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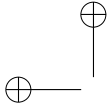
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Summer feeding ecology of Great Pampa-finches, *Embernagra platensis* at Laguna de Guaminí, Buenos Aires, Argentina

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ABSTRACT

The aim of this study was to assemble data on the summer feeding ecology of the Great Pampa-finch, *Embernagra platensis* at the Laguna de Guaminí, Buenos Aires, Argentina, and to explore the differences related to the dietary patterns for each sex between winter and summer when possible. The stomach contents of 43 birds were analyzed. The animal fraction was composed of Hymenoptera (45.1%), Coleoptera (32.4%), Lepidoptera (6.0%), Araneae (5%) and Orthoptera (3.2%). The application of the index of relative importance (IRI) resulted in 1490.4 for Coleoptera, 428.8 for Hymenoptera and 162.5 for Lepidoptera caterpillars. The vegetal fraction consisted of *Triticum aestivum* (26.9%), Cyperaceous (25%), Poaceae (Gramineae) (19.3%) and *Panicum* sp. (11.2%). The IRI values were 893.8 for *Triticum aestivum*, 174.5 for Gramineae, 126.5 for *Panicum* sp. and 112.8 for *Scirpus* sp. The food niche width was 0.33 for both sexes; the diversity index resulted in 1.06 for females and 1.33 for males and specific diversity ranged from 1.87 to 2.8. A canonical component analysis (CCA) was performed on environmental and morphometric variables, and a Monte Carlo test confirmed the canonical correlations. A t-test showed that some birds harmonized with a logarithmic model and some with a geometric curve. During the summer, *Embernagra platensis* ingests Hymenoptera and Coleoptera more often than seeds, suggesting that two biological mechanisms could be taking place in this bird.

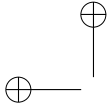
Key words: Argentina, *Embernagra platensis*, feeding ecology, Great Pampa-finch.

INTRODUCTION

The Great Pampa-finch, *Embernagra platensis*, belongs to the Emberizinae finches, distributed from the south-east Brazil (north of Minas Gerais to Espírito Santo), through most of Paraguay (local in the dry Chaco), north-west Bolivia (north to Beni), and Uruguay, to central and south Argentina (Misiones, Formosa, Chaco, Santa Fé, La Pampa and Río Negro (Short 1975, Ridgely and Tudor 1989)).

It inhabits open grasslands, often with scattered shrubs, and can fairly frequently be seen flying along and over roadsides, although some prefer damp places. They form pairs or small groups, are territorial and consistently sing while perched on the top of bushes and

Previous papers on the Great Pampa-finch reported mainly arthropods, mostly insects as its prey items (Marelli 1919, Aravena 1928, Zotta 1932, 1940, Montalti et al. 2005). Beltzer (1990) reported the diet of *Embernagra platensis* in the middle valley of the Río Paraná (Province of Santa Fé, Argentina) was dominated by an animal fraction (16 taxa), followed by a plant fraction (8 taxa). Current feeding studies carried out at the Laguna de Guaminí during the summer registered arthropods (40% biomass), mostly Formicidae and Coleoptera, and typical seeds of the Iridaceae (60% biomass) as part of its diet (Montalti et al. 2005). The previously known facts about the dietary composition of the Great Pampa-finch were incomplete



the summer, compare its diet between seasons and sexes at the Laguna de Guaminí, Province of Buenos Aires, Argentina.

METHODS

STUDY AREA

This research was carried out in the area of the Laguna de Guaminí (37°1'60S, 62°25'0W), near the neighboring city of Guaminí, in the Province of Buenos Aires, which is part of the biogeographical province of Pampa. The dominant climate is temperate semiarid, with thermal fluctuations ranging from 15.2°C to 7°C. The vegetation arrangement corresponds to an herbaceous steppe or sub-steppe. Natural grasslands have been reduced and replaced by annual crops. The winter harvest includes oat, wheat, and rye, while the summer crops are of sunflower, corn, soy and sorghum.

STOMACH SAMPLES

Great Pampa-finches at the Laguna de Guaminí were collected (N=43) with the permission of the Dirección Provincial de Recursos Naturales de la Provincia de Buenos Aires in December 1997. Birds were sexed, measured, weighed and promptly frozen. The stomach contents were collected in numbered plastic bags; the samples were processed to avoid stomach decomposition and, then, transferred into glass containers and preserved in 70% ethyl alcohol. The minimum number of prey individuals in each stomach sample was determined using diagnostic fragments, such as head capsules, caterpillar mandibles, elytra and wings (Yard and Blake 2002). Insect determination was carried out using the classifications by Merritt and Cummins (1978) and Kusnezov (1978). The systematic determination of plant species was made following Cronquist (1993). The minimum sample was calculated using the collected stomachs (represented by each individual) and taxa (prey items).

