

...awa, H., Aoki, T., Nakayama, R., Takahoko, M., Goto, M., Sassa, T., Kawakami, K. and Okamoto, M. (2016). Hardness removal from waters by using...
 ...habentia is crucial for experience-dependent modification of fear responses in zebrafish. *Journal of Experimental Biology* 129, 1354-1356.
 ...and Bahar, N. (2016). Hardness removal from waters by using...
 ...Taiwan Institute of Chemical Engineers 58, 219-225.
 ...checking and self-directed behaviors in giant manta rays: *Journal of Experimental Biology* 34, 167-174.
 ...properties of corneal receptors in a teleost fish *Journal of Experimental Biology* 116, 47-54.
 ...ception in fish: stimulus-response pro...
 ...M., Verdile, G. and Martins, R. N. (2012). Regulation and maintenance of a zebrafish (D...
 ...laboratory: An introduction. *Journal of Visualized Experiments* 69, e4196.
 ...Birch, J. (2017). **Animal sentience and the precautionary principle.** *Animal Sentience* 16(1).
 ...Brand, M., Granato, M. and Nüsslein-Volhard, C. (2002). *Keeping and raising zebrafish.* In N...
 ...and Dahm, R. (Eds.), *Zebrafish: A Practical Approach.* Oxford University Press, Oxford, p...
 ...Broglio, C., Gomez, A., Duran, E., Salas C. and Rodriguez, F. (2011). Brain and cognition in t...
 ...Brown, C., Laland, K., Krause, J. (Eds.), *Fish Cognition and Behaviour.* Wiley-Blackwell...
 ...Broom, D. M. (2014). *Sentience and Animal Welfare* (pp. 200). Wallingford: CABI.
 ...Broom, D. M. (2016a). **Considering animals' feelings: Précis of Sentience and animal wel...**
 ...*Animal Sentience* 5(1).
 ...Broom, D. M. (2016b). **Fish brains and behaviour indicate capacity for feeling pain.** *Animal...*
 ...Brown, C. (2017). **Risk assessment and phylogenetic approach.** *Animal Sentience* 16(3).
 ...Bshary, R., Wilbur, W. and Fricke, H. (2002). Fish cognition, a primate's eye view. *Animal...*
 ...Chen, J., Han, K. C., Lu, K., Yu, S. W., Chang, C. C., Liu, C. C., Spielberger, J., Ku, P. Y. and Tan, P. H. (2012). The...
 ...emptive analgesic effect of a cycl...
 ...Anaesthesia 67, 1225-1231.
 ...reia, A. D., Cunha, S. R., S...
 ...for testing analgesics...
 ...A. D. (2014). T...
 ...concentrations...
 ...A. R...
 ...in zebrafish: Exposure to water containing dilute...
 ...Innovators Projects. Paper 33.
 ...er, E., Sharifi, J., Raible, D. W. and Dhaka, A. (2015). Modeling...
 ...d-oz-anbiased analgesic discovery. *PLoS One* 10, e0116766.
 ...isms. In Byrne, J. H. and Dafny, N. (Eds.), *Neuroscience Online: An...*
 ...ooke, S. J., Cowx, I. G., Kasumyan, A. O., Key, B., Rose, J. D.,...
 ...Stevens, E. D., Watson, C. A. and Wynne, C. D. L. (2017).
 ...immersion assay. Comment on Lopez-Luna et al. *Journal of*
 ...2006). Avoidance learning in goldfish (*Carassius auratus*) and trout...
 ...ations for pain perception. *Applied Animal and Behaviour Science* 97, 255-

Co A Matter of Sentience

Fish feel pain, or don't they? Despite a growing body of sound evidence that fish do indeed feel pain and are sentient beings capable of all the types of cognition found in the "higher" mammals, with the possible sole exception of the ability to imitate, a group of critics seems to systematically seek to discredit this research. But for what reasons? Ila France Porcher takes a closer look at the stakes involved.



“What can be asserted without evidence can be dismissed without evidence.”

