Why are octopuses going to be the 'poster child' for invertebrate welfare?

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Abstract

Animal welfare consideration and actions are generally addressed to animals similar to us, predominantly large mammals. Invertebrates are neglected partly because we sometimes are not even aware of their existence, though new exploration of the oceans has helped with this. Even when we do, we know little about their ecology and welfare. This is gradually changing, and the octopuses are likely to be the first beneficiaries of this information increase. Scientists are finding that cephalopods are far more intelligent than we gave them credit for, with the Cambridge Declaration of Consciousness suggesting they might possess this quality of mind. Partly as a result, the European Union has described and demanded good care for cephalopods such as the octopus in captivity. Public opinion has been swayed to approval by anecdotes of octopuses doing unusual actions, as well as by several recent books pointing out interesting and intelligent behavior of cephalopods. Aquariums have begun to feature octopuses for them. With this progress, welfare of animals other than vertebrates has begun to matter. While the octopuses are likely to be the first animal group to benefit, they may pave the way for us to see that different does not mean unworthy of regard and welfare consideration.

Keywords: Octopuses, welfare, consciousness, cephalopods, intelligence.

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Humans have reduced their anthropocentrism gradually across the centuries (Mather, 2011) and begun to protect the animals that we share the planet with, although care and protection of invertebrates is differential and slow in coming (Horvath, Angeletti, Nascetti & Carere, 2013). We still mainly show concern for animals 'like us'. There are three main influences which minimize concern by scientists and the general public for the welfare of invertebrates like the octopuses. The first problem is lack of knowledge: if scientists do not even know much about all the octopuses or all invertebrates, even what species exist, how can we be concerned for their welfare? Scheffers, Joppa, Pimm & Laurance (2012) note this 'missing biodiversity'. They estimate that we have identified 97% of mammals, but less than half of the molluscs and about 1/3 of crustaceans. There is an extension to this problem: how do we care for them if we also do not know what the species' ecological demands are? A second problem area is that we extend concern only to those animals that we think 'deserve it'. As welfare concerns are based on animals' cognitive capacity and ability to 'feel', how can we determine what cephalopods are cognitively capable of and whether they can experience pain and suffering? How can we care if humans' philosophical attitudes exclude consideration of them (Mather, 2011), what are the procedures to begin to protect a group of animals? The third difficulty is more over-reaching: if the public know little about octopuses and other invertebrates, what makes them care, and how can scientists reach out to the public?

Driscoll (1995) looked at the characteristics humans gave to a wide variety of animals based on six dimensions (useful-useless, smart-stupid, responsive-unresponsive, loveable-unloveable, safe-dangerous and important-unimportant). She found four clusters: species used as food, popular species, dangerous ones and intelligent ones (like octopuses). Popular books like

those of Cousteau and Diole (1973) and Mather, Anderson & Wood (2010) emphasize this, having 'intelligent' in their titles. Again looking at invertebrates only, Kellert (1993) found humans had really poor knowledge of them, as only 27% of respondents, for instance, knew that an octopus was not a fish. He found that attitudes to invertebrates were normally fear and disgust, with occasionally positive attitudes of esthetics for butterflies or utilitarian towards food species such as shrimp (he did not use any cephalopod examples). Children's comments on land invertebrates (Breuer, Schlegel, Kauf & Rupf, 2015) revealed again the two dimensions of fear and disgust, with a somewhat better attitude to fliers than to crawlers. In particular, insects are regarded with disgust (Boppre & Vane-Wright, 2019). This disdain for invertebrates does not bode well for extending concern for their welfare.

The animals that people do care about are often called 'charismatic megafauna' and they are predominantly large mammals. A study of entries for North American wild animals on Twitter (Roberge, 2014) overwhelmingly found polar bears mentioned, followed by bison, brown bear, cougar and killer whales. Large mammalian predators are featured as charismatic (Ducharme, Luque & Courchamp, 2015), and they are distinct, socio-economically important and aesthetically pleasing to us. A similar but more sweeping assessment (Albert, Luque & Courchamp, 2018) used an internet survey, species on the homepage of zoos (though not aquariums), and posters of Disney and Pixar films. They found 20 species were featured, again 17 large mammals and small koalas, as well as great white sharks and crocodiles. Most were assessed as beautiful/cute, dangerous/impressive and endangered/rare (the shark was definitely not cute). A similar survey of what kinds of animals visitors wanted to see in zoos revealed they wanted them to be intelligent, endangered and active. Although many species kept in aquariums are invertebrates and most of the rest are fish, a recent fundraiser at the Vancouver Aquarium

