PETA

# Animal Sentience and Emotions: The Argument for Universal Acceptance






**Prepared by**

**Ingrid L. Taylor, D.V.M.**

**Research Associate, Laboratory Investigations Department**

**People for the Ethical Treatment of Animals | 2021**

# Introduction

Though the fact of animal sentience is implicit in experimentation,[1] researchers have traditionally downplayed and ignored certain aspects of it, and in nonvertebrate species they have often denied it altogether. While it is established that vertebrate animals feel pain and respond to pain drugs in much the same ways that humans do,[2] emotions such as joy, happiness, suffering, empathy, and fear have often been ignored, despite the fact that many psychological and behavioral experiments are predicated on the assumption that animals feel these emotions and will consistently react based on these feelings. The evidence for animal sentience is overwhelming, yet denial of the emotional states of animals still occurs in the research community.

Animal sentience refers to "the ability of animals to feel and experience emotions such as joy, pleasure, pain and fear."[3] Charles Darwin was the first scientist to make a serious study of animal emotions, and he pioneered comparisons between human facial expressions of emotions and the expressions of other animals. This comparative approach fell by the wayside with the advent and subsequent dominance of behaviorism in scientific thought, led by B.F. Skinner and others. Skinner considered emotions "fictional causes to which we attribute behavior," and under the influence of this school of thought, the study of animal consciousness essentially became a "disembodied mind" devoid of emotional experience. It was considered "unscientific" to characterize animal emotion, and to some extent human emotion, as attributable to anything other than "learning and memory."[4] Thus, in observations of animal behavior, descriptive labels that did not attribute any intentionality were acceptable. Noted primatologist Frans de Waal describes how, when he observed the way chimpanzees would reconcile with a kiss after a fight, he was pressured to use the phrase "postconflict reunions with mouth-to-mouth contact" rather than the terms "reconciliation" and "kiss." He goes on to state that for three decades in primatology research, simpler explanations had to be systematically countered before the term "reconciliation" was accepted in situations in which primates quite obviously "monitored and repaired social relationships."[5] De Waal notes that this dependence on descriptive labels, i.e., that animals can be aggressive but not angry or affiliative but not loving, runs counter to the principle of cognitive parsimony. This principle argues against the assumption that humans have developed unique emotional responses within the context of evolution and has consequently led to rigidity on this topic among some scientific researchers.

**The evidence for animal sentience is overwhelming, yet denial of the emotional states of animals still occurs in the research community.**

A common objection to the study of animal sentience is that researchers can never truly know what an animal is feeling and, thus, all research into animal emotion is speculation. While it is not possible to know what an individual animal is truly feeling, neither is it possible to know this about another human being, yet merely on the basis of our shared ability to communicate, researchers attribute emotion to humans and recognize the connection between emotions and expressions of feelings. However, humans can be unreliable narrators of their own experience and may not accurately describe what they are feeling. Investigations into neurobiology support the idea that similar structures in the mammalian brain may perform similar functions when it comes to emotional expressions and that even very different structures may have analogous functions, such as, for example, in Klein and Barron's analysis of analogous insect brain structures, which postulates subjective experience in insects.[6]

Another challenge in cultivating wider recognition of animal sentience and emotions within the research community is the demand that animal sentience be proved beyond a shadow of a doubt, an unrealistic standard that is not adhered to in any other scientific field. Even concepts of evolution, though widely accepted, cannot be proved beyond a reasonable doubt.[7] Helen Proctor and her colleagues also note this paradox of animal sentience, stating, "Whilst other areas of science often make do with imperfect data, animal sentience is required to buck the trend and provide unequivocal proof."[8] In their systematic review of scientific literature from 1990 to

2012, Proctor et al. found 2,562 publications that attributed sentience to animals and referenced an animal's emotional state. The overwhelming majority of these publications referenced a negative rather than positive emotional state, i.e., depression or anxiety. Interestingly, the majority of these experiments had been performed for supposed human benefit, namely in pharmaceutical studies, indicating that animal emotional states can be and are studied when they are perceived to benefit human medical progress.[9]

