate convincingly from "reflex" actions (which might theoretically occur without associated experiences). Stronger evidence may be provided by behaviours linked to processing of emotional states. For example, Sneddon (2020) suggested that sentience could be demonstrated by evidence for second order processes such as evaluating others' actions, relevant memory, and evaluative decision-making. We should remember that these may provide additional evidential support for ascribing sentience, but such higher cognitive abilities are not required for sentience (e.g. one can feel pain without being able to write a novel on it).

4. Qualitative Behavioural Assessment

Looking at animals, we do not just see physical behaviours, such as walking or eating; we also see that these behaviours are performed in different ways. There is a continuous stream of dynamic emotional expressivity in everything an animal does, indicating how it is experiencing a situation. A pig, for example, can walk towards a human in a way that is relaxed, confident, and curious, or hesitant, nervous, and on-edge. QBA is designed to describe and quantify such 'whole animal' expressivity, and has been shown, across decades of research, to be rigorous, reliable and valid in vertebrates. QBA assessments are generally found to correlate well to behavioural and physiological measurements, and to provide an additional layer of information reflecting an animal's subjective perspective that cannot be gained in other ways. This extra 'layer of information', is not merely another spoke in a wheel, but creates crucial connections between the science and practice of animal welfare, and between scientific and public views of animals

Suggested forms of evidence are listed in Table 1.

Table 1. Categories of evidence to be considered in relation to sentience

Category of Evidence	Capacity	Example References
Phylogenetic proximity		
	Membership of humans' clade Vertebrata/Chordata/etc	
	Membership of clade of another species with evidence of sentience (using other criteria)	
Neuroanatomical functioning		
	Nervous system sufficient in structure and functioning to enable experience	Winlow and Di Cosmo 2019 Mellor 2019 Sneddon et al 2014
	Possession of higher brain centre, analogous to the human cerebral cortex	Andrews et al. 2013
	Possess receptors sensitive to stimuli connected by nervous pathways to a central nervous system and brain centres	EFSA 2005 Walters 2018
Behavioural indicators		
	Plasticity of Behaviour	EFSA 2005
	Complexity of behaviour	EFSA 2015
	Behaviour consistent with personality	Voss 2016
	Stereotypy response to stress	BIAZA 2011
	Discrimination and generalisation	EFSA 2005
	Reversal learning	EFSA 2005
	Flexible problem solving (such as tool use)	Amodio et al 2019
	Evaluate the actions of others/form relationships	Sneddon 2020
	Integrative perceptive abilities	Macknick 2006, Hanlon et al 2009
	Spatial awareness and formation of cognitive maps, as evidence of primary consciousness	Mather 2008
	Deception	Jozet-Alves et al2008
	Appropriate performance in operant studies	EFSA 2005

Specific affective states

The SAWC definition of animal sentience was one of the first to explicitly recognise that (many) sentient animals can experience a range of both positive and negative emotions. Evidence for (the capacity to have) a particular emotional state may be considered as evidence of sentience, insofar as sentience is an umbrella term for the ability to have various such states. Evidence of sentience may therefore come from evidence of (as examples): pain (see below) or malaise; discomfort; fear or distress; pleasure or enjoyment; motivation, frustration or relief; and longer-term moods.

Evidence for one state does not necessarily imply the ability for all other emotional states (e.g. an animal may be able to experience pain, and so be sentient, but not boredom). However, the SAWC assumes firstly, that if an animal can experience one such emotion, it seems more plausible that it may experience other such states in the absence of sound scientific arguments otherwise (i.e. the burden of proof shifts). Secondly, from the perspective of animal welfare, if the animal has the capacity to experience any such state, then we should consider its welfare as relevant and worthy of protection overall.

Pain and sentience

Pain is an element of sentience that merits particular consideration. Pain is the unpleasant emotional component of experiencing a noxious stimulus. It can lead to the alterations of behaviour on the expectation that sentient animals will aim to avoid or minimise pain (where possible and not outweighed by another motivation).

