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Diet of Adult and Nestling Scarlet Macaws in Southwest Belize, Central America[1]

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ABSTRACT

Scarlet Macaw diet was determined during the breeding season of February–June 1998. Macaws were primarily granivorous, exhibiting a narrow diet during the dry season, with low variety of food items in adult and nestling diets. Seeds of *Cnidoscolus* spp. and *Schizolobium parahybum*, tree species characteristic of floodplain forest, were predominant in nestling diets, and may provide protein-rich food resources. River floodplains provided important nest sites and food resources for Scarlet Macaws during the breeding season.

RESUMEN

La dieta de la guacamaya roja (*Ara macao*) fue determinado durante la época de reproducción de febrero a junio 1998. Las guacamayas son principalmente granívoros, exhibiendo una dieta limitada durante el verano, con una baja variedad de productos comestibles en la dieta de los adultos y las crias. Las semillas de *Cnidoscolus* spp. and *Schizolobium parahybum*, especies arboreas caracteristicas del bosque de tierras inundadas, fueron predominantes en la dieta de las crias y posiblemente pueden servir como una fuente rica en proteinas. Las zonas de tierras inundadas son sitios importantes para anidar y obtener recursos comestibles para la guacamaya roja durante la época de reproducción.

Key words: Ara macao; Chiquibul National Park; feeding ecology; floodplain habitat; niche breadth; nutrition; Psittacidae; seed predation; subtropical wet forest.

THE SCARLET MACAW (*ARA MACARO*) IN CENTRAL AMERICA IS currently restricted to small, remnant populations in Mexico, Guatemala, Belize, Honduras, Nicaragua, and Costa Rica (Wiedenfeld 1994). The species is classified under Appendix I of the Convention on International Trade in Endangered Species (CITES), and considered Endangered on the International Union for the Conservation of Nature (IUCN) Red List (Snyder *et al*. 2000).

The Scarlet Macaw breeding season extends from late November to May, and nest sites are located in cavities of tall live or dead trees (Forshaw 1989). Their diet is varied, consisting of seeds, fruits, flowers, and leaf stems from a variety of plant species (Marineros & Vaughan 1995, Gilardi 1996). Few studies, however, have been conducted on the feeding ecology of large macaws, and little is known of nestling diets.

In Belize, the Scarlet Macaw occurs only in the Chiquibul National Park and Cockscomb Basin in the southwest of the country, and the remaining population is estimated at a few hundred birds (Snyder *et al*. 2000). Almost nothing is known of the breeding and feeding ecology of the Scarlet Macaw in Belize, and such information is essential to develop effective conservation strategies for this endangered species. In this study, I determined some of the important plant species in the diet of adult and nestling Scarlet Macaws during the breeding season in Belize.

The study was conducted in the 1700 km^2 Chiquibul National Park and Forest Reserve, southwest Belize, encompassing an area from 16°44′N to 16°52′N, and 88°54′W to 88°59′W. I made additional observations in the Cockscomb Basin Forest Reserve and Wildlife Sanctuary, and the village of Red Bank in Stann Creek District (16°36′N, 88°34′W). The area is dominated by a limestone topography, moderately to steeply sloped at 25°–40° (Brokaw 1991), with elevations from sea-level to 800 m. Annual rainfall is 2500 mm, occurring on 150–200 d of year (Johnson & Chaffey 1973). The dry season occurs from February to May, with a rainy season from June to November. Brokaw (1991) places the Raspaculo river basin in the subtropical wet forest and subtropical lower montane wet forest life zones (Holdridge 1967). Tree species characteristic of lowland and riparian forest include: *Cecropia obtusifolia*, *Ceiba pentandra*, *Guarea grandifolia*, *Schizolobium parahybum*, and *Spondias* spp. (Brokaw 1991). Highland forest tree species include: *Bursera simaruba*, *Cedrela odorata*, *Sebastiana longicuspis*, *Swietenia macrophylla*, and *Xylopia frutescens* (Brokaw 1991).

I determined the diet of Scarlet Macaws during the breeding season from February to June 1998. Observations of feeding macaws were conducted while traveling by paddle canoe along the Monkey Tail, Raspaculo, and Macal rivers, and by walking trails around Las Cuevas Research Station in the Chiquibul National Park. When I encountered Scarlet Macaws, I recorded date, time, location, food species, and habitat type, as well as the number of macaws observed feeding, and the plant part eaten, *i.e*., fruit pulp, seed, or flower. A feeding bout was an observation of one or more macaws feeding on a food source. If the macaws changed to another food source during the period of observation, this was recorded as a second feeding bout (Galetti 1993). I identified tree species in the field, or by comparison with samples at the National Herbarium in Belmopan, Belize.