STATISTICAL ANALYSIS

In this study, the relationship between prey item variables and the variation explained by morphometric mea-

morphometric measurements (environmental variables) of birds were also analyzed. All data were combined in a matrix. The associations between sets of two variables were investigated performing a canonical correlation analysis (CCA) using the Canoco statistical software.

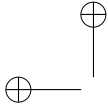
In order to compare diet patterns through the diversity index among groups from different seasons, statistical tests were carried out using SYSTAT 7.0. When running the program, we operated with groups of birds collected in each season as “different communities”, and prey species items were named by taxonomical category. We worked with four sets of data named from ‘C1’ to ‘C4’, and with the abundances of prey items. In the analysis, ‘C1’ refers to summer males, ‘C2’ to summer females, ‘C3’ to winter males, and ‘C4’ to winter females (Montalti et al. 2005).

The abundance range hypothetical model method was used to determine whether the real data fit the hypothetical model curves of richness-abundance. The model curves tried were logarithmic, geometric and broken stick shaped. The analysis evaluates and compares biodiversity community rates. We worked with ‘C1’ to ‘C4’ and proposed hypothetical curves for each community using SYSTAT 7.0.

The food niche breadth (FNB) was calculated using Levins’ index (Levins 1968, Krebs 1989), as $1/(\sum p_i^2)$, where p_i is the proportion of prey i in the diet. A standardized food niche breadth value (FNBst) was calculated, as $(FNB - 1)/(n - 1)$, where n is the total number of prey categories (Colwell and Futuyma 1971). Lower values of Levins’ index indicate relatively more specialized species, whereas higher values indicate more generalized ones (Krebs 1989).

The importance relative index (IRI) was used to establish prey contribution to diet composition. The H’ index (Shannon and Weaver 1949) was calculated between seasons and sexes, and a t -test was also used in order to compare the differences in diversity indices among the communities mentioned above.

RESULTS



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the food (g) eaten by the Great Pampa-finch consisted primarily of arthropods (83%) and seeds (17%). Table I shows the arthropod fraction consumed in terms of importance by number (N) and by frequency of occurrence (F). The reported insects were Hymenoptera (Formicidae, 45.1%; Coleoptera (Curculionidae, Carabidae), 32.4%; Lepidoptera caterpillars, 6%; Araneae, 5%; and Orthoptera, 3.2%. In the Hymenoptera, Formicidae fraction, we distinguished leaf-cutter ants, winged reproductive individuals and small red-colored ants.

Insect length ranged from 5.5 mm in Curculionidae and Formicidae to 30 mm in Lepidoptera caterpillars. The resultant IRI for the arthropod fraction was 1490.4 (149%) for Coleoptera, 428.5 (42.85%) for Hymenoptera, and 162.5 (16.25%) was represented by Lepidoptera caterpillars.

Table II shows the plant species ingested by number and frequency of occurrence. Seeds were *Triticum* sp. (26.9%), *Scirpus* sp. (25.1%), Poaceae (Gramineae, 19.3%) and *Panicum* sp. (11.2%). Seed size ranged from 1 mm in *Chenopodium* sp. to 7 mm in *Triticum aestivum*. The IRI for the vegetal fraction resulted in 893.8 (89.38%) for *Triticum aestivum*, 174.5 (17.45%) for Poaceae (Gramineae), 126.5 (12.65%) for *Panicum* sp., and 112.8 (11.28%) for *Scirpus* sp.

The trophic spectrum based on the identification of 507 items was integrated by 41 taxa (9 plants and 32 insects) and the standard FNB resulted in 0.33 for the summer period. Gastroliths (5 samples) ranged between 1 and 2 mm.

The mean stomach sample was 0.57g (SD±0.21) and it ranged from 0.16 g to 1.36 g, representing ca. 1.36% of the body mass. The mean body mass was 41.7 g, and the mean number of items was 12 per stomach per bird for the summer.

The H' index was 2.24 for males and 1.94 for females during the summer. The diversity index was 1.08 for males and 1.5 for females during the winter, and there was no difference between these seasons.