highlighted the possibility to 'adopt' a marine animal. Despite the small number of marine mammal species, their candidates were a shark (fish), sea lion or a sea otter (both mammals), and no invertebrates. Why might this matter? Charismatic megafauna have been seen as conservation tools, in that protecting them might allow conservation of important ecosystems of which they are a part (Sergio et al, 2008). This is particularly true for the 'big five' animals sought by tourists visiting sub-saharan Africa, who have been keyed to look for elephants, giraffes, lions, leopards and rhinos (note these are mostly North American studies). This hope for conservation is not necessarily true, as they are 'umbrella' species for some but not all diverse ecosystems (Sergio et al, 2008).

Meanwhile, despite the fact that oceans comprise over 70% of the earth's area and far more in volume, few marine species are listed as charismatic. Even though there are about 130 species of marine mammals, in contrast to 15,000 fishes, they are the only ones mentioned as charismatic, with dolphins and 'whales' (which constitute two sub-orders) making the top 20 of Albert et al (2018). Dolphins (44 species scattered amongst one of the whale sub-orders) make the list of charismatic animals with positive, aesthetic and humanistic viewpoints towards them, although often with utilitarian attitudes and little actual understanding of dolphin behavior (Barney, Mintzes & Yen, 2005). Given these values, and a summary of 'animals that we care for' as being phylogenetically related to humans, not competitors for energy, not dangerous or disgusting, useful to humans, and intelligent (Batt, 2009), it is easy to see why invertebrates do not appear to be animals whose welfare we should care about. This is all the more incongruous as invertebrates make up 97% of the animal species on the planet, although perhaps 80% are insects, mostly land-based. Nevertheless, when discussing anthropomorphism in a comparative perspective on animal cognition, Eddy, Gallup and Povinelli (1993) managed to include only

three invertebrate species in a list of thirty to evaluate. Clearly, for care about species, invertebrates are the neglected, overlooked 'other'. Why might octopuses be somewhat different?

I. Knowledge base

Obviously basic knowledge about animals stems from scientific research, and the specialist cephalopod research community is not large and is very diverse. Researchers on cephalopods have been slow to recognize behavior as an important aspect of these animals, let alone turn it to welfare concerns. The professional organization, Cephalopod International Advisory Council (CIAC), began as group of nine researchers in 1983, concentrating on taxonomy and distribution. For years they kept a firm hold on leadership in the area, as members of the Council were the only ones who could approve of new members joining them, and others who might have had different initiatives and agendas were blocked. In the mid-1990s, they decided that a technique to recruit new researchers would be to join with Fisheries organizations. This was extremely successful in terms of recruitment. In the CIAC conference in 2018, there were 221 registrants from 28 different countries, with interest in a variety of topics from systematics to genetics and also fisheries stock assessment and management, but only one paper and a few posters on raising cephalopods in captivity, where welfare concerns might arise. Those interested in animals as food are not likely to be centrally concerned with their welfare, and so these issues rarely surfaced. Welfare concerns were raised in one of the pre-conference workshops in 2018 by European members (see below), and will become emphasized more.

Welfare concerns and actions must be based on knowledge of the animals concerned. It is obviously difficult to work for the welfare of animals that have not been well described or,

worse still, you don't even know exist. In a small scale, the number of octopus species is a moving target, as new ones have been described every year; *Octopus insularis*, which dominates the Caribbean near-shore ecosystem, was defined in 2008 (Leite, Haimovici, Molina & Warnke, 2008). Before that we thought it was *Octopus vulgaris,* with the same behavior as the species from the Mediterranean, and Mather (eg 1991a, b) has several published papers with the incorrect species designation. *Octopus dofleini* was moved to the genus *Enteroctopus* when it was re-organized in 1998, so even a series of publications on this species may have a different name and expectations of behavior, depending on the year of publication. Recently this species was split as a new one was discovered (Toussaint, Scheel, Sage & Talbot, 2012), but we do not know to what extent the two species are different. The genus *Abdopus* (organized in 2000) comprises eight species, and nothing is known except the taxonomy and range of seven of these species, though see Huffard (2007) for *Abdopus aculeatus*. These changes confuse such knowledge of their biology as we have been able to gather.

