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DIET OF THE GRAYISH SALTATOR (*SALTATOR COERULESCENS*) IN NORTHEASTERN ARGENTINA

Mario L. Chatellenaz

Departamento de Biología, Facultad de Ciencias Exactas y Naturales y Agrimensura, Universidad Nacional del Nordeste, Av. Libertad 5470 (3400), Corrientes, Argentina.
E-mail: mchatellenaz@yahoo.com.ar

Dieta del Pepitero Gris (*Saltator coerulescens*) en el nordeste de Argentina.

Key words: Grayish Saltator, *Saltator coerulescens*, diet, frugivory, folivory, Argentina.

INTRODUCTION

The Grayish Saltator (*Saltator coerulescens*) is a species of the Cardinalidae family, distributed from Central America (Trinidad, Mexico and Costa Rica) to western Uruguay and northern Argentina (Ridgely & Tudor 1989).

The existing bibliography referring to their feeding habits is scarce. In Venezuela, Bosque *et al.* (1999) made studies on their metabolism in relation to folivory; Rodríguez-Ferraro *et al.* (2007) offered a list of species of plants included in the diet and nutritive preferences of this species. Data on the fruits consumed by this species are provided from Mexico (Eguiarte & Martínez del Río, 1985) and Peru (Rosenberg 1990). Other data on their feeding habits are given for Costa Rica (Stiles & Skutch 1998). However, most of the available information comes from Argentina (Zotta 1932, Beltzer 1988, Ordano *et al.* 1999, De la Peña 2001, De la Peña & Pensiero 2003, Beltzer *et al.* 2004, Di Giacomo 2005). All the published reports indicate fruits as the main component of its diet and, to a lesser extent, leaves, flowers and insects. However, the number of vegetal species already mentioned is low, and the data come from a few localities, mainly from the province of Santa Fe.

In this work, detailed information about the plant species and the structures that are consumed by the Grayish Saltator in northeastern Argentina are given. In addition, other items registered as part of the feeding are included.

STUDY AREA AND METHODS

The data comes from different localities in the provinces of Corrientes, Chaco and Formosa, Argentina (see Appendix 1). The study area has a subtropical climate with monthly average temperatures of between 16 and 27ºC and occasional frosts from June to August (austral winter). During the summer months (December–March), the absolute highest temperatures can exceed 40º C. A gradient of annual rainfall was verified from 1600 mm in

TABLE 1. Plant species and structures consumed by the Grayish Saltator (*Saltator coerulescens*) in northeastern Argentina, with mention of the months, the number of observations (n), and the types of habitats where the feeding took place.

Families and species	Life-forms	Structures consumed	Months	n	Type of habitats
DICOTYLEDONEAE					
Apiaceae					
Bowlesia cf. *incana*	Herb	Leaves	Dec	5	Orchard
Apocynaceae					
Tabernaemontana catharinensis	Tree	Arils	Mar	2	Edge of forest
Anacardiaceae					
Schinus terebinthifolius	Tree	Fruits	Jan	4	Isolated tree
Asclepiadaceae					
Oxypetalum sp.	Climber	Leaves	Jul	1	Scrubland
Schubertia grandiflora	Climber	Leaves	Feb	1	Scrubland
No identified	Climber	Leaves	Jun	1	Scrubland
Begoniaceae					
Begonia cucullata	Herb	Leaves	Jan	1	Garden
Celtidaceae					
Celtis spinosa	Climber shrub	Fruits, leaves	Feb, Sep, Jun	3	Edge of forest
Cecropiaceae					
Cecropia pachystachya	Tree	Fruits	Mar	2	Edge of riparian forest
Commelinaceae					
Commelina erecta	Herb	Leaves	Jan	2	Orchard
Compositae					
Calyptocarpus biaristata	Herb	Leaves	Jan	5	Orchard
Hypochoeris cf. microcephala	Herb	Scapus of inflorescence	Jan	2	Orchard
Mikania cordifolia	Climber	Leaves	Mar	1	Edge of forest
Cucurbitaceae					
Cucurbita maxima	Herb	Leaves	Jan	1	Orchard
Erythroxylaceae					
Erythroxylum cuneifolium	Shrub	Fruits	Mar	1	Edge of forest
Euphorbiaceae					
Euphorbia heterophylla	Herb	Leaves	Jan	1	Garden
Sapium haematospermum	Tree	Arils	Jan	1	Isolated tree
Fabaceae					
Acacia aroma	Shrub	Fruits	Jul	1	Scrubland
Holocalyx balansae	Tree	Fruits	Mar	1	Gap in forest
Flacourtiaceae					
Banara arguta	Tree	Fruits	Oct	1	Edge of riparian forest
Lauraceae					
Ocotea acutifolia	Tree	Leaves buds	Jul	1	Edge of forest

