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Foraging substrate selection by ochre-rumped antbird *Drymophila ochropyga*

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RESUMO. **Seleção de substrato de forrageio pelo trovoada-ocre *Drymophila ochropyga.*** Seleção de substrato de forrageio pelo especialista em folhas mortas *D. ochropyga* foi avaliado em relação à distribuição de artrópodos em diferentes tipos de folhas secas (folhas secas enroladas suspensas, folhas secas de bambu e de pteridófitas). Os estudos foram conduzidos no sudeste da Mata-Atlântica, durante março a setembro de 1996. Os artrópodos mais comuns coletados nas folhas secas foram Aracnida, Coleoptera, Blattodea, Ortoptera e Isopoda. A densidade de artrópodos (número de artrópodos/g de folhas secas) foi similar nos diferentes tipos de substratos, mas as folhas secas enroladas tiveram maior proporção de grandes artrópdos (> 20 mm) em relação às folhas secas de bambu e folhas secas de pteridófitas (c^2 = 76.82; gl = 6; p < 0.001). O especialista em folhas secas *D. ochropyga* forrageou principalmente em agrupamentos de folhas secas de bambus (41% das 139 observações) em relação aos outros substratos (p < 0.001). Tais resultados sugerem que: 1) há diferenças na distribuição biomassa de artrópodos em diferentes tipos de folhas secas, e 2) diferentes tipos de folhas secas são selecionados por *D. ochropyga*.
Palavras-Chave: *Drymophila ochropyga*, trovoada-ocre, substrato de forrageio.

ABSTRACT. Selection of foraging substrates by the dead-leaf specialist *Drymophila ochropyga* was examined in relation to arthropod distribution on different dead-leaf types (curled, bamboo, ferns - Pteridophyta), in southeastern Brazilian Atlantic forest, from March to September of 1996. The most common arthropods collected in dead-leaves were Arachnida, Coleoptera, Blattodea, Orthoptera and Isopoda. Density (number of arthropods per gram of dead-leaves) in different substrates was similar, but curled leaves had greater proportions of large arthropods (> 20 mm) when compared to bamboo and ferns (c^2 = 76.8; df = 6; p < 0.001). The dead-leaf specialist *D. ochropyga* foraged mainly on clumped bamboo leaves (41% of 139 observations) in relation to other substrates (p < 0.001). This results suggest that 1) arthropod biomass varies among different dead-leaf types, and 2) different leaf types are selected by *D. ochropyga*.
Key Words: *Drymophila ochropyga*, ochre-rumped antbird, foraging substrates.

Understanding resource availability and distribution, as well as resource-use patterns by birds, is central to the study of foraging specialization and avian community organization (Holmes *et al.* 1979, Morse 1980, Remsen 1985, Wiens 1989). Very often, however, food abundance and availability have proven difficult to measure, especially in structurally complex environments such as tropical forests (Sherry 1984, 1985; Karr and Brown 1990). However, because many tropical birds are specialized in a particular spectrum of resources (e.g. birds specializing on dead-leaf substrates), studies of relationships between these specialists and their resources can overcome some of these difficulties (Smith and Rotenberry 1990).

A number of tropical antbirds (Formicariidae), ovenbirds (Furnariidae) and other insectivorous species forage extracting arthropods from dead-leaves (Willis 1972, Gradwohl and Greenberg 1982, 1984, Remsen and Parker 1984, Rosenberg 1990, 1993; Stotz 1990). Such substrate specialization is thought to promote coexistence in tropical bird communities and thus, contribute to high tropical diversity due to reduction of resource competition among congeneric foliage-gleaning species (Munn and Terborgh 1979, Munn 1985). Similarly to some neotropical birds, ochre-rumped antbird *D. ochropyga* (Tamnophilidae), an endemic species of Brazilian Atlantic forest (Sick 1985, Ridgely and Tudor 1994), can be considered a dead-leaf specialist, since this species obtains most of its prey probing dead-leaves suspended on vegetation (Leme, submitted).

In this study, I aim to identify finer levels of resource use in a species that was already considered highly specialized with regard to foraging substrate. By sampling prey abundance in particular dead-leaf substrates and foraging substrate use by birds, I tested the following questions: (1) are there differences in absolute abundance of large prey in distinct dead-leaf types? (2) how does the dead-leaf specialist *D. ochropyga* concentrate their search efforts on different leaf types?

STUDY AREA AND METHODS

Field studies were carried out at Intervales State Park (24°17'S, 48°25'W), state of São Paulo, Southeastern Brazil, from March to December 1996. The reserve is covered by Atlantic Forest, including old second growth and primary evergreen cloud forest. The altitudinal range of the reserve is from 60 to 1100 m. Annual mean rainfall is nearly 1800 mm with few seasonal differences (Olmos

Table 1. Number of arthropods collected in different dead-leaf types.

