SCIENTIFIC COMMUNICATION

The relative contribution of fruits and arthropods to the diet of three trogon species (Aves, Trogonidae) in the Brazilian Atlantic Forest

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ABSTRACT. Trogons are pan-tropical forest birds that eat a mix of fruits and arthropods. With direct observations of wild feeding birds, I assessed the relative contribution of fruits and arthropods to the diet of three trogon species (*Trogon viridis*, *T. surrucura*, and *T. rufus*) at Parque Estadual Intervales, southeast Brazil. Fruits and arthropods made the bulk of the food items recorded, with a tendency of frugivory increasing with body mass. The *Trogon* species differed in the proportion of fruits and arthropods taken, with *T. viridis* being the most frugivorous species (66% of feeding bouts, n = 47). The relative contribution of fruits and arthropods did not differ between the wet and dry seasons for any species. In the omnivorous gradient, *T. viridis* is close to the frugivorous extreme, whereas *T. surrucura* and *T. rufus* is next to the insectivorous end. Such a distinction may have important consequences for the territoriality and social behavior of these birds.
KEY WORDS. Brazil; frugivory; insectivory; *Trogon*.

RESUMO. **A contribuição relativa de frutos e artrópodes para a dieta de três espécies de surucuás (Aves, Trogonidae) na Mata Atlântica.** Os surucuás são aves florestais pantropicais que se alimentam de frutos e artrópodes. Com observações diretas de aves forrageando na natureza, estudei a contribuição relativa de frutos e artrópodes para a dieta de três espécies de surucuás (*Trogon viridis*, *T. surrucura*, and *T. rufus*) no Parque Estadual Intervales, sudeste do Brasil. Frutos e artrópodes foram os itens mais registrados, com uma tendência do grau de frugivoria aumentar com o aumento da massa corporal da ave. As três espécies diferiram em relação à proporção de frutos e artrópodes de que se alimentam; *T. viridis* foi a espécie mais frugívora (66% dos registros, n = 47). As contribuições relativas de frutos e artrópodes para a dieta não diferiram entre as estações seca e úmida para nenhuma das três espécies. A diferença no grau de frugivoria aqui revelada pode ter conseqüências importantes para a territorialidade e organização social dos surucuás.
PALAVRAS-CHAVE. Brasil; frugivoria; insetivoria; *Trogon*.

Trogons are pan-tropical birds occurring preferentially in forests on almost all major land masses around the Equator, from sea-level to 3,500 m (Johnsgard 2000, del Hoyo *et al*. 2001). Nine species occur in Brazil, five of which in the Atlantic forest (Sick 1997). Ecologically, they play a critical role in dispersing large seeds (i.e. > 15 mm diameter), which usually have a small group of seed dispersers (Silva & Tabarelli 2000). The most detailed study on the diet of Neotropical trogons revealed that they eat a mix of fruits and arthropods, with the frugivory level increasing with body mass (Remsen *et al*. 1993). This study, however, was based on information recorded on labels of museum skins, a method that may bias the results due to the inaccuracy and small resolution of label notations in what concerns stomach contents. Direct observations are thus preferable over label information as a source of general diet composition. In this paper I present information on the diet of three trogon species in the Atlantic forest (*Trogon viridis* Linnaeus, 1766, *T. surrucura* Vieillot, 1817, and *T. rufus* Gmelin, 1788) gathered through direct observations of foraging birds. Given the general scarcity of fleshy fruits during the dry season at the study site, I predicted that the relative contribution of fruits and arthropods would vary seasonally, with the consumption of arthropods being higher in the dry season, as suggested for *Trogon citreolus* Gould, 1835 in Mexico (Eguiarte & Martinez del Rio 1985).

