FEEDING BIOLOGY OF PECTORAL SANDPIPER *Calidris melanotos* (BIRDS: SCOLOPACIDAE) IN THE FLOODPLAIN OF THE PARANÁ RIVER, ARGENTINA

MÓNICA BAGNAROL[1], ADOLFO BELTZER[2,3], MARTÍN QUIROGA[2,3], MARÍA DE LA PAZ DUCOMMUN[2] & ANA LAURA RONCHI VIRGOLINI[2,3]

[1] Facultad de Humanidades y Ciencias, UNL, Santa Fe, Argentina. [2] INALI (CONICET–UNL), Santa Fe, Argentina. [3] Facultad de Ciencias y Tecnología, UADER, Paraná, Argentina.

E-mail: adolfohec2001@yahoo.com.ar

ABSTRACT

This study focuses on the nourishing biology of the Pectoral Sandpiper at the floodplain of the Paraná river during spring and summer. Trophic spectrum, feeding selectivity and efficiency, extent of the trophic niche, circadian rhythm of feeding activity, size of preys and habitat preference were evaluated. Twenty eight stomachs containing twenty–seven taxonomic entities (12 vegetal and 15 animal entities) were analyzed. The highest index values of relative importance were for seeds and coleopteran, being this species one of a generalist diet. The amplitude of the trophic niche remained constant along the period studied. Feeding was more active during the early morning hours. The most frequent prey size ranged from 1.5 to 5 mm. This work constitutes the first contribution to the knowledge of the feeding ecology of this species in this region.

Key words:
stomach content, trophic ecology, Santa Fe.

BIOLOGÍA ALIMENTARIA DEL PLAYERO PECTORAL *Calidris melanotos* (AVES: SCOLOPACIDAE) EN LA LLANURA DE INUNDACIÓN DEL RÍO PARANÁ, ARGENTINA

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E-mail: adolfohec2001@yahoo.com.ar

RESUMEN

Este estudio se centra en la biología alimentaria del Playero Pectoral en la llanura de inundación del río Paraná durante la primavera y verano. Fue evaluado su espectro trófico, selectividad y eficiencia alimentaria, amplitud del nicho trófico, ritmo circadiano de la actividad alimentaria, tamaño de las presas y preferencia de hábitat. En 28 estómagos analizados registramos 27 entidades taxonómicas, 12 vegetales y 15 animales. Los mayores valores del índice de importancia relativa se registraron para semillas y coleópteros; siendo esta una especie con una dieta generalista. La amplitud del nicho trófico se mantuvo constante a lo largo del período estudiado y el valor de la eficiencia alimentaria indicó una alta eficiencia en la utilización de los recursos. Los resultados sobre su actividad alimentaria dan indicios de una mayor actividad durante las horas de la mañana. Los tamaños de presas más frecuentes estuvieron entre 1,5 y 5.0 mm. Este trabajo constituye la primera contribución al conocimiento de la ecología alimentaria de la especie en esta región.

Palabras clave:
contenido estomacal, ecología trófica, Santa Fe.

INTRODUCTION

Shorebirds, sandpipers and plovers are water birds that feed on shores, and muddy and shallow water areas (Brandolín *et al*., 2007). The diet of these birds is composed mainly of macrobenthic invertebrates such as insects of the families Corixidae (Hemiptera, Heteroptera) and orders Coleoptera, Homoptera, Diptera (Eldridge, 1992; Lyons & Haig, 1997; Bueno Soria *et al*., 2005; Torres *et al*., 2006).

Many shorebird species inhabit Argentina in spring and summer and return to the breeding areas in the tundra of the northern hemisphere in March and April (Petracci & Delhey, 2005). Some of these species remain all summer in the floodplain of the Paraná river, but others continue to migrate to the wetlands of Santa Cruz province (50° 20' S – 68° 52" W) (Canevari *et al*., 2001; Bremer & Fernández Balboa, 2005). Because of their extreme long–distance migrations large amounts of energy and stop–over sites along the migratory routes are crucial for their survival (Lyons & Haig, 1997; Blanco, 2000; Torres *et al*., 2006).

