

Breeding season diet of the Floreana mockingbird (*Mimus trifasciatus*), a micro-endemic species from the Galápagos Islands, Ecuador

LUIS ORTIZ-CATEDRAL

Ecology and Conservation Group, Institute of Natural and Mathematical Sciences, Massey University, Private Bag 102-904, Auckland, New Zealand

Abstract I conducted observations on the diet of the Floreana mockingbird (*Mimus trifasciatus*) during its breeding season in February and March 2011. The Floreana mockingbird is a critically endangered species restricted to Gardner and Champion Islets off the coast of Floreana Island, in the Galápagos Islands, Ecuador. During 11 days, 172 feeding bouts of adult and nestling mockingbirds were observed. The majority of feeding bouts of adults (31%; 19 feeding bouts) involved the consumption of nectar and pollen of *Opuntia megasperma*. Another important food item consisted of Lepidopteran caterpillars (27%; 17 feeding bouts). The majority of food items fed to nestlings consisted of Lepidopteran caterpillars (26%; 29 observations), followed by adult spiders (19%; 21 observations). The reintroduction of the species to its historical range on Floreana Island is currently being planned with an emphasis on the control or eradication of invasive cats and rats. To identify key areas for reintroduction, a study on the year-round diet of the species as well as availability and variability of food items is recommended. Nectar and pollen of *Opuntia megasperma* was an important dietary item for the species during its breeding season. This slow-growing plant species was widespread on the lowlands of Floreana Island but introduced grazers removed *Opuntia* from most of its range. In the context of the potential reintroduction of this species to Floreana Island, it is important to establish if this high-energy resource is key for breeding, and consideration should be given to a supplementary food program as it has been successfully implemented for bird species elsewhere.

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INTRODUCTION

The Floreana mockingbird (*Mimus trifasciatus*) has been dubbed “Darwin’s muse” due to the role this species played in shaping his ideas about speciation and natural selection (see Hoeck *et al.* 2009). Formerly widespread on the lowlands of Floreana Island (Steadmann 1982), the Floreana mockingbird is now restricted to 2 islets off the coast of Floreana Island: Champion and Gardner (Grant *et al.* 2000).

It now occupies less than 1% of its historical range, and is classified as critically endangered (CR) by the IUCN (iucnredlist.org). Despite the historical relevance of the species and its critically endangered status, the Floreana mockingbird remains one of the least studied species in the Galápagos Archipelago, possibly due to the inaccessibility to the only 2 islets where it lives, occupying an area of just under 90 ha. Three other species of mockingbird occur in the Galápagos Islands including the Española mockingbird (*M. macdonaldi*) and San Cristobal mockingbird (*M. melanotis*), each restricted to their

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Correspondence: l.ortiz-catedral@massey.ac.nz

Table 1. Food types consumed by Floreana mockingbirds on Champion and Gardner Islets, Galápagos Islands, Ecuador.

Food type	Feeding bouts	Proportion of diet
<i>Opuntia megasperma</i> *	19	0.31
Catepillars (Lepidoptera)	17	0.27
Adult spider (<i>Argiope</i> sp.)	9	0.15
Unidentified insect	5	0.08
Beetles (Curculionidae)	3	0.05
Fruits**	2	0.03
Adult moth (Lepidoptera)	2	0.03
Beetles (Carabidae)	2	0.03
Land snail (<i>Bulimulus</i> sp.)	1	0.02

*Pollen and nectar

***Cordia lutea*

namesake islands. A third species, the Galápagos mockingbird (*M. parvulus*) is the most widespread mockingbird and occurs on 10 islands in the Galápagos archipelago (darwinfoundation.org/datazone). While conducting surveys of Floreana mockingbird on Champion and Gardner Islets, I recorded feeding observations of the species. Given the limited information about the diet of the species, this paper presents observations on the diversity of food items consumed by the species during its breeding season.

METHODS

Observations were carried out over 11 days during the breeding season of Floreana mockingbird, either through opportunistic encounters with adult individuals foraging (6 days) or during 1-hour long observations on breeding pairs feeding young (5 days). I visited Champion Islet (9.4 ha) from ~07:00 to 12:00 h on 24 February and 1 March 2011. Visits were limited to ~9 hours, which allowed covering the entire islet due to its small size. Gardner Islet (84 ha) was visited 9 times, every visit lasting between 3 to 4 days on 23 and 26 January, 23 February, 3 March, 24 to 27 March, and 10 April 2011. For adult mockingbirds, 2 observers recorded "feeding bouts", a non-invasive approach to document animal dietary diversity (Altman 1974; Galetti 1993). Given the critically endangered status of the Floreana mockingbird and the requirement to keep disturbance to a minimum during these visits, I considered this approach suitable. When observing adult mockingbirds, only 1 feeding bout per individual was recorded to prevent pseudo-replication. Given that the entire population of mockingbirds on Champion Islet, and approximately a third of the Gardner Islet population are banded,

individual birds could be distinguished from one another. Whenever an adult mockingbird was spotted, observers registered the time, the band combination, and the food item being consumed. Food items were classified to species whenever possible or as belonging to a broad category (*i.e.*, spider, insect, *etc.*). For nest observations, one observer located 10 to 15 m from the focal nest made observations using binoculars. A scribe recorded the time and the food items brought to the nest by Floreana mockingbirds. Before feeding nestlings, mockingbirds perch on the edge of the nest, carrying the prey items near the tip of the bill, thus it was possible to identify, in some cases to genus, the arthropods carried. Grant and Grant (1979) conducted similar observations on nests of the closely related Galápagos mockingbird, the only other study on the diet of mockingbirds in the Galápagos Islands to date. Observations lasted for 1 hour and were conducted on 8 nests. Only nests on Gardner Islet were recorded. Only food provided to nestlings aged 5-8 days old was recorded due to the duration of field trips. The typical nestling period of Floreana mockingbirds is approximately 14 days (*pers. obs.*).