Despite this, octopuses of the family Octopodidae are the best know cephalopods. An ethogram of the family, gathering fragmentary knowledge of many species, has recently been published (Mather & Alupay, 2016). This, at least, gives us some idea of what behavior to see in this group. On a larger scale. description of behavior of other, Cirrate, octopuses in the group is represented by fragments, because their habitat is so difficult to access. Some deep sea cephalopods eg *Grimpoteuthis*, the 'Dumbo octopus', are only known by pictures and video. This gap will not be filled soon. Humans can seldom travel to the deep ocean, and we cannot keep deep-sea octopuses in the laboratory if we haven't any idea of their ecological demands, given that they live in an environment quite different in terms of light, pressure and temperature than the surface. Thus we know and rely on information from the shallow-water and near-shore

'representative' octopus species. Why should we care about the welfare of species that we don't hold in captivity? Given the human dominance of the planet in the Anthropocene and the effects of human-made climate change, in essence our species hold the whole planet in captivity.

Sensing the need for information about all cephalopods, Ron O'Dor and James Wood at Dalhousie University in Canada began to set up an information source on cephalopods called CephBase in 1998, assisted by a grant from the Sloane Foundation. This was moved within a couple of years to Galveston, Texas, where the University of Texas had established a breeding facility for octopuses, squid and cuttlefish in 1975 and had been actively supplying cephalopods to researchers (Daw, Barord & Hanlon, 2018). A precursor of the Encyclopedia of Life, an effort to give information about all plants and animals, CephBase was an important resource but funding ran out, the facility closed in 2003 and the taxonomic effort stalled. Importantly, the Sloane Foundation went on to spearhead the Census of Marine Life (COML.com), a huge international cooperation which spent 10 years from 2000 to 2010 evaluating the life in the oceans, and Ron O'Dor became its Chief Scientist. But this was far broader than understanding cephalopods, although they are among the organisms being newly discovered and described each year, thanks to COML, and our knowledge of them is far from complete.

II. Moral concerns

Historically, concern by the scientific community for the welfare of cephalopods and other invertebrates has not kept pace with that based on vertebrates. Even for the bees, domesticated for centuries, there is sometimes conflict between welfare concerns and agricultural practices, and Garrido & Nanetti (2019) recommend much better communication. Knowledge of cephalopod intelligence, sentience and capacity for pain and suffering took much longer. An

evening conversation with Steve Zawistowski led Mather (2001) to write about invertebrate suffering for the Journal of Applied Animal Welfare Science (JAAWS). Consciousness in non-human animal groups, including cephalopods (Mather, 2008) was suggested by and for the philosophy community (Edelman, Baars & Seth, 2005: Mather, 2008). That was followed by the Cambridge Declaration on Consciousness (Low, Edelman & Koch, 2012), which suggests that this ability might be found in non-mammals, especially some birds and even cephalopods. This did not always translate to welfare concerns, though.

The first comprehensive coverage of invertebrate welfare appeared in a special issue of the Institute for Laboratory Animal Research (ILAR) Journal, led by Paul Andrews (2011), and entitled "Spineless wonders: Welfare and use of invertebrates in the laboratory and classroom". Topics were: invertebrates as models, maintenance, internet resources, pain and suffering and nociception, anesthesia, philosophical background to invertebrate welfare, and dealing with IACUC committees. The coverage was so thorough that it is still a useful reference today.

The only welfare book focused solely on invertebrates, The Welfare of Invertebrate Animals (Carere & Mather, 2019), a part of the Springer series on Animal Welfare, was published at the end of last year. It includes chapters on cephalopods, crustaceans, cnidarians, spiders and insects, and the chapter by Cooke, Tonkins & Mather (2019) has many practical solutions for behavioral enrichment of octopuses and cuttlefish. It is a start.

Despite a gradual rise in attention to care, formal recognition of the right of any invertebrate to consideration and protection did not follow always or everywhere. In the last few years of the 20th century, Dr Gail Michener was a member of the board of the Canadian Council of Animal Care (CCAC) and knew of Dr Mather's work with cephalopods. She realized that, using the US Department of Agriculture's standards for experimentation, cephalopods and other

invertebrates could have any procedure done to them that could be carried out on dissected-out tissue. She convened a committee of three, who consulted with colleagues, and by 1991 Cephalopods joined the list of animals for which regulation of research for ethical reasons were required in Canada. There was uneven coverage of regulations for care in the beginning of the 21st century, some areas of Australia, New Zealand, Switzerland and Norway covered various combinations of cephalopods and decapod crustaceans; Norway even protected bees. In the UK in 1986, the Animals (Scientific Procedures) Act covered only one species, *Octopus vulgaris*. None of these regulations made a big impact on the public or even researchers' attitudes to care of cephalopods.