— Christopher Hitchens

A Matter of Sentience

Text by Ila France Porcher
Illustrations by Peter Symes

It was in 2003 that Dr Lynne Sneddon of the University of Liverpool found through rigorous scientific research that fish are sensitive to pain and suffer. In the years since then, many other researchers around the world have confirmed her findings and expanded on them.

Yet, each new discovery is fiercely opposed by a group of critics who systematically deny that fish have the capacity to suffer, no matter what form the evidence takes.

This is not a case of intellectual discussion of contradictory findings. The papers published by the deniers are not studies presenting new evidence, but reviews that cite only favourable references to promote the interests of the fishing industry. They misquote the researchers' papers, claim that things are suggested that were not, and make incorrect statements that discount both the findings and the researcher. All evidence that contradicts their beliefs is ignored.

No brain, no pain!?

The deniers' main claim is that fish cannot feel pain because

they lack a human brain, but the sole reference for the idea that humans are that unique is the Bible. The group¹, led by James Rose, have coauthored a variety of papers that argue against fish sentience. Their writings have a creationist feel as they ignore all evidence provided by the evolution of the brain in vertebrate animals from fish to humans, as well as evolution in general.

Pseudoscience

But the idea that fish cannot feel pain is nothing but an old wives' tale—it comes from the pool of information that is believed by the public but is not solidly based on

facts. By definition, claims that are not based on evidence fall in the category of pseudoscience.

Science requires evidence, and no evidence has been produced to support the possibility that fish, or any animal, could live successfully and survive without the ability to feel pain. Though the deniers claim that pain sensitivity is a higher mental ability, in fact it is an essential warning sensation. An inability to feel pain, and thus recognize bodily damage, would result in inappropriate behaviour, and the animal would go straight into evolution's garbage can.

Thoughtful behaviour

Further, observations of fish behaviour do not support the idea that they are insensible robots. Fish appear cautious and careful, and will display complex, thoughtful behaviour in their efforts to eat food, such as sea urchins, that could sting them. Indeed, the evolution of such animals, as well as a host of other oceanic stingers, seems to have depended specifically on the sensitivity of fish to pain.

Furthermore, in terms of cognitive (thinking) ability, fish are capable of all the types of cognition found in the “higher” mammals, with the sole exception of the ability to imitate. Their nest building capabilities, for example, are superior to primates with the exception of humans. And many humans would produce quite slipshod nests compared to those of certain fish, without the help of a builder.

The evidence as a whole indicates that fish are sentient. In other words, they are aware of the external environment and of their own internal emotional states. Yet, as a result of the systematic criticism of papers published on the subject, including fish pain and suffering, many scientists have become reticent to speak out on the subject and promote fish welfare through fear of being targeted by vicious reviews slandering their work, and making it more difficult to be published and get grants.

The evidence is solid

Since we cannot ask animals what they are feeling, and they cannot answer in a way we can understand, scientists have searched indirectly for evidence about how they experience physical harm in the studies of neuroanatomy, neurophysiology, and behaviour. Strict criteria have been developed, all of which need to be met, before it can be concluded that an animal can feel pain.

Pain pathways exist

First, there must be *nociceptors*, sensory neurons that respond to tissue damage by sending nerve signals to the spinal cord and brain. This process is called nociception, and causes the sensation of pain. There must be neural pathways from the nociceptors to higher brain regions, and the signal from the nociceptor must be processed in the higher brain, not in the reflex centres in the hind brain or spinal cord. There must

be opioid receptors within the nervous system, and opioid substances produced internally. Pain-killing drugs should relieve the symptoms of pain that the animal displays, and it should be able to learn to avoid a painful stimulus.

Fish react similarly

This should be so important to the animal that it avoids the threat of pain right away. The painful event should strongly interfere with normal behaviour, and the animal's reaction should not be an instantaneous withdrawal response, but long-term distress. Fish comply with all of these criteria, as has been shown in a wide variety of experiments. The whole brain of the fish is active during painful events, not just the hind brain.

Evidence indicates that fish are sentient, aware of the external environment and of their own internal emotional states.

