

Parrots as overlooked seed dispersers

Shortly after our friend and colleague Gary R Bortolotti passed away in 2011, his widow Heather Trueman sent JLT ten photographs of parrots that Gary had taken in Brazil. In one of these images, we saw a flying chestnut-fronted macaw (*Ara severus*) carrying in its beak a defleshed fruit of the motacú palm (*Attalea phalerata*; upper-right arrow in Figure 1); upon enlarging this picture for publication in *Frontiers*, we noticed another macaw transporting a smaller-sized seed (lower-left arrow in Figure 1). Gary's photograph had captured what has been described as an unusual behavior: active seed dispersal by parrots. The unexpected nature of this observation was reinforced during discussions with colleagues who specialize in avian frugivory and seed dispersal. As they argued – and contrary to well-recognized avian seed dispersers such as frugivorous passerines, trogons, and toucans, which typically swallow whole fruits and disperse seeds after gut passage – parrots handle and destroy fruits in situ to eat the pulp or to gain access to the seeds. Although more than 400 known species of parrot inhabit the world's tropical ecosystems, only lesser vasa parrots (*Coracopsis nigra*; Böhning-Gaese *et al.* 1999) and plain parakeets (*Brotogeris tirica*; Sazima 2008) have previously been reported to regularly disperse seeds transported in their bills. This has led to the general assumption that parrots are seed predators and thus do not participate in seed-dispersal mutualisms (Fleming and Kress 2013).

Because only two parrot species were known to routinely carry seeds in flight, this behavior is considered to be unusual. However, these two species are among the more ancestral (*Coracopsis*) and more modern (*Brotogeris*) species within the phylogenetic tree of the Psittacidae fam-

ily of parrots (Wright *et al.* 2008), suggesting that this behavior could be well-conserved through the evolution and diversification of this large lineage of birds, but nonetheless overlooked. Parrots often forage in the canopy of tropical forests, and their foraging behaviors are difficult to study due to remote locations and logistical constraints. Thus, the likelihood of observing a parrot in flight carrying a fruit or seed in its bill may be low, and such behaviors may go largely unreported. A new photograph (Figure 2) taken by JLT, this time of a large flock of red-fronted macaws (*Ara rubrogenys*) in Bolivia, led us to reconsider this second hypothesis. In this case, the transport of an ear of corn (*Zea mays*) by a macaw went unseen until the photograph was examined more closely. We then decided to reassess the foraging behavior of parrots, searching for indications of other dispersal events.

To that end, we joined a group of parrot biologists and ecologists studying foraging behavior who, since 2012, have recorded hundreds of observations of parrots dispersing fruits or seeds using their bills or, less often, their feet (WebFigure 1). Although preliminary, our data suggest that seed dispersal by parrots is not unusual. Observations came from 28 parrot species belonging to 16 genera, ranging in body size from the smallest parakeets to the largest macaws, and involved the dispersal of fruits and seeds from 94 species of trees (including palms) and shrubs. Instances were recorded in seven countries (Argentina, Bolivia, Brazil, Chile, Ecuador, Peru, and Spain), comprising mostly neotropical parrots but also an African and an Asian species from introduced populations of parrots in Spain. They covered a wide variety of ecosystems – from the sea-level Argentinean Pampas to high-altitude Andean forests, from continents to islands, from the wettest Amazonian savannas to the driest Caatinga forests, and from pristine to urban habitats. Regarding functional interactions, parrots – regardless of their origin – dispersed both native and non-native (including cultivated) plants.

We measured the distances that fruits or seeds were carried by parrots, with the aid of laser rangefinders, in 686 dispersal events. Unsurprisingly, given the long-distance flying abilities of most parrot species, the distances spanned a wide range (maximum = 1200 m, median = 27 m, mean = 44 m; WebFigure 2). This indicates that parrots may serve as efficient long-distance seed dispersers. Moreover, we observed several incidents where transported



Gary R Bortolotti

Figure 1. Chestnut-fronted macaws (*Ara severus*) transporting a defleshed motacú palm fruit (*Attalea phalerata*; upper-right arrow) and an unidentified seed (lower-left arrow). Photo taken on 17 Oct 2009 (Rio Cristalino, Brazil).

fruits or seeds were accidentally dropped in flight or when the parrot perched during eating. Importantly, we often found uneaten, ripened seeds and seedlings growing under tree perches used by parrots, far from the nearest plant that could have provided those seeds. All of these observations point to parrots as genuine, but thus far overlooked, seed dispersers.

This short story illustrates how serendipitous photographic evidence can lead scientists to question what has been considered unusual or difficult-to-observe behaviors, and highlights how much we have yet to learn about the natural history of most organisms. Given that parrots are large, colorful, and loud birds that have attracted the attention and company of humans for centuries (Tella and Hiraldo 2014), how many small yet important life-history details are we missing about numerous other, perhaps less charismatic, species? The net effect of parrots on the population dynamics of their food plants relies on the negative impact of seed predation versus the benefits for the genetic structure of tropical forests derived from long-distance seed dispersal. This contribution of parrots as antagonists and mutualists with respect to their diverse food plants warrants further research. The fact that one-third of parrot species in the world are threatened with extinction should urge the assessment of their ecological roles and the ecosystem-wide consequences of parrot population declines. Parrots may play a key role in the functioning and maintenance of biodiversity not only in tropical ecosystems but also in regions where parrots have been introduced.