After the turn of the century, the European Union (EU) decided to review its regulations on the care and protection of animals used in research, and one of the topics that came up was what specific animals should be protected. Donald Broom (2006), well known for his work in animal welfare, spearheaded the investigation of the topic. Both cephalopods and decapod crustaceans were presented as potential candidates for inclusion in the array of protected species. Eventually it was decided that cephalopods should be included for protection and not decapods. It is not clear why such exclusion was deemed correct; Elwood (2011) had been making a case for the perception of pain through research on crustaceans for some time. This exclusion triggered some protests, and after Brexit, a group from the United Kingdom called Crustacean Compassion has begun to campaign for protection of decapods in that country.

The new directive on the Protection of Animals Used for Scientific Purposes, otherwise known as Directive 2010/63/EU, was officially approved by the European Parliament in 2010, but came into force some years later, and see Ponte et al (2019) for a description of the process. Member states were required to transpose the Directive into their national laws. Many

cephalopod researchers were not comfortable with the idea of major regulation of their research. To explain what this mean to for European cephalopod scientists, a conference was organized in 2011 in Naples, called EuroCeph. While it was partly a standard research conference, it was designed to bring together cephalopod experts from around the world to examine what the challenges of the new law might be and how they might be answered. The next year a smaller group met in Naples to begin construction of a common standard and begin networking. This resulted in the setting-up of an agency COST Action (www.cost.eu) called Cephs*in*Action, with about 140 members from 20 countries. During the four years of operation, 2013-2017, meetings and organizations were set up for implementation. Working Groups set goals in five areas: investigating research needs, studying stress and disease, looking at anesthesia and euthanasia, developing a cephalopod welfare index and setting up a training program for cephalopod workers (Giovanna Ponte, personal communication, January 10th, 2019). A major goal was to set up a Training School Program to support vocational training of experts, caretakers and regulators using cephalopod subjects. In addition, one group focused on advancing the use of the 3 Rs (replace, reduce, refine), which were originally proposed in 1959 by Russell and Burch and gradually spread throughout the international research community, see a Canadian example (Griffin, 2009). Among the outcomes of Cephs in Action were several major papers published in international research journals, including Smith et al. (2013) covering the practical implications of the new law, including the requirements of the Directive, the evaluation process, and practical steps that researchers might take to ensure compliance with the law. Andrews et al (2013), looked at necessary ethical procedures. These included evaluation of pain, suffering and distress in cephalopods as well as anaesthesia and analgesia and humane killing, and specifically identified gaps in our current knowledge. Finally, a paper aimed at practitioners including

animal care committees, facility managers and animal care staff (Fiorito et al., 2015), provided guidance for the standardization of care for cephalopods. As a result of these changes, a major segment of the cephalopod research community had changed its care practices. Despite these advances, there were many gaps in our knowledge of octopus physiology and welfare. For instances, it was not known until later whether the common anesthetics for octopuses extended to neural tissues or only immobilized the muscles (Butler-Streuben, Brophy, Johnson & Crook, 2018), a horrifying thought for an intelligent animal (it did).

Invertebrates are still not protected in the United States, and an admission that cephalopods at least should be give welfare consideration would be important. A petition was sent to NIH in June, 2020, from a group led by a professor from Harvard Law School, asking for protection for cephalopods. Many universities already consider cephalopods 'honorary vertebrates' and require such evaluation, but endorsement by the NIH would a big step forward. Extending from informal protection by scattered universities is a necessary control, as already at Woods Hole Marine Laboratories, scientists are raising several cephalopod species to make models for the effects of gene manipulation, without any consideration for welfare outcomes (King & Marino, 2019).

III. Public attitudes, values and knowledge

Welfare of animals is inextricably entwined with public knowledge and attraction to species, as well as political will, education and even media attention (Mather, 2019). For the public to care about octopuses, they should hear about them in a good way, believing they are intelligent, attractive, interesting or important, and institutions that display them should help us care about them. Even though octopuses are 'lowly' invertebrates, they have some

characteristics that make them noticeable to humans (see Kellert, 1993). Obviously they are phylogenetically distant from us, but they are not competitors for food, nor are they seen as useful to humans. Octopuses and other cephalopods comprise 5% of fisheries for food consumption (Food and Agricultural Organization, 2018). Fish make up much more at 50%, but the cephalopod populations are rising with overfishing of their large vertebrate predators (Doubleday et al, 2016), so they may become more important and thus noticeable as food sources. Cephalopods are not consumed much by Westerners, which negates this advantage. They are not seen as dangerous and not really as disgusting, though see 'all those arms' and their flexibility of movement. Most of all, they are seen as smart, and to some extent admirable in their problem solving, and to the public as 'cute'.