This cognitive disconnection can be found in research and demonstrated by the differences in the ways experimenters talk about their own companion animals versus the animals they conduct experiments on. Thus, joy and sadness can be attributed to one's own personal companion animal—for example, as in the case of a dog who is left behind and sits longingly at the door—but animals in the laboratory, even of the same species, are not perceived to experience the same longing. Bekoff calls this the formation of a "distinct category of animal … perceived by researchers as ontologically different."[10] PETA Senior Science Adviser Dr. Frances Cheng describes this as a process of desensitization that begins with young biomedical researchers, in which cartoons of "happy" rats are marketed to them on T-shirts and mugs, rat skeletons holding lab books are auctioned off in fundraisers, and the bodies of dead animals are used for amusement.[11] This serves to reinforce the notion that evidence of animal emotion, based on both direct observation and scientific evidence, can continue to be ignored because certain categories of animals don't matter as much as others. This can also be observed in veterinary training, where students are taught that animals with certain labels, i.e., "food" animals or "lab" animals, don't deserve the same consideration as "pets."

# Evidence of Animal Sentience

## Vertebrates

### Mammals

This section does not include primates and dogs, although there is a wealth of evidence demonstrating their sentience. Rather, rodents and large animals who are commonly used in experiments are highlighted in this section.

Tens of millions of rodents are used in experiments every year; indeed, rats and mice are the animals most commonly used. They are held in small enclosures and genetically altered, their family relationships are manipulated at will, they are sometimes housed singly in stressful isolation, and any number of painful and distressing experiments are performed on them. There is truly no limit to what experimenters are permitted to do to these animals, no matter how painful or senseless. But like other mammals—including dogs and primates—rats and mice can experience feelings of fear, pain, and suffering as well as positive emotions.[12]


Play is an important activity that humans derive pleasure from, and it's been shown that animals who engage in play experience similar pleasure. Play has been documented in a wide range of animals, including most mammals studied and some orders of avian species, reptiles, and invertebrates.[13] Neurobiological data collected from animals at play provide evidence that play is enjoyable to them, and rabbits, dogs, elk, buffalo, elephants, and primates have all been shown to engage in it.[14] Rats are no exception. Not only do they enjoy play,[15] they also anticipate it and have been shown to have increased dopamine activity in their brains when they know a play event is imminent.[16] They enjoy pleasurable activities like tickling and possess an array of facial expressions that convey both positive and negative emotions.[17] Rats who were tickled showed more optimism in their decision-making.[18] They can also feel remorse for their actions[19] and exhibit empathy and altruistic behavior by forgoing a treat to help a fellow rat.[20] Mice also exhibit empathy for other mice who are in pain.[21]

Sheep, goats, cattle, and pigs are used in experiments that investigate a range of conditions including fractures, respiratory ailments, spinal cord trauma, and burns. There is a body of evidence attesting to their ability to experience both positive and negative emotions. Sheep can recognize both familiar and unfamiliar faces from two-dimensional images,[22] which is a cognitive skill identified in humans and other primates, and isolated and stressed sheep can be comforted by a picture of a familiar face.[23] Sheep can anticipate rewards, react with disappointment when they do not receive the reward,[24] and experience an array of emotions including fear, anger, boredom, disgust, and happiness.[25]

Goats also display an array of emotions. They can show optimism after being rescued from a situation of neglect,[26] remember their kids' calls and recognize them up to at least 17 months after weaning (the time frame of the study),[27] and excel at learning and remembering novel tasks.[28] They communicate with humans using eye contact, a strategy they share with dogs and horses.[29]

Pigs understand time, are capable of spatial learning and memory, can understand the perspective of another,[30] are able to categorize front and back views of human heads using

open-ended categorization,[31] and engage in complex forms of play.[32] They also demonstrate emotional contagion, a process long documented in humans whereby individuals reflect and empathize with a companion's emotions, both negative and positive.[33]

Cows grieve when separated from their calves, show frustration, and exhibit a sense of accomplishment when completing a task. Like pigs, cows engage in complex forms of play, exhibit emotional contagion and social buffering, and demonstrate stable and unique personality traits among individuals.[34]

**Birds**

Birds are used in a variety of experiments, including infectious disease, toxicology, cancer, neurology, vaccine development, and embryology experiments. Chickens and turkeys are used in experiments for the agricultural industry as well. Some birds are taken from the wild or held in colonies and captive bred, yet birds consistently demonstrate sentience and the expression of emotions such as joy and grief.

