

Book Reviews

Other Minds: The Octopus and the Evolution of Intelligent Life

P Godfrey-Smith (2017). Published by William Collins, 1 London Bridge Street, London SE1 9GF, UK. 272 pages Hardback (ISBN: 978-0-00-822627-5). Price £20.00.

Cephalopods, literally, are animals that ‘walk on their head’ but are better known as octopus, cuttlefish, squid and the shelled nautilus. Class Cephalopoda, has more than 700 known species and is a phylogenetically ancient group of animals with the ancestral group of the Octobranchia (octopuses), Decabranchia (cuttlefish and squid) and Nautiloidea being more than 400 million years old. Recent molecular evidence indicates that ancestral octopuses diverged from ancestral cuttlefish and squid around 300 million years ago (mya) (Tanner *et al* 2017).

Humans have had a long-standing fascination with cephalopods as food and as animals with cultural connotations. The classical authors Aristotle and Pliny the Elder both described aspects of their behaviour with studies facilitated by the ability to observe species, such as *Octopus vulgaris* (common octopus) and *Sepia officinalis* (cuttlefish), in the clear and relatively shallow waters of the Mediterranean. The ability to change colour rapidly, the jetting locomotion accompanied by inking when escaping and the relatively large eyes which, in octopus, are particularly mobile and appear to follow you, are all features which pique the interest of even the most casual observer. Scientific research has focused upon the brain (brain: bodyweight ratio is comparable to bony fish) in relation to learning and memory and their complex behavioural repertoire, the visual system (human-like eye) and the nervous control of the skin chromatophores. The public’s fascination with cephalopods is further stimulated by the relatively recent discovery of particularly ‘telegenic’ species, such as the dumbo, vampire and mimic octopuses and the reporting in the media of cephalopod research (eg the cuttlefish being “better at maths than one-year-old child” story [*i* newspaper, 25th August 2016, reporting a paper entitled ‘Number sense and state-dependent valuation in cuttlefish’ by Yang & Chiao 2016]).

Although the title of this book in the UK is *Other Minds: The Octopus and the Evolution of Intelligent Life*, it was first published in the USA in 2016 under the title, *Other Minds: The Octopus, the Sea, and the Deep Origins of Consciousness*. Perhaps ‘intelligence’ makes a book more marketable in the UK but not the USA, or in the UK ‘consciousness’ is thought by publishers to be too hard a concept to promote sales. However, since the two words are not interchangeable I was left wondering initially whether this book is about the evolution of consciousness or intelligence? In a sense this does not matter, given both have implications for welfare and the capacity of animals to suffer.

My personal view is that the emphasis is on consciousness and this is indicated by the statement in the first, scene-setting, chapter (of eight), in which the author (a philosopher

and historian of science) states “I want to know how consciousness arose from the raw materials found in living beings” (p 10) and poses a question, the type of which is often considered by those responsible for animal welfare, “Does it feel like something to *be* one of the large-brained cephalopods or are they just biochemical machines for which all is dark inside?” (p 12). The answer to this question is of obvious general importance but particularly so for cephalopods which have been regulated, since 2013, under Directive 2010/63/EU — based on an opinion in 2005 by a European Food Safety Authority (EFSA 2005) committee on Animal Health and Welfare — that they were capable of experiencing pain, suffering, distress and lasting harm (for discussion of EFSA report, see Andrews *et al* 2013).

Consideration of the inclusion of cephalopods in legislation pre-dates the EFSA panel decision as illustrated by this quote from Lord Halsbury on the second reading of the Laboratory Animals Protection Bill, 1980; “There is a case which I will argue in Committee for inclusion of higher mollusca, the octopods and perhaps the decapods (squids and cuttlefish) along with the vertebrates. They are entirely alien life forms but we ought to try to think of these matters on their merits.” In the UK, *Octopus vulgaris* was included in the 1993 legislation by an amendment to the Animals (Scientific Procedures) Act 1986. Lord Halsbury’s erudite comment is reflected in the flyleaf of *Other Minds: The Octopus and the Evolution of Intelligent Life*; “The octopus is the closest we will come to meeting an intelligent alien. What can we learn from the encounter?” I would argue that we can learn much and this book provides enough interesting material at several levels to both fascinate and engage the general reader and stimulate (or perhaps provoke) researchers to test some of the hypotheses. The premises and observations in this book should also be considered by those contemplating the aquaculture of octopuses and those responsible for their care in public aquaria.