TABLE 1. Continued.

Families and species	Life-forms	Structures consumed	Months	n	Type of habitats
Meliaceae					
Melia azedarach	Tree	Leaves and fruits	Jan, Oct	3	Edge of forest, peridomicile
Moraceae					
Ficus sp.	Tree	Fruits	Aug	1	Edge of forest
Morus nigra	Tree	Fruits	Oct	2	Peridomicile
Myrsinaceae					
Rapanea laetevirens	Tree	Fruits	Jun	3	Edge of forest
Myrtaceae					
Eugenia uniflora	Shrub	Fruits	Oct	5	Gap in forest
Guapurium peruvianum	Shrub	Fruits	Nov	1	Gap in forest
Myrcianthes pungens	Tree	Fruits	Mar	3	Edge of forest
Oleaceae					
Ligustrum lucidum	Tree	Fruits	Jul	2	Peridomicile
Ligustrum sinense	Shrub	Fruits	Jan	4	Peridomicile
Rubiaceae					
Psychotria carthagenensis	Shrub	Fruits	May, Jun	3	Gap in riparian forest
Rutaceae					
Citrus sinensis	Tree	Fruits	Apr, Sep	1	Garden
Citrus reticulata	Tree	Fruits	Aug	1	Garden
Fagara naranjillo	Tree	Fruits	Mar	1	Edge of forest
Santalaceae					
Acanthosyris falcata	Tree	Fruits	Dec	1	Edge of forest
Sapindaceae					
Allophylus edulis	Shrub	Fruits	Jan	1	Edge of forest
Cupania vernalis	Tree	Arils	Dec, Jan	30	Edge of forest
Sapotaceae					
Chrysophyllum marginatum	Tree	Flower buds	Jun	1	Scrubland
Chrysophyllum gonocarpum	Tree	Fruits	Oct	1	Edge of forest
Solanaceae					
Cestrum guaraniticum	Shrub	Leaves	Aug	1	Scrubland
Solanum glaucophyllum	Shrub	Leaves, flowers and fruits	Dec	1	Isolated shrub
Solanum granuloso-leprosum	Tree	Fruits	Jan, Feb	2	Scrubland
Solanum sp. 1	Shrub	Leaves	Jun	1	Scrubland
Solanum sp. 2	Shrub	Leaves	Jun	1	Scrubland
Solanum sp. 3	Shrub	Leaves	Jun	1	Gap in forest
Vassobia breviflora	Shrub	Leaves	Jan	3	Scrubland
Sterculiaceae					
Byttneria rhamnifolia	Climber shrub	Fruits	May	1	Gap in riparian forest
Verbenaceae					

TABLE 1. Continued.

Families and species	Life-forms	Structures consumed	Months	n	Type of habitats
No identified	Shrub	Fruits	Oct	1	Isolated shrub
Viscaceae					
Phoradendron cf. hieronymi	Hemiparasite	Fruits	Jul	1	Edge of forest
MONOCOTYLEDONEAE					
Bromeliaceae					
Tillandsia decomposita	Epiphyte	Flowers	Apr	1	Edge of forest
Gramineae					
No identified	Grass	Leaves	Aug	1	Peridomicile
Smilacaceae					
Smilax campestris	Climber	Leaves and fruits	Jan	2	Edge of forest
Marantaceae					
Thalia multiflora	Aquatic herb	Fruits	Dec	1	Edge of marsh

the east of Corrientes, to only 900 mm in the central part of Chaco and Formosa (Bruniard 1981), the western limit of the area considered in this work.

