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EDITORIAL

Key frontiers in camera trapping research

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Biodiversity monitoring makes a central scientific contribution to conservation management and environmental policy. Without it, we have an impaired evidence base for decision-making in areas such as species management, and forest and agriculture policy. Yet, for the world's terrestrial mammals, traditional monitoring systems based on direct observations have been relatively limited in spatial, temporal and taxonomic coverage, and in the quality and depth of information they provide. This is in large part because terrestrial mammals are typically difficult to reliably observe in a way that generates robust data on distribution and abundance.

In recent decades, camera traps have greatly expanded what is possible in mammal research. These remote monitoring devices have become increasingly cost-effective, as high-quality camera and sensor components have become more affordable, and manufacturers compete for market share. As a result, camera traps are now firmly established as a core tool for mammal ecologists and conservationists, and the number of publications reporting on studies that used camera traps is continuing to grow rapidly (Burton et al. 2015). These publications are providing insights into a range of species and locations that would have been unthinkable prior to the introduction of this technology.

However, while I believe camera trapping is well established, I would argue that it is not yet fully mature as a methodological discipline. There are a number of important frontiers on which camera trapping research currently has considerable potential for progress, and this special issue presents a collection of papers that focus on some of these developmental frontiers – conceptual, taxonomic and practical.

While camera trapping has overwhelmingly been used to determine species richness, distribution and, to a lesser extent, abundance, there has always been a strand of research seeking to understand animal behaviour through the lens of camera trapping. This approach has the great advantage of allowing us to observe animals with minimal invasiveness, but is limited by the fact that our observations are mostly just brief glimpses in space and time. In order to make robust inferences from these fleeting observations, we need innovative analytical approaches, based on solid theoretical underpinnings. Caravaggi et al. (2017) and Frey et al. (2017) both review aspects of behavioural research, in the former case highlighting several areas where camera trapping has begun to contribute to the field of conservation behaviour, in the latter case focusing on the study of activity patterns, temporal niche partitioning and human impacts. However, both reviews raise at least as many questions as answers, highlighting as yet unmet potential in these areas.

On the taxonomic front, I introduced this editorial with a focus on mammals because 95% of camera trapping research has been focused on this group (Burton et al. 2015), but Welbourne et al. (2017) would like to expand the utility of camera traps to reptiles (more specifically, squamates). A key challenge here is that squamates, being both ectothermic and relatively small on average, produce little or no heat signal, so rarely trigger standard passive infra-red camera trap sensors as they are usually deployed. As a result, rather few studies have yet used camera traps to survey squamates (although what has been done is reviewed in this paper). I wonder whether, ultimately, this problem will be solved by the development or adaptation of technologies that can effectively sense animals without requiring a heat signal, while maintaining the advantages of compact autonomy and low power use that camera traps offer. In the meantime, though, Welbourne et al. (2017) outline some interesting possibilities for increasing the chances of detecting squamates by effectively manipulating heat signals.

Arboreal species often comprise much of the mammalian diversity at a given location, particularly in the moist tropics. However, the practical difficulties of placing cameras in an effective way anywhere but at ground level have prevented their widespread use in the trees, and only a handful of publications yet exist on arboreal camera trapping. Seeking to push practice forward on this frontier, Bowler et al. (2016) show that camera traps can be at least as effective as ground-based observational surveys for detecting arboreal species, and much more so for nocturnal species, which encourages me that further effort in this area is warranted. Of course, effective arboreal placement of camera traps requires skilled climbers and careful position selection, but Bowler et al. provide guidelines for successful arboreal survey that should help to make this practice more accessible and widely used.

Another very practical frontier in camera trapping research is the standardization of data management and sharing to facilitate collaboration on large-scale research and monitoring. Such large-scale work is the foundation needed to tackle big global and regional challenges (Steenweg et al. 2017), and calls for engagement in this area go back at least a decade (e.g. Rowcliffe and Carbone 2008). The need for improved data standards to facilitate sharing is at least touched on by all the papers in this special issue, underscoring the continuing relevance of this call. Scotson et al. (2017) go further by making this their central focus. Speaking from their problematic experience of trying to construct a large data set from multiple camera trap surveys in order to carry out a regional analysis, Scotson et al. (2017) present a succinct set of software-independent recommendations for best practice in the management of camera trap data, as well as reviewing the growing range of software solutions that aim to help researchers to maintain easily accessible and sharable databases. I hope that widespread and efficient sharing of camera trapping data will be the norm in future, helping us to address global questions more effectively, and that Scotson et al. (2017) will have helped to achieve this.

The topics covered in this special issue are by no means a comprehensive survey of current frontiers in camera trapping. For example, one area not touched on where I anticipate rapid developments in the near future is the application of computer vision tools to the processing of camera trap images, which has the potential to ease the sheer quantity of work needed, and so make camera trapping more cost-effective. However, with the contributions in this special issue, as well as the two or three other camera trapping papers that are now being published every week, it seems that the approach is maturing rapidly as a remote sensing tool. I suspect that the way we process, store, analyse and share camera trap data will look quite different in ten years' time. I am excited to see how it works out.

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