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Fifty years of the Biological Records Centre

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In this special issue of the *Biological Journal of the Linnean Society*, we celebrate 50 years of the Biological Records Centre (BRC) but, more importantly, we celebrate the pioneers of BRC and the volunteer recording community. It is inspiring to consider the many individuals who have contributed to the rich legacy of biological recording since the 16th Century. The core activity of BRC has remained unchanged since its foundation in 1964: working in partnership with volunteer recording schemes and societies to collate, manage, disseminate, and interpret species observations (biological records). However, innovative technologies and the development of statistical approaches are taking biological recording in new and exciting directions. The large spatial coverage and increasingly fine-scale spatial precision of biological records enable ecologists to examine large-scale processes that would be impossible to address without the contribution of voluntary recorders. © 2015 The Linnean Society of London, *Biological Journal of the Linnean Society*, 2015, **115**: 469–474.

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What is more we hope …. that others, in emulation of us, may investigate the spontaneous plants, each of his own area, more diligently so that in this way a complete Phytologia Britannica may finally appear from all their contributions (Ray, 1660; in the Preface to the Cambridge Catalogue; translated by Oswald & Preston, 2011).

Over 350 years ago, John Ray recognized that a complete account of the taxonomy and distribution of British plants could only be achieved by the cooperation of botanists throughout the country. As natural history increased in popularity in the 19th and early 20th Centuries, the earlier informal collaboration practised by Ray and his successors became increasingly formalized, either under the leadership of individuals such as H. C. Watson, R. L. Praeger, and F. Balfour-Browne, or under the aegis of specialized societies such as the Entomological Club (founded 1826; still active) and the Moss Exchange Club (founded 1896; now the British Bryological Society). By this time, the professionalization of science that had developed in the 19th Century had left botany and zoology amongst the small number of sciences in which amateurs are still able to make a substantial contribution (astronomy is another obvious example). Sir Arthur Tansley (widely considered the founding father of ecology and first chairman of the Nature Conservancy in 1949) acknowledged the importance of amateur experts, stating that their 'acquaintance with their local floras is absolutely unequalled'. The launch of the Botanical Society of the British Isles (BSBI) Maps Scheme in 1954 represented a major advance. The resulting publication, the *Atlas of the British Flora* (Perring & Walters, 1962), demonstrated the potential of such coordinated recording and led to the establishment of the Biological Records Centre (BRC) in 1964 (Preston, Roy & Roy, 2012; Preston, 2013; Roy *et al.*, 2014).

In celebrating 50 years of BRC, it is interesting to reflect that the core activity remains unchanged: working in partnership with volunteer recording schemes and societies to collate, manage, disseminate, and interpret species observations (biological records). It is also humbling to consider the many individuals who have contributed to the rich legacy of biological recording. In this special issue of the *Bio-*

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logical Journal of the Linnean Society, we celebrate 50 years of BRC but, more importantly, we celebrate the pioneers of BRC and the volunteer recording community. It is an immense privilege to be a part of BRC and exciting to see the large-scale and long-term datasets accrued over centuries supporting conservation and research.

Citizen science, comprising the involvement of volunteers in the scientific process (Roy *et al.*, 2012), is a new term. However, Pocock *et al.* (2015) point out that biological recording has a long history and is undoubtedly leading the way in citizen science, even if this is not always recognized. A recent estimate suggested that 70 000 volunteers annually contribute wildlife observations (Pocock *et al.*, 2015). Biological recording in the UK covers a wide diversity of approaches, from opportunistic recording to systematic monitoring. The number of taxonomic groups covered is extensive, with more than 80 different schemes and societies representing a diverse range of taxa from mosses to mammals. The Water Beetle Recording Scheme for Britain and Ireland is over 100 years old (Foster, 2015) and so it can celebrate the accolade of being the oldest insect recording scheme in the world. Foster (2015), in defining a recording scheme, points out that: 'The most important requirement of a recording scheme is that it should be motivated by the need to produce something, at least maps but better an overview of the conservation status of a species or, more dangerously, evidence in support of an hypothesis!'.

Most recording schemes and societies focus on the compilation of the records required to develop an atlas documenting the distribution of species. For the less popular groups, this may take many years. Pescott *et al.* (2015b) provide an overview of the distinction between such 'atlas projects' and structured monitoring but recognize that there can be considerable blurring between the two approaches because recording protocols and support networks for atlas projects can eliminate the distinction between monitoring schemes and atlas-focused fieldwork. It is intriguing to consider the ways in which monitoring schemes evolve and the motivations for developing different approaches. There are many benefits of gathering wildlife observations, whether through systematic or opportunistic approaches, including deriving robust trends and the detection of unexpected ecological change, so-called 'ecological surprises' (Wintle, Runge & Bekessy, 2010).