In addition to simple reflex responses to noxious stimuli, stronger evidence of sentience is given by demonstration that the animal has an experience of pain, for example that the animal attends to the noxious stimulus. Sneddon et al (2014) argue for two key concepts to be used to evaluate the capacity for pain:

1. Responses to noxious, potentially painful events should affect neurobiology, physiology and behaviour in a different manner to innocuous stimuli. This might be evidenced by subsequent behaviour being modified, such as avoidance learning and protective responses.
2. Animals should show a change in motivational state after experiencing a painful event such that future behavioural decision making is altered. This might be measured as a change in conditioned place preference, self-administration of analgesia, paying a cost to access analgesia or avoidance of painful stimuli and reduced performance in concurrent events

A simplified version of Table 1 can then be applied to assess whether, on the balance of evidence, an animal can be considered to be capable of experiencing pain (Table 2, adapted from Sneddon et al., 2014).

Table 2: Categories of evidence to be considered in relation to pain experiences

Neuroanatomical functioning
Presence of nociceptors (i.e. receptors sensitive to noxious stimuli) Central processing in brain Physiological responses to noxious stimuli Pathways from nociceptors to CNS Receptors for analgesic drugs (e.g. opioid receptors)
Behavioural indicators
Responses with high priority over other stimuli (e.g. ignores other cues) Behavioural changes from norm due to noxious stimuli (short and longer term) Altered behavioural choices/preferences (e.g. showing unwillingness to resubmit to a painful procedure Movement away from noxious stimuli Protective behaviour Rubbing, limping or guarding Trade-offs with other requirements Self-administration of analgesia No Pay cost to access analgesia Relief learning Paying a cost to avoid stimulus Modulation of behaviour due to analgesics Verbal communication of an experience associated with noxious stimuli

Evidence against sentience
We should also consider any relevant reasons to give less weight to evidence for sentience. For example, humans' programming of robots' responses means that cognitive or behavioural evidence that might legitimately support ascribing sentience to a "natural" animal should be viewed as less convincing in manmade robots. However, it is worth noting that arguments that weaken the force of evidence in implying sentience are not in themselves reasons to deny sentience.

We should avoid or try to overcome unwarranted biases towards discounting evidence in some animals that we consider convincing in others. For example, there may be cultural "prejudices" against ascribing sentience to less humanlike or familiar species (Broom 2016). For example, we should not assume that mammalian brain function is superior to other animals', especially given evidence that fish have cognitive capabilities that mammals appear to lack (Sneddon et al. 2018).

Conclusions and recommendation

The SAWC recommends that animal welfare policy in Scotland should have regard to and build on its current definition of sentience, including negative and positive welfare. This should identify which animals should be considered sentient, which specific emotions should be considered, and the implications thereof for how such animals should be treated. It is legitimate to commence the process of ascribing sentience to animals by considering the question of pain and the criteria set out above offer a useful approach.

Part 2

Ascribing sentience to cephalopods: a case study

Background
The cephalopods are represented by over 800 exclusively marine living species, including squid, octopus, cuttlefish and nautilus (Jereb and Roper, 2010). The invertebrates show an enormous diversity of species with profound differences in their body plan, nervous organisation and cognitive capacity. The most advanced class among the invertebrates is the Cephalopoda, which possess the largest invertebrate nervous system (Zullo and Hochner, 2011).

Cephalopods are a significant source of food for humans, are popular aquarium exhibits, and have been considered valuable experimental subjects. For example, the squid giant axon enabled the discovery of the basic mechanisms of the action potential (Hodgkin and Huxley, 1952), and fundamental discoveries were also made about mechanisms of neurotransmitter release at the squid giant synapse (Katz and Miledi 1967).

In recent years the question of their sentience and consequent need for legal protection has been the subject of considerable discussion. The cephalopod molluscs and the decapod crustaceans are believed to be the most cognitively developed and intelligent invertebrates (Winlow and Di Cosmo, 2019). They are consequently often used as the "next" taxon to consider for sentience after vertebrates, and therefore an illustrative example of the approach proposed and adopted by the SAWC.

