Letters

New technology facilitates the study of social networks

Jens Krause[1,2], Alexander D.M. Wilson[1] and Darren P. Croft[3]

[1] Leibniz-Institute of Freshwater, Ecology and Inland Fisheries, Department of Biology and Ecology of Fishes, 12587 Berlin, Germany
[2] Humboldt-University of Berlin, Department for Crop and Animal Sciences, Philippstrasse 13, 10115 Berlin, Germany
[3] Centre for Research in Animal Behaviour, College of Life and Environmental Sciences, Washington Singer Laboratories, University of Exeter, Perry Road, Exeter, UK, EX4 4QG

The study of social networks has become widespread in the behavioural sciences. This is largely due to several recent conceptual and analytic advances that enable characterisation of the social fine structure of animal populations [1,2]. Insights into social network structure have greatly advanced understanding of the dynamics of social processes [3–5] and have provided novel predictions for the evolution of behavioural strategies [6,7].

However, a common problem of social network studies concerns data collection. For many species, it is often time consuming (and sometimes simply not feasible) to record the interactions among all members of a group or population by direct observation. In some species, interactions are also difficult to observe because the animals are easily disturbed or hard to follow (e.g. birds and marine mammals). Several technological innovations have the potential to provide a break-through with these issues surrounding data collection. For example, in studies of human social networks, blue-tooth technology via mobile phones has been successfully used to track individuals and their encounter frequencies with others [8]. In non-human animals, tags have been developed that can be deployed to record (or infer) social interactions between individuals (i.e. the basic building blocks of social networks) based on spatial and/or temporal proximity. Perhaps the simplest tags that can be used for this purpose are PIT (passive integrated transponder) tags, which can be detected by receivers in the environment. For example, PIT tags can be used to record the visits of animals to known food sites (e.g. bird feeders) or nest boxes and it might be biologically meaningful to record individuals that visit the same location at the same time (or within a short time period) as socially interacting [1].

The technological development with probably the most potential for social network studies is the development of proximity loggers that record the identity of individuals carrying the loggers when they come within a specified distance of one another [9–11]. Over the past decade, this technology has advanced significantly and new-generation proximity loggers weigh so little (~1 g) that even small species (such as song-birds) can be fitted with them. The low cost of these tags means that sufficiently large numbers of individuals can be tagged to record the fine details of social patterns in whole groups or populations (e.g. Encounter Net project; http://encounternet.net/).

Corresponding author: Krause, J. (j.krause@igb-berlin.de).

The technology already exists for proximity loggers to also provide information about physiological parameters (such as heart rate, body temperature and stress levels) during the interaction and to give a GPS location that provides a spatial context for the encounter. Physiological data are important because they might help decide whether spatial proximity resulted in a social interaction and could even provide insights into the nature of the interaction. In the case of very small animals (such as social insects), it has also become possible to use computer vision (i.e. digital cameras that are connected to a computer) to carry out continuous real-time tracking of all individuals in a group or colony and to recognise automatically different types of behaviour [12] to build up datasets on interactions over periods of days or even weeks.

These technologies have the potential to revolutionise the way in which social behaviour is studied, because information about interactions can be obtained in an unprecedented quantity and of an unprecedented quality. Detailed information on the frequency and duration of encounters with conspecifics (and potentially heterospecifics) can be gathered. This approach also opens up new possibilities for hypothesis testing. However, there have been few applications of these technological developments so far (see [9–11] for examples), which leaves an enormous potential largely untouched.

There are some issues that need to be taken into account when using such technology. Depending on the species, huge datasets can be quickly accumulated over just a few days and this can create new challenges for data processing. Furthermore, the emphasis on large data quantities could mean that rare behaviours get overlooked or neglected. Although these problems are important, they are not insurmountable and we believe that the study of social organisation could enter a new era through the application of these technologies, ushering in a more standardised and quantitative approach to the study of social interactions.

Acknowledgements

We thank Simon Griffith, Dick James and Stefan Krause for stimulating discussions.

References

1 Croft, D.P. *et al.* (2008) *Exploring Animal Social Networks*, Princeton University Press
2 Wey, T. *et al.* (2008) Social network analysis of animal behaviour: a promising tool for the study of sociality. *Anim. Behav.* 75, 333–344