Table III shows in the CCA analysis that the second components contemplate about 71% of the information among variables, meaning that the samples (birds) corre-

TABLE I
Insect species by number (N) and frequency (F) of occurrence consumed by *Embernagra platensis* during the summer at the Laguna de Guamini.

Insect species	N	N%	F
LEPIDOPTERA			
Caterpillars	17	5.98	8
COLEOPTERA			
Curculionidae	41	14.43	16
Lucanidae	1	0.35	1
Tenebrionidae	2	0.70	2
Buprestidae	6	2.11	3
Carabidae	32	11.26	20
*Undeterm. Coleoptera	10	3.52	8
HEMIPTERA			
Belostomatidae	1	0.35	1
Cicadellidae	1	0.35	1
*Undeterm. Hemiptera	5	1.76	5
HETEROPTERA			
Pentatomidae	1	0.35	1
DICTIOPTERA			
Blattidae			
<i>Periplaneta americana</i>	1	0.35	1
Mantoidea			
<i>Mantis religiosa</i>	2	0.70	1
ORTOPTERA			
SubO. Ensifera	2	0.70	2
SubO. Celifera	4	1.41	3
*Undeterm. Orthoptera	3	1.05	3
HYMENOPTERA			
*Formicidae	120	42.25	12
Undeterm. Formicidae	4	1.41	4
Apidae	2	0.70	2
Vespidae	1	0.35	1
<i>Symphyta</i> sp.	1	0.35	1
ODONATA			
SubO. Anisoptera	3	1.05	2
*Undeterm. Odonata	2	0.70	2
DERMAPTERA			
<i>Forficula</i> sp.	1	0.35	1
DIPTERA			
Brachicera			

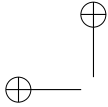


TABLE I (continuation)

Insect species	N	N%	F	F%
ARANEA				
Opiliones				
Lagnatore	1	0.35	1	2.32
Araneida				
Lycosidae				
<i>Lycosa</i> sp.	6	2.11	2	4.65
Pseudoescorpionidae	1	0.35	1	2.32
*Undeterm. Araneida	6	2.11	6	13.95

Undeterm. = undetermined fraction due to decomposition. We used body structures for classification. Total number of insects = 284. Total stomach contents = 43. *Formicidae (*Atta* sp., *Solenopsis saevissima*, *Acromyrmex lundii* and *Acromyrmex striatum*).

TABLE II
Plant species number (N) and frequency (F) of occurrence consumed by *Embernagra platensis* during the summer at the Laguna de Guaminí.

Plant species	N	N%	F	F%
DICOTYLEDONEAE				
CHENOPODIACEA				
<i>Chenopodium</i> sp.	16	7.17	3	6.97
MONOCOTYLEDONEAE				
Cyperaceae				
<i>Scirpus</i> sp.	56	25.11	2	4.65
POACEAE (Gramineae)	43	19.28	4	9.30
<i>Triticum aestivum</i>	60	26.90	14	32.55
<i>Paspalum</i> sp.	14	6.27	2	4.65
<i>Panicum</i> sp.	25	11.21	5	11.62
<i>Leptochloa</i> sp.	2	0.89	2	4.65
<i>Schizochinum</i> sp.	1	0.44	1	2.32
* Undeterm. Plants	6	2.69	6	13.95

*Undeterm. = undetermined fraction due to deterioration, material that was weighed and contributed to the diet but that couldn't be classified as a plant gender or species. Total number of plants = 223.

of about 0.016 (F-ratio = 42.287; P-value = 0.002). The test of significance of all canonical axes (trace) was 0.041 (F-ratio = 139.205; P-value = 0.002). The first two canonical correlations were significant, representing a good association between the two sets of variables.

The *t*-test for the abundance range hypothetical

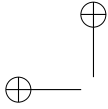
hand, 'C2' (summer females), and 'C4' (winter females) paired better with the geometric curve ($p = 2.5 \times 10^6$; $p = 5.2 \pm 10^6$). During the summer, 'C1' (males) consumed 393 preys of 21 species; 'C2' (females) 119 preys of 16 species. During the winter, 'C3' (males), ingested 485 preys of 11 species, and 'C4' (females) consumed 423 preys of 11 species.

Tables IV and V show the mean values of diet items for the winter and summer, based on 38 and 43 stomach contents, respectively.

