Taylor & Francis
Taylor & Francis Group

Emu - Austral Ornithology

ISSN: 0158-4197 (Print) 1448-5540 (Online) Journal homepage: https://www.tandfonline.com/loi/temu20

Parrots move to centre stage in conservation and evolution

Robert Heinsohn, Katherine L. Buchanan & Leo Joseph

To cite this article: Robert Heinsohn, Katherine L. Buchanan & Leo Joseph (2018) Parrots move to centre stage in conservation and evolution, Emu - Austral Ornithology, 118:1, 1-6, DOI: 10.1080/01584197.2018.1411223

To link to this article: https://doi.org/10.1080/01584197.2018.1411223

Published online: 16 Jan 2018.

EMU - AUSTRAL ORNITHOLOGY, 2018
VOL. 118, NO. 1, 1–6
https://doi.org/10.1080/01584197.2018.1411223

Taylor & Francis
Taylor & Francis Group

EDITORIAL

Parrots move to centre stage in conservation and evolution

Across the globe, people identify with parrots (Psittaciformes). Though parrots are renowned for their extraordinary colours, intelligence, and personable natures as pets, researchers in conservation, ecology and evolution have been slow to accord the approximately 400 species of extant parrots their rightful place in these studies. Yet parrots are now viewed as one of the most threatened bird orders. Research into parrots has snowballed over the last three decades, from less than 50 publications per year prior to 1990 to over 250 studies each year since 2014 (Figure 1).

This special issue of *Emu – Austral Ornithology* aims to capture the essence of some of the recent major breakthroughs in our understanding of the demographic, ecological and evolutionary forces at work on this remarkable group of birds. Courtesy of the explosive power of new genomic techniques, initial papers in this issue examine parrots' evolutionary past and future. Other contributions focus on recent discoveries of remarkable morphological and behavioural evolution and the role of parrots as ecosystem engineers. Ultimately, this issue explores our new understanding of how parrot life histories interact with the pervasive selective forces of the Anthropocene to make the Psittaciformes a flagship taxon for biodiversity conservation. This special issue finishes with case studies of the rarest, elusive, and most enigmatic parrot species to highlight both recent lows and highs in parrot conservation.

Phylogenetic pathway through dazzling diversity

Though unified in ways that always make them easily identifiable as parrots (e.g. bill shape, plumage), the order Psittaciformes is also extraordinarily diverse in its behaviour and morphology. Parrots sport the colours of the rainbow and range in size from tiny (10 g) pygmy parrots to massive (>1 kg) macaws and cockatoos. They prefer fruits and seeds but also consume nectar and insects, and occupy tropical forests, deserts, and even coastlines and, of course, urban landscapes. Parrots are the consummate social creature and operate in fission–fusion social groups of great complexity. Although infamous for their less melodious screeches, they have complex communication systems, often centred on the sharing of information about food resources. They have large brains for their body size, no doubt reflecting their complicated social lives and need for complex spatial memories to allow them to find ephemeral food sources.

Parrots have presented something of an evolutionary enigma both in terms of their origin and relationships with other birds, and in terms of their relationships within the order. This is probably because their traits are so conservative and thus so diagnostic. Perhaps the biggest surprise of recent years was when molecular systematics showed the closest relatives of parrots to be the passerines (Passeriformes) and that those two groups' closest relatives are the falcons (Falconidae) (Hackett *et al.* 2008). The sister relationship between parrots and passerines, together with shared ancestry with falcons, has since been confirmed repeatedly (McCormack *et al.* 2013; Jarvis *et al.* 2014; Prum *et al.* 2015). One reason why this was surprising is that passerines are very different morphologically, for example having straight and slender bills and an anisodactyl toe arrangement compared to parrots with their chunky curved bills and zygodactyl toes. However, passerines and parrots do converge behaviourally in several ways. For example, both groups score highly in terms of intelligence and problem solving, and prefer social monogamy when breeding. Importantly, in both groups the young rely heavily on vocal learning to acquire their songs and calls.

