

FRUGIVORY BY *ELAENIA* FLYCATCHERSM. Â. MARINI¹ & R. B. CAVALCANTI*Departamento de Zoologia, Universidade de Brasília, Brasília, DF, Brazil, 70910-900*¹ *Departamento de Biologia Geral, ICB, Universidade Federal de Minas Gerais, Belo Horizonte, MG, Brazil, 30161-970. E-mail: marini@mono.icb.ufmg.br*

Resumo. Quarenta conteúdos estomacais de sete espécies de *Elaenia* (Tyrannidae) foram analisados em relação ao volume de frutos e em relação ao tipo de item alimentar. A porcentagem média de frutos nos estômagos foi de 91 %, não havendo diferenças entre as espécies, nem entre as estações seca e chuvosa. Estes dados associados a uma revisão da literatura revelam que o gênero *Elaenia* é altamente frugívoro, consumindo pelo menos 51 espécies de frutos de 30 famílias de plantas.

Key words: diet, *Elaenia*, stomach contents

Palavras chave: conteúdos estomacais, dieta, *Elaenia*.

Flycatchers (Tyranninae), as their common name implies, are insectivorous birds with hundreds of species restricted to the Neotropics. The genus *Elaenia* as well as some other members of the family, however, have been regularly reported to consume fruits to various extents. No estimate of the proportion of fruits in the diet of the 16 species of *Elaenia* has been made so far, except for Plain-crested *Elaenia* (*E. cristata*) which consumed 20 % fruit (Fitzpatrick 1980). Also, it is not known whether frugivory or arthropod consumption in the genus is obligatory or not, and if there is any adaptation of the digestive tract to frugivory. At the La Pampa Province in Argentina, for example, the White-crested *Elaenia* (*E. albiceps*) even has the popular name of "comerribes", berry eater (Williamson 1975). Other authors, such as Haverschmidt (1968), mention only berries in the diet of the Lesser *Elaenia* (*E. chiriquensis*) and the Plain-crested *Elaenia*. French (1973) stated that the food of the Yellow-bellied (*E. flavogaster*) and the Lesser *Elaenia* is berries and small fruits, but also insects, whereas only insects for the Yellow-bellied *Elaenia*. A better knowledge of the diet of *Elaenia*, and other flycatchers as well, may have important implications to other studies, such as communities, plant-animal interactions or fruit dispersal systems (Howe 1993). Diet studies may

also have taxonomic implications, as has been suggested by Remsen *et al.* (1993) for trogons, momots, barbets, and toucans. Here, we present data on the diet, based on stomach contents, of five species of *Elaenia*, and review the reports of frugivory among *Elaenia*.

METHODS

Stomachs (N = 40) preserved in alcohol 70 % in museum collections were cut open and their contents were analyzed in relation to food type (plant parts or arthropods) and the relative percentage (volume) of each food type. Whenever possible, arthropods were identified. Fruits were not identified taxonomically, but only classified as different morphs based on seed and fruit characteristics (size, shape and color). We analyzed stomachs of Lesser *Elaenia* (N = 15), Plain-crested *Elaenia* (N = 10), Yellow-bellied *Elaenia* (N = 6), Olivaceous *Elaenia* (*E. mesoleuca*) (N = 5), Highland *Elaenia* (*E. obscura*) (N = 2), and two unidentified *Elaenia* spp. We pooled the data of all species for analyses because of similarities in their stomach contents.

Individuals studied were collected in the Distrito Federal, Minaçú (GO), and Serra dos Carajás (PA), Brazil, from 1985 through 1988,

in April (N = 4), May (N = 4), June (N = 6), July (N = 5), August (N = 4), September (N = 10), October (N = 1), November (N = 3), and December (N = 3). Habitats sampled include "cerrado" (dry savanna-like vegetation) (N = 18 stomachs), gallery forest/cerrado border (N = 15), Amazonian forest/"canga" (dry scrub vegetation) border (N = 5), and "capoeira" (second growth scrub) (N = 2). Seasonal differences in diet were analysed between dry (winter) and wet (summer) seasons.

RESULTS

Fruits were abundant in the diet of the genus *Elaenia*. This result was substantiated by both the analysis of stomach contents and the literature review.