The Pectoral Sandpiper feeds primarily on invertebrates. It moves along steadily with its head down, picking up preys on the surface and probing lightly into the sand or mud. It eats flies and fly larvae, spiders and seeds during the breeding season and eats small crustaceans, other aquatic groups and mainly insects during migration (Bueno Soria *et al*., 2005).

The wetlands in the floodplain of the Paraná river are important wintering sites for the Pectoral Sandpipers that can be found in large numbers during the periods of low waters (Giraudo, 1992). The aim of the present study was to determine *C. melanotos'* trophic range, spatial and temporal extent of the trophic niche, feeding efficiency, circadian rhythm of activity and habitat selection in this region.

MATERIALS AND METHODS

STUDY AREA

The study was carried out on the Carabajal island (Santa Fe, 31º 39'S – 60º 42'W), belonging to the geomorphologic unit called "banks' plain" (Iriondo & Drago, 1972). Phytogeographically, it is located in the Amazonic domain, in the province of Paraná, mixed forests district (Cabrera & Zardini, 1979) (Fig. 1). The island covers a surface area of about 4000 Ha. It has numerous lenitic water bodies, some of them such as La Cuarentena lagoon (250 Ha.), La Cacerola lagoon (80 Ha.) and Vuelta de Irigoyen lagoon (70 Ha) are of a considerable extension.

Following the criteria proposed by Beltzer (1990a,b, 1991), Neiff (1986) and Beltzer & Neiff (1992) for the flood valley of the Paraná river, the following units of vegetation and

environment ("UVEs") have been recognized: open water, floating and rooted aquatic vegetation, gallery forest, grassland, pasture, beach and forest.

Some of these UVEs take up a reduced extension of the Paraná river and its main tributaries because of the magnitude and amplitude of the hydro–sedimentary pulses. The existence of UVEs is restricted to prominent low water periods, which uncover large sandbanks on the islands along the course of water, or concentric rings in the flood valley lagoons.

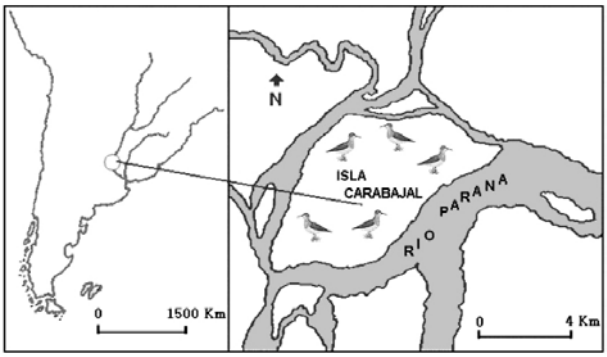

Figure 1. Study area: Carabajal island.

DATA COLLECTION

Feeding activity was observed in 30 individuals by 15–min continuous focal sampling with the use of 10x50 binoculars. Observations were made biweekly for a total of 24 days, and the length of time that the each bird spent foraging, flying and resting was recorded.

The stomachs of the birds captured between 05:00 and 07:50 pm were analyzed during the period studied (1997–1998), in order to determine the trophic spectrum. The stomachs of the collected individuals were removed at the field and preserved in alcohol.

For scientific aims, the captures were taken with guns, as authorized by the *Dirección de Ecología y Protección de la Fauna de la Provincia de Santa Fe* (Argentina).

Trophic diversity was calculated using Brillouin's (1965) formula (Huturbia, 1973)

$$H = \left(\frac{1}{N}\right) . \left(\log_2 N! - \sum \log_2 N_i! \right)$$

where N is the total number of taxonomic entities found in the stomach of each individual and N_i is the total number of preys of the species in each stomach. Individual contents were added at random, obtaining the accumulated trophic diversity (Hk). Trophic

diversity ranges (low, medium and high) were determined by dividing the difference between the lowest and highest values into three equal intervals.