The records, obtained exclusively by means of binocular observations, were made during a 9-year period (1996 to 2005), comprising all the seasons of the year. Whenever Grayish Saltator individuals were observed feeding, one individual was followed during the longest period of time possible, which was between 30 s and 5 min. Data about the plant species consumed, the ingested structures, the way they obtain food items, the interspecific interactions with other birds, and the vegetal formation in which the observations were made, were registered. The plant species that could not be identified in the field were collected, turned into herbarium specimens, and identified by means of bibliography and the consultation of specialists at The Herbarium Humboldtianum (CTESN), of the Facultad de Ciencias Exactas y Naturales y Agrimensura of the Universidad Nacional del Nordeste (Corrientes). The insects were identified in the field to the lowest taxonomic level possible.

RESULTS

The Grayish Saltator was a common, resident species in the area of study all year long. It was always found in scrubs, secondary forests, the edge of mature forests or cleared areas. It was never registered inside dense forests, but was also found in orchards and gardens. Fifty-three plant species belonging to 33 families, were registered as food of the Grayish Saltator (n = 115). Of them, 92% were dicotyledonous, and 8% monocotyledonous (Table 1). Of the considered nutritional items, 53% of the diet corresponded to fruits. The seed coats were not considered within this category since, in spite of being inside dehiscent fruits, they are not developed precisely from the ovary, but from the funicle of the ovule (Skutch 1980, Esau 1993). Leaves were the most important food items after the fruits, with 36% of the diet, most of them pertaining to dicotyledonous. In three species, *Celtis spi-*

nosa, Melia azedarach and *Smilax campestris*, the ingestion of fruits and leaves was verified. The Mirtaceae and Rutaceae were the families with the greatest number of species with consumed fruits (10% in each case), whereas the leaves of the Solanaceae were consumed the most (35%). The remaining 11% corresponded to flowers, flower buds and other vegetative structures. The Grayish Saltator always feeds on fruits and leaves while resting on branches; it was never observed taking them in flight. The fruits were taken and manipulated with the beak, so that the pulp was separated from the seeds before being ingested. In the case of arillate seeds, those of *Tabernaemontana catharinensis* were swallowed as a whole, but those of *Sapium haematospermum* and *Cupania vernalis* were discarded most of the time, after the removal and consumption of the aril. The leaves were from ligneous as well as herbaceous plant species. In several instances, the herbaceous ones were consumed while the bird remained on the ground. In all the cases, it took a fragment of the leaf, and rotated it several times in its beak before swallowing it. Occasionally, a leaf was completely consumed, but in most of the cases, after taking some pieces, the bird started to eat a different one.

The consumption of leaves and fruits did not vary as a function of the annual cycle, but was rather related to the period of flowering and fructification of the vegetal species. Many of the observations of leaf consumption happened in spring–summer, at the time of fructification of the majority of the vegetal species in the region. In some cases, the same individual was observed consuming simultaneously the leaves, flowers and fruits of the same plant (e.g., *Solanum glaucophyllum*, *Smilax campestris*). This agrees with what has been shown by Beltzer *et al.* (2004), who indicated the opportunistic behavior of this species, and the predominance of the most abundant seasonal resources in their diet.

Five events of capture and consumption of insects were observed. Two of them were captures of unidentified termites (Isoptera) during a nuptial flight; the other two consisted in the capture of a specimen of Tettigoniidae (Orthoptera) and of *Quesada gigas* (Cicadidae, Homoptera), while the insects were resting on trees. The last prey was a larvae of Lepidoptera, located on the ground. Interactions with other bird species [that frequently fed on the same plants, e.g., Sayaca Tanager (*Thraupis sayaca*)] were not verified, with the exception of their congeneric, the Green-winged Saltator (*S. similis*), which was aggressively expelled by the Grayish Saltator in all the opportunities in which both species were feeding on the same food source.

