

cooperative, reminding him of a healthy human community. In a year with food stress, though, these seabirds turned on one another and attacked and ate neighbouring chicks that in previous years they would have sheltered and looked after. He relates these behavioural changes to the onset of a stress response as a result of the food shortage, which in turn changed the emotional state of the birds and resulted in anti-social behaviour. Thus, one argument is that birds undergo physiological changes similar to mammals, and these changes may mediate similar emotional changes. Birkhead extends this argument from stressful situations to two other examples: changes that occur when losing an aggressive encounter, and variation in brain activity related to rewarding events such as pair formation.

I have a few quibbles with the examples that Birkhead chooses to illustrate the uniqueness of avian sensory processes. In the chapter on hearing, it might have been good to illustrate the many specializations of the auditory system of songbirds that are geared to facilitate the perception of song, such as electrophysiological studies that have demonstrated the phenomenon of neurons tuned to respond to the bird's own song (Margoliash & Fortune 1992) and studies of immediate early gene expression in the auditory forebrain showing that gene expression responses are biased towards not only conspecific song but also to behaviourally preferred song (Mello 2002), biases in perception that can be influenced by social experience either during ontogeny or in adulthood!

In the chapter on olfaction, Birkhead provides some of the most dramatic examples, from species with relatively large olfactory bulbs. It may also have been valuable to point out remarkable examples in passerine species with relatively small olfactory bulbs, such as the European starling, which responds to olfactory cues when selecting plant material to reduce the parasite load when reneating (Clark 1990). The intriguing notion that some avian species may use pheromones may also have deserved mention (Caro & Balthazart 2010). In the section on emotion, evidence to support a case for emotional equivalences in mammals and birds might have included work on sex steroid hormones and the neurotransmitter dopamine, showing that patterns of release in the brain and in the blood of these chemical messenger systems are similar in association with sexual arousal in both birds and mammals (Ball & Balthazart 2011).

The book is remarkably error-free. However, Birkhead's discussion of the lateralized control of song gives one the wrong impression about the state of the field. Although Nottebohm (1971) described a left-biased neural control of the syrinx in canaries, later studies have shown that syringeal control in songbirds and other avian taxa can be lateralized to either the right or left or be under bilateral control, depending on the species and the vocalization being considered (e.g. Suthers & Zollinger 2004). The discussion of the role of the neuropeptides oxytocin and vasopressin in relation to pair bonding (page 197) is also too simplistic and imprecise for my taste. It is accurately stated that this work on peptides is all based on studies in mammals, but it might have been useful to note that oxytocin and vasopressin do not occur in birds, although homologous forms (mesotocin and vasotocin) do. Birkhead refers to these peptides modulating 'reward' systems to promote pair bonding. The reward systems in mammals involve dopamine, and these systems are present in birds with an anatomical pattern basically identical to the mammalian system, and more importantly, these systems have been shown to be released in relation to copulatory behaviour in a manner similar to that of mammals (Ball & Balthazart 2011). Thus the neurobiological control of pair bonding may be quite similar in birds and mammals.

Overall this is a very enjoyable book that I highly recommend. I think it does capture the challenge one faces when trying to

imagine what it is like to be a nonhuman animal, even one as accessible as a bird. The philosopher Thomas Nagel published a famous essay entitled 'What is it like to be a bat?' (Nagel 1974). He argued for the importance of considering consciousness when constructing a theory of mind. We do not learn much in that essay about the subjective life of bats, just that it is a very interesting question. Birkhead's treatise marshals years of empirical study by animal behaviourists to give us some insights into the mental life of another taxon. It is a very personal account, based on the examples selected and the overall tone of the book. But that is what a book like this should be.

Gregory F. Ball

Department of Psychological and Brain Sciences, Johns Hopkins University, Baltimore, MD 21230, U.S.A.

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**Behavioural Responses to a Changing World. Edited by U. Candolin & B.B.M. Wong. Oxford: Oxford University Press (2012). Pp. xix + 256. Price £34.95 paperback**

Ernst Mayr (1963, page 604) pointed out that 'a shift into a new niche or adaptive zone is almost without exception initiated by a change in behavior'. In the foreword to this book (page xiii), Nicholas Davies writes 'organisms have evolved in response to environmental change ever since life began, but the current scale and pace of change is unparalleled'. Environmental change caused by humans is the greatest threat to biodiversity and we are just beginning to understand how global change will affect our planet. *Behavioural Responses to a Changing World* is a comprehensive overview devoted to understanding behavioural responses to anthropogenic changes. The book is well structured and organized into three main parts: (1) mechanisms, (2) responses and (3) implications. Overall the book consists of 17 chapters, each written by experts in a particular field.

The first part of the book on mechanisms focuses on how behavioural responses depend on the environment. Chapter 1 provides a conceptual overview of our current knowledge of behavioural

responses and their consequences. Chapter 2 looks into how environmental changes affect communication, acoustic, visual and chemical, and how changes in signalling may affect populations. Chapter 3 gives an overview of how endocrine systems may change in response to changes in the environment. The first part of the book concludes with an examination of how animals may use learning to adjust to environmental change and its role in the development of behaviour.