The four species with at least five stomachs analysed had very similar percentage of fruit volume in their stomachs (Lesser *Elaenia* = 92.7 ± 12.3 %, Plain-crested *Elaenia* = 96.5 ± 6.7 %, Yellow-bellied *Elaenia* = 95.8 ± 4.9 %, and Olivaceous *Elaenia* = 79 ± 38.8 %). The lower mean fruit volume for Olivaceous *Elaenia* is due to one stomach with only 10 % of fruit volume. Considering our analyses of stomach contents, all species combined showed a high mean percentage of fruits (mean = 91 %, range = 10-100 %) in the total volume of the stomachs, and a low percentage of arthropods (mean = 9 %, range = 0-90 %). Also, 55 % of the 40 stomachs analyzed had only fruits; arthropods were present in 45 % (N = 18) of the stomachs, but they comprised more than 20 % of the food volume in only three (7.5 %) of the stomachs.

No significant difference (Wilcoxon Rank Sum test, $z = 0.78$, $P = 0.44$) was detected in the fruit volume between wet (September-April, 89.7 ± 21.8 %, N = 17 stomachs) and dry (May-August, 89.5 ± 10.0 %, N = 23 stomachs) seasons.

Arthropods present in the stomachs include: Hymenoptera (12 specimens in 5 stomachs), Diptera (20 in 3), Homoptera (7 in 3), Coleoptera (4 in 3), Hemiptera (2 in 2), Araneae (2 in 2), Isopoda (1 in 1), and several unidentified arthropod parts. Fruits and seeds were not identified, but there were about 20 kinds of seed morphs in the stomachs of all species.

Several reports indicate frugivory among 10

of 16 *Elaenia*, including the consumption of fruits of 51 plant species of 30 plant families Appendix.

DISCUSSION

Our results indicate that at least five species in the genus *Elaenia* are highly frugivorous flycatchers, in spite of arthropod consumption by some species. This statement is reinforced by the lack of seasonal variation in diet, showing year-round fruit consumption.

Other studies provide further evidence of high fruit consumption by species of *Elaenia*. Foster (1987), for example, found only fruits in the stomachs of the Yellow-bellied *Elaenia* (N = 7), the Small-billed *Elaenia* (*E. parvirostris*) (N = 5), the White-crested *Elaenia* (N = 3) and the Large *Elaenia* (*E. spectabilis*) (N = 3). Also, Poulin *et al.* (1994) registered 120 fruit items but only 25 arthropod items in 12 emetic samples of the Small-billed *Elaenia*.

Besides being highly frugivorous, the several species of *Elaenia* seemed to be generalists in relation to fruit type, consuming fruits of several sizes, colors, varying seed sizes and shapes. Some plant families seem to be consumed more, such as Myrsinaceae, Moraceae, and Melastomataceae Appendix. The best-studied *Elaenia* so far is the Mountain *Elaenia* (*E. frantzii*), which, in Costa Rica, was observed feeding on 22 species of plants, 12 of which were commonly used (Wheelwright *et al.* 1984).

The consumption of fruits by flycatchers is not restricted to species of the genus *Elaenia*. Dozens of species of flycatchers, including 10 out of the 16 species (Meyer de Schauensee 1982) of *Elaenia*, have been reported to consume fruits to some extent (see references below). Highly frugivorous genera include: *Elaenia*, *Mionectes*, *Myiozetetes*, *Empidonomus*, *Tyrannus* (Fitzpatrick 1980, Sick 1997), *Conopias*, *Phyllomyias*, *Zimmerius*, *Tyrannulus*, *Phaeomyias*, *Myiopagis*, *Leptopogon*, *Phylloscartes* and *Myiodynastes* (Fitzpatrick 1980).

Even though several flycatchers have been suggested to be highly frugivorous, this statement lacks quantitative documentation. A better knowledge of the diet of several bird species may influence future studies. For example, analysis of trophic composition of bird communities should

Appendix. List of plant taxa or items consumed by *Elaenia* species.