RESULTS

A total of 172 observations were recorded on adult and nestling Floreana mockingbirds. For adults, 62 feeding bouts were recorded, all on individuals foraging alone. Adult Floreana mockingbirds were observed consuming nectar and pollen of *Opuntia megasperma* (Fig. 1) and fruits of *Cordia lutea* as well as arthropods from a variety of orders, one land snail (*Bulimulus* sp.) and one gecko (*Phyllodactylus* sp.). Of the total of dietary items ingested ($n = 62$ feeding bouts), 61% corresponded to arthropods and 34%



Fig. 1. Floreana mockingbird feeding on the nectar and pollen of a *Opuntia megasperma* flower. Photo by author.

to plants. When classified by taxonomic rank the dietary items are: *Opuntia megasperma* (nectar) 31%; Lepidopteran caterpillars 27%; and spiders (*Argiope* sp.) 15%. All other dietary items represent 2 to 8% of feeding bouts (Table 1).

Nestlings were fed exclusively arthropods ($n = 110$ observations), mostly Lepidopteran caterpillars 31%; Orthopterans (*Schistocerca* sp.) 20%; and spiders (*Argiope* sp.) 19%. Other arthropods included beetles (Coleoptera) 14% and flies (Diptera) 9%. The remaining 7% of observations corresponded to unidentified arthropods.

DISCUSSION

The feeding ecology of mockingbirds in the Galápagos Islands has not been studied in detail; however, the available literature indicates that they are generalist feeders, like their mainland counterparts (see Cody 2005). In one of the first studies on the diet of Galápagos birds, Snodgrass (1902) examined the stomach contents of 33 Galápagos mockingbirds and 5 Española mockingbirds and identified the seeds of 22 plant species, a variety of orthopterans, dipterans, coleopterans, as well as arachnids. Later observations have confirmed the generalist nature of the diet of *M. parvulus*. For instance, a wide variety of items was observed in the diet of mockingbirds on Genovesa Island including insects, fruits, crabs and eggs of the Galápagos dove (*Zenaida galapagoensis*; Grant & Grant 1979). On Española Island, *M. macdonaldi* has been observed eating the eggs of waved albatross (*Phoebastria irrorata*; Anderson & Fortner 1988) and muscle tissue from the tail of marine iguanas (*Amblyrhynchus cristatus*; Swing

2012). On the same island, mockingbirds have been observed drinking blood from seabirds, sea lions (*Zalophus californianus*) and marine iguanas (Curry & Anderson 1987). Floreana mockingbirds have also been observed feeding on the carrion of seabirds, sealions, lava lizards and geckos (Curry & Anderson 1987), and are reported to feed on newly hatched blue-footed boobies (*Sula nebouxii*; Harris 1968).

Although the present study is based on only a brief period of observations, the results support the view of Floreana mockingbirds as being a generalist feeder, consuming pollen, nectar and fruits as well as invertebrate and vertebrate prey. To the best of my knowledge, my observations are the first record of the capture and consumption of a living vertebrate by Floreana mockingbirds: a small gecko (*Phyllodactylus* sp.). Outside the study period reported here, I have also seen mockingbirds hunting and consuming Galápagos centipedes (*Scolopendra galapagoensis*) on Champion and Gardner Islets, as well as the introduced yellow-paper wasp (*Polistes versicolor*). Combined, these observations suggest that Floreana mockingbirds have a diverse diet, which might reflect temporal and spatial changes in resource availability.

One of the most important dietary items appeared to be nectar from the cactus *Opuntia megasperma*. It is possible that the availability of *Opuntia megasperma* flowers is linked to the timing and success of breeding of Floreana mockingbirds. Although determining the amount of *Opuntia megasperma* flowers and their effect on reproductive success of mockingbirds was outside the scope of this study, the majority of feeding bouts of adults involved the consumption of nectar and pollen, suggesting that the species consumes a readily available resource. A similar association between flowers and other birds has been documented in the Galápagos Islands, where finches, doves, and other mockingbirds consume nectar, fruits and seeds of various *Opuntia* species, which peak in flower production during the late dry and wet seasons (Grant & Grant 1980; 1981).

A central element in the conservation of Floreana mockingbirds is the eventual reintroduction of the species to its former range in the lowlands of Floreana Island (Charles Darwin Foundation 2008). In contrast to the islets of Champion and Gardner, the last strongholds of Floreana mockingbirds, *Opuntia megasperma* is all but extinct in the lowlands of Floreana Island, which has been attributed to browsing by domestic goats and donkeys (Heleno *et al.* 2011). If *Opuntia megasperma* is in fact a key high-energy resource linked to the breeding of the mockingbird, its absence from the lowlands of Floreana Island might limit the establishment of a reintroduced population. Re-vegetation using *Opuntia* might take considerable time, given the

slow growth of these cacti (Grant & Grant 1989). A potential alternative approach is supplementary feeding using sugar feeders as it has been implemented for other endangered island birds (see Castro *et al.* 2003). Clearly, a more detailed study on the temporal and spatial variability of food resources used by Floreana mockingbirds and its relationship to reproductive success is needed.

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