The second section on behavioural responses describes how behaviours are affected by anthropogenic changes. Each of chapters 5–10 gives a nice overview of how specific behaviours such as dispersal, migration, foraging, reproduction and social behaviour, as well as species interactions, are affected by environmental changes. The final part of the book focuses on the implications and the potential consequences of behavioural changes for populations, ecosystems and biodiversity. Chapter 11 discusses how behavioural plasticity might help to mitigate the detrimental effects of environmental change on both individuals and populations. This leads nicely to Chapter 12 discussing the interplay between behavioural and population dynamics, pointing out that we need more information on how changes in behaviour affect population dynamics. Chapter 13 looks at the potential consequences of behavioural changes at the ecosystem level. Chapter 14 looks at biological invasions, another form of global change, by illustrating the importance of behaviour in the spread and impact of invasive species. Chapter 15 explains how environmental change may influence sexual selection by affecting sexually selected behaviours, and discusses the consequences for the individual, population and species. Chapter 16 focuses on potential evolutionary responses and potential constraints to environmental change. The last chapter reviews the recent wildlife disturbance literature and calls for animal behaviourists to initiate collaboration between behavioural ecologists, wildlife biologists and policy-makers.

Most of us interested in animal behaviour would probably prefer that such a book would not have been necessary. The reality is that we face one of the biggest biodiversity crises our planet has known. Looking on the bright side, I found reading the book very interesting and stimulating, because anthropogenic-induced environmental changes allow us to study many different aspects of behaviour in action. The answers of this research are unlikely to be simple and probably will not please us. However, we need them as soon as possible to mitigate the effect of global change.

In conclusion, this book is the first to provide an overview of how the behaviour of animals is affected by human-induced environmental changes. The wide range of topics covered is impressive and certainly of interest to people involved in the fields of animal behaviour, behavioural ecology and conservation. The clarity of the text will also enable students to find their way in this fascinating area of research. Moreover, the book will also appeal to a more general audience interested in aspects of environmental change and its consequences. The editors Candolin and Wong have done a marvellous job in summarizing all these different aspects in one book. I can highly recommend it.

Hansjoerg P. Kunc  
School of Biological Sciences, The Queen's University Belfast,  
97 Lisburn Road, Belfast BT9 7BL, U.K.

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**Getting Started with R: An Introduction for Biologists**, A.P. Beckerman, O.L. Petchey. Oxford: Oxford University Press (2012). Pp. x+113. Price £19.99 paperback

**Data Analysis with R Statistical Software. A Guidebook for Scientists**, R. Thomas, I. Vaughn, J. Lello. Cardiff: Eco-explore (2012). Pp. 80. Price £10.00 paperback

**Discovering Statistics Using R**, A. Field, J. Miles, Z. Field. London: Sage (2012). Pp. xxxiv+958. Price £46.99 paperback

R is taking over the statistical world. This includes the statistical analysis of studies of animal behaviour, as any flick through this journal will now tell you. As such, those not on the R gravy train (and I myself don't yet have a season ticket) need to decide whether to be part of the R revolution or instead continue to use proprietary statistical software packages such as SPSS, SAS, Minitab or S-Plus. And this decision is two-fold. First, there is the decision about one's own research (and the analyses done in one's research group). Second, there is the decision about what we use to teach our students statistics, both at undergraduate and postgraduate level. For instance, if R becomes ever more common, are we doing our students a disservice not teaching them R, even if it does prove to be a passing fashion (and my guess is that it will not, at least not for a while)? So why not just decide to learn and teach R?

The reason why the decision is tricky is simple: as acknowledged by all three of these new books, R has a very steep and slippery learning curve. Thomas et al. sum this up very nicely with two quotes (both on page 4). The first is from Mick Crawley, doyen of statistical analysis for evolutionary ecologists: 'Learning R is not easy, but you will not regret investing the effort to master the basics'. The second is from an anonymous student: 'Learning R is an absolute nightmare, but apparently it is in some way good for me'.

And the reason that R has such a steep learning curve, that is easy to slip back down, is that R is not a stats package. Rather, it is a programming language in which statistical programmes have been developed and collected together to form a de facto statistical computing environment. Being a programming language, its programs are run using commands delivered using a command line, rather than via the user-friendly graphical user interfaces (GUIs) and drop-down menus now typical of many other stats software. While R does have a GUI that appears when you install and run the program on your computer, what you can do with the few available menus is limited to a bit of housekeeping (opening and saving files, directing R where to find and save data, and such like). The command line is where the action is.

This harsh learning curve, typified by the back-to-the-future nature of the command line, has two consequences. First, it is deeply challenging for our students, especially undergraduates who probably do not consider mathematics or computer programming as remotely relevant to their interest in animal behaviour (although hopefully everyone would read Maynard Smith 1982). Second, it may be rather challenging for the rest of us. I suspect I am not the only academic who knows of colleagues who own computers that have a 20th century date setting just so that their favourite but woefully out-of-licence SAS or Genstat or what-not still runs. And this may not be due to laziness or statistical illiteracy: skills learned are not easy to give up, especially when many of us do not manage to get the time to analyse data every week (or every month). Also, if the old package does the right analysis, then why change? Time-limited, of course we use what we know and