In this special issue Provost *et al.* (2018) present a fresh synthesis and re-analysis of the many recent molecular data sets that pertain to higher level relationships among parrots. On one hand, their analysis of 307 taxa and 30 genes reinforces much of what has been learned in recent years about higher level relationships. Examples are the sister taxon relationship between Neotropical parrots and the larger African parrots, the sister relationship between the larger New Zealand parrots and *all* other parrots including the New Zealand region's other species. On the other hand, they also highlight how few species have been studied at the intraspecific, phylogeographical levels. Few cockatoos and similarly few parrots of Southeast Asia and even parts of Australasia have been studied in this regard, just

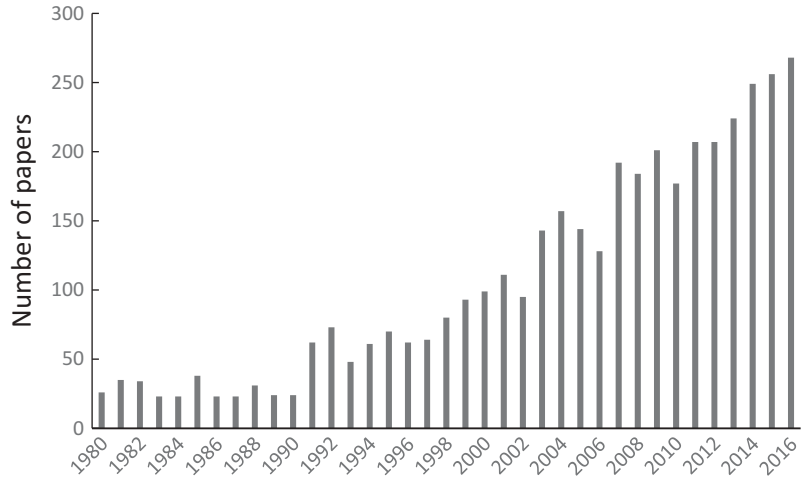

Figure 1. The number of publications by year from the Web of Science database using the topic words parrot, ecology, conservation, behaviour, evolution, systematics.

a third of all parrots having been so studied. The trend of recent years to split genera of parrots shows no sign of abating. Finally, Provost *et al.* (2018) have set the stage for a further assessment through genomic methods. Parrots are likely a microcosm of such work in many higher vertebrates, not just birds. In this special issue McElroy *et al.* (2018), however, do show how genomic tools can change the way in which intraspecific diversity is studied. They link genomic perspectives on phylogeography to the effects of purifying selection on bill morphology, as well as to more traditional systematics-based implications.

Paradigm-shifting insights into evolutionary ecology

Parrots are increasingly recognised for a set of attributes which, when placed in context of their sister relationship with passerines, give them great potential for advancing evolutionary biology. The classic view of parrots has been that they are long-lived and monogamous; however, studies have also revealed extraordinarily diverse mating systems (e.g. cooperative breeding, polyandry; Heinsohn *et al.* 2007). Colour, for example, is clearly of supreme evolutionary importance for parrots, but the potential that parrots hold for revealing the secrets of the evolution of animal colours remains to be properly harnessed (Berg and Bennet 2010). We now know that parrot feathers are coloured with brilliant red, orange and yellow psittacofulvins, a class of pigment unique to the group (Taysom *et al.* 2011). Importantly, these polyenes are not acquired from the diet but are manufactured endogenously. Because they are costly to produce, they open new opportunities for evaluating natural vs. sexual selection in shaping animal colours (Masello *et al.* 2008).

Parrots also play a profound role in shaping plant communities. Parrots have long been 'pigeon-holed' as efficient seed predators and exploiters of plants. Recent research, however, reviewed in this special issue (Blanco *et al.* 2018) challenges this view and uncovers subtle ways in which they interact with and even help their food species through complex mutualistic interactions. The ultra-strong bill with its high mobility in both jaws, zygodactyl feet for climbing and hanging, and large mobile tongue allow parrots to access and exploit a wide range of plant resources. Combined with their metabolic ability to ingest toxic but highly nutritious foods, parrots seem like the ultimate predator and exploiter of prey species, when in reality they are also important dispersers of seed and pollen, often over very long distances. They also provide benefits to other animal species via the seeds they drop, and can even promote the health of their plant food species by removing parasites. The view is slowly emerging of parrots as landscape architects having essential roles in shaping entire ecosystems through the cascading effects of both antagonistic and mutualistic interactions with plants (Blanco *et al.* 2018).