Taxonomic Group	> 20 mm	Between 20 and 10 mm	Between 9 and 5 mm	< 5 mm	Total
Arachnida	6:8:0*	18:39:17	14:58:28	10:92:43	48:197:88
Blattodea	2:9:0	5:25:3	2:13:13	3:2:17	12:49:33
Coleoptera	7:14:0	9:9:2	9:13:5	4:41:21	29:77:28
Isopoda	4:3:0	0:2:1	5:4:8	2:1:15	11:10:24
Orthoptera	2:5:0	6:2:0	3:7:3	0:0:0	11:14:3
Miriapoda	0:2:1	2:2:1	0:0:1	0:3:0	2:7:3
Opiliones	2:2:1	0:4:0	0:1:0	0:0:0	2:7:1
Hymenoptera	0:0:0	1:0:0	0:5:1	0:7:2	1:12:3
Homoptera	0:0:0	2:0:0	1:0:2	0:0:0	3:0:2
Larvae Lepid.	1:5:0	0:10:1	0:3:0	0:1:0	1:19:1
Hemiptera	1:1:0	0:1:0	0:0:1	0:0:2	1:2:3
Diptera	0:0:0	1:0:0	0:1:0	0:1:0	1:2:0
Dermaptera	0:0:0	0:1:0	0:2:0	1:11:0	1:14:0
Others	2:2:0	5:3:1	2:10:3	3:12:4	12:30:8
Total	27:51:2	49:102:26	36:116:65	23:171:104	135:441:197

* Curled dead-leaves: bamboo dead-leaves: Pteridophyta dead-leaves.

1991). There is a rainy season lasting from October to March and a slightly drier season from April to September (Olmos and Rodrigues 1990). The temperature varies markedly seasonally, ranging from 5°C in the winter to 35°C in the summer (Rodrigues *et al.* 1994a, b). The data were collected at upland forest, from 800 to 1000m above sea level.

Aerial litter arthropods were sampled follow methods used by Gradwohl and Greenberg (1982) and Rosenberg (1990). Three types of dead-leaves previously identified as foraging sites by *D. ochropyga* (Leme, submitted), including bamboo clustered leaves, curled-leaves suspended on vegetation and Pteridophyta leaves ("samambaiuçu"), were collected to sample arthropods. It was collected one sample of each substrate type monthly from 0.5-2 m above ground. For each sample, leaves were removable with minimal disturbance along random points of the transects from 500 to 1000 m, and placed into a zip-lock plastic bags. Arthropods were separated from the leaves on laboratory, classified to order, measured to the nearest 1.0 mm and preserved in 70% ethanol. Collected specimens were identified to lower taxonomic levels and deposited at the Universidade Federal de São Carlos and Instituto Butantã. Absolute abundance of arthropods was expressed as number of arthropods/g of dry-weight litter (Cooper and Whitmore 1990). These estimates excluded social arthropods such as ants, which were considered as one individual.

Single individuals or couple were encountered opportunistically and followed on designed transects from 100 to 1000 m during morning period (6:00 to 12:00 am). Foraging patterns and resources use were observed with Pentax 8 x 40 binoculars and recorded with a tape on foraging individual birds. It was recorded foraging substrate, including plant species or type (e.g. bamboo, curled dead-leaves, herbaceous vegetation, twigs and others).

Comparisons of arthropod abundance in different substrate types and plant foraging selection were examined with Chi-square heterogeneity test and Mann-Whitney test (Sokal and Rolph 1981).

RESULTS

Abundance and distribution of dead-leaf arthropods. In general, arthropods in dead-leaves consisted mostly of spiders (35-45%), roaches (9-17%) and beetles (14-21%) (table 1). Arthropod mean density did not differ significantly among three kinds of aerial-litter sampled ($p > 0.1$, Mann-Whitney Test-U; table 2).

Arthropod size classes varied significantly across categories of different dead-leaves (c^2 =76.82; df = 6; $p < 0.001$). Over 56.3% of the arthropods founded in curled dead-leaves were larger than 10 mm, compared with 34.9% in bamboo-dead leaves and 14.2% in Pteridophyta dead-leaves. There was a significant difference of distribution of arthropod class sizes, largely due to the overabundance of large arthropods in curled leaves, and low abundance of large ones in Pteridophyta dead-leaves (table 3).

Foraging substrate. Of 98 foraging records of dead-leaf use by *D. ochropyga*, 57 (58.2%) were searched significantly in bamboo dead-leaves when compared to other dead-leaf categories (c^2 = 29.04; $p < 0.001$), while curled and Pteridophyta dead-leaves had similar proportion of use (table 4), despite of higher proportion of large prey in the former (table 1).

Table 2. Mean of number of individuals/g aerial litter.