Cephalopod welfare protection in law
As with most animals used as a resource for humans, the need for legal protection in different contexts has begun to be recognised, but this remains limited.

There is currently no general welfare protection for cephalopods in Scotland. Section 16 of the Animal Health and Welfare (Scotland) Act 2006 refers to protected animals as being "vertebrates other than man" and specifically excludes protection for foetuses or embryos. The Act does allow for Scottish Ministers to regulate for the extension of this definition to include invertebrates but only on the proviso that scientific evidence can be found to show that such invertebrates are "capable of experiencing pain or suffering" (Animal Health and Welfare (Scotland) Act 2006, section 16(4)).

Cephalopods have been included in various national codes of practice and legislation covering research in several countries outside the EU, for example: Canada, 1991; New Zealand, 1999; Australia, 2004; Switzerland, 2011; Norway, 2011 (Smith et al., 2013; Fiorito et al., 2014). One species of cephalopod, Octopus vulgaris, was added to the UK Animals [Scientific Procedures] Act 1986) in 1993, while the Animals (Scientific Procedures) Act 1986 Amendment Regulations 2012 extended protection to any living cephalopod, excluding embryonic forms. Humane killing of cephalopods in contexts other than scientific research is not a statutory requirement in any EU member state.

Through Directive 2010/63/EU on the protection of animals used for scientific purposes, cephalopods gained the same EU legal protection as previously afforded only to vertebrates (Fiorito et al., 2014). The Directive, which came into force in 2013, marked a paradigm shift in policy, by including an entire Class of Molluscs.

Much of the evidence for inclusion of cephalopods in the Directive is based upon various aspects of neuroscience research on cephalopods (Fiorito, 2014). In the European Food Safety Authority Opinion on the "Aspects of the biology and welfare of animals used for experimental and other scientific purposes" (EFSA 2005), the Scientific Panel on Animal Health and Welfare (AHAW) concluded that Directive 86/609/EEC relating to the protection of animals used for experimental and other scientific purposes should be revised to include cephalopods. Stopping short of claiming that cephalopods were sentient, the AHAW argued that "cyclostomes, all Cephalopoda and decapod crustaceans fall into the same category of animals as those currently protected" (EFSA 2005). The decision to include cephalopods was based primarily upon the recommendations of a scientific panel which concluded that there was "scientific evidence of their ability to experience pain, suffering, distress and lasting harm" (i.e. Directive 2010/63/EU: Recital 8, European Parliament and Council of the European Union 2010).

Categories of evidence to be considered in relation to sentience

Some authors have stated that proving the ability for experiences is infeasible (Walters, 2018). A counter argument uses the precautionary principle, arguing that certain species should be assumed to be sentient given the current limitations of science (Sneddon et al 2018). We have taken a middle ground of considering the multiple sources of relevant evidence relating to neuroanatomical, behavioural and cognitive functions.

Using the criteria laid out in Table 2 we have considered the evidence in support of pain responses and thus sentience for cephalopods.

1. Phylogenetic "proximity" to sentient species

Cephalopods are, like mammals, classified within Eumetazoa and ParaHoxozoa, but are not very closely related to mammals. However, the evidence of convergent evolution in various cognitive functions suggests this phylogenetic distance is not a sufficient reason to reject ascriptions of sentience based on other categories of evidence. Convergent evidence indicates that many non-human animals, including some cephalopods, possess the capacity for consciousness (Low, 2021)

2. Neuroanatomical functioning

<u>Nociceptors</u>

In both squid and octopus, mechanical force applied to the tentacles or arms results in rapid behavioural responses (withdrawal of the damaged limb), and sensitisation of responses to further stimulation (Crook et al., 2013; Perez et al., 2017). Further examination demonstrates the presence of neurons that only responded to noxious stimuli, and which are more reactive (sensitised) following previous injury (Perez et al., 2017). Interestingly, as seen in mammals, there is evidence that early life injury in squid permanently alters neural excitability to later stimulation (Howard et al., 2019).