Both parrots and the oscine passerines (songbirds) use vocal learning in mate attraction and territory defence (Podos and Warren 2007; Bradbury and Balsby 2016), but parrots seem to go further by using vocal learning in an open-ended way to maximise opportunities in their large social groups. It seems that the major differences in vocal learning between parrots and songbirds may result from contrasting foraging styles. Rather than defend discrete territories having quality food resources like most songbirds,

parrots typically forage in fission–fusion groups over large overlapping home ranges. Parrots specialise on foods that are often difficult to find and access, and that are toxic. They are often neophobic as a response and seem to rely on social information to learn how to exploit such marginal food sources over large geographic areas, leading to selection for imitation of others, referential signalling and recognition of many individuals in their highly fluid social circles (Bradbury and Balsby 2016).

One fascinating outcome of vocal learning and cultural transmission is the formation of vocal dialects. Dialects were first described in passerine birds but also occur in parrots, hummingbirds, bats, and cetaceans. They include cases having either sharp boundaries or more gradual (clinal) variation between dialects as Wright and Dahlin (2018) show in this special issue. The weight of early evidence supports the broad hypothesis that vocal learning in parrots leads to social advantages, the important caveat being that dialects are not individual-level phenomena subject to selection but are rather population-level phenomena that arise as a result of individual-level behaviour. Parrots present an important opportunity for examining dialect formation because they have highly developed vocal learning abilities but differ in social organisation to their sister taxon, the passerines, the group most studied in this context. Wright and Dahlin (2018) found that over 90% of parrots showed geographic variation and propensity to share local call types, but many also demonstrate important evolutionary lability in this trait. They also found little support for the idea that dialects isolate populations and thus generate genetic differences among populations, but instead concluded that dialects are maintained by the social benefits of matching local call types (Wright and Dahlin 2018).

The most threatened bird order

Sadly, parrots are now considered the most threatened bird Order, 28% (111/398) of extant species being classified as threatened under IUCN criteria, and the group having the lowest Red List Index (higher aggregate extinction risk) of all comparable bird groups (Olah *et al.* 2016). Psittaciformes is the fourth largest bird order after Passeriformes (5913 spp., 10% threatened), Caprimulgiformes (593 spp., 9% threatened), and Piciformes (484 spp., 7% threatened) (Olah *et al.* 2016). The main anthropogenic threats to parrots are habitat loss and degradation caused mostly by agriculture, logging and trapping for the bird trade. A recent analysis of parrots on the global scale showed that the likelihood of parrot species being classified as threatened was highest for forest species, and those with small historical distribution size, large body size and long generation times. The economic status of people living within a parrot species' range was also an important determinant with both extent of urbanisation and per capita gross domestic product (GDP) associated with higher risk of extinction (Olah *et al.* 2016).

A consolidated international effort to understand the threats facing parrots and the necessary actions to protect them is now underway. The Working Group Psittaciformes (WGP), comprising scientists and conservationists, was formed under the auspices of the International Ornithologists' Union in 2010. One of the group's first tasks has been to evaluate and review the situation concerning the threats facing Psittaciformes in each of several regions. Thus far, and alongside Olah *et al.* (2016) covering the global situation, reviews of Afrotropical (Martin *et al.* 2014) and Neotropical parrots (Berkunsky *et al.* 2017) have been completed. This special issue presents Olah *et al.*'s (2018) equivalent review for Oceania (comprising Australia, New Zealand, and the islands of the Pacific and Wallacea). The three regional reviews have identified much consistency in the threats faced by parrots together with some important differences (see below), as well as the poor state of ecological knowledge of many species. For example, many parrot species in Africa and Madagascar are known to be declining, yet at present there are major knowledge gaps hindering conservation action, the most recent conservation gains being made in southern Africa (Martin *et al.* 2014). The review of threats faced by Neotropical parrots (Berkunsky *et al.* 2017) followed a population-based approach and reported the scope of threats affecting 192 populations of 96 species of Neotropical parrots across 21 countries. Many populations have been affected by multiple threats, including agriculture, capture for the pet trade, and logging, for example, affecting 55% of the populations; importantly, capture for the pet trade is the threat most associated with decreasing population trends (Berkunsky *et al.* 2017).

In this special issue, Olah *et al.* (2018) use comparative methods to review the factors related to extinction risk of 167 extant and five extinct parrot species from Oceania. They test a range of ecological and socioeconomic variables while controlling for phylogeny. Alongside variables known to be important globally (smaller historical ranges, larger body size, and high forest dependency), they find that parrot species in this region are most likely to be threatened if endemic to a single country and if they occur in regions having high human unemployment. Importantly, they find that

invasive species, including predators and competitors, pose the single most pervasive threat to parrots of Oceania. This is an important difference with Africa and the Neotropics.