This book draws upon information from three main areas. Firstly, cephalopod biology and evolution of nervous systems. This is dealt with in a clear way for the general reader with a wide range of interesting facts supplemented by a number of helpful diagrams to summarise aspects of evolution. Some diagrams of the cephalopod brain might have been useful to help emphasise how it differs from that of vertebrates (eg the oesophagus runs through the middle of the brain) but to also highlight the similarities (eg gyri in the vertical lobe). Secondly, philosophical considerations of consciousness and intelligence are discussed and comparisons made with both humans and other vertebrates (chapter entitled ‘Our minds and others’). The ‘philosophy’ is dealt with in a clear way, with a light touch and the author sets out his stall very early on, with the view of philosophy as “trying to put things together, trying to get the pieces of very large puzzles to make some sense” (p 12). And, finally, personal field observations of *Octopus tetricus* and the giant cuttlefish (*Sepia apama*) are supplemented by drawings and photographs, many in colour. The latter afford the book greater

accessibility to the general reader with descriptions of the behaviour of what appears to be a local high-density population of animals in 'Octopolis' illustrating the behavioural diversity and interactions between individual octopuses. The observation of wild cephalopods in Australia is the route by which the author became interested in the 'mind' of cephalopods. Systematic field observations by 'citizen scientists' make an important contribution to understanding the natural behaviour of animals and can provide clues for 'professionals' to pursue. The author has published some of these field observations in peer-reviewed publications.

The main text is supplemented by detailed notes and, in many cases, original peer-reviewed references (~10% of the book) making it easy for the reader to fact-check or pursue areas of particular interest.

The basic thesis is that consciousness evolved separately in the bilaterian phylogenetic branch, eventually leading to vertebrates, and in the cephalopod arm of the mollusc branch. This is an intriguing idea and the author supports the proposal primarily via a detailed examination of cephalopod behaviour supplemented with more limited discussion of the cephalopod brain. The split of the two bilaterian branches (Deuterostomes, including vertebrates and Protostomes, including molluscs) occurred around 600 mya and around 300 my later the ancestral cephalopods that gave rise to the modern octopuses diverged from the cuttlefish and squid branches. Presumably, at that point, either consciousness was established in both cephalopod lineages or both possessed the neural substrate with the eventual capacity for consciousness. The key evidence for the evolution of consciousness in octopus is presented mainly in a chapter entitled 'From white noise to consciousness', a title which nicely encapsulates the idea of gradual emergence of consciousness based upon the sensory inputs received by the brain (probably photo- and chemo-reception initially), the increasingly complex motor actions taken by animals (random, reflex and self-directed reflecting increasingly complex integration of inputs) and the adaptive pressures driving increasing brain complexity. The thesis is well-argued but, as with many hypotheses predicated on evolution, it is hard to prove by experiment.

One of the photographs from field observations includes the moment an octopus is bitten by a leatherjacket fish resulting in a "startled jump, arms going everywhere" (p 101). This observation prompts discussion of nociception and pain perception in cephalopods in addition to fish, chickens and crabs. Whilst neurophysiological studies have demonstrated the presence of mechano-nociceptors, wound-guarding in some species and avoidance of, and aversion to, potentially noxious stimuli, there still remains discussion about the central processing of information from the nociceptors and the nature of any sensory experience. In response to injury to one arm in an octopus there is evidence for afferent sensitisation in both the injured limb as well as contralateral uninjured arms (Alupay *et al* 2014) and, in squid, sensitisation may extend more widely over the body (Crook *et al* 2011, 2013). Clearly, these features of nociception/pain in cephalopods require further physiological investigation and represent a practical challenge to all involved in the care and welfare of these animals following surgical procedures.

The discussion around the topic of pain in relation to cephalopods and the type of data available (primarily neurophysiology and behaviour) resonates with the similar discussions regarding pain in fish. The cephalopod research community within the EU has, in effect, adopted the precautionary principle with regards pain perception as definitive data are lacking. However, this is an area which requires research, particularly to identify analgesic agents (other than local anaesthetics) and specific behavioural indices of pain which can be used in routine health and welfare monitoring. *Guidelines for Care and Welfare of Cephalopods* (Fiorito *et al* 2015) have been developed by an EU-wide researcher-led initiative (<http://www.cephsination.org/>) and provide a starting point for further development as knowledge increases. Obviously, pain and consciousness are inextricably linked, but if definitive evidence is presented that octopus do 'feel pain' then, as has happened with vertebrates, we will need to rapidly consider whether they experience other unpleasant, but biologically relevant, sensations, such as breathlessness (asphyxia) or nausea.