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TABLE 1. *Diet observations of adult Scarlet Macaws in southwest Belize, Central America.*

Family/Species	Plant part eaten	Feeding bouts	No. of Macaws	Date
Anacardiaceae/*Spondias mombin*[a]	Seed	1	5	May/June 1997
Annonaceae/*Xylopia frutescens*	Seed	6	35	March 1998
Bromeliad spp.	Pith of stem	4	5	March–May 1998
Burseracea/*Bursera simaruba*	Unripe seed	3	14	April–May 1998
Euphorbiaceae/*Cnidoscolus* spp.	Unripe seed	1	1	March, May 1998
Euphorbiaceae/*Sebastiania longicuspis*	Unripe seed	3	8	April–May 1998
Homoptera: leaf-gall larvae of *Astronium graveolens*	Insect larvae	2	8	April 1998
Leguminosae/*Schizolobium parahybum*	Unripe + ripe seed	18	28	March–May 1998
Leguminosae/*S. parahybum*	Pith of stem	3	4	March-May 1998
Marcgraviaceae/*Schwartzia* spp.	Seed	1	2	May 1998
Moraceae/*Cecropia obtusifolia*	Fruit	2	4	March–April 1998
Moraceae/*Pourouma bicolour*	Unripe seed	1	2	April 1998
Palmae/*Attalea cohune*[b]	Pericarp	1	2	June 1998
Sapotaceae/*Sloanea tuerckheimii*	Seed	1	2	April 1998
Sterculiaceae/*Bytnerria* cf. *catalpifolia*[c]	Seed	1	10	February 1991
Sterculiaceae/*Guazima ulmifolia*[d]	Seed	1	18	August 1988

[a]N. Bird, pers. comm.; [b]S. Matola, pers. comm.; [c]D. Sutton, pers. comm.; [d]G. Sho, pers. comm.

Niche breadth for macaw diets during March–May 1998 was calculated from the number of macaws observed feeding on a resource. The standardized Levins' (1968) niche breadth index was applied, where a value close to 0 indicates dietary specialization, and a value close to 1 indicates a broad diet (Colwell & Futuyma 1971).

I also determined nestling diet for two Scarlet Macaw chicks in one nest located on the Macal River. Samples of the crop contents of both nestlings were taken four times during 17–22 May 1998, following the procedure developed by Enkerlin-Hoeflich *et al*. (1999). I took crop samples using an open-ended plastic cylinder of 1 cm outside diameter and 6 cm length, which was inserted down the nestling's gullet to the crop. The crop was then gently massaged to maneuver the food contents into the cylinder, thereby extracting a sample of the crop contents. The sample was transferred to a zip-lock plastic food storage bag for immediate processing. Crop samples were not taken until the nestlings were more than 20 d of age (Enkerlin-Hoeflich *et al*. 1999). I did not take samples if there was little food in the crop, as determined by visual inspection of crop expansion.

Prior to weighing, crop samples were placed on absorbent paper to drain excess water. Individual food items were differentiated by type, size, shape, and color. Food items were identified to species by comparison with samples collected from the field. The number of seeds of each species were counted and weighed on a portable electronic balance of 200 g capacity, 0.01 g precision. Results of crop samples for the two siblings were combined at each revision to provide an overall sample for the nest. Dietary variety was determined as the number of different food items per nest sample, while composition of the diet was evaluated both by the overall frequency of occurrence and the proportion of total biomass for each food item in crop samples.

In this study, Scarlet Macaws fed on 15 plant species from 12 families (Table 1). Seeds formed 76 percent of the diet, while bromeliad and young leaf stems formed 14 percent, fruit 6 percent, and leaf-gall larvae 4 percent of macaw diets ($N = 49$ feeding bouts). The leaf gall larvae and the seven tree species of *Attalea cohune*, *C. obtusifolia*, *Cnidosculus* spp., *Guazima ulmifolia*, *Pourouma bicolor*, *S. longicuspus, Sloanea tuerckheimii*, and *X. frutescens* have not been previously recorded in the diet of the Scarlet Macaw (Marineros & Vaughan 1995, Gilardi 1996). Scarlet Macaws were also observed to drink water on 16 occasions from shallow hollows in the trunks of live trees. Tree species used as drinking hollows were *Acacia* spp., *Ficus* spp., and an unidentified tree species.

During the dry season of March–May 1998, Scarlet Macaw diets presented a standardized Levins' niche breadth of $B = 0.394$. Macaws used 12 food resources, but concentrated foraging on seeds of *X. frutescens* and *S. parahybum* (Table 1). Three other frequently used resources (>5%) were seeds of *B. simaruba* and *Sebastiania longicuspis*, and leaf-gall larvae of *Astronium graveolens*.

I recorded six items in the diet of Scarlet Macaw nestlings during 17–22 May 1998. Variety of nestling diets averaged 4 ± 1.7 (SD) food types (range 3–6, $N = 4$) per nest sample. The most frequently occurring items in crop samples of Scarlet Macaw nestlings were seeds of *Cnidoscolus* spp. (100% of samples), *S. parahybum* (100%), and *Schwartzia* spp. (75%), as well as small pieces of wood resembling broken-off twigs (75%). Less frequent items were seeds of *S. longicuspis* (25%), and gall-forming larvae (25%). For biomass, the predominant items in nestling diets were seeds of *Cnidoscolus* spp. (69% of total biomass), followed by seeds of *S. parahybum*, and *Schwartzia* spp. (each 12% of biomass). Small pieces of wood comprised only 5 percent of total biomass, followed by seeds of *S. longicuspis*, and gall-forming larvae (each <1% of biomass).