The stomachs were studied individually, and the organisms were identified and quantified at different taxonomic levels. As regards the count of ingestions in an advanced state of digestion, those which kept structures or key pieces for their identification such as heads, elytrons or jaws were considered individuals.

To establish the contribution of each food category to the species diet, an index of relative importance (IRI) was applied, following Pinkas *et al*. (1971):

$$IRI = \%FO \cdot (\%N + \%V)$$

where FO is the frequency of occurrence of a category of food, N is the numeric percentage and V the volumetric percentage. To calculate this index, all stomach contents were treated as only one sample.

Dietary selectivity was evaluated applying Spearman's value of range correlation (rs) (Schefler, 1969).

The niche trophic scope per season was calculated by means of the Levins index (1968):

$$Nb = \left(\sum p_{ij}^{2}\right)^{-1}$$

where pij is the probability of item I in sample j.

With the purpose of establishing the circadian rhythm of the nourishing activity, the average index of satiety (IF) was calculated, measured as the volume of the stomach contents in milliliters divided by the bird corporal weight in grams (including stomach and its content) for each time of capture (Maule & Horton, 1984).

$$IF = \left[\bar{x}\ vol\ cont.\ (ml) \Big/ \bar{x}\ peso\ corp.\ (g) \right] \cdot 100$$

Feeding efficiency was obtained through Acosta Cruz *et al.* (1989) expression.

$$1'e = 1 - \left[\bar{x}\ peso\ cont.\ (g) \Big/ \bar{x}\ peso\ corp.\ (g) \right] \cdot 100$$

RESULTS

All the individuals observed (n=30) showed a similar feeding pattern. These birds move rapidly on wet coastal sand seeking preys synchronously with the backward and forward movement of water. Birds feeding bouts lasted for about 60% of the observed time (9 minutes) and were occasionally interrupted by shorts flights (2 minutes) or rest (4minutes), usually within a flock, returning to the same feeding area.

Of all the stomachs analyzed (n = 28), 27 contained nourishing material. The trophic diversity in each stomach oscillated between 0 and 3.18. Low values corresponded to 50%, whilst medium values corresponded to 46% and high values to 4%. The medium diversity was 1.07 (s = 59) and the trophic diversity accumulated (Hk) varied between 0.897 and 4.55. (Fig. 2). The trophic spectrum based on the identification of 423 preys was composed of 27 taxonomic entities, 15 corresponding to animals and 12 to plants (Table 1). The contribution of each category of nourishing material estimated with the index of relative importance (IRI) was: seeds = 3160; Coleoptera = 2809; Mollusca = 289; Diptera = 34; Lepidoptera = 12; Hymenoptera = 0.81; and larvae n/i = 18. (Fig. 3).

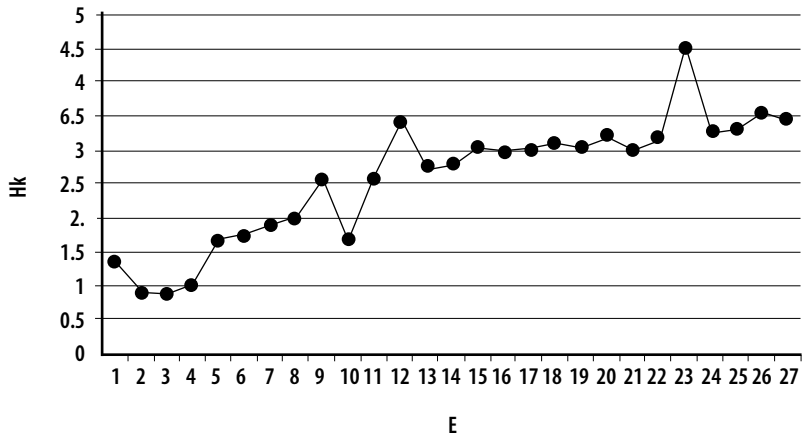

Figure 2. Accumulated trophic diversity (Hk) as a function of the number of stomachs (E).