Furthermore, certain genes that are crucial to the experience of pain in humans are also found in fish, and they are active throughout the fish's brain during painful

events. This activity of the brain at the molecular, as well as the physiological level, indicates that the fishes' responses to tissue damage are not reflex reactions. If they were, such activity would not be seen in the higher brain.

Though humans can over-ride pain at times in certain heightened mental states, and particularly when they are in danger, it seems that fish cannot do so.



A Matter of Sentience

Studies have shown that after being hurt, fish become far less alert to danger, as if their pain is too overwhelming for them to ignore it, even to escape a predator. It is thought that due to their simpler neural design and mental states, they lack the ability to think about their pain, and put it in perspective as humans can. This suggests that pain for them is always an intense experience, and that fish may actually feel pain more intensely than humans.

Muddying the waters

Yet, in spite of all the evidence, the deniers continue to claim that fish show reflexive responses only, and that they are incapable of true cognitive abilities. They are using the authority of science to manipulate public opinion while weakening the voices of true researchers.

So Sneddon, with several colleagues² whose results have been twisted and criticized, recently published a paper directly addressing the situation entitled, *Fish Sentience Denial: Muddying the Waters*. She and her coauthors describe how each criticism of their evidence has been rebutted with sound scientific points that identified the fallacies in the arguments, not only by the authors, but by other researchers as well.

For example, Brian Key, with the same group of coauthors, wrote a criticism of Sonia Rey's work pretending, among other things, that she and her coauthors³ had stated that the expression of emotional fever in zebrafish proves that fish are conscious. But, in fact, Rey had found that zebrafish exhibit emotional fever and had

stated only that its absence can no longer be used in support of the idea that fish are not conscious.

Medical models

Coauthor Culum Brown writes: "Medical science increasingly uses zebrafish as an alternative to lab rats to understand human physiology and to test drugs and so on. The reason this is so widely accepted is the high degree of similarity between fish and human physiology. Of course this brings with it further emphasis to be certain that fish are given the appropriate ethical treatment when used in medical research."

Indeed, sequencing the zebrafish genetic make-up revealed that 70 percent of the human genes that code for proteins, and 84 percent of genes associated with

human disease have counterparts in the zebrafish.

Culum continues:

"An interesting question raised in response to our article is the question as to whether the lives of fishes would change if it was broadly recognised that they are sentient and capable of suffering. Here, we have the age old problem: Fish are a commodity worth a lot of money, and when there is money to be made, there will always be pressure to keep using fish in the way we currently do (i.e. with little thought to their welfare). This is really a question of shifting human behaviour, and the analogies with our response to climate change are rather obvious."

A matter of cost

Sneddon and her coauthors make the point that sentience is being denied to fish because of the current laws in place in the European Union, which demand that sentient animals must be treated humanely. This point is confirmed by the deniers. In one of his arguments, Ben Diggles lays out his reason for denying fish sentience:

"Accepting the premise that fish are sentient and experience pain and suffering has had a pervasive impact on recreational fishing, particularly in Germany and Switzerland. In Germany, risk assessments weighing the presumed suffering of fish against the benefits to anglers, and to local economies and fish conservation from angling, has led to severe constraints or bans on competitive fishing, put-and-take fishing, and the use of live baitfish and keep nets."