DISCUSSION

Results confirmed that the Grayish Saltator is a frugivorous-folivorous species, with insects being a secondary item in its diet. The previously existing information from Argentina indicates a diet composed of insects (Zotta 1932), fruits and insects (Beltzer 1988), and fruits (Ordano *et al.* 1999, De la Peña 2001). De la Peña & Pensiero (2003) only mention, in addition to fruits, the consumption of leaves of two plant species. Di Giacomo (2005) provides a list of 19 plant species of which the Grayish Saltator consumes the fruits, leaves and flowers of (74% of the food items corresponded to fruits, 16% to leaves and the remaining 10% to flowers), and only mentions the consumption of unidentified ants of the genus *Acromyrmex*. Nine of the vegetal species mentioned by this author also were registered in this study. The present work agrees with the one of Bosque *et al.* (1999) and that of Rodríguez-Ferraro *et al.* (2007) which mentions that, in Venezuelan llanos, the species is almost exclusively herbivorous throughout the annual cycle, with fruits occupying the first place in its diet, followed

by mature leaves of ligneous plants, flowers, flower buds and other vegetal tissues, while insects represented only 0.1% of the food items. Although the order of importance of items is the same in both surveys, the percentage contribution of each one is different in the present paper, the values being higher for fruits and leaves and lower for flowers and other structures. Furthermore, Rodríguez-Ferraro *et al.* (2007) quote a total of 43 species belonging to 28 families (a discrepancy exists between the number of species mentioned in the text and the tabulated information, the latter one was used), with lower counts to those reported here. Whereas in this work the family with more species consumed was Solanaceae, these authors mention that it was the family Fabaceae. Another difference is that whereas in the northeastern Argentina there was consumption of four species of monocotyledons, in the plains of Venezuela only the ingestion of flower buds of one species was observed (*Thalia geniculata*).

Is the Grayish Saltator a legitimate disperser of seeds? Beltzer *et al.* (2004) consider the Grayish Saltator as "depredator of seeds", based on the finding of seeds of 11 plant species in 73 analyzed stomach contents. This statement does not agree with the observations here exposed, and it might owe to an error of interpretation. The plant species mentioned by these authors possess seeds of limited size, which surely were consumed together with the flesh of the fruit. These fruits could have been digested in their entirety and then the seeds were identified at the moment of the analysis of stomach contents. This would suggest that the Grayish Saltator is a disperser of the above-mentioned plants and not a predator of their seeds in the strict sense (Howe & Smallwood 1982, Snow and Snow 2001). It was verified that in most of the cases it manipulated the fruits with its beak, separating and ingesting the pulp, and dropping the seeds underneath the parental plant. The same happened with the arillate seeds of *Cupania vernalis* and *Sapium haematospermum*. Identical behavior was reported by Skutch (1980) for Buff-throated (*Saltator maximus*) and Streaked (*S. albicollis*) saltators when they fed on the arils of *Lacistema aggregatum* (Flacourtiaceae) in Costa Rica. This implies a negative effect for plants and seeds, due to the competition that can occur between seedlings and the mother plant. In addition, the risk of seed and seedling predation by insects and rodents significantly increases underneath the mother plant, also increasing the attacks of fungi and other pathogens (Howe & Smallwood 1982). This observation puts in doubt its function as a disperser of these vegetal species. Rather, it would be a "pulp-predator" according to the definition of Snow & Snow (2001). Although many plants adopt mechanical or chemical defences in the fruits or seeds to avoid the predation of non-disperser species, both mechanisms do not appear simultaneously in most cases (Snow & Snow 2001). These defences also can be present in the leaves of many plants, in order to avoid herbivory. Several *Solanum* in the study area have, in addition to alkaloids, thorns on both faces of their leaves. Nevertheless, a species of this type was consumed by a Grayish Saltator that took fragments of the leaves, and rotated them several times in its beak, squashing the thorns, so that they did not offer any difficulties in being ingested. It is remarkable that several of the species or genera of plants, in particular the Solanaceae, are toxic for other animals. For example, a congeneric of *Cestrum guaraniticum*, *C. parqui*, is toxic for cattle, and has alkaloids like parquine, solanine, digitogenine, and ursolic acid among others (Marzocca 1976). The species of *Solanum* have been traditionally considered of great toxicity and, in all of them, alkaloids of the solanine and saponine group are verified. The genus *Mikania* is char-