Month	Curled dead-leaves	Bamboo dead-leaves	Pteridophyta dead-leaves
March	0.36 (47/128)	–	–
April	0.60 (32/53)	0.27 (45/164)	0.21 (37/175)
Mai	0.29 (25/85)	0.28 (86/305)	0.24 (87/359)
June	0.43 (52/121)	0.30 (92/306)	0.28 (18/65)
July	0.31 (16/51)	0.59 (133/224)	0.24 (35/146)
September	0.48 (10/21)	0.36 (38/104)	0.34 (20/58)
Mean (S.E)	0.41 (0.11)	0.36 (0.15)	0.24 (0.05)

Table 3. Chi-square test for heterogeneity.

Arthropod lenght	Bamboo	Curled	Pteridophyta
> 20	0.64	12.10	16.61
10 – 20	0.01	10.52	8.13
5 – 9	0.48	0.10	1.67
< 5	0.01	16.26	10.28

Table 4. Foraging bouts of *D. ochropyga*..

Foraging substrate	Number of observations	Percentage of observations
Bamboo dead-leaves	57	(41.0)
Curled dead-leaves	26	(18.7)
Pteridophyta dead-leaves	15	(10.8)
Twigs and bamboo nodes	26	(18.7)
Green-leaves	10	(7.2)
Others	5	(3.6)
Total	139	

DISCUSSION

Suspended dead-leaves may occur from the top of the canopy to near the ground, especially in lower forest substrate where vegetation is more dense, persisting either individually or in dense clusters, offering daytime hiding places for nocturnal arthropods (Remsen and Parker 1984). Similarly to other studies (Rosenberg 1990, 1993), spiders, beetles, roaches, crickets and isopods were the most abundant taxonomic groups of arthropods founded in dead-leaf clumps. Arthropods mean leaf did not differ significantly among dead-leaf substrates and are comparable to some values found in other tropical sites (Rosenberg 1990), but larger arthropods were found in curled, bamboo and pteridophyta dead-leaves, respectively. Preferences for some dead leaf types for large arthropods as refugia can be related to dead-leaf size, structure and/or habitat distribution (Gradwohl and Greenberg 1982).

Resource availability for insectivorous birds are determined by type, abundance and prey detectability, which in turn depend on vegetation structure, morphological and behavioral abilities of the bird to perceive and capture prey (Holmes and Schultz 1988, Holmes 1990). So, absolute abundance of resources still is not sufficient to define which prey will be available, selected and consumed by birds, but arthropod absolute abundance censused here give us an idea of arthropod density, biomass and taxonomic distribution, and consequently allow us to make some inferences of substrate selection and diet based on literature informations.

Determinants of diet can be considered from several ecological and behavioral perspectives, resulting of daily or seasonal prey availability, microhabitat selection, innate preferences, habitat structure or nutritional needs (Cowie and Hinsley 1988, Grundel and Dahlsten 1991). Empirical studies of diet and behavior show that antwrens (*Myrmotherula*) exhibit high degree of prey selectivity, capturing readily roaches, spiders and crickets, whereas nearly all ants, flies, wasps, opiliones, hard-bodied or bright colored arthropods were ignored (Gradwohl and Greenberg 1983). In addition, analyses of stomach contents of several dead-leaf specialist birds by Rosenberg (1990, 1993) demonstrated that 63-92% of dead-leaf specialists diet are composed of orthopterans, spiders, roaches and beetles. So, despite of lack of informations in relation to diet of *D. ochropyga*, it is possible that prey consumed by this species did not differ considerably from other dead-leaf specialists whitin the family, where prey consumed correspond to the most common arthropod taxonomic groups collected in the dead-leaves.

Dead-leaf foragers search for suitable substrates and then closely inspect these hidden prey, taking them roughly in proportion to what is available in the leaves, being recognized as substrate-restricted searching mode

(Robinson and Holmes 1982). They did not, however, exhibit great overall selectivity of prey, nor a great tendency to avoid prey not normally encountered in nature (Rosenberg 1990). The ability to take larger prey may be important in these birds probably because specialization on dead-leaves imposes a cost in terms of lower foraging rates (Thiollay 1988). Thus, the relative abundance of larger prey, may be the single most important factor promoting specialization on dead-leaves.

Several studies have been demonstrated that insectivorous birds tend to select more profitable substrates based on visual cues such as leaf type, leaf damage created by herbivorous insects and so forth (Holmes and Robinson 1981, Heinrich and Collins 1983, Greenberg and Gradwohl 1980, Gradwohl and Greenberg 1984). For sedentary, permanent birds, foraging specialization may be enhanced where resources exist in predictable patches. So the persistence of individual dead leaves and the turnover rates of potential prey in these leaves suggest that antwrens may perceive these leaves as predictable and renewable resources (Rosenberg 1990).

In spite of higher proportion of larger arthropods in curled dead-leaves, bamboo dead-leaves had more frequent use by *D. ochropyga*, possibly due to their greater availability on habitat, since curled dead-leaves are much less abundant and more patchily distributed than bamboo dead-leaves at study site (pers. obs.). However, because there is not quantitative data on substrate availability, further studies might consider diet, measuring availability and dispersion of such foraging microhabitats in order to better understand selection of foraging sites by *Drymophila* and other tropical birds.

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