Neurological anatomy
In the European Food Safety Authority Journal report 2005 (EFSA 2005), the authors state that there is evidence that 'cephalopods have a nervous system and relatively complex brain, similar to many vertebrates, and sufficient in structure and functioning for them to experience pain.'

Evidence for this includes;

a. they release adrenal hormones in response to situations that would elicit pain and distress in humans
b. they can experience and learn to avoid pain and distress such as avoiding electric shocks
c. they have nociceptors in their skin
(EFSA 2005)

Cephalopods have been shown in at least one taxon to have receptors for anaesthetic drugs (Sneddon et al., 2014). Additionally, anaesthesia in octopus and cuttlefish has been demonstrated to act in a similar way to mammals, by providing strong and reversible blockade of afferent and efferent nerve activity (Butler-Struben et al., 2018). These data suggest that cephalopods show loss of consciousness and anaesthesia when treated with drugs that have similar impacts in vertebrates, and that this is not merely immobility when applied to these animals.

3. Behavioural indicators
The complex behavioural and learning capabilities of cephalopods (Hanlon and Messenger 1996; Borrelli and Fiorito 2008; Huffard 2013) correspond to a highly sophisticated nervous system that appears to be correlated with their lifestyle (Nixon and Young 2003; Borrelli 2007 in Fiorito et al 2014).

As noted in EFSA (2005), cephalopods can experience and learn to avoid pain and distress such as avoiding electric shocks, they have significant cognitive ability including good learning ability and memory retention, and they display individual temperaments since some individuals can be consistently inclined towards avoidance rather than active involvement.

Octopus and squid show behavioural sensitisation following injury, involving defensive behaviours (Alupay et al., 2014), which are expressed earlier under threat of predation than in uninjured animals (Crook et al., 2014). These responses could be interpreted as an adaptive response to avoid predation, as fish predators target injured animals over uninjured, and suggest altered behavioural choices or responses.

During periods of stress, Giant Pacific Octopuses may show signs of stereotypy, by pacing around the tank, or sitting under water returns for long periods of time – however these may also be signs of poor health or senescence (BIAZA 2011). Giant Pacific Octopuses react rapidly to environmental changes or external stimuli with physiological consequences that can be relatively long lasting (Fiorito et al, 2015), and signs of stress may include autophagy, non-healing epidermal lesions (Anderson et al, 2002) and reduced epidermal colour change (AITAG 2014).

Cephalopod behaviour and memory may be altered by environmental conditions. An enriched environment can positively influence cephalopod behaviour in cuttlefish (Poirier et al. 2004, 2005; Yasumuro and Ikeda 2016) and octopus (Beigel and Boal, 2006; Yasumuro and Ikeda, 2011, BIAZA, 2011). Memory formation may also be affected (Dickel et al. 2000; Borrelli et al. 2020). Octopus avoid a location previously associated with noxious stimuli (Crook, 2021).

Octopuses demonstrate flexible and varied approaches to feed on different shellfish, finding food in a dynamic environment and navigating predator-prey relationships (Amodio et al., 2019). They can also apply these skills in an artificial laboratory setting by for example opening jars, using methods that are more complex than simple trial and error learning (Amodio et al., 2019).

Many cephalopods live in social groups and hence may have levels of cognitive ability similar to those of vertebrates that have complex social relationships (EFSA 2005). Learning is involved in most signalling and the most elaborate signalling and communication systems occur in cuttlefish and squid that can show rapid emotional colour changes and respond to these changes in other individuals (EFSA, 2005). Deception (possibly indicating they possess a theory of mind) – for example male mourning cuttlefish (Sepia plangon) can simultaneously signal courtship patterns on one half of their body to receptive females and display female patterns to a single rival male on the other, thus preventing the rival from disrupting courtship (Brown et al 2012).