DISCUSSION

In order to discuss the feeding ecology of the Great Pampa-finch during the summer, we made some comparisons concerning the proportions and the diversity of prey items ingested between the two seasons when possible. The specimens collected had consumed 17% of seeds (biomass) in the summer and 60% in the winter. Plant seed families were Chenopodiaceae, Asteraceae, Cyperaceae, and Poaceae for the winter, and they differed from the summer in certain species, namely *Helianthus annuus*, *Setaria* ssp., *Zea mays*, and *Eleusine tristachia* (Montalti et al. 2005). The summer plant species diverged considerably from the winter species (Table II), but they were all local components, both cultivated and ornamental crops. We assume that the undetermined vegetal fraction was obtained as part of indigestible seed husks and grass that were picked while birds were eating fallen seeds. Wheat and corn were obtained from leftover crops at the end of August-November. The harvesting activity spreads native and exotic seeds, but also grain storage offers “free” nourishment, especially for pest insects commonly preyed upon seed-eating birds. Even though seeds are important components of the winter diet, during the nesting season most of the birds feed on insects. Energy and protein requirements increase in birds during breeding (Klasing 1998). Arthropod ingestion provides more nutrients than fruit for most passerine birds (Izhaki 1998). During the summer, the amount of seeds and gastroliths decreased in comparison with the winter (Montalti et al. 2005).

The animal fraction found in the Great Pampa-finch



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TABLE III
CCA analysis summarizing the correlation among variables and the information explained by axes.

Axes	1	2	3	4	Total inertia
Eigen values	0.016	0.013	0.006	0.003	0.044
Species environment correlation	0.962	0.981	0.993	0.939	
Cumulative percentage variance of species data	37.3	67.1	80.6	86.4	
of species-environment relation	39.4	70.9	85.1	91.3	
Sum of all eigen-values					0.044
Sum of all canonical eigen-values					0.041

All four eigen-values reported above are canonical and correspond to axes that are constrained by the environmental variables.

TABLE IV
Mean winter dietary item values of *Embernagra platensis* at the Laguna de Guaminí during July 2000 (Montalti et al. 2005).

	TW	GN	GW	SN	SW	IN	IW	ItN
Mean*	1.13	16.54	0.25	11.17	0.59	19.09	0.41	27.21
Ds	0.28	12.78	0.32	9.75	0.39	23.51	0.34	24.14
Min.	0.62	2	0.01	1	0.01	1	0.04	2
Max.	1.8	50	1.11	43	1.4	77	1.23	104
N	38	28	30	36	36	33	34	38
Total				391		630		1034

*Mean values were based on N = 38 stomach contents collected during the winter. TW = total stomach content weight, GN = number of gastroliths, GW = weight of gastroliths, SN = seed number, SW = seed weight, IN = insect number, IW = insect weight, ItN = number of items.

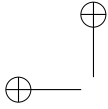
TABLE V
Mean summer dietary items values of *Embernagra platensis* at the Laguna de Guaminí during December 1997.

	TW	GN	GW	SN	SW	IN	IW	ItN
Mean #	0.57	0.82	0.01	7.19	0.21	7.39	0.40	11.95
Ds	0.21	2.22	0.02	11.10	0.20	9.77	0.40	13.44
Min.	0.16	0	0	0	0	1	0	1
Max.	1.16	10	0.06	56	0.66	50	1.77	63
N	43	22	22	26	26	43	43	43
Total				223		284		507

Mean values were based on 43 stomach contents collected during the summer. TW = total stomach content weight, GN = number of gastroliths, GW = weight of gastroliths, SN = seed number, SW = seed weight, IN = insect number, IW = insect weight, ItN = number of items.

and Coleoptera. The summer dietary components were terrestrial insects, such as the 44.1% of Formicidae (bio-

were trapped during short flights. We also found *nopsis saevissima*, *Acromyrmex lundii* and *Acron-*



Blattidae, Coleoptera, and Hymenoptera, compared to the winter even though they had eaten a larger quantity of preys. The presence of Araneae, Lycosidae, Carabidae, Curculionidae and Tenebrionidae may suggest that birds are digging the ground, removing leaves, tree barks and tissues, and exploring soil surfaces. Dermaptera (*Forficula* sp.) and Heteroptera (*Periplaneta* sp.) are not abundant, but we suggest that they were trapped during flying displays or while scavenging the soil stratum. A similar dietary diversity was registered in South African passerine birds also composed by beetles, termites, berries, seeds and ants (Kopij 2003, 2005).