Isaac and Pocock (2015) not only recognize the value of biological records for addressing large-scale questions about biodiversity change, but also reflect on the inherent biases: uneven sampling over space and time, uneven sampling effort per visit, and uneven detectability of species. Biological recording is evolving, particularly with the increase in mass participation citizen science (Pocock *et al.*, 2015), and both new challenges and opportunities are arising (Isaac & Pocock, 2015). An increased understanding of the various sources of bias and information associated with records will be needed to ensure that biological records remain one of the most important sources of data for policy, conservation, and science. Powney and Isaac (2015) review the application of biological records, focussing on four areas of biodiversity research: biogeography, trend assessments, conservation biology, and climate change ecology. Phenology is widely seen as one of the clearest ways of documenting ecological responses to climate change. Therefore, it is timely to consider analytical methods for studying phenological change using biological records. Chapman *et al.* (2015) conclude that biological recording will capture data on a broader range of taxa and from a wider area than has been the case with traditional, direct long-term phenological monitoring. Indeed, the large spatial coverage and fine-scale spatial precision of biological records enable ecologists to examine large-scale processes that it would be impossible to address without the voluntary contribution of recorders.

The contributions within this special issue highlight the breadth and value of biological records to advancing knowledge. However, even within well-studied taxa, there are neglected groups, and vascular plant hybrids are one of these. Biologists have wrestled with the species concept for centuries; as Darwin acknowledged: 'no one definition (of species) has as yet satisfied all naturalists; yet every naturalist knows vaguely what he means when he speaks of a species'. Hybridization is known to have been involved in the origin of many plant species and biological records have been informative in enhancing understanding of the biology of hybrids (Preston & Pearman, 2015).

The way in which wildlife is changing is evident both in the short- and long-term (Gurney, 2015). Gurney (2015) considers a total of 7420 species in a wide range of taxonomic groups and, perhaps surprisingly, notes that there have been a similar number of species lost and gained: 125 and 126, respectively. However, the functional traits of the species colonizing differ from those species prone to extinction. Gurney therefore concludes that: 'If we want to maintain the richness of our flora and fauna, we need to hold on to as much as we can and not just see one species as replaceable by another'. Mason *et al.* (2015) continue the theme of change by exploring range expansions of 1573 southerly-distributed species from 21 animal groups. They confirm the conclusion of a previous study (Hickling *et al.*, 2006) that the northern range margins of many species have moved northwards, although they demonstrate an acceleration in this expansion, especially for Lepidoptera. By contrast, Hill & Preston (2015) consider Boreal species of vascular plants and bryophytes at the southern edges of their range, and show that many have declined markedly in southern Britain (Hill & Preston, 2015). Both climate change and habitat loss affect boreal vascular plants, although only habitat loss is implicated in the decline of boreal bryophytes.

The richness of the invertebrate datasets is one of the most notable features of biological recording in Britain; the invertebrate recording schemes and societies provide unprecedented sources of data on fauna that are otherwise often neglected. The value of these datasets is particularly demonstrated by two papers included in this special issue (Stewart *et al.*, 2015; Thomas *et al.*, 2015). Thomas *et al.* (2015) explore the status of 299 invertebrates representing ten taxonomic groups that exploit early seral stages in a variety of habitats. They conclude that woodland species are particularly vulnerable when contrasted with those of semi-natural grasslands and lowland heaths, which appear to have benefited from agri-environment schemes. Stewart *et al.* (2015) examine the relationship between the distributions of 1265 phytophagous insects and their associated food plants, representing an impressive 9128 interactions. Phytophagous insects rarely exploit the full distribution extent of their host plants; the relationship between the distribution of insects and their food plants is not linear. However, Stewart *et al.* (2015) suggest that, in a changing environment, there will be opportunities for novel interactions and consequently changes in distributions that will be hard to predict. Clearly, there is an exciting future for biological recording with respect to documenting such changes, particularly through a focus on interactions between species.

Pescott *et al.* (2015a) highlight another interaction by examining the changes in the distribution of bryophytes and lichens in response to airborne pollutants and associated changes in lichenivorous moths. It is apparent that the effects of environmental change cascade between trophic levels and that reductions in pollutants have led to the recovery of species in all three groups (Pescott *et al.*, 2015a). One of the most intimate forms of interaction is that of a parasite with its host. Purse and Golding (2015) consider the role of biological records in providing evidence to underpin models of disease. Species distribution models are widely used to analyze spatial patterns of pathogens and vectors of disease and thus to develop risk maps to inform policy (Purse & Golding, 2015).