Follow the money

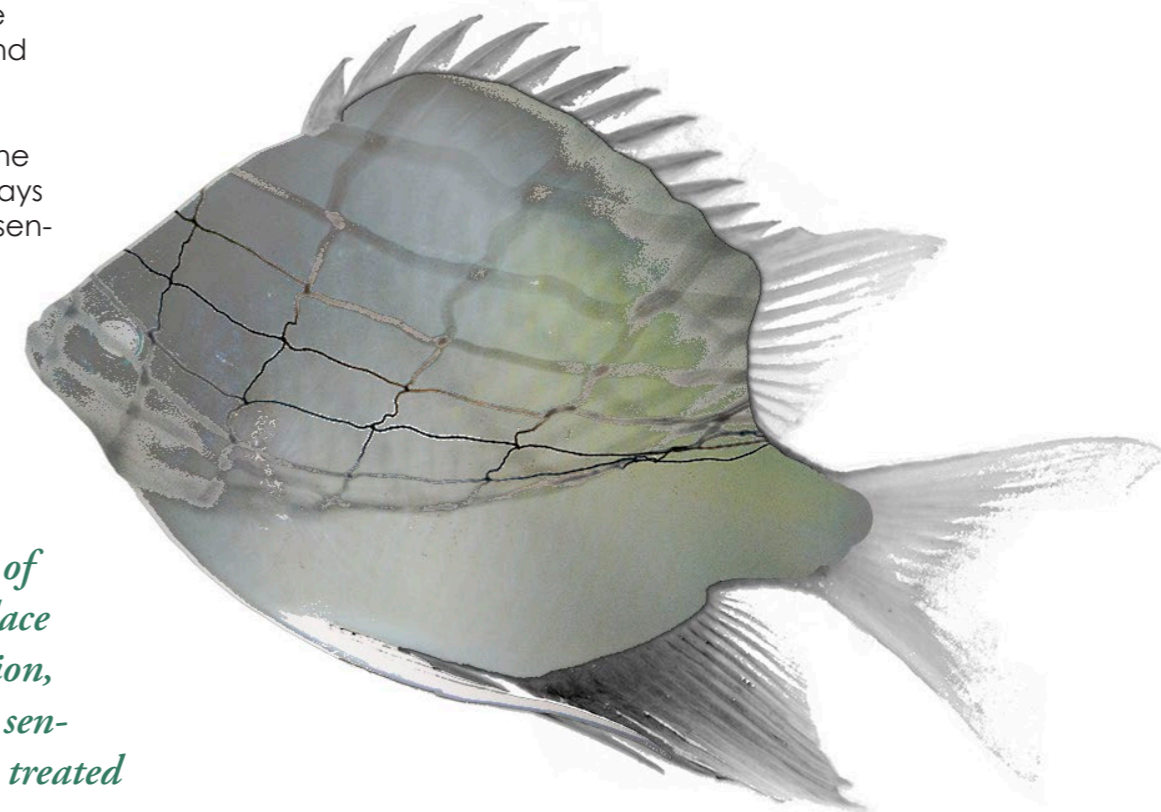
The purpose of the deniers' arguments, therefore, is to promote business as usual for the fishing industry. Diggles goes on to make the point that it is acceptable for fishermen to treat wild fish as cruelly as they wish without regard for their suffering.

Veterinarians observe pain

In contrast, veterinarians are fully aware that fish feel pain through direct experience in treating and performing surgery upon them daily. They systematically use pain relieving drugs and consider that the pain system in fish is virtually the same as in birds and mammals.

Industry lobby at work

It is now a matter of record that industry will use science to support a political platform for favoured and often paid researchers to influence public opinion and its perception of the science. This was done successfully for decades by the tobacco industry in its efforts to influence public thinking about the effects of smoking, and the oil industry to discredit the findings of global warming.⁴ Such denialism has been ana-



Sentience is being denied to fish because of the current laws in place in the European Union, which demand that sentient animals must be treated humanely.

lysed in several social science studies as forms of pseudoscience.

Sneddon and her colleagues have made it clear that the fishing industry is doing the same thing. Indeed, the fishing industry is a multi-billion dollar power that has taken control of both the wild fish populations, and the way these animals are viewed by the public. Like the tobacco and oil industries, the fisheries industry is actually creating uncertainty and doubt where none exists, using rhetoric, cherry-picked ideas from the literature, incorrect facts and personal opinions to reach conclusions that always favour fishermen.

Scientific truth

But the establishment of scientific truth should be independent from the interests of industry. If fish feel pain, that should be accepted as part of the truth about the world in which we live.

Sneddon writes: "As humane, ethical, educated beings, we must minimise any negative situation into which animals may be placed, and seek to reduce any damage that is likely to lead to some sensation of a negative welfare state in the interests of building a moral society. To deliberately cause injury and suffering is unethical, and as moral beings, we have a duty of care to the animals

that we place in the completely unnatural environment of fishing equipment."