Birds have rich and complex emotional lives and possess advanced cognitive abilities. For example, chickens show declarative representation, object permanence, self-control when making decisions, and advanced social learning abilities.[35] Chickens also show evidence of emotional empathy and physiological and behavioral stress when their chicks are distressed by an aversive stimulus (e.g., an air puff). However, they also show cognitive flexibility and are able to attenuate their reaction based on the level of distress, i.e., they are more upset when the chick shows greater levels of distress.[36] Furthermore, hens function as social buffers to chicks, ameliorating their distress.[37] Chickens can also anticipate positive and negative events and show behavior consistent with pleasure, relaxation, and stress, depending on the event.[38]

Starlings and white-throated sparrows exhibit emotional responses when they hear the songs of conspecifics,[39] budgerigars demonstrate contagious yawning[40] (a marker of empathy), and crows and western scrub jays hold "funerals" and mourn their dead.[41,42] Ravens remember reciprocal actions both short- and long-term[43] and engage in synchronized play, an indicator of emotional contagion that is a key element in empathy and social cognition.[44] Of 27 orders of birds studied, play has been reported in 13.[45] Crows and psittacines demonstrate analogical reasoning,[46,47] which scientists believe forms the foundational thought process in humans for scientific discovery, and crows develop and use tools to accomplish tasks.[48,49]

**Fish**

Goldfish: © iStock.com/9george

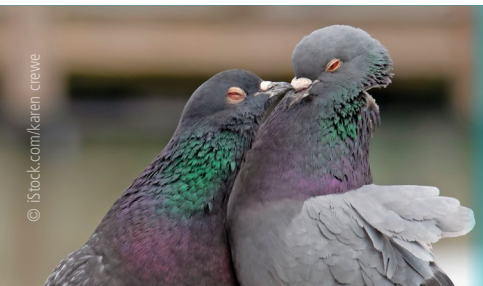
There are many species of fish who are used in biomedical experiments, including goldfish, zebrafish, and trout. They are subjected to experiments in toxicity, neurology, embryonic development, disease control, and cancer, and they are increasingly being proposed as a replacement for mammals in experiments.[50]

The preponderance of evidence in current literature indicates that fish not only feel pain but also experience a range of positive and negative emotions and demonstrate significant cognitive abilities. In her book *Do Fish Feel Pain?* Victoria Braithwaite presents evidence that fish possess key traits associated with consciousness, including the ability to form and use mental representations; consider a current mental state and associate it with a memory; alter their view of an aversive situation, depending on the context; and consider the consequences of their actions. Though their brain structure is different from that of mammals, they possess the neural structures and limbic system suggestive of the ability to process pain as an emotional experience.[51] Vila Pouca and Brown echo this, stating, "Learning, memory and the emotional drivers are, therefore, important components of pain and all of them are present in fish."[52] Fish also show distinct personality traits that seem to shape their spatial learning abilities.[53] While database searches did not turn up any studies on positive emotions in fish, research has shown that fish retain memories based on both positive and negative experiences.[54]

## Invertebrates

Recent investigations indicate that there is a basis for subjective experience in animals, like invertebrates, whose brains don't look like ours. In the absence of a neocortex, analogous brain structures can perform the same function.[55]

In July 2012, a prominent group of scientists, including cognitive neuroscientists, neuropharmacologists, neurophysiologists, neuroanatomists, and computational neuroscientists, met at the University of Cambridge to assess