Organism	Spring		Summer	
	F	N	F	N
Animals				
Lepidoptera	3	4	-	-
Coleoptera	3	6	2	13
Hydrophilidae	2	2	5	13
Berosus sp.	2	3	6	54
Dytiscidae	2	2	1	1
Noteridae	1	1	-	-
Curculionidae	13	34	1	2
Diptera				
Chironomidae	4	5	-	-
n/i	-	-	1	1
Hymenoptera	-	-	-	-
Formicidae	1	1	-	-
Larvae n/i	2	4	1	7
Mollusca	-	-	-	-
Pomacea insularum	1	1	1	3
Depanotrema sp.	1	3	-	-
Gundlachia concentricus	1	1	-	-
Planorbidae	7	53	-	-
Plants				
Seeds				
Sporobolus sp.	2	3	2	7
Paspalum sp.	2	2	-	-
Poligonum sp.	1	1	2	21
Scirpus californicus	2	27	5	76
Sisyrinchium megapotamicun	1	3	-	-
Brassica sp.	-	-	2	3
Brachiaria sp.	-	-	1	1
Verónica sp.	-	-	2	2
Setaria glauca	-	-	1	1
Canavaria bonariencis	1	1	-	-
Eichhornia crassipes	1	4	-	-
n/i	5	22	4	36

Table 1. Trophic spectrum of Pectoral Sandpiper. F:capture frequency, N:number of preys, n/i: unidentified.

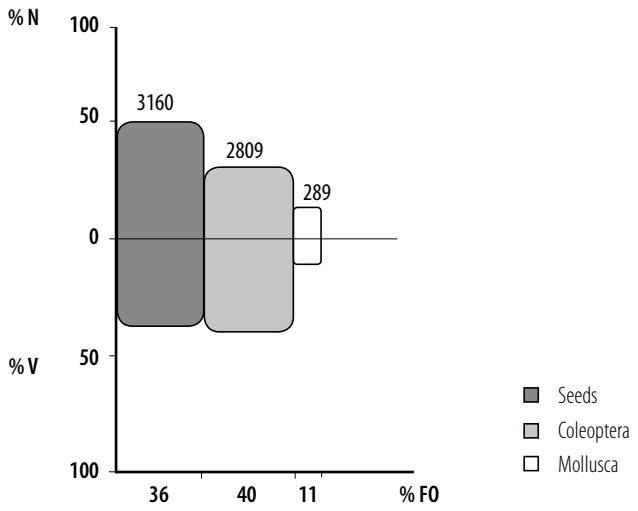

Figure 3. Relative Importance Index (IRI). Note that categories Diptera; Non–identified Larvae; Lepidoptera and Hymenoptera were not represented due to the low values obtained.

Seeds of the species *Scirpus californicus* accounted for the highest number of records. *Poligonum* sp. located in marshy environments, was frequently consumed during the summer months. In a lesser proportion, other contributors to the diet were *Sporobulos* sp., *Brassica* sp., *Verónica* sp., *Bracharis* sp. and *Setaria* sp. In spring, the species consumed were *Eichhnornia crassipes, Sisyrinchium magapotamicum Canavalia bonariensis* and species of *Bracharis* and *Paspalu*. Other seeds, the abundance of which was relatively similar in the spring and summer months, were not identified.