Gary's photograph presented us with an enlightening moment in our own research, and we hope that the preliminary data discussed here will encourage other researchers to more thoroughly explore the role of parrots in providing a key ecosystem service as seed dispersers.

Acknowledgements

Gary R Bortolotti inspired us to explore this parrot behavior as well as many other aspects of avian behavior and ecology. Preliminary results on parrot seed dispersal were obtained through projects funded by Fundación Biodiversidad, Fundación Repsol, World Parrot Trust, and a Severo Ochoa award (to FH), and discussed within the ParrotNet COST Action group.

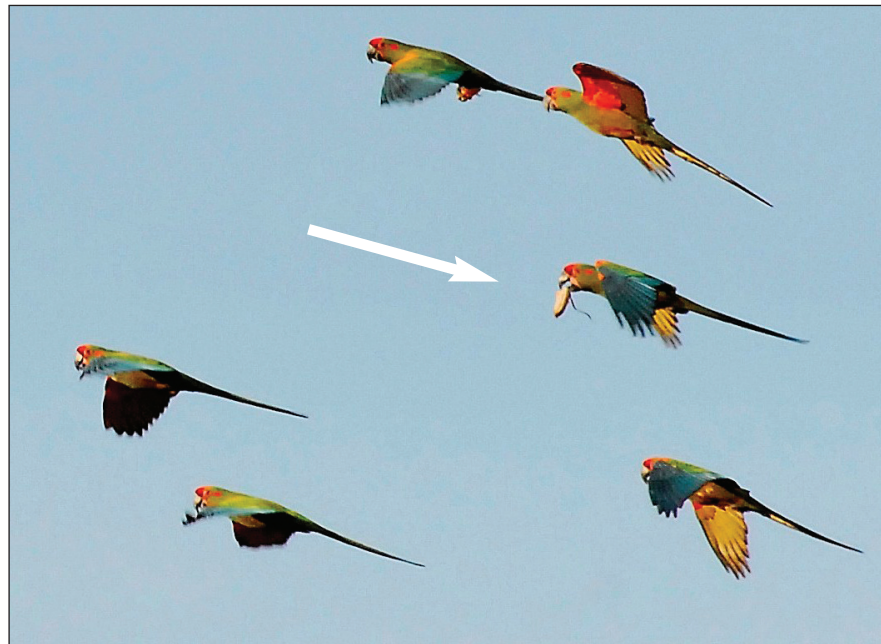


Figure 2. Red-fronted macaw (*Ara rubrogenys*) transporting an ear of corn (*Zea mays*). Photo taken on 27 Aug 2011 (Los Negros, Bolivia).

References

- Böhning-Gaese K, Gaese BH, and Rabemanantsoa SB. 1999. Importance of primary and secondary seed dispersal in the Malagasy tree *Commiphora guillaumini*. *Ecology* 80: 821–32.
- Fleming TH and Kress WJ. 2013. The ornaments of life. Chicago, IL: University of Chicago Press.
- Sazima I. 2008. The parakeet *Brotogeris tirica* feeds on and disperses the fruits of the palm *Syagrus romanzoffiana* in southeastern Brazil. *Biota Neotropica* 8: 231–34.
- Tella JL and Hiraldo F. 2014. Illegal and legal parrot trade shows a long-term, cross-cultural preference for the most attractive species increasing their risk of extinction. *PLoS ONE* 9: e107546.
- Wright TF, Schirtzinger EE, Matsumoto T, et al. 2008. A multilocus molecular phylogeny of the parrots (Psittaciformes): support for a Gondwanan origin during the Cretaceous. *Mol Biol Evol* 25: 2141–56.

José L Tella^{1*}, Adrián Baños-Villalba²,
Dailos Hernández-Brito^{1,2}, Abraham Rojas³,
Erica Pacífico^{1,4}, José A Díaz-Luque⁵,
Martina Carrete², Guillermo Blanco⁶,
and Fernando Hiraldo¹

¹Estación Biológica de Doñana (CSIC), Sevilla, Spain
*(tella@ebd.csic.es); ²University Pablo de Olavide, Sevilla,
Spain; ³Museo de Historia Natural Noel Kempf Mercado
and Zoológico Municipal, Santa Cruz de la Sierra, Bolivia;
⁴Museu de Zoologia, Universidade de São Paulo, São Paulo,
Brazil; ⁵Proyecto de Conservación Paraba Barba
Azul, World Parrot Trust, Beni, Bolivia; ⁶Museo
Nacional de Ciencias Naturales (CSIC),
Madrid, Spain