The applied value of biological records to inform conservation is the central theme of a number of the contributions in this special issue (Gillingham *et al.*, 2015; Maes *et al.*, 2015). Roy *et al.* (2015) celebrate the role of the volunteer recording community in contributing to the understanding of invasion biology, reflecting that their expertise and commitment will continue to be invaluable with the desire to increase understanding of community and ecosystem-level effects of invasions. Detailed field observations, through biological recording, will provide the spatial, temporal, and taxonomic breadth required for such research. Biological records are increasingly used for estimating trends and so have an application for the development of IUCN Red Lists (Maes *et al.*, 2015). However, IUCN criteria have not been used consistently across regions or taxonomic groups. Maes *et al.* (2015) provide recommendations for a uniform approach to decision-making for threat assessments. The designation and management of protected species and areas is a pivotal component of conservation action. However, environmental change could render existing protected areas climatically unsuitable for the very species that they are supposed to protect. Gillingham *et al.* (2015) use occurrence data to demonstrate the value of protected areas in promoting colonization and preventing extinctions of butterflies and birds. Thomas *et al.* (2015) further highlight the role of protected areas in mitigating climate change. Indeed protected area networks act 'as stepping-stones of suitable breeding conditions and facilitating range shifts, with many species remaining protected across protected area networks as a whole'. Shifts in the ranges of species as a consequence of environmental change are most dramatically seen with the arrival of non-native species, often originating from far-flung native ranges.

Technological advances have revolutionized biological recording (August *et al.*, 2015). From the use of punched record cards in the early days of computing to the recent development of online databases, BRC has developed by embracing new opportunities offered by developments in computational and communication technology. The possibilities offered by modern computing have allowed the development of analytical techniques that maximize the use of the largely unstructured datasets accrued through biological recording (Chapman *et al.*, 2015; Isaac & Pocock, 2015; Powney & Isaac, 2015; Thomas *et al.*, 2015). The automated capture of images and sound will add new dimensions to biological recording (August *et al.*, 2015). August *et al.* (2015) outline the exciting possibilities, stating: 'Technological advances are also changing the landscape of biological recording: websites and mobile technologies are streamlining data gathering, ensuring data quality and engaging a wider audience with nature; automation and crowd-sourcing are improving verification

Figure 1. Past and present Biological Records Centre staff and students at the 50th anniversary symposium at the University of Bath, 27 June 2014. Left to right, standing: Owen Mountford, Mark Jitlal, Helen Roy, Marc Botham, Colin Harrower, David Roy, Paul Harding, Chris Preston, Dorian Moss, Jane Croft, Nick Greatorex-Davies, Hannah Dean, Björn Beckmann, Oli Pescott; sitting: Jon Cooper, Mark Hill, Tom Oliver, Michael Pocock, Nick Isaac, Tom August, Suzanna Mason, Jodey Peyton, Louise Barwell. Photograph: Heather Lowther.

and meaningful analyses at policy relevant scales; and data contributors are being rewarded with data visualisation tools, feedback and game like elements'.

The molecular revolution is also providing alternative approaches to monitoring biodiversity (Lawson Handley, 2015). Lawson Handley (2015) highlights the potential of molecular techniques to describe entire communities, as well as detect rare or elusive species. Molecular techniques have been used for the detection of invasive non-native species, trophic interactions, and monitoring of biodiversity. The increased sensitivity for assaying degraded or low concentration DNA, coupled with decreasing costs and rapid increase in the rate of processing samples, will further the potential for using molecular techniques for biological recording. The challenge will be to manage and integrate the vast molecular datasets alongside conventional biological records.

Biological records have been widely used to predict the changes in species distribution as a consequence of projected climate change (Hill, Thomas & Huntley, 1999; Hill *et al.*, 2002; Mason *et al.*, 2015; Thomas & Gillingham, 2015). However, the potential use of records for forecasting extends beyond climate change (Oliver & Roy, 2015) to inform environmental management. Sutherland *et al.* (2015) conclude this special issue with a 10-point plan for BRC over the next decade. Development (e.g. encouraging the collection of associated data on species and combining different types of data) and reflection (e.g. identifying the interests, motivations and skills of recorders) will be critical to the future of biological recording (Sutherland, Roy & Amano, 2015).

The 22 papers within this special issue have been written by 72 individuals who are involved with biological recording as volunteers and professional ecologists. However, this is only a small number in comparison with the tens of thousands of individuals involved in biological recording across the UK (Pocock *et al.*, 2015). Biological recording has engaged people throughout the centuries. The value of the inspiring contributions made by volunteers meticulously documenting our wildlife to inform conservation and research will undoubtedly ensure an exciting future for biological recording.

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