Coleoptera and particularly *Berosus*, was registered more frecuently in the summer months, and mollusks (Planorbidae) were identified in similar quantities during the spring. These items were followed by Curculionidae, *Lepidoptera* and *Depanotrema*. During the summer season, most ingested preys belonged to the Hydrophilidae family, non–identified Coleoptera and *Pomacea insularum*. Spring and summer larvae were not identified. The individuals with fewer records of capture (one sample) were Noteridae (Coleoptera), Formicidae (Hymenoptera) and *Gundlachia concentricus* (Mollusca) in spring, and Diptera in summer. Dietary selectivity was not significant ($r_s = 0.03$; $P>0.05$). The extent of the trophic niche was 6.27 for spring and 5.33 for summer . Nourishing efficiency for the spring–summer period were I'e = 0.75. The highest unfolding of trophic activity (Fig. 4) corresponds to the 05:00–09:00 a.m. time range. Later, it presents minimum activity between 09:00 and 01:00 pm and continues with a moderate increase from 01:00

pm to 05:00 pm, to lightly diminishing its nourishing activity from 05:00 pm onwards.

The size of preys oscillated between 0.4 and 10 mm. The largest seeds recorded were 2 mm in size, and for Coleoptera of the genus *Berosus* sp. seeds were 8 mm big. For larvae n/i and mollusks of the Planorbidae family, it was evident that their most frequent sizes varied between 0.5 to 10 and 0.5 to 7, respectively. The Diptera of the Chironomidae family presented an average size of 10 mm. (Fig. 5).

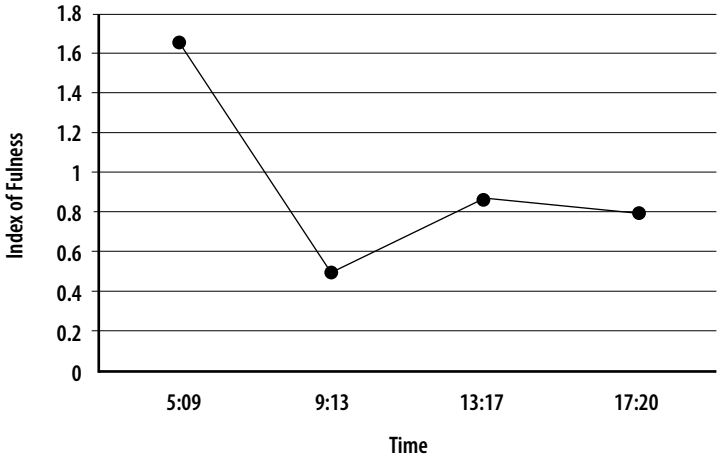

Figure 4. Circadian rhythm of feeding activity.

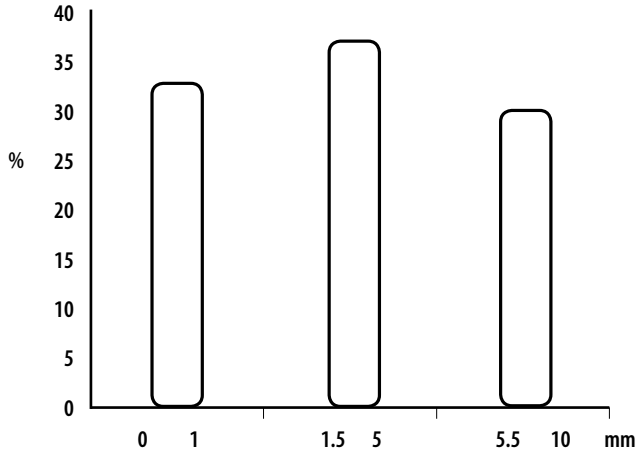

Figure 5. Body size of ingested preys.

DISCUSSION

Antecedents of *C. melanotos* refer mainly to aspects of its population state census, registers and species description (Olrog, 1963; Dabbene, 1972; Heinzel *et al*., 1975; Frisch, 1981; Meyer de Schauensee, 1982; Cuello, 1985; De la Peña, 1992).

