

estate as the latter married, had children and managed his lands. Birkhead gives a wonderful sense of the pair's delight in nature, even as Willughby, never robust, began to have recurring fevers. Inspired by physician William Harvey's discovery of blood circulation, published in 1628, Willughby contemplated the movement of sap in trees years before the subject surfaced in the Royal Society's journal, *Philosophical Transactions*. He was the first to classify insects by their metamorphoses, recognizing that a caterpillar, pupa and butterfly were life stages of one insect, not separate species. He asked astute questions, such as which birds survive winters by migrating. He observed the life cycle of a leaf-cutter bee, later named after him — *Megachile willughbiella*. He even wrote a study on games, from football to cards.

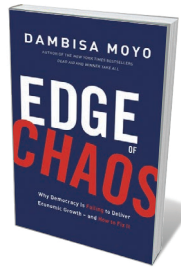
Birkhead's account is vividly textured, drawing from his collaborations with science historians. We follow Willughby from seabird nesting grounds on the Isle of Man to glass-making factories in Murano, Venice. Willughby's letters and notebooks, full of his swift, impatient writing, tell how avidly he worked. The strangeness of his scientifically liminal century shines through, exemplified by an "insect" collected in Italy, a fake made from a moray eel's jaws and a thorny plant. Birkhead tightens the links between Willughby's work and modern biology, confirming that he and Ray identified some 90% of around 200 bird species often seen in England and Wales.

As Birkhead emphasizes, the bond between the restless Willughby and the more restrained Ray was extraordinarily fruitful. Yet there were challenges, not least differences in social circumstances. Willughby was a gentleman, Ray a blacksmith's son — disparities they finessed in life. That became more difficult after Willughby's death. In exchange for an annuity, the family expected Ray to educate Willughby's children; he was reluctant. They also resented Ray's control over Willughby's posthumous legacy. They quarrelled over access to Willughby's collections and papers as Ray produced *The Ornithology* (1676), *The History of Fishes* (1686) and *The History of Insects* (1710), based on his joint work with his friend. Subsequently, historians have struggled to divide the credit, sometimes favouring one man, sometimes the other.

"This game of spot-the-genius is inappropriate and unhelpful," writes Birkhead. He invites us to see a scientific life well lived, rich with ideas, adventure and companionship — and, in Willughby's profound collaboration with Ray, two very different personalities who saw further because they worked together. ■

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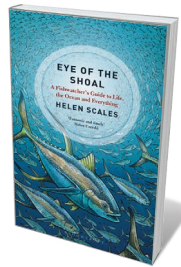
## Books in brief



### Edge of Chaos

*Dambisa Moyo* LITTLE, BROWN (2018)

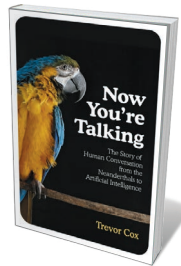
Does the "new normal" in many democracies, from high unemployment to political turmoil, make them poor models for sustainable growth? In this trenchant analysis, economist Dambisa Moyo explores that provocative question. She examines growth across the political spectrum, from China to the United States, and probes entangled challenges such as debt and protectionism. Unsurprisingly, she points to an urgent need for political reform. Her blueprint for that (including civics courses for the electorate) is ambitious, but, as she asserts, "All the easy choices are behind us".



### Eye of the Shoal

*Helen Scales* BLOOMSBURY SIGMA (2018)

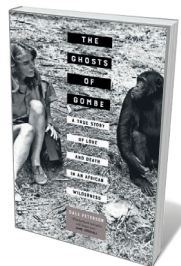
Marine biologist Helen Scales's *Spirals in Time* (2015) opened up a whorled wonderland of marine molluscs. This gifted writer now deep-dives into piscine realms. Scales, whose research has spanned the South China Sea and Australia's Ningaloo coral reef, weaves the history of ichthyology with explorations of adaptations, such as how glycoproteins act like 'antifreeze' in the blood, and why shoaling saves energy. Perhaps most beguiling are the hums and pops of fish 'calls', which the creatures sense through the lateral line — a series of organs that effectively turn their bodies into giant ears.



### Now You're Talking

*Trevor Cox* BODLEY HEAD (2018)

On average, humans utter 500 million words over a lifetime. And it's a crazily complex process, as acoustic engineer Trevor Cox reveals in this intensive survey. Speaking involves "anatomical gymnastics" linked to multiple brain regions; hearing is a subtle decoding of tone, timbre and sense. Cox's investigation sweeps from the putative protolanguage of human ancestor *Homo heidelbergensis* to the likelihood of creative algorithmic discourse. In between, he looks at the infant's acquisition of language, the neuroscience of beatboxing (vocally mimicking percussion instruments) and much more.



### The Ghosts of Gombe

*Dale Peterson* UNIVERSITY OF CALIFORNIA PRESS (2018)

In July 1969, Ruth Davis — a volunteer at Jane Goodall's chimpanzee research centre in Gombe, Tanzania — disappeared. Her body was found below a waterfall six days later. Goodall biographer Dale Peterson probes the tragedy and its convoluted context in forensic detail, casting back and forth from the centre's primate findings to the human stories of its researchers. Peterson's engrossing, sometimes dizzyingly kaleidoscopic narrative is bookended by nuanced analyses of how Davis might have died, and the aftershocks that still rock those who knew her best.



### On Color

*David Scott Kastan and Stephen Farthing* YALE UNIVERSITY PRESS (2018)

Artistic innovator Paul Cézanne accurately noted that colour is a collaboration between mind and world. So remind literary scholar David Scott Kastan and artist Stephen Farthing in this vivid and erudite tour of a phenomenon that entwines microphysics and electromagnetics with human physiology and cognition. Their march through ten hues drives home why much of culture is deep-dyed in colour, from political affiliations (think the Greens, or Ireland's Orange Order) to blue notes in music, "uncannily microtonal slides and bends" expressive of emotional subtleties. **Barbara Kiser**