The study was carried out from approximately 400 to 900 m asl at Parque Estadual Intervales (PEI, 24°16'S, 48°25'W) where the three trogon species occur sintopically. PEI is a 49,000-ha reserve of Atlantic rain forest (sensu Morellato & Haddad 2000) in a mosaic of successional stages. Annual rainfall is around 1,600 mm. Although climate is generally wet, a driest season can be

distinguished between May and August. Data were collected opportunistically during visits to PEI carried out from 1990 to 2002. Every time I found a bird apparently looking for food (i.e. in the typical manner of trogons, turning the head slowly from side to side while scanning the vegetation; DEL HOYO *et al*. 2001), I waited until the bird made a foraging attack (invariably through flight-powered maneuvers) or moved away. For each attack, I recorded a foraging bout and noted the item taken. Contrary to fruits, the arthropods captured, especially small ones, could not be always seen with certainty. In such instances, when birds directed their foraging maneuver to foliage with no fruit in the immediate vicinity, I recorded an arthropod foraging. Alternatively, when fruits were present, no record was made. To ensure independent records, I considered only the initial observation for each individual bird (HEJL *et al*. 1990). I cross-classified all foraging bouts by trogon species and season (wet x dry) categories. To the resulting two-way frequency table I performed log-linear analyses to examine whether species and season (design variables) affect the frequency of feeding bouts on fruits and arthropods (response variables). The significance of each design variable and their interaction was assessed by Maximum Likelihood Chi-square relative to the model it was added (Test of Marginal Association). Analyses were implemented in Statistica v. 6.0 (STATISOFT 1996).

Fruits and arthropods made the bulk of the food items recorded (Tab. I). The only other item was an unidentified flower ate by *Trogon viridis* in the dry season. Although trogons may occasionally eat small vertebrates (DEL HOYO *et al*. 2001), none was recorded. The general tendency of frugivory increasing with body mass revealed by REMSEN *et al*. (1993) held also in the present study: *T. viridis*, the largest species (87.6 g; all weights from JOHNSGARD 2000), had 66% of the records on fruits; this proportion dropped to 25% in *T. surrucura* (75 g), and 14.3% in *T. rufus* (52.8 g). The species differed in the relative use of fruits and arthropods (χ^2 = 12.48, df = 2, p = 0.002), mainly due to the frequent consumption of fruits by *T. viridis*. Contrary to expectations, the relative contribution of fruits and arthropods did not varies seasonally (χ^2 = 0.00, df = 1, p = 0.97), and the interaction between species and season was not significant as well (χ^2 = 4.48, df = 2, p = 0.11) (Tab. I).

The higher tendency to frugivory by *T. viridis* in comparison with *T. surrucura* and *T. rufus* has already showed up in the data presented by REMSEN *et al*. (1993). Of the 29 *T. viridis* stomachs they analyzed 58.6% had fruits, a figure that dropped to 35.7% for *T. surrucura* (n = 14), and 37.0% for *T. rufus* (n = 27). Together these data reveal that in the omnivorous gradient, *T. viridis* is close to the frugivory extreme, whereas *T. surrucura* and *T. rufus* are next to the insectivorous end. Such a distinction may have important consequences for the territoriality and social behavior of these birds (STUTCHBURY & MORTON 2001), which deserves further investigation

The optimal foraging theory predicts that niche breadth should generally increase as resource availability decreases (MACARTHUR & PIANKA 1966, SCHOENER 1971). Under such conditions, a consumer can not afford to bypass inferior food items because mean search time per item encountered is long and the expectation of finding a preferable food item is low. Given this one could expect a more pronounced reliance upon arthropods by *T. viridis* during the dry season when fruits are scant at the study site. However, *T. viridis* used roughly the same proportion of fruits and arthropods between the two seasons, suggesting that either *T. viridis* adjust its time budget to overcome the general fruit scarcity in the dry season (*e.g.* spending more time searching for fruits) and/or arthropods also decrease in abundance in the dry season, a possibility that I can not presently evaluate for the study site but that proved to be true for other Atlantic forest areas (DAVIS 1945, DEVELEY & PERES 2000).

Table I. Number of foraging bouts in fruits, arthropods and flowers by three *Trogon* species during the wet (September-March) and dry (May-August) seasons.

	Fruits	Arthropods	Flowers
Wet season			
T. viridis	11	9	0
T. surrucura	4	5	0
T. rufus	1	6	0
Dry season			
T. viridis	19	7	1
T. surrucura	3	16	0
T. rufus	1	6	0

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