This attention extends far back. Romanes (1885) noted many instances of learning and sensory discrimination in cephalopods and singled them out as intelligent and different from the rest of the molluscs; indeed, the coleoid cephalopods are taxonomically a real outlier from the other molluscs. Widespread public belief in octopus intelligence, though only then supported by anecdotes, dates back to Cousteau and Diole's (1973) book on octopuses and squid, the 'soft intelligence'. Recent American public focus came from *The soul of an octopus* (Montgomery, 2015), a subjective account of her experiences with octopuses which was a National Book Award for Non-fiction finalist. Godfrey-Smith's (2016) popular philosophy book*, Other minds: The octopus, the sea, and the deep origin of consciousness* caught the attention of the educated public with its combination of direct experience and thoughtful assessment. Casual accounts of anecdotes involving octopuses that attract public attention included Paul, the octopus who was supposed to predict the wins and losses of Germany in the World Cup; you can read all about it on Wikipedia. Inky was an octopus who escaped from his tank and down the drain to freedom,

and Otto shot jets of water to short out annoying night-time lighting, and both animals were extensively covered in the media. Film has contributed to public attention to octopuses, as one is featured in Disney's movie *Dory.* In 2018 a video circulated from a remote operated vehicle cruising a seamount off Monterey Bay of a deep-water octopus 'flying' with fins. In an ironic turn-about, it has been given the nickname Dumbo from a Disney baby elephant character who 'flies' with enlarged ears. This is certainly more poetic than its genus name, *Grimpoteuthis*. Such public interest moves the octopuses towards a charismatic focus. This focus includes giving individual animals human names, something done by workers at the Seattle Aquarium only for seals, sea lions, sea otters, and octopuses, due to their distinct 'personalities' (Anderson, 1987). This variability was scientifically studied (Mather & Anderson, 1993), and they were one of the first animal species to be thus described. Such attention led to scientific books by Darmaillacq, Dickel and Mather (2016) and Hanlon & Messenger (1996, 2018), and cephalopod learning was featured in a major work on animal learning (Marini, DeSoto, Ponte & Fiorito, 2017). A well-illustrated 'coffee-table book' *Octopus, squid and cuttlefish* by Hanlon, Veccione and Alcock (2108) extends the public coverage of cephalopods. Cephalopods moved into the public eye.

Amateurs contribute both to public information and knowledge of animal groups. Aquarists often keep octopuses, and this is a major challenge because of their physiology—and see James Wood's chapter on how to keep a captive octopus healthy in Mather et al (2010). Amateurs are often support for scientists and may even attend conferences with them, see shell collectors and malacologists (researchers on the other non-cephalopod molluscs). Such information had been scattered until Tony Morelli started the domain TONMO, out of interest in and concern for octopuses, in 2000. He quickly enlisted James Wood to help him, along with other cephalopod aficionados. He found that the population that was interested was mostly

aquarists, and that TONMO became the ‘place to go’ for advice on keeping octopuses in captivity (Morelli, 2013). TONMO now has an annual conference in locations conducive to cephalopod inquiry--the last one was at Woods Hole, where Hanlon conducts his research. Surprisingly few cephalopod researchers have reached out to TONMO, the big exception being Steve O’Shea, and Tony has not attended CIAC conferences. Such a linkage seems obvious and would be welcome for welfare concerns.

Finally, zoos and aquariums hold animals in captivity and display them to the general public, and the giant Pacific octopus is a mainstay of aquariums. They contribute information about octopuses but also must be conscious of animal welfare. For instance, when giant Pacific octopuses grow large in their tanks, the public complains that they are crowded, even though octopuses seek shelter in small enclosed spaces (Roland Anderson, personal communication). A general guide to welfare of captive animals since the 1990s has been the ‘five domains’, the idea of ensuring animals’ *nutrition, environment, health and behavior*, and an over-arching *mental state.* Mellor and Beausoleil (2015) argue that these are tuned to preventing deficits and that instead we should pay more attention to enhancing positive outcomes, and zoos and aquariums must attend to visitor perceptions as well as what they perceive as their priorities. So a major survey (Roe, McConney & Mansfield, 2014) reported on commonalities and differences between what the zoos themselves saw as important and what visitors wanted of them. Both had the highest priority for public education, especially that of children, but zoos also emphasized research much more and visitors wanted to know more about how they might enhance conservation. Since public view is all tied up with welfare (Mather, 2019) education, especially through schools and aquariums, is gong to be important.