In general, Rappole *et al.* (1993) mention a diet composed by soil, dead leaves, aquatic and aerial invertebrates including adults and larvae (Rodríguez, 1994). Besides, the ingestion of small Coloptera, Chyronomidae and Diptera larvae as well as small crustaceans, seeds, sea algaes (*Ulva latissima)* and Arachnidae was reported (Audubon, 1995; Del Hoyo *et al.,* 1996). This species also feeds on worms, clams and Orthoptera that it captures under the substrate surface in shallow waters or marshes where these organisms are abundant (Dittman & Cardiff, 1999; Klingel, 2000). Rozenberg (1986) remarks that *C. melanotos* inserts the beak (total or partially) into a soft substrate without using their sense of sight without employing sight in vegetation or muddy zones. According to Canevari *et al.* (1991a,b), when this species feeds it does so in a solitary way or in disperse groups, at times defending the feeding territory.

For Argentina, Canevari *et al.* (1991a,b – location not provided) mention the capture of crustaceans and insects and other invertebrates in aquatic environments and moist pastures. For Buenos Aires province, Marelli (1919), point out a diet composed by Coleoptera larvae. Aravena (1927) describes in detail stomach contents residues of Coleoptera (Sphenophorus sp., undetermined Hydrophilidae, Dytiscidae and Chrysomelidaes) and wild seeds, among which the author found those of alfalfa *(Medicago sativa*). Zotta (1934), registers a great amount of Coleoptera (Lamellicomea), small mollusks, Orthoptera (*Schistocerca paranaensis*), lots of Orthoptera with small pebbles and residues of *Gryllus* sp. legs.

The only availabe record outside Buenos Aires is the one provided by de La Peña (1981–Santa Fe) who reports the presence of worms, larvae, crustaceans, mollusks, insects and other invertebrates.

All the antecedents make a qualitative reference to the diet and frequently do not arrive to a good taxonomic resolution of food items. Seeds, which represented a high percentage of the trophic spectrum in our study, seem be omitted or scarcely quoted in previous works. The commonly aquatic invertebrates are the ones that follow. Coleoptera and mollusks were also abundantly quoted, althought Coleoptera was never quantified. The Chironomidae family and non identified Diptera were frequently found as items constituting the diet of *C. melanotos*. There is evidence that this species feeds on seeds and invertebrates associated with roots of aquatic plants like *Eichhornia crassipes*, as well as on youngsters of Planorbidae, Coleoptera, *Berosus* sp. larvae, Dytiscidae and Hydrophilidae and (Paporello, 1987). These last two items agree with what was previously found for the species (Rodríguez, 1994; Wright, 1994; Del Hoyo *et al*., 1996). The order Lepidoptera, belonging to the functional group of suckers (Paporello, 1996) and

Hymenoptera are the least represented within the diet. Summing up, the diet of Pectoral Sandpiper comprises in first place groups of invertebrates and to a lesser extent seeds and algae. This order of priority is not coincident with our results possibly due to the fact that seed consumption constitutes its main contribution. The apparent absence of dietary selectivity may indicate an opportunistic pattern for *Calidris melanotos*. The niches extent revealed a slight difference for the spring–summer months, suggesting that the availability of preys does no register a noticeable seasonal variation. Alimentary efficiency high values may sugest that the combination of feeding space selection and capture strategies allow facing energy costs. Forraging activity reached its peak in the early morning and decreased to the lowest near twilight. However it was no possible to determine whether the species is active at night, since our study was limited to daylight hours due to operative and budget contraints.

The type of diet corresponds, just as Chikilián *et al*. (1993) point out, to a greater development of the proventriculus of the stomach which allows a better benefit from food with a low protein proportion, as it happens with other birds (Ziswiler & Farner, 1972; Sing, 1973). The muscular stomach —probably in relation with the high amount of seeds detected— presents an important cover of gastric cuticle with numerous folds and plaques of friction which make mechanic digestion more effective.

CONCLUSIONS

According to the results obtained, we are in a condition to state that the Pectoral Sandpiper showed no preference for any food item, and feeds mainly on seeds and insects that it captures with more intensity from dawn to mid morning.

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