No fruit items were recorded in crop samples of Scarlet Macaw nestlings.

Scarlet Macaws were predominantly pre-dispersal seed predators, with fruit pulp comprising only 6 percent of the diet observed during the dry season. Most psittacine species are primarily canopy granivores (Galetti 1993, Renton 2001), although some psittacines may be more frugivorous (Wermundsen 1997). Seeds are the most nutritious part of the plant resource being high in protein, minerals, and lipid content, while fruits such as figs are high in calcium and fiber (Gilardi 1996).

Insect larvae may provide additional protein or fat in the diet; however, they did not form a major component of the diet of Scarlet Macaws, and are only occasionally reported for Neotropical parrots (Martuscelli 1994, Enkerlin-Hoeflich & Hogan 1997, Renton 2001). Scarlet Macaws were frequently observed feeding on the stems of bromeliads and leaves of *S. parahybum*. It is unlikely that these were consumed to obtain water because Scarlet Macaws were observed drinking water directly from tree hollows; however, bromeliad and leaf stems may provide minerals such as calcium (Gilardi 1996).

Small pieces of broken-off twigs were also frequently encountered in crop samples of Scarlet Macaw nestlings, indicating that they were intentionally ingested. Small pieces of wood occur in 79 percent of crop samples of Red-crowned Parrot (*Amazona viridigenalis*) nestlings (Enkerlin-Hoeflich & Hogan 1997), and 85 percent of crop samples of Lilac-crowned Parrot (*Amazona finschi*) nestlings (Renton 1998). The role of these wood pieces in nestling diets is unclear; however, they may assist in the removal of food remains from the crop, or provide additional minerals or fiber in the diet.

Scarlet Macaws exhibited a relatively narrow diet during the dry season months of February to May. Lilac-crowned Parrots in western Mexico also exhibited narrow diets during the dry season in response to decreased food resource availability (Renton 2001). The diet of Scarlet Macaws throughout the year may be highly varied, with Scarlet Macaws reported to consume 52 food species in the Amazonian rainforest of Peru (Gilardi 1996), and 28 food species in tropical dry forest of Costa Rica (Marineros & Vaughan 1995). It is to be expected that Scarlet Macaws in Belize would exploit a greater range of food resources at different times of the year. Few data exist, however, on seasonal variation in food resource availability and resource use by large macaws.

Seeds of *Cnidoscolus* spp. were predominant in crop samples of Scarlet Macaw nestlings, but were very rarely recorded in feeding observations of adult macaws. The same was found for the Red-crowned Parrot in Mexico, with seeds of *Cnidoscolus* spp. occurring in 96 percent of nestling crop samples, and comprising 71 percent of total biomass, but rarely recorded in observations of adult diets (Enkerlin-Hoeflich & Hogan 1997). Field observations have potential limitations as many psittacines are more wary or secretive when feeding on food items in smaller trees, closer to the ground, where there is a greater risk of predation. Hence, care should be taken to avoid bias toward observations of psittacines feeding in tall canopy trees.

Few items were recorded in crop samples of Scarlet Macaw nestlings. Low variety in nestling diets is also reported for Lilac-crowned Parrots (Renton 1998) and Red-crowned Parrots (Enkerlin-Hoeflich & Hogan 1997) in Mexico, and may indicate greater selectivity in nestling diets. The high protein requirement for nestling growth (Klasing 1998), may oblige parent birds to select nutrient-rich resources for the young. Cockatiel chicks require 20 percent crude protein for maximum growth and survival (Roudybush & Grau 1986), while larger granivorous species require higher levels of protein (Klasing 1998). Seeds of *Cnidoscolus angustidens* contain 30–36 percent crude protein and 26 percent lipids (Leon de la Luz *et al*. 1999), while seeds of *S. parahybum* and *Schwartzia* spp. contain 43 percent and 19 percent crude protein, respectively (Gilardi 1996). Hence, Scarlet Macaws may need to provide nestlings with a protein-rich diet.

Few data are available on nestling diets of psittacines, and the influence of food resource availability on reproduction, which is essential to understand the potential impacts of environmental variability and habitat fragmentation on wild populations of threatened species. A varied opportunistic diet may permit individuals to adapt to fluctuations in food resources associated with habitat fragmentation. In contrast, dependence on a selective diet makes wild populations vulnerable to changes in food resource availability. The inability of Carnaby's Cockatoo (*Calyptorhynchus funereus latirostris*) to adapt to changes in food resources as a result of habitat loss may have been a principal factor in the species' decline (Saunders 1990).

River floodplains provide important nesting sites for large macaws (Renton 2004). Tree species such as *S. parahybum* and *Cnidoscolus* spp. are characteristic of riparian or floodplain habitats. The predominance of these species in nestling diets, and their potential as a protein-rich resource, highlights the importance of these floodplain habitats in providing nest sites and food resources for Scarlet Macaws during the breeding season.

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