High rates of trapping for the pet trade are a pervasive threat to parrots in all three regions reviewed so far, and have led to most parrot species being listed on the appendices of the Convention on International Trade in Endangered Species of Fauna and Flora (CITES). In this special issue, Martin (2018) examines the revealing cases of two African parrot species, Grey and Timneh Parrots (*Psittacus erithacus* and *P. timneh*), which have regularly ranked among the most traded of all bird species. He used the CITES database to demonstrate that patterns of trade have varied dramatically over time. Over 1.2 million wild-sourced parrots of these two species were exported to North America and Europe prior to 1992 and 2005, respectively. More recently, and after legislative controls on the trade of wild birds, there has been a rapid rise in exports of captive-bred parrots, especially to Asia. Marked regional shifts in the key exporting and importing countries indicate a dynamic global trade. Shifting patterns of imports and exports driven by regulatory changes including CITES, unilateral restrictions on imports and exports, and variation in the social, economic and biological factors specific to the birds in each region mean that the forces driving supply and demand in both legal and illegal markets are complex and becoming less easy to predict on a global scale.

Such threats make methods for estimating population size essential for identifying key species, targeting protection and compiling effective management plans. However, reliable information on population sizes and trends is lacking for most parrot species. Although methods for estimating abundance and population size exist, their effectiveness is not guaranteed because parrot behaviour often does not fit into the raft of assumptions of most statistical approaches. In this special issue, Dénes *et al.* (2018) revisit the basic problem facing most parrot researchers concerning how best to estimate abundance and population size of the species they study. They review established and emergent analytical methods, taking a close look at assumptions and practicalities. Roost surveys, capture–recapture methods, distance sampling, roadside transects, occupancy surveys and acoustical methods have all advanced considerably but the logistics of counting parrots will clearly never allow a 'one-size-fits-all' approach.

The special issue also addresses the growing concern of wildlife diseases. They are difficult to monitor and control and can cause devastating outbreaks on wild parrot populations when they strike. Psittacine beak and feather disease (PBFD) is a common, viral disease of parrots, characterised by long-term defective feather development which limits flight in infected birds (Raidal and Peters 2018). The relevant virus, BFDV, is the dominant pathogen of wild parrots in Australasia where it has been present for at least 10 million years. All endemic Australasian parrots appear susceptible. The disease has been recorded in wild and captive populations worldwide, possibly as a result of the export of wild-caught Australian species such as budgerigars (*Melopsittacus undulatus*). Raidal and Peters (2018) review the extent of understanding of both epidemiology and virus co-evolution in BFDV. All threatened and endangered Australian parrot species can be infected by BFDV genotypes from other host reservoir species. The most dramatic example so far of threatened species being impacted is the critically endangered Orange-bellied Parrot (*Neophema chrysogaster*). Conservation efforts at sustaining a viable population of Orange-bellied Parrots have been severely hit by outbreaks of BFDV both in captivity and the wild.

The special issue concludes on both high and low notes: the plight of one of the world's rarest parrots and the rediscovery of another parrot whose rarity had conferred almost mythical status upon it. Orange-bellied Parrots (OBPs) became arguably the most threatened parrot species in the world when the population crashed in the 2016–2017 breeding season to only 3 females and 13 males (Stojanovic *et al.* 2018). The birds pose an especially difficult conservation conundrum. Unusually for parrots (e.g. Saunders *et al.* 2016), they migrate annually between their austral spring/summer breeding grounds in south-west Tasmania to coastal, south-eastern mainland Australia for the austral winter. There is still considerable uncertainty about the causes of decline in this species, but losses suffered while on migration are a large part of the annual mortality. Habitat loss, biased sex ratios among adults and low female breeding participation are also likely drivers of decline. In this special issue, Stojanovic *et al.* (2018) analyse the latest data available, updating population parameters and critically evaluating current recovery actions and management plans. Among other suggestions, they propose that suppression of fires in the breeding range may have resulted in a shortage of the OBP's natural food sources. On balance, the likelihood of recovery for OBPs does not look promising as the recent use of captive-bred birds to bolster the wild population has not proven successful.