Elaenia species	Plant taxa/ food item (Author*)
<i>Elaenia</i> sp.	<i>Ficus turckheimii</i> (Moraceae) (1); <i>Miconia</i> sp. (Melastomataceae) (2); <i>Stenocereus griseus</i> (Cactaceae) (3)
<i>E. flavogaster</i>	<i>Conostegia</i> sp. (Melastomataceae) (4); Berries and insects (5); Fruits and arthropods (6); <i>Hampea appendiculata</i> (Malvaceae), <i>Sapium oligoneurum</i> (Euphorbiaceae), <i>Actinistus arborescens</i> (Solanaceae) and <i>Viburnum costaricanum</i> (Caprifoliaceae) (7); <i>Ficus pertusa</i> (Moraceae) (8); Partial frugivore (9); <i>Copaifera langsdorfii</i> (Caesalpiniaceae) (10); <i>Rapanea schwackeana</i> (Myrsinaceae) (11); <i>Ficus microcarpa</i> (Moraceae) (12); Fruits (13)
<i>E. spectabilis</i>	Fruits (13); <i>Cecropia</i> sp. (Moraceae) (14); <i>Cordia curassavica</i> . (Borraginaceae) (15)
<i>E. spectabilis ridleyana</i>	<i>Lantana</i> sp. (Verbenaceae) (16)
<i>E. albiceps</i>	<i>Allophylus edulis</i> (Sapindaceae) and insects (13); <i>Rapanea</i> sp. (Myrsinaceae) (17); <i>Ribes</i> sp. (Saxifragaceae) (18); Fruits and insects (19); <i>Aristotelia chilensis</i> (Eleaeocarpaceae), <i>Lithrea caustica</i> (Anacardiaceae), <i>Luma apiculata</i> (Myrtaceae), <i>Muehlenbeckia hastulata</i> (Polygonaceae), <i>Maytenus boaria</i> (Celastraceae), <i>Tristerix</i> sp. (Lorantaceae), <i>Trichocereus</i> spp. (Cactaceae) (20); <i>Drimys winteri</i> (Winteraceae), <i>Amomyrtus luma</i> (Myrtaceae), <i>Ovidia pillophillo</i> (Thymeliaceae) (21); Insects, small fruits and a tiny flower (22); <i>Schinus polygamus</i> (Anacardiaceae), <i>Celtis pallida</i> (Ulmaceae), <i>Achatocarpus praecox</i> (Achatocarpaceae) (23); Insects, but also fruits and buds (24)
<i>E. parvirostris</i>	<i>Allophylus edulis</i> (Sapindaceae) and insects (13); <i>Cecropia</i> sp. (Moraceae) (14); <i>Lantana megapotamica</i> (Verbenaceae), <i>Acnistus breviflorus</i> (Solanaceae) (15); <i>Schinus polygamus</i> (Anacardiaceae), <i>Celtis pallida</i> (Ulmaceae), <i>Achatocarpus praecox</i> (Achatocarpaceae) (23); Small fruits (25)
<i>E. mesoleuca</i>	<i>Michelia champaca</i> (Magnoliaceae), <i>Rapanea gardneriana</i> , <i>R. lineata</i> and <i>R. villosissima</i> (Myrsinaceae) (11); Small fruits and berries (25); Seeds (26); <i>Ajonea saligna</i> (27); <i>Mabea fistulifera</i> (Euphorbiaceae) (28)
<i>E. pelzelni</i>	<i>Cecropia</i> sp. (Moraceae), <i>Mimosa</i> sp. (Leguminosae) (14)
<i>E. cristata</i>	Berries (5); Fruits (29); 20 % of fruits in the diet (30); <i>Miconia</i> sp. (Melastomataceae) (31)
<i>E. chiriquensis</i>	Berries (5); Fruits (29); <i>Miconia</i> sp. (Melastomataceae) (31)
<i>E. frantzii</i>	<i>Leandra subseriata</i> (Melastomataceae) (1); <i>Bocconia frutescens</i> (Papaveraceae), <i>Trema micrantha</i> (Ulmaceae), <i>Urera elata</i> (Urticaceae), <i>Phytolacca rivinoides</i> (Phytolaccaceae), <i>Hampea appendiculata</i> (Malvaceae), <i>Xylosma chloranthum</i> and <i>X. intermedium</i> (Flacourtiaceae), <i>Ardisia palmana</i> and <i>Rapanea myricoides</i> (Myrsinaceae), <i>Conostegia bernoulina</i> (Melastomataceae), <i>Perrottetia longistylis</i> (Celastraceae), <i>Ilex lamprophylla</i> (Aquifoliaceae), <i>Sapium oligoneurum</i> (Euphorbiaceae), <i>Matayba apetala</i> (Sapindaceae), <i>Dendropanax</i> sp. and <i>Oreopanax oerstedianum</i> (Araliaceae), <i>Actinistus arborescens</i> (Solanaceae), <i>Citharexylum integerrimum</i> and <i>C. macradenium</i> (Verbenaceae) and <i>Viburnum costaricanum</i> (Caprifoliaceae) (7); <i>Ficus pertusa</i> (Moraceae) (8)
<i>E. obscura</i>	<i>Conostegia</i> sp. (Melastomataceae) (4 ^b); <i>Copaifera langsdorfii</i> (Caesalpiniaceae) (10); <i>Schinus terebinthifolius</i> (Anacardiaceae) and <i>Podocarpus lambertii</i> (Podocarpaceae) (27); <i>Ficus subtriplinervia</i> (Moraceae) (32)