acterized by the presence of sesquiterpene lactones, many of which have a poisonous effect (Ricciardi in prep.). Anyway, it must be considered that substances toxic for mammals could not have the same effect on birds, and birds are not equally susceptible to particular poisons (Snow & Snow 2001).

Ant consumption, which had great importance in the middle Paraná river valley in the province of Santa Fe (Beltzer 1988, Beltzer *et al.* 2004), was not registered in this study. This could owe simply to the fact that the observations were realized in free individuals, and stomach contents were not analyzed. It is probable therefore that the ants and other insects constitute an important part of the Grayish Saltator food.

The diet might differ noticeably between the *Saltator* species, some of them being frugivorous and others mainly folivorous. Because of this reason, it would be extremely interesting to make comparative studies in order to establish the morphological, physiological and behavioral characters specifically associated with folivory. For example, the Thick-billed Saltator (*S. maxillosus*) is probably an obligate folivorous species. A study developed in Brazil by Munson & Robinson (1992) showed that the leaves consumed by this species constituted 91% of the food items. The Masked Saltator (*S. cinctus*), however, seems to feed exclusively on the cones of *Podocarpus oleifolius* (Podocarpaceae) in Ecuador (Tobias & Williams 1996). Beltzer (1988) mentions five plant species consumed by the Golden-billed Saltator (*S. aurantiirostris*) that are also eaten by the Grayish Saltator, besides beetles of the family Carabidae and ants. Di Giacomo (2005) mentions the consumption of fruits, leaves and flowers of five species of plants, by the Green-winged Saltator (*S. similis*), and of fruits and seeds of two vegetal species by the Golden-billed Saltator who, in addition, also captures winged ants of the genus *Acromyrmex*. These scanty records corroborate the poor knowledge that exists on the diet of the species of this genus.

Of course, the present list of plants is not definitive; probably many other vegetal species are part of the Grayish Saltator diet. In addition, the feeding surely varies as a function of geographic areas, due to their floristic compositions. Further quantitative studies will be necessary to determine the numerical and volumetric importance of each item in the diet, and the energetic contribution represented by each one. The results presented in this paper constitute a contribution to future studies of plant-animal interactions and to the analyses of the trophic structure of bird communities.

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APPENDIX 1: Sampled localities.

Province of Corrientes

Capital Department: Paraje "El Perichón" (27°24'S, 58°45'W), 5 km NW of Corrientes City; Arroyo Riachuelo, at intersection of National Road 12 (27°35'S, 58°45'W); Estancia "Plumas Verdes", San Cayetano (27°34'S, 58°41'W).

Itatí Department: Paraje Yacareí (27°20'S, 58°05'W).

Mburucuyá Department: Mburucuyá National Park (28°00'S, 58°01'W).

Loreto Department: Estancia "San Juan Poriahú" (27°42'S, 57°11'W). Mercedes Department: Estancia "Rincón" (28°24´S, 57°21´W); Provincial Road 40, km 026.

Carlos Pellegrini Department: Provincial Reserve Iberá (28°24'S, 57°07'W).

Ituzaingó Department: Colonia Liebig (27°55'S, 55°50'W).

Province of Chaco

San Fernando Department: Near the Interprovincial Bridge "General Belgrano" (27°28'S, 58°51'W).

1º de Mayo Department: Near Puerto Antequera (27°25'S, 58°52'W).

Presidencia de la Plaza Department: 8 km east of Presidencia de la Plaza City (27°01'S, 59°51' W).

Independencia Department: Lote 32, near of Campo Largo (26°45'S, 60°43'W)

Province of Formosa

Patiño Department: Estancia "Fortín Quebracho", near El Cogoik (24°45´S, 59°14'W).