Everyone needs a good-news story, especially conservation biologists tackling the environmental concerns of

the Anthropocene. There are few bird species as mysterious as the elusive Night Parrot (*Pezoporus occidentalis*), and even fewer in which the news is indisputably good. Despite a previously vast range in inland Australia, reliable records of Night Parrots almost completely disappeared between 1912 and the early 1990s when a desiccated body was found by a roadside in remote south-eastern Queensland. Another corpse was found 16 years later. It was not until 2013, however, that photographic evidence was provided of a wild, living Night Parrot (Murphy *et al.* 2017). In this special issue, Murphy *et al.* (2018) take a landscape perspective to investigate why Night Parrots have persisted in the region of Queensland in which they were rediscovered. They discuss the low prevalence of the invasive species that typically explain faunal absences elsewhere in central Australia. Foxes, for example, are absent, feral cats are fairly infrequent, and grazing pressure from domestic herbivores has been moderate. Also of importance is that large fires have not been a feature of the landscape, meaning that patchy habitats with the preferred grasses (*Triodia* spp.) have persisted.

We started our editorial by noting that to humans there is something special about the parrots, order Psittaciformes. This is probably because of their aesthetic appeal as beautiful, wild birds or their intelligence and highly interactive nature as companion animals. Yet parrots have also long been exploited by humans worldwide for their plumage and meat, and for trade. It seems that being so important to humans brings mixed blessings! On the one hand, growing human populations mean ever greater pressure on wild populations, whereas on the other hand, the high profile of parrots means that many people care deeply about their conservation. Our aim in this special issue is to consolidate the recent gains in the knowledge base, the hope being that increasing scientific attention will foster our appreciation of, and efforts to preserve, this remarkable group of birds. From this perspective we hope that readers will enjoy this special issue of *Emu – Austral Ornithology*.

References

Berg, M. L., and Bennet, A. T. D. (2010). The evolution of plumage colouration in parrots: A review. *Emu – Austral Ornithology* **110**, 10–20. doi:10.1071/MU09076

Berkunsky, I., Quillfeldt, P., Brightsmith, D. J., Abbud, M. C., Aguilare, J. M. R. E., Alemán-Zelaya, U., Aramburú, R. M., *et al.* (2017). Current threats faced by Neotropical parrot populations. *Biological Conservation* **214**, 278–287.

Blanco, G., Hiraldo, F., and Tella, J. L. (2018). Ecological functions of parrots: An integrative perspective from plant life cycle to ecosystem functioning. *Emu – Austral Ornithology* **118**, 36–49. doi:10.1080/01584197.2017.1387031

Bradbury, J. W., and Balsby, T. J. (2016). The functions of vocal learning in parrots. *Behavioral Ecology and Sociobiology* **70**, 293–312.

Dénes, F. V., Tella, J. L., and Beissinger, S. R. (2018). Revisiting methods for estimating parrot abundance and 1 population size. *Emu – Austral Ornithology* **118**, 67–79. doi:10.1080/01584197.2017.1401903

Hackett, S. J., Kimball, R. T., Reddy, S., Bowie, R. C., Braun, E. L., Braun, M. J., Chojnowski, J. L., *et al.* (2008). A phylogenetic study of birds reveals teir true ancestry. *Science* **320**, 1763–1768.

Heinsohn, R., Ebert, D., Legge, S., and Peakall, R. (2007). Genetic evidence for cooperative polyandry in reverse dichromatic *Eclectus* parrots. *Animal Behaviour* **74**, 1047–1054.

Jarvis, E. D., Mirarab, S., Aberer, A. J., Li, B., Houde, P., Li, C., Ho, S. Y., Faircloth, B. C., Nabholz, B., *et al* (2014). Whole-genome analyses resolve early branches in the tree of life of modern birds. *Science* **346**, 1320–1331. doi:10.1126/science.1253451

Martin, R. O., Perrin, M. R., Boyes, R. S., Abebe, Y. D., Annorbah, N. D., Asamoah, A., Bizimana, D., *et al.* (2014). Research and conservation of the larger parrots of Africa and Madagascar: A review of knowledge gaps and opportunities. *Ostrich* **85**, 205–233.

Martin, R. P. F. (2018). Grey areas: Temporal and geographical dynamics of international trade of Grey and Timneh Parrots (*Psittacus erithacus* and *P. timneh*) under CITES. *Emu – Austral Ornithology* **118**, 113–125. doi:10.1080/01584197.2017.1369854

Masello, J. F., Lubjuhn, T., and Quillfeldt, P. (2008). Is the structural and psittacofulvin-based colouration of wild Burrowing Parrots *Cyanoliseus patagonus* condition dependent? *Journal of Avian Biology* **39**, 653–662.