© iStock.com/karen crewe

**Birds have rich and complex emotional lives and possess advanced cognitive abilities.**

the state of research on animal consciousness. Stephen Hawking was also present at this meeting. They produced The Cambridge Declaration on Consciousness, which, in critical part, states the following:

> The absence of a neocortex does not appear to preclude an organism from experiencing affective states. Convergent evidence indicates that non-human animals have the neuroanatomical, neurochemical, and neurophysiological substrates of conscious states along with the capacity to exhibit intentional behaviors. Consequently, the weight of evidence indicates that humans are not unique in possessing the neurological substrates that generate consciousness. Non-human animals, including all mammals and birds, and many other creatures, including octopuses, also possess these neurological substrates.[56]

Thus, based on available evidence and scientific consensus, invertebrates must also be included in the consideration of sentience.

**Cephalopods**

Octopuses indicate when they are suffering from pain or distress, demonstrate complex cognitive abilities,[57] and are able to connect perceptual experiences and memory and retain memories long-term.[58] They also show a variety of emotions through changes in coloration and skin patterns (though the meaning of many of these patterns is still speculative) and demonstrate play behavior.[59] They can learn to open jars to obtain food[60] and develop and use tools.[61] There are anecdotal accounts of octopuses engineering escapes from aquariums, squirting experimenters with water, and communicating with divers through touch and gestures. They appear to recognize and distinguish between individual humans and modify their behavior based on whether they like the particular individuals.[62] Cuttlefish, close relatives to octopuses, appear to experience REM sleep similar to humans[63] and have demonstrated the ability to count.[64]

**Decapods**

While there has been little investigation into the emotional states of decapods, including crabs and lobsters, there is evidence that they experience and are conscious of pain. Crabs exhibited the following criteria for a sentient awareness of pain: avoidance learning, trade-offs between avoidance of the pain and other requirements, response to opioid analgesics, and high cognitive abilities.[65] In one experiment, hermit crabs with a high-quality shell withstood higher levels of pain (electric shocks) in order to retain the shell. Low-quality shells were vacated. This motivational tradeoff indicates a conscious awareness of pain and an ability to weigh the consequences of experiencing continued pain versus losing a coveted resource.[66]

**But not accepting this evidence comes at a heavy cost—the suffering and deaths of millions of thinking, feeling animals tormented by experimenters who only acknowledge their sentience and awareness when it's convenient.**

## Conclusion

Given the evidence demonstrating the sentience of animals—they have the capacity to feel joy, pain, fear, suffering, and happiness—and that those emotions are meaningful within the context of their lives, the ethical and moral issues that preclude the use of humans in painful and invasive experiments also hold true for animals. Even if full scientific certainty is lacking for certain species or evidence has not yet been collected on them, this does not justify using them in painful and distressing experiments. The precautionary principle, originally formulated as a directive in environmental policy, states that "where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."[67] Birch argues that this principle should be extended to animal welfare and suggests that when there is a risk of serious, negative effects on animal welfare, "lack of full scientific certainty" should not be used as a reason for failing to prevent them. Indeed, Birch extends this argument even further, stating that if there is evidence of sentience within just one species of a particular order of animals, such as Octopoda, which encompasses 300 species, then protection should be extended to the entire order. Birch also notes that those who argue against sentience in animals must face a burden of proof to show this, not the other way around.[68]

There are significant challenges to accepting this notion within the scientific community. Young researchers are indoctrinated into a professional culture that often suffocates empathy and condones ignoring the evidence in favor of animal sentience. But not accepting this evidence comes at a heavy cost—the suffering and deaths of millions of thinking, feeling animals tormented by experimenters who only acknowledge their sentience and awareness when it's convenient.