Sneddon and other researchers have published guidelines for handling fish to minimize their suffering, for concerned fishermen. However, with industry muddying the waters, this valuable information is not being recognised.

Shameful reality of fishing

It is now known that, in spite of all of its pomposity, the fisheries industry is responsible for much of the destruction of the aquatic ecosystems around the world. Whatever measures fisheries authorities have taken to conserve their target species have failed.

Forty-three percent of fish species are considered in danger of extinction. Ninety million tons of wild fish are taken globally through fishing, and half is fished by only one percent of fishing

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boats—the factory ships. Some trawling nets measure 40km in length and drag the sea floor to a depth of three kilometres. Trawlers rake the continental shelves entirely every few years, destroying the ecosystems upon the sea floor. Many fishing methods take the whole wild community and throw away all but one or two

of the species so that 80 percent of the living things that were killed are wasted.

Ninety percent of the biomass of the predators has disappeared and 80 percent of global fish stocks have been declared over-exploited or fully exploited.

The Atlantic bluefin tuna is on the verge of extinction, yet is still fished legally in the Mediterranean. A top quality tuna can be sold for 500,000 Euros. Solely because of its commercial value, this species will be extinct within a few years.

Fish are the only wild animals commercially taken to supply the world market, and given the over-population of humans, it is self-evident that it is ecologically unsound to expect a wild ecosystem to feed us all. In the case of large-scale and middle-scale fishing, the wild fish taken mostly supply the industrialized nations, where people are already eating too much protein, and would buy something else if fish were not available. Fish are also devalued by use in pet food, fish farming and fertilizer.

Small-scale fishermen, on the other hand, need the fish to fill their protein requirements, but large- and middle-scale fisheries have driven millions of traditional fishers, often among the poorest people on earth, to hunger, both by taking all the fish, and by driving up the local prices to export levels.

Given the current ecological oceanic crisis, deep-sea fishing should be stopped permanently, gov-



ernments should stop subsidizing industrial fishing, and small-scale fishing only should be allowed.

More MPAs needed

More key regions should be set aside as Marine Protected Areas (MPAs) where fish populations can recover and eventually replenish the surrounding areas.

As divers, we appreciate how the intricate community of interlacing species, which we find on our underwater excursions, is nothing like the one on land. It is clear to see that fish and their companions, the invertebrates, are very different from the

low, cold creatures with binary brains, which have always been described based on fishermen's tales. So, the increasing popularity of recreational diving is important because it provides another point of view to contrast the one expressed so often by fishermen.

It is curious to see how many people continue to wax expansive when describing their efforts to outwit fish. They do not seem to see the irony in claiming that fish are too simple-minded to feel pain, while being proud of their ability to outwit them. ■

It is ecologically unsound to expect a wild ecosystem to feed us all.

NOTES AND REFERENCES

1. The fish sentience denial co-authors: Robert Arlinghaus, Howard Browman, Steven Cooke, Don Stevens, Ben Diggles, Brian Key, Alexander Schwab, Anne Berit Skiffesvik, and Craig Watson.
2. Coauthors: Javier Lopez-Luna, also of the University of Liverpool, UK; Culum Brown of Macquarie University, Australia; David C.C. Wolfenden of the Blue Planet Aquarium, UK; Matthew C. Leach of Newcastle University, UK; Ana M. Valentim of the University of Porto, Portugal; Peter J. Steenbergen, European Molecular Biology Laboratory Heidelberg, Germany; Nabila Bardine, Holistic Life Coach, Heidelberg, Germany; Amanda D. Currie of Macalester College, USA; Donald M. Broom of the University of Cambridge, UK.
3. Coauthors: Felicity A. Huntingford, Toby G. Knowles, and Simon Mackenzie
4. The tobacco industry link: <http://www.ncbi.nlm.nih.gov/pubmed/12791525> <https://www.ncbi.nlm.nih.gov/pubmed/15313097> The oil industry link: <http://www.okepsc.org/sites/default/files/u6/Dunlap%20%26%20McCrigh%20Routledge%20HB%2C%202010.pdf>