* 1 = Leck (1972); 2 = Alves (1991); 3 = Silvius (1995); 4 = Willis (1966); 5 = Haverschmidt (1968); 6 = Novaes (1973); 7 = Wheelwright *et al.* (1984); 8 = Bronstein & Hoffmann (1987); 9 = Levey (1988); 10 = Motta-Júnior & Lombardi (1990); 11 = Pineschi (1990); 12 = Figueiredo *et al.* (1995); 13 = Foster (1987); 14 = Rosenberg (1990); 15 = Rosendo M. Fraga (pers. comm.); 16 = Olson (1994); 17 = Zotta (1936); 18 = Williamson (1975); 19 = Remsen *et al.* (1985); 20 = Solar (1975 cited in Armesto *et al.* 1987); 21 = Armesto *et al.* (1987); 22 = Kratter *et al.* (1993); 23 = Caziani & Protomastro (1994); 24 = Vigil (1973 cited in Foster 1987); 25 = Belton (1985); 26 = Moojen *et al.* (1941); 27 = Voss & Sander (1980); 28 = Vieira *et al.* (1992); 29 = Schubart *et al.* (1965); 30 = Fitzpatrick (1980); 31 = Personal observations at the "cerrado" region in Central Brazil; 32 = Voss (1979).

^b Unsure about identification of the Highland *Elaenia* (*E. obscura*).

consider the genus *Elaenia* and probably many other tyrannid genera as frugivores. Also, other studies, such as the competition among migratory and resident species of frugivores, should consider flycatchers in their analysis.

ACKNOWLEDGMENTS

IBAMA provided collecting permits. M.Â.M. and R.B.C. had research fellowships from CNPq. K. Kitayama, I. Rocha and C. D'allaglio for help in the identification of arthropods. J. V. Remsen, Jr. and an anonymous reviewer for critical improvements of the manuscript.