# References


[1]Proctor, H. S., Carder, G., & Cornish, A. R. (2013). Searching for animal sentience: A systematic review of the scientific literature. *Animals, 3*(3), 882-906.
[2]Sneddon, L. U., Elwood, R. W., Adamo, S. A., & Leach, M. C. (2014). Defining and assessing animal pain. *Animal Behaviour, 97*, 201-212.
[3]Proctor, H. S., Carder, G., & Cornish, A. R.
[4]de Waal, F. B. M. (2011). What is an animal emotion? *Annals of the New York Academy of Sciences, 12241*(1), 191-206.
[5]de Waal, F. B. M.
[6]Barron, A. B., & Klein, C. (2016). What insects can tell us about the origins of consciousness. *Proceedings of the National Academy of Sciences, 113*(18), 4900-4908.
[7]Bekoff, M. (2000). Animal emotions: Exploring passionate natures. *BioScience, 50*(10), 861-870.
[8]Proctor, H. S., Carder, G., & Cornish, A. R.
[9]Proctor, H. S., Carder, G., & Cornish, A. R.
[10]Bekoff, M.
[11]Cheng, F. (2017). Can animals be treated well in laboratories? *The Ark, 236*, 35-37.
[12]Makowska, I. J., & Weary, D. M. (2013). Assessing the emotions of laboratory rats. *Applied Animal Behaviour Science, 148*(1-2), 1-12.
[13]Siviy, S. M., & Panksepp, J. (2011). In search of the neurobiological substrates for social playfulness in mammalian brains. Neuroscience & Biobehavioral Reviews, *35*(9), 1821-1830.
[14]Bekoff, M.
[15]Siviy, S. M., & Panksepp, J.
[16]Siviy, S. M. (1998). Neurobiological substrates of play behavior: Glimpses into the structure and function of mammalian playfulness. In M. Bekoff & J. A. Byers (Eds.), *Animal play: Evolutionary, comparative, and ecological perspectives*. Cambridge University Press.
[17]Finlayson, K., Lampe, J. F., Hintze, S., Würbel, H., & Melotti, L. (2016). Facial indicators of positive emotions in rats. *PloS One, 11*(11), e0166446.
[18]Rygula, R., Pluta, H., & Popik, P. (2012). Laughing rats are optimistic. *PLoS One, 7*(12), e51959.
[19]Steiner, A. P., & Redish, A. D. (2014). Behavioral and neurophysiological correlates of regret in rat decision-making on a neuroeconomic task. *Nature Neuroscience, 17*(7), 995-1002.
[20]Sato, N., Tan, L., Tate, K., & Okada, M. (2015). Rats demonstrate helping behavior toward a soaked conspecific. *Animal Cognition, 18*(5), 1039-1047.
[21]Langford, D. J., Crager, S. E., Shezad, Z., Smith, S. B., Sotocinal, S. G., Levenstadt, J. S., Chanda, M. L., Levitin, D. J., & Mogil, J. S. (2006). Social modulation of pain as evidence for empathy in mice. *Science, 312*(5782), 1967-70.
[22]Knolle, F., Goncalves, R. P., & Morton, A. J. (2017). Sheep recognize familiar and unfamiliar human faces from two-dimensional images. *Royal Society Open Science, 4*(11), 171228.
[23]da Costa, A. P., Leigh, A. E., Man, M., & Kendrick, K. M. (2004). Face pictures reduce behavioural, autonomic, endocrine and neural indices of stress and fear in sheep. *Proceedings of the Royal Society B: Biological Sciences, 271*(1552), 2077-2084.
[24]Reefmann, N., Kaszàs, F. B., Wechsler, B., & Gygax, L. (2009). Physiological expression of emotional reactions in sheep. *Physiology & Behavior, 98*(1-2), 235-241.
[25]Veissier, I., Boissy, A., Désiré, L., & Greiveldinger, L. (2009). Animals' emotions: Studies in sheep using appraisal theories. *Animal Welfare, 18*(4), 347-354.
[26]Briefer, E. F., & McElligott, A. G. (2013). Rescued goats at a sanctuary display positive mood after former neglect. *Applied Animal Behaviour Science, 146*(1-4), 45-55.
[27]Briefer, E. F., Padilla de la Torre, M., & McElligott, A. G. (2012). Mother goats do not forget their kids' calls. *Proceedings of the Royal Society B: Biological Sciences, 279*(1743), 3749-3755.
[28]Briefer, E. F., Haque, S., Baciadonna, L., & McElligott, A. G. (2014). Goats excel at learning and remembering a highly novel cognitive task. *Frontiers in Zoology, 11*(1), 20.
[29]Nawroth, C., Brett, J. M., & McElligott, A. G. (2016). Goats display audience-dependent human-directed gazing behaviour in a problem-solving task. *Biology Letters, 12*(7), 20160283.
[30]Marino, L., & Colvin, C. M. (2015). Thinking pigs: A comparative review of cognition, emotion, and personality in Sus domesticus. *International Journal of Comparative Psychology, 28*. Available at https://escholarship.org/uc/item/8sx4s79c#author.
[31]Wondrak, M., Conzelmann, E., Veit, A., & Huber, L. (2018). Pigs (Sus scrofa domesticus) categorize pictures of human heads. *Applied Animal Behaviour Science, 205*, 19-27.
[32]Horback, K. (2014). Nosing around: Play in pigs. *Animal Behavior and Cognition, 1*(2), 186-196.
[33]Reimert, I., Bolhuis, J. E., Kemp, B., & Rodenburg, T. B. (2013). Indicators of positive and negative emotions and emotional contagion in pigs. *Physiology & Behavior, 109*, 42-50.
[34]Marino, L., & Allen, K. (2017). The psychology of cows. *Animal Behavior and Cognition, 4*(4), 474-498.
[35]Nicol, C. J. (2004). Chicken cognition. In G. Perry (Ed.), *Welfare of the laying hen* (pp. 177-189).