McCormack, J. E., Harvey, M. G., Faircloth, B. C., Crawford, M. G., Glenn, T. C., and Brumfield, R. T. (2013). A phylogeny of birds based on 1500 loci collected by target enrichment and high throughput sequencing. *PLoS One* **8**. doi:10.1371/journal.pone.0054848

McElroy, K., Beattie, K., Symonds, M., and Joseph, L. (2018). Mitogenomic and nuclear diversity in the mulga parrot of the Australian aridzone: Cryptic subspecies and tests for selection. *Emu- Austral Ornithology* **118**, 22–35. doi:10.1080/01584197.2017.1411765

Murphy, S. A., Austin, J. J., Murphy, R. K., Silcock, J., Joseph, L., Garnett, S. T., Leseberg, N. P., *et al.* (2017). Observations on breeding Night Parrots (*Pezoporus occidentalis*) in western Queensland. *Emu – Austral Ornithology* **117**, 107–113.

Murphy, S. A., Paltridge, R., Silcock, J., Murphy, R., Kutt, A. S., and Read, J. (2018). Understanding and managing the threats to Night Parrots insouth-western Queensland. *Emu – Austral Ornithology* **118**, 135–145. doi:10.1080/01584197.2017.1388744

Olah, G., Butchart, S. H. M., Symes, A., Medina Guzma, I., Cunningham, R., Brightsmith, D. J., and Heinsohn, R. (2016). Ecological and socio-economic factors affecting extinction risk in parrots. *Biodiversity and Conservation* **25**, 205–223.

Olah, G., Theuerkauf, J., Legault, A., Gula, G., Stein, J., Butchart, S. H. M., O'Brien, M., and Heinsohn, R. (2018). Parrots of Oceania – A comparative study of

extinction risk. *Emu – Austral Ornithology* **118**, 94–112. doi:10.1080/01584197.2017.1410066

Podos, J., and Warren, P. S. (2007). The evolution of geographic variation in birdsong. *Advances in the Study of Behavior* **37**, 403–458.

Provost, K. L., Joseph, L., and Smith, B. T. (2018). Resolving a phylogenetic hypothesis for parrots: Implications from systematics to conservation. *Emu – Austral Ornithology* **118**, 7–21. doi:10.1080/01584197.2017.1387030

Prum, R. O., Berv, J. S., Dornburg, A., Field, D. J., Townsend, J. P., Lemmon, E. M., and Lemmon, A. R. (2015). A comprehensive phylogeny of birds (Aves) using targeted next-generation DNA sequencing. *Nature* **526**, 569–573. doi:10.1038/nature15697

Raidal, S. R., and Peters, A. (2018). Psittacine beak and feather disease: Ecology and implications for conservation. *Emu – Austral Ornithology* **118**, 80–93. doi:10.1080/01584197.2017.1387029

Saunders, D. L., Cunningham, R., Wood, J., and Heinsohn, R. (2016). Responses of critically endangered migratory swift parrots to variable winter drought. *Emu – Austral Ornithology* **116**, 350–359.

Stojanovic, D., Alves, F., Cook, H., Crates, R., Heinsohn, R., Peters, A., Rayner, L., Troy, S. N., and Webb, M. H. (2018). Further knowledge and urgent action required to save Orange-bellied Parrots from extinction. *Emu – Austral Ornithology* **118**, 126–134. doi:10.1080/01584197.2017.1394165

Taysom, A. J., Stuart-Fox, D., and Cardoso, G. C. (2011). The contribution of structural-, psittacofulvin- and melanin-based colouration to sexual dichromatism in Australasian parrots. *Journal of Evolionary Biology* **23**, 303–313.

Wright, T. F., and Dahlin, C. R. (2018). Vocal dialects in parrots: Patterns and processes of cultural evolution. *Emu – Austral Ornithology* **118**, 50–66. doi:10.1080/01584197.2017.1379356

Robert Heinsohn
Fenner School of Environment and Society, Australian National University, Canberra, Australia
robert.heinsohn@anu.edu.au http://orcid.org/0000-0002-2514-9448

Katherine L. Buchanan
Centre for Integrative Ecology, School of Life and Environmental Sciences, Deakin University, Geelong, Australia

Leo Joseph
Australian National Wildlife Collection, CSIRO, Canberra, Australia