Whether or not one agrees with the overall premise that consciousness (or intelligence) evolved independently in the invertebrate lineage, this book challenges us to think about an animal that is very different in many respects from a vertebrate but which clearly has a complex behavioural repertoire which, in some cases, parallels the ability of birds and mammals. The book provides a good, scientifically based, introduction to cephalopod neurobiology and behaviour. The author notes (p 97) *en passant* that if the trait of consciousness evolved twice in divergent lineages (vertebrates and cephalopods) then in principle subjective experience may be present in other invertebrate lineages. Crabs are used as an example and this is particularly well-chosen as, although arthropoda are protostomes like the cephalopods, they diverged from the molluscan lineage. Indeed, the EFSA panel that considered the capacity of cephalopods to suffer also reviewed other invertebrates and recommended that decapod crustacea (crabs and lobsters, some shrimps and prawns) should also be included in Directive 2010/63/EU, but this recommendation was not finally adopted. I wonder if we will ever see a book on 'Crabs and Consciousness'?

The overall view presented in this book that octopus is 'conscious' is consistent with current views, such as those expressed in *The Cambridge Declaration on Consciousness* (Low 2012) which specifically mentions octopus and emphasises that we should take a broader view of the origins of consciousness than the human cerebral cortex. This is clearly a 'live' and controversial issue with wider implications for welfare of all species of animal in multiple contexts. Cephalopods may be an ideal group of animals in which to test the evolution of consciousness as Nautiloids appear to have changed little over ~400 my and clearly have much 'simpler' brains than octopus. Additionally, even within the coleoid cephalopods (octopus, cuttlefish and squid) there is a diversity of brain size and morphology around a common theme and which appears related to habitat. Comparative studies of neuroanatomy, physiology and behaviour in carefully selected cephalopod species may

eventually provide the author with the answer to the question posed at the beginning of the book: “I want to know how consciousness arose from the raw materials found in living beings” (p 10).

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Paul Andrews

West Finchley, London, UK

Conflict, Negotiation and Coexistence: Rethinking Human-Elephant Relations in South Asia

P Locke and J Buckingham (2016). Published by Academic Marketing, Oxford University Press, Great Clarendon Street, Oxford OX2 6DP, UK. 304 pages Hardback (ISBN: 978-0199467228). Price £34.99.

This book was developed from talks given at a conference at the University of Canterbury, New Zealand from 7-8 May 2013, entitled ‘Symposium on Human-Elephant Relations in South and South-east Asia’, involving a range of researchers from across the globe. The subject matter is very topical, as human/elephant conflict is a present and continuing problem for both human and elephant populations living in south and south-east Asia, and has been identified by many conservationists as the single biggest threat to the continued existence of elephants in the wild.

The book is divided into three sections. In the first section, there are discussions of the historical use of and interaction with elephants in these countries, including the cultural history of mahouts, and their interactions with elephants. This section sets the scene for understanding the complex cultural history that exists in people’s relationships with elephants, and the points of view that people have about elephants. For those unfamiliar with this history, it provides a useful overview.

The second section focuses on the lives of mahouts, and their approach to and interaction with elephants. These chapters help the reader to better understand the cultural context of human/elephant conflict in the region, as those involved often seem to be struggling with conflicting and apparently contradictory views which raises associated challenges for conservationists and policy-makers, addressing human/elephant conflict while respecting or reconciling differing views. A number of the authors suggest that it may be helpful to consider humans in the context of their interdependencies with elephants, rather than apart from them which is quite an unusual approach to this issue, and may suggest alternative approaches to addressing the problem.

The final section of the book discusses many of the previously identified causes for human/elephant conflict in a number of locations in south and south-east Asia. There is also a discussion by Thekaekara and Thornton on the different attitudes toward elephants seen in different communities, depending on their use of and dependence on the land, and different views and beliefs about elephants and their role in human/elephant conflict. An approach based on these factors could be useful in helping policy-makers or regional planners develop a more effective and customised strategy for managing land use and resolving human elephant conflict in different areas, as different strategies might be more or less effective in different communities