[36]Edgar, J. L., Paul, E. S., & Nicol, C. J. (2013). Protective mother hens: Cognitive influences on the avian maternal response. *Animal Behaviour, 86*(2), 223-229.
[37]Edgar, J., Held, S., Paul, E., Pettersson, I., Price, R. L., & Nicol, C. (2015). Social buffering in a bird. *Animal Behaviour, 105*, 11-19.
[38]Marino, L. (2017). Thinking chickens: A review of cognition, emotion, and behavior in the domestic chicken. *Animal Cognition, 20*(2), 127-147.
[39]Siviy, S. M.
[40]Gallup, A. C., Swartwood, L., Militello, J., & Sackett, S. (2015). Experimental evidence of contagious yawning in budgerigars (*Melopsittacus undulatus*). *Animal Cognition, 18*(5), 1051-1058.
[41]Iglesias, T. L., McElreath, R., & Patricelli, G. L. (2012). Western scrub-jay funerals: Cacophonous aggregations in response to dead conspecifics. *Animal Behaviour, 84*(5), 1103-1111.
[42]Swift, K. N., & Marzluff, J. M. (2015). Wild American crows gather around their dead to learn about danger. *Animal Behaviour, 109*, 187-197.
[43]Müller, J. J. A., Massen, J. J. M., Bugnyar, T., & Osvath, M. (2017). Ravens remember the nature of a single reciprocal interaction sequence over 2 days and even after a month. *Animal Behaviour, 128*, 69-78.
[44]Osvath, M., & Sima, M. (2014). Sub-adult ravens synchronize their play: A case of emotional contagion? *Animal Behavior and Cognition, 1*(2), 197-205.
[45]Emery, N. J., & Clayton, N. S. (2015). Do birds have the capacity for fun? *Current Biology, 25*(1), R16-R20.
[46]Smirnova, A., Zorina, Z., Obozova, T., & Wasserman, E. (2015). Crows spontaneously exhibit analogical reasoning. *Current Biology, 25*(2), 256-260.
[47]Obozova, T., Smirnova, A., Zorina, Z., & Wasserman, E. (2015). Analogical reasoning in amazons. *Animal Cognition, 18*(6), 1363-1371.
[48]Wimpenny, J. H., Weir, A. A. S., Clayton, L., Rutz, C., & Kacelnik, A. (2009). Cognitive processes associated with sequential tool use in New Caledonian crows. *PLoS One, 4*(8), e6471.
[49]Auersperg, A. M. I., von Bayern, A. M. P., Gajdon, G. K., Huber, L., & Kacelnik, A. (2011). Flexibility in problem solving and tool use of Kea and New Caledonian crows in a multi access box paradigm. *PLoS One, 6*(6), e20231.
[50]Schaeck, M., Van den Broeck, W., Hermans, K., & Decostere, A. (2013). Fish as research tools: Alternatives to *in vivo* experiments. *Alternatives to Laboratory Animals, 41*(3), 219-229.
[51]Braithwaite, V. (2010). *Do fish feel pain?* Oxford University Press.
[52]Vila Pouca, C., & Brown, C. (2017). Contemporary topics in fish cognition and behaviour. *Current Opinion in Behavioral Sciences, 16*, 46-52.
[53]Vila Pouca, C., & Brown, C.