Aquatic arthropods were represented by larval stages of Odonata (dragonflies) and Hemiptera such as *Belostoma* sp., that were found in six different samples (Beltzer 1990). We found several brownish and greenish caterpillars. A diversity measurement gave us the trophic spectrum, which was composed of 41 taxa (9 plants, 32 arthropods) for the summer and 21 (9 plants, 12 arthropods) for the winter (Montalti et al. 2005).

During the summer, the mean seed weight of the content (0.57g , $\text{SD}\pm 0.21$) (0.21g) was half of the mean weight encountered for the winter (Tables IV and V), which was 1.6% and 3% of the body mass, respectively. Other summer values resulted in a minor proportion in comparison to the values of the winter. The items consumed throughout the summer were also half in quantity (abundance) in comparison with the winter period. This behavior could be related to the feeding period of chicks. However, variety in the trophic spectrum was higher during the summer, whereas the mean body weight was similar for both seasons (Tables IV and V).

Concerning the animal fraction, we would like to emphasize the proportion of ants in the diet of *Embernagra platensis*, which is notorious and very abundant when compared to other insect proportions. Beltzer (1990) found *Atta* sp. and *Acromyrmex* sp., the same genus found in this study for both seasons. These “leaf-cutter ants” can be universally found in a variety of ecosystems. 44.1% of ants (out of a total of 83% of insect biomass for the summer) and 39% (out of a total of 95.8% for the winter) are too many ants for a seed-

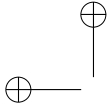
showing a behaviour indulged in by birds called “ant-ing”. Many bird species have been observed picking up ants and rubbing them on their plumage, a behavior which is displayed frequently (Clark and Clark 1990). Most anting reports involve passerines, especially of the Corvidae, Sturnidae and Emberizidae families (Wenny 1998) but, in fact, though anting is not well understood yet, birds seem to acquire the defensive secretions of ants due to their fungicidal and bactericidal properties. Video-recording could be a helpful tool in case of laboratory experiments, but what happens during the anting behavior is not known. These finches could be performing a defensive treatment by using ants or stimulating the formic acid discharge before eating them because of their taste. In this sense, the Great Pampa-finch could naturally be displaying some kind of pest biological control in local agriculture, feeding on harmful insects, ants and beetles (*e.g.* Curculionidae). This could be an auspicious hint of an opportunity to study some of the feeding mechanisms that *Embernagra platensis* uses.

ACKNOWLEDGMENTS

This work was part of an integral research program carried out by many groups of investigators researching in the same Laguna de Guaminí area. We want to thank the Dirección Provincial de Recursos Naturales de la Provincia de Buenos Aires (Direction of Natural Resources of the Province of Buenos Aires) for the permission granted according to federal laws to do research in this area in December 1997. We also want to thank Magdalena Ponce for manuscript corrections.

RESUMO

O objetivo deste estudo foi reunir dados referentes à ecologia alimentar do Sabiá-do-banhado, *Embernagra platensis*, na laguna de Guaminí, Buenos Aires, Argentina, e explorar as diferenças relacionadas aos padrões dietéticos para cada sexo entre inverno e verão, quando possível. O conteúdo estomacal de 43 pássaros foi analisado. A fração animal foi composta por Hymenoptera (45,1%), Coleoptera (32,4%), Lepidoptera (6,0%), Araneae (5%) e Orthoptera (3,2%). A aplicação do



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(26,9%), Cyperaceae (25%), Poaceae (Gramineae) (19,3%) e *Panicum* sp. (11,2%). Os valores de IRI foram 893,8 para *Triticum aestivum*, 174,5 para Gramineae, 126,5 para *Panicum* sp. e 112,8 para *Scirpus* sp. A largura do nicho alimentar foi 0,33 para ambos o sexos; o índice de diversidade resultou em 1,06 para fêmeas e 1,33 para machos, e a diversidade específica variou de 1,87 a 2,84. A análise canônica de componentes (ACC) foi realizada nas variáveis ambientais e morfométricas, e o teste de Monte Carlo confirmou as correlações canônicas. O teste-*t* mostrou que alguns pássaros harmonizaram com um modelo logarítmico e alguns com uma curva geométrica. Durante o verão *Embernagra platensis* ingere Hymenoptera e Coleoptera com mais frequência do que sementes, sugerindo que dois mecanismos biológicos poderiam estar ocorrendo neste pássaro.

Palavras-chave: Argentina, *Embernagra platensis*, ecologia alimentar, Sabiá-do-banhado.

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