What of the concern that aquariums might raise for the invertebrates in their keeping? In general, aquariums feature marine mammals to the public. The exception is the giant Pacific octopus, *Enteroctopus dofleini (*GPO*)*, its size (adults commonly weigh over 10 kg or 25 pounds) and its mobility and flexibility make it attractive. An example of this focus is the Seattle Aquarium, where Roland Anderson championed the GPO as a feature animal and one deserving of attention and care. He published extensively in zoo/aquarium and scientific journals on such topics as octopus' propensity to escape, feeding and food preferences, senescence and even formal release back into the ocean. He spearheaded the first technical manual for care and handling of octopuses in aquariums (AITAG, 2014). Importantly, this very thorough 149-page manual confirmed that octopuses could be bored, and included a section on enrichment for captive octopuses, echoed by a paper in Journal of Applied Animal Welfare Science (Anderson & Wood, 2001) and a theme taken up in the invertebrate welfare book (Cooke et al, 2019). Through these writing he began to focus the attention of both the public and aquarium caretakers on octopuses.

Part of the mandate of aquariums is to reach out to the public, and they look for ways to engage with them. Roland initiated octopus-related activities at the Seattle Aquarium. He thought up the idea of *Octopus Week* in February, which is often a month of low attendance. On or near February 14th, the aquarium held an Octopus Blind Date in the tank in the round, complete with red roses, valentines pinned to the outside of the tank and Barry Manilow music. If there is an appropriate animal, an octopus is released to the wild to go find a reproductive opportunity at the end of its lifespan. Sometimes an octopus dissection is done if there is an appropriate recently deceased animal, and extensive publicity on the media assures good attendance. Every second year the Aquarium sponsors a one-day low key specialty meeting of

scientists and aquarists. It also reached out beyond the walls, as Seattle has an active scuba diving community, often communicating 'hot spots' where an octopus can be found and watched, and organizing an annual underwater census of GPOs.

In an unexpected way, this public education effort raised concern about a welfare issue. As a marine species without threatened status, the octopus is a target for recreational as well as commercial fisheries. A young man without any knowledge of the local mores decided to prove his ability by spear fishing for an octopus at one of the popular dive sites. To the horror of a group of recreational divers, he killed one of the well-known and frequently visited octopuses and dragged it out of the water to take home and eat. In the ensuing public furor, it became apparent that he had done nothing illegal, but the recreational divers wanted to ensure that the animals they loved to visit could remain safe. After much discussion, the Washington State Department of Fish and Wildlife decreed a ban on capture of GPOs at eight popular dive sites around Seattle, with a map specifying their location and a notification posted at each of the sites (Washington Department of Fish and Wildlife, 2013). It is likely one of the few protections of a non-endangered species outside parks, and undoubtedly octopuses are one of very few invertebrate groups that are not endangered to be protected. This example shows how knowledge, moral concerns and public values can become united for the good of a species.

How will the areas mentioned in the beginning of this paper be addressed so that octopuses can be the first marine invertebrates to whom welfare concern is widely extended? We can learn from the lesson of the Seattle Aquarium, yet this process is already well under way. We continue to chip away at the lack of basic knowledge about octopuses and other cephalopods. With the European Union's Directive on animal protection being extended to cephalopods, many scientists are already using its approaches and extending care and consideration to these animals

(see Ponte et al, 2019, for the EU COST experiences). Importantly, this is accompanied by a widespread public knowledge of the intelligence, particularly of octopuses but also other invertebrates. Formally the Cambridge Declaration acknowledged their possible consciousness, but informally there are widely publicized accounts of octopus intelligence, and this will provide the background on which welfare advances will be made. For instance, Mikhalevich and Powell (2020) recently highlighted that the insects, despite their small brains, show possible sentience and should be extended welfare concern, and see also Boppre and Van-Wright's (2019) suggestion of an Insect Welfare Charter. So featuring the octopus 'poster child' may be the beginning, and from it a new wave of concern for the invertebrates hopefully will spread.

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