[54]Millot, S., Cerqueira, M., Castanheira, M. F., Øverli, Ø., Martins, C. I. M., & Oliveira, R. F. (2014). Use of conditioned place preference/avoidance tests to assess affective states in fish. *Applied Animal Behaviour Science, 154*, 104-111.
[55]Key, B. (2014). Fish do not feel pain and its implications for understanding phenomenal consciousness. *Biology & Philosophy, 30*(2), 149-165.
[56]Low, P., Panksepp, J., Reiss, D., Edelman, D., Van Swinderen, B., & Koch, C. (2012). The Cambridge Declaration on Consciousness. Francis Crick Memorial Conference. Cambridge, England.
[57]Andrews, P. L. R., Darmaillacq, A. S., Dennison, N., Gleadall, I. G., Hawkins, P., Messenger, J. B., Osorio, D., Smith, V. J., & Smith, J. A. (2013). The identification and management of pain, suffering and distress in cephalopods, including anaesthesia, analgesia and humane killing. *Journal of Experimental Marine Biology and Ecology, 447*, 46-64.
[58]Mather, J. A. (2008). Cephalopod consciousness: Behavioural evidence. *Consciousness and Cognition, 17*(1), 37-48.
[59]Kuba, M. J., Byrne, R. A., Meisel, D. V., & Mather, J. A. (2006). When do octopuses play? Effects of repeated testing, object type, age, and food deprivation on object play in Octopus vulgaris. *Journal of Comparative Psychology, 120*(3), 184.
[60]Mather, J. A., & Anderson, R. C. (1999). Exploration, play and habituation in octopuses (Octopus dofleini). *Journal of Comparative Psychology, 113*(3), 333.
[61]Finn, J. K., Tregenza, T., & Norman, M. D. (2009). Defensive tool use in a coconut-carrying octopus. *Current Biology, 19*(23), R1069-R1070.
[62]Godfrey-Smith, P. (2017). The mind of an octopus. *Scientific American*. Available at https://www.scientificamerican.com/article/the-mind-of-an-octopus/.
[63]Frank, M. G., Waldrop, R. H., Dumoulin, M., Aton, S., & Boal, J. G. (2012). A preliminary analysis of sleep-like states in the cuttlefish Sepia officinalis. *PLoS One, 7*(6), e38125.
[64]Yang, T. I., & Chiao, C. C. (2016). Number sense and state-dependent valuation in cuttlefish. *Proceedings of the Royal Society B: Biological Sciences, 283*(1837), 20161379.
[65]Elwood, R. W., Barr, S., & Patterson, L. (2009). Pain and stress in crustaceans? *Applied Animal Behaviour Science, 118*(3-4), 128-136.
[66]Elwood, R. W., & Appel, M. (2009). Pain experience in hermit crabs? *Animal Behaviour, 77*(5), 1243-1246.
[67]Birch, J. (2017). Animal sentience and the precautionary principle. *Animal Sentience: An Interdisciplinary Journal on Animal Feeling, 2*(16), 1.
[68]Birch, J.

501 Front St.
Norfolk, VA 23510
757-622-PETA
757-622-0457 (fax)
PETA.org

People for the Ethical Treatment of Animals | 2021