There is some argument that cephalopods show evidence of cognitive abilities including spatial and visual awareness and learning abilities, long and short term memory, higher learning such as discrimination and reversal learning, brain lateralization, learning in response to both visual and tactile cues, and potential domain generality and simple concept formation, awareness of their position, both within themselves and in larger space, including having a working memory of foraging areas in the recent past, and complex spatial problem-solving (Macknick, 2006; Mather, 2008).

Reasons against ascribing sentience to cephalopods

Some of the arguments used by Elwood et al. (2009) to explain why crustacean welfare is overlooked also apply to the cephalopods and include that it might be inconvenient (given that it is considered normal to boil crustaceans alive prior to eating), that they are not held in high regard by the public and that the absence of concrete data to prove that they suffer is used as an excuse to overlook their potential for suffering. There may be conflict between practice and invertebrate welfare (Garrido and Nanetti, 2019). Appeals to the lack of scientific data to refute claims of suffering, which otherwise appears intuitively likely, echo the conclusions of the Brambell report (Brambell, 1965).

Recently, public assumptions are being altered by anecdotes of octopus behaviour, and by several recent popular books on cephalopods behaviour and intelligence (Mather, 2020). Several authors have argued that, although proving that invertebrates suffer requires a different paradigm of data collection and interpretation, the evidence is becoming clear that these animals can suffer and so require further legal protection (Sherwin 2001, Elwood and Appel, 2009).

A specific debate surrounds the design of models based on human and AI studies used to demonstrate whether non-human animals are sentient. For example: Sneddon refutes claims such as those made by Key and Brown (2018) that evidence gathered using an AI-based model demonstrates that cephalopod neuroanatomy is incapable of human like neural processing. Sneddon states: “What is fascinating is that to process all the information, the computers used for AI are powerful and considered very complex. However, animals such as fish, that exhibit a similar range of complex actions without programming, are not considered complex.” (Sneddon 2018).

Conclusions and recommendation

The welfare of invertebrate animals has ‘begun to matter’ to the public and the scientific community (Mather, 2020), and whilst current scientific evidence can never provide absolute proof of the existence of sentience in non-human species (or indeed in anyone other than oneself), the weight of evidence indicates ‘that humans are not unique in possessing the neurological substrates that generate consciousness’ (Low, 2012). Appreciation of the diverse forms of sentience in the animal world may lead to more inclusive animal ethics (Mikhalevich & Powell, 2020).

The overall weight of scientific evidence discussed in this paper supports the conclusion that cephalopods fulfil the same criteria as other animals that are considered sentient. If we consider that evidence of an ability to feel pain can serve as evidence for sentience, then cephalopods have been shown to have nearly all the capacities defined in Table 2. This, coupled with the additional evidence of behavioural and other abilities as outlined above, is supportive of cephalopods being treated as sentient. It would logically follow that their welfare should be considered within policymaking.

The SAWC therefore recommends that the Scottish Government consider whether the welfare considerations and legal protection that have been afforded to vertebrates should now be extended to cephalopods.

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Appendix I – Membership of the Scottish Animal Welfare Commission

The Scottish Animal Welfare Commission Members are:

- Professor Cathy Dwyer from Scotland's Rural College and the University of Edinburgh (Chair)
- Dr Harvey Carruthers, veterinary surgeon
- Mike Radford, lawyer specialising in Animal Welfare
- Paula Boyden, Veterinary Director at Dogs Trust
- Professor Marie Haskell, Professor in Animal Welfare Science at Scotland's Rural College
- Dr James Yeates, Chief Executive Officer of Cats Protection
- Libby Anderson, Animal Welfare Policy Advisor
- Dr Simon Girling, Head of Veterinary Services, Royal Zoological Society of Scotland
- Mike Flynn, Chief Superintendent at the Scottish SPCA
- Dr Pete Goddard, veterinary surgeon
- Dr Andrew Kitchener, Principal Curator of Vertebrates at the National Museum of Scotland

Full biographies are at https://www.gov.scot/publications/scottish-animal-welfare-commission-member-biographies/.

Appendix II – Contact Details

The Commission is contactable through the Scottish Government's Secretariat Support:

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