3 Flack, J.C. *et al.* (2006) Policing stabilizes construction of social niches in primates. *Nature* 439, 426–429
4 Croft, D.P. *et al.* (2006) Social structure and co-operative interactions in a wild population of guppies (*Poecilia reticulata*). *Behav. Ecol. Sociobiol.* 59, 644–650
5 McDonald, D.B. (2007) Predicting fate from early connectivity in a social network. *Proc. Natl. Acad. Sci. U. S. A.* 104, 10910–10914
6 Ohtsuki, H. *et al.* (2006) A simple rule for the evolution of cooperation on graphs and social networks. *Nature* 441, 502–505
7 Santos, F.C. *et al.* (2006) Evolutionary dynamics of social dilemmas in structured heterogeneous populations. *Proc. Natl. Acad. Sci. U. S. A.* 103, 3490–3494
8 Eagle, N. (2009) Inferring friendship network structure by using mobile phone data. *Proc. Natl. Acad. Sci. U. S. A.* 106, 15274–15278
9 Weihing, J. *et al.* (2005) Contact rates between possums revealed by proximity data loggers. *J. Appl. Ecol.* 42, 595–604
10 Guttridge, T.L. *et al.* (2010) Novel acoustic technology for studying free-ranging shark social behaviour by recording individuals' interactions. *PloS One* 5, e9324
11 Böhm, M. *et al.* (2009) Contact networks in a wildlife-livestock host community: identifying high-risk individuals in the transmission of bovine TB among badgers and cattle. *PLoS One* 4, e5016
12 Balch, T. *et al.* (2006) How multi-robot systems research will accelerate our understanding of social animal behavior. *IEE Proc.* 94, 1445–11463

0169-5347/$ – see front matter
doi:10.1016/j.tree.2010.10.004 Trends in Ecology and Evolution, January 2011, Vol. 26, No. 1

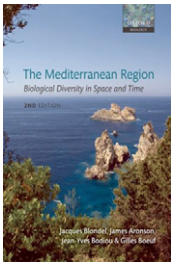
Book Review

Continuing sculpting

The Mediterranean Region: Biological Diversity in Space and Time (2nd edn) by Jacques Blondel, James Aronson, Jean-Yves Bodiou and Gilles Boeuf. Oxford University Press, 2010. £65.00 hbk; £34.95 pbk (392 pages) ISBN 978 0 19 955798 1/978 0 19 955799 8

Sinos Giokas

Department of Biology, University of Patras, Greece, GR-26500



I started to read *The Mediterranean Region: Biological Diversity in Space and Time* in the middle of summer, a time of year that comes to many people's minds when they hear the word 'Mediterranean'. As I read, I felt that I was a part of its subject, not only because I live and carry out research in this area, but also because, according to the convincing suggestion of this book, my predecessors have drastically contributed to its present-day biodiversity patterns.

The Mediterranean region is the ultimate example of an area where humans have been co-sculptors of biodiversity (despite some opposing arguments [1]) and perhaps the hottest area for the application of synthesis tools for conservation. In 13 chapters, Blondel, Aronson, Bodiou and Boeuf have managed to include all the pertinent information available about this important biodiversity hotspot. However, the book is not only this. Most importantly, the authors also present a convincing array of the processes that have shaped Mediterranean biodiversity in space and time. Unstable geology, geographical position, climate changes and human activities now and in the past have interacted, often in unpredictable ways, to shape Mediterranean biological diversity. In Chapter two, the authors provide a concise framework for considering these processes and also give examples and insights throughout the book that focus on the interactions between biotic and abiotic factors. In this way, the Mediterranean region (and, in my opinion, its islands especially) is shown to be a paradigm of an easily accessible, semi-natural laboratory, calling for more research on various scales of space and time.

The book is both old and new simultaneously. Its first edition, published about ten years ago fulfilled the ambition of its authors, Blondel and Aronson, and the expectations of its readership for a comprehensive, yet not tiresome, presentation of the biological richness and diversity patterns of the Mediterranean region. This current edition not only keeps those merits, but also includes two new chapters by new co-authors, devoted to the Mediterranean Sea. This is not the only change. During the past ten years, much research has produced hundreds of papers dealing with the ecology, evolution and conservation of this region. It is a difficult task to filter and classify all that information, full as it is with idiosyncratic characteristics and, at the same time, to present clearly all these advances in knowledge. Blondel *et al.* have done an excellent job in that respect and give a well-updated, filtered and clear account of this decade's worth of findings. Of course, some readers might find that several references are missing, some data have not been updated, or perhaps that new results concerning Mediterranean phylogeography or community ecology have been neglected. However, as the authors say, their main aim was to provide an introductory textbook for ecology students and researchers, free of unnecessary and distracting details and, in those terms, the book fulfills its role nicely, keeping a good balance between scientific completeness and ease of reading.

Blondel *et al.* not only describe the current and past situations and trends in the Mediterranean. Throughout their book, there is a strong, yet dispassionate, opinion concerning the relative importance of the various factors contributing to Mediterranean biodiversity and about what should be done to preserve this biological wealth, both on land and in the sea. The authors provide a convincing and stimulating critique of current practices and propose realistic measures for the conservation of species, habitats and landscapes. In doing this, they take into account not only expectations, but also demographic facts and current projections about climate change. From that point of view, this book can stand as a valuable tool for policy makers or for the scientists that advise them.

Corresponding author: Giokas, S. (sinosg@upatras.gr).