LITERATURE CITED

- ALVES, M.A.S. 1991. Dieta e tática de forrageamento de *Neothraupis fasciata* em cerrado no Distrito Federal, Brasil (Passeriformes: Emberizidae). *Araçajuba* 2: 25-29.
- ARMESTO, J.J. R. ROZZI, P. MIRANDA, & C. SABAG. 1987. Plant/frugivore interactions in South American temperate forests. *Rev. Chil. Hist. Nat.* 60: 321-336.
- BELTON, W. 1985. Birds of Rio Grande do Sul, Brazil. Part 2. Formicariidae through Corvidae. *Bull. Amer. Mus. Nat. Hist.* 180: 1-241.
- BRONSTEIN, J.L., & K. HOFFMANN. 1987. Spatial and temporal variation in frugivory at a Neotropical fig, *Ficus pertusa*. *Oikos* 49: 261-268.
- CAZIANI, S.M., & J.J. PROTOMASTRO. 1994. Diet of the Chaco Chachalaca. *Wilson Bull.* 106: 640-648.
- FRENCH, R. 1973. A guide to the birds of Trinidad and Tobago. Wynnewood, Pennsylvania: Livingston Publ. Company.
- FIGUEIREDO, R.A., J.C. MOTTA-JUNIOR, & L.A.S. VASCONCELOS. 1995. Pollination, seed dispersal, seed germination and establishment of seedlings of *Ficus microcarpa*, Moraceae, in southeastern Brazil. *Rev. Brasil. Biol.* 55: 233-239.
- FITZPATRICK, J. 1980. Form, foraging behavior, and adaptive radiation in the Tyrannidae. *Ornithol. Monogr.* 36: 447-470.
- FOSTER, M.S. 1987. Feeding methods and efficiencies of selected frugivorous birds. *Condor* 89: 566-580.
- HAVERSCHMIDT, F. 1968. Birds of Surinam. Edinburgh London: Oliver and Boyd Ltd.
- HOWE, H.F. 1993. Specialized and generalized dispersal systems: where does 'the paradigm' stand? *Vegetatio* 107/108: 3-13.
- KRATTER, A.W., T.S. SILLETT, R.T. CHESSE, J.P. O'NEILL, T.A. PARKER III, & A. CASTILLO. 1993. Avifauna of a Chaco locality in Bolivia. *Wilson Bull.* 105: 114-141.
- LECK, C.F. 1972. The impact of some North American migrants at fruiting trees in Panama. *Auk* 89: 842-850.
- LEVEY, D.J. 1988. Spatial and temporal variation in Costa Rican fruit and fruit-eating bird abundance. *Ecol. Monogr.* 58: 251-269.
- MEYER DE SCHAUENSEE, R. 1982. A guide to the birds of South America. Philadelphia.
- MOOJEN, J., J.C. CARVALHO, & H.S. LOPES. 1941. Observações sobre o conteúdo gástrico de aves brasileiras. *Mem. Inst. Oswaldo Cruz* 36: 405-444.
- MOTTA-JUNIOR, J.C., & J.A. LOMBARDI. 1990. Aves como agentes dispersores da copaíba (*Copaifera langsdorffii*, Caesalpiniaceae) em São Carlos, estado de São Paulo. *Araçajuba* 1: 105-106.
- NOVAES, F.C. 1973. Aves de uma vegetação secundária na foz do Amazonas. *Mus. Paraense Emílio Goeldi, Publ. Avuls.* 21.
- OLSON, S.L. 1994. The endemic vireo of Fernando de Noronha (*Vireo gracilirostris*). *Wilson Bull.* 106: 1-17.
- PINESCHI, R.B. 1990. Aves como dispersores de sete espécies de *Rapanea* (Myrsinaceae) no maciço do Itatiaia, estados do Rio de Janeiro e Minas Gerais. *Araçajuba* 1: 73-78.
- POULIN, B., G. LEFEBVRE, & R. MCNEIL. 1994. Characteristics of feeding guilds and variation in diets of bird species of three adjacent tropical sites. *Biotropica* 26: 187-197.
- REMSEN, J.V., JR. 1985. Community organization and ecology of birds of high elevation humid forest of the Bolivian Andes. *Ornithol. Monogr.* 36: 733-756.
- REMSEN, J.V., JR., M.A. HYDE, & A. CHAPMAN. 1993. The diets of Neotropical trogons, motmots, barbets and toucans. *Condor* 95: 178-192.
- ROSENBERG, G.H. 1990. Habitat specialization and foraging behavior of birds of Amazonian river islands in northeastern Peru. *Condor* 92: 427-443.
- SCHUBART, O., A.C. AGUIRRE, & H. SICK. 1965. Contribuição para o conhecimento da alimentação das aves brasileiras. *Arq. Zool. Est. São Paulo* 12: 95-249.
- SICK, H. 1997. *Ornitologia Brasileira*. Rio de Janeiro: Editora Nova Fronteira.
- SILVIUS, K.M. 1995. Avian consumers of cardón fruits (*Stenocereus griseus*: Cactaceae) on Margarita Island, Venezuela. *Biotropica* 27: 96-105.
- VIEIRA, M.F., G.T. MATTOS, & R.M. CARVALHO-OKANO. 1992. *Mabea fistulifera* (Euphorbiaceae) na alimentação de aves na região de Viçosa, Minas Gerais, Brasil. *Iheringia, Sér. Zool.* 73: 65-68.
- VOSS, W.A. 1979. Notas sobre aves do Rio Grande do Sul. *Pesquisas, Zoologia (São Leopoldo)* 31: 1-24.
- VOSS, W.A., & M. SANDER. 1980. Frutos de árvores nativas na alimentação das aves. *Trigo e Soja* 51: 26-30.
- WHEELWRIGHT, N.T., W.A. HABER, K.G. MURRAY, & C. GUINDON. 1984. Tropical fruit-eating birds and their food plants: a survey of a Costa Rican lower montane forest. *Biotropica* 16: 173-192.
- WILLIAMSON, J. 1975. Alimentación de algunas aves de la Pampa. *Hornero* 11: 322-324.
- WILLIS, E.O. 1966. Competitive exclusion and birds at fruiting trees in western Colombia. *Auk* 83: 479-480.
- ZOTTA, A. 1936. Sobre el contenido estomacal de aves Argentinas. *Hornero* 6: 261-270.