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WINTER DIET AND FEEDING PREFERENCES OF THE SOUTHERN LAPWING (*Vanellus chilensis*, MOLINA 1782) IN PASTURES OF SOUTHERN CHILE

Dieta invernal y preferencias tróficas del Queltehue *Vanellus chilensis*, Molina 1782 en praderas del sur de Chile

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ABSTRACT.- The diet and feeding preferences of Southern Lapwing *Vanellus chilensis* were evaluated by analysing the stomach contents of 10 specimens. Stomachs were collected from birds caught on their feeding grounds in the agricultural pastures of Chahuilco (40º44'S; 73º10'W), southern Chile. Our results reveal that all Southern Lapwing analysed consumed 127 prey items mainly insects in their larval and adult stages. *Lumbricus* spp. and Arachnida were the only non-insect preys consumed. Southern Lapwing show preference for the larvae of *Agrotis* spp. and Elateridae and the adult stages of Carabidae and Curculionidae. These prey species live close to, or on the ground surface, making them more vulnerable to Southern Lapwing depredation, which would suggest that *V. chilensis* has a preference for prey with the highest depredation risk. **KEY WORDS.-** Southern Lapwing, diet, pastures, South Chile.

RESUMEN.- Evaluamos la dieta y preferencia dietaria de queltehues *Vanellus chilensis* analizando el contenido de 10 estómagos. Los estómagos los colectamos de aves cazadas en sus sitios de alimentación en praderas agrícolas de Chahuilco (40º44'S; 73º10'W), Osorno, sur de Chile. Nuestros resultados mostraron que los queltehues consumieron principalmente estados larvales y adultos de insectos, con excepción de *Lumbricus* spp. y Arachnida. Los queltehues mostraron preferencias por larvas de *Agrotis* spp. y de Elateridae y por estados adultos de Carabidae y Curculionidae. Estas presas viven cerca o en la superficie del suelo que los hace más propensos a la depredación por los queltehues, lo que sugiere que esta ave muestra preferencias por las presas con el mayor riesgo de depredación. **PALABRAS CLAVE.-** Queltehue, dieta, praderas, sur de Chile.

INTRODUCTION

The Southern Lapwing, *Vanellus chilensis*, is distributed throughout most of South America (Meyer de Schauensee 1982, Araya & Millie 1986). In Chile it is found from Antofagasta to Tierra del Fuego, from sea level to 1000 m of elevation in the Andes (Housse 1945, Johnson 1965). Their most used breeding habitats are plowed fields, wetland meadows and humid pastures (Johnson 1965). In this later habitat, Southern Lapwings in southern Chile form reproductive territories and loose flocks from 3 to >200 individuals when feeding during the winter season (A. Gantz, personal observation).

Previous reports of the diet of Southern Lapwings show that this bird consumes earthworms and several insect species (Housse 1945, Johnson 1965). As far as we have been able to determine, no other diet and prey selection studies have been conducted since these early anecdotal studies.

Herein we present the first quantitative evidence on the diet and prey preferences of the Southern Lapwing during the winter season in agricultural landscapes of southern Chile.

METHODS

We analyzed the contents of 10 stomachs of Southern Lapwings collected during August, 1999. This species is fully protected by the Chilean law, but for this study we obtained a special permit by the Chilean Agriculture and Livestock Bureau (SAG, DEPROREN Department; Resolution Act Nº 2490, 17/08/1999) to shoot 10 individuals. We decided to use the stomach analysis method because it provides a more complete and precise analysis of prey contents (Rosenberg & Cooper 1990). All stomachs were obtained from birds collected from pastures used by diary cattle at Chahuilco (40º44'S; 73º10'W) 20 km south of Osorno in southern Chile. Birds were hunted with firearms at dawn while they fed on the grasslands and stomachs were extracted immediately. In order to avoid *post-mortem* digestion of the soft bodied prey specimens, an AFA was injected (a solution of 2 parts acetic acid, 10 parts formaldehyde, 50 parts 96º alcohol, and 40 parts distilled water) into the stomachs immediately after collection. Injecting this preservative into the stomachs made it possible to detect whole and fragmented soft-bodied prey specimens such as *Lumbricus* spp. which ensured that their presence was accurately recorded. We thus sustain that soft-bodied prey species were not under-represented in the samples studied.

The stomachs were later analyzed in the laboratory of ecology of the Universidad de Los Lagos, Osorno, Chile. When possible, all the consumed prey was identified at the species level. The preys consumed were identified with the help of entomological guides (Etcheverry & Herrera 1971, González 1989, Peña 1998) and private reference collections.

The head capsule of each prey species detected in stomachs and in the field was measured in order to determine whether the Southern Lapwing has a positive (*i.e.*, prey preference) or negative preference (*i.e.*, prey avoidance) with regard to the size of its prey. The head capsule measurements (greatest width of the head capsule when looking down) were obtained using a graduated eye-piece in a stereoscopic microscope.

The relative abundance of prey in the field was evaluated by analyzing 40 soil samples (19 x 19 cm wide x 8 cm deep) obtained the day after stomachs were collected. The soil samples were obtained with a garden shovel (22 x 19 cm) marked with a white line at the 2 cm level, indicating the required depth of sampling according to bill size (*i.e.*, bill length 29.2 mm ± 0.31 SD) of this bird. All soil samples were taken at random from the same areas where birds were observed feeding.

All prey in the core sample was counted and the biomass of each prey species was evaluated in the field with a portable balance to the nearest 0.01 g. Pitfall traps (8 cm diameter plastic glasses) were installed 15 days before birds were shot in the same feeding area, which allowed us to evaluate the relative abundance of prey insects (both larvae and adult insects) that used the ground surface. We used 25 Pitfall traps that were disposed in a 64 m^2 grid with 5 rows each one with 5 glasses separated from each other at 2 m intervals.

Table 1. Winter diet of Southern Lapwing expressed as prey number (Nº) and frequency of occurrence (F %) of prey among ten stomachs analysed. (L) = Larvae insect stages; (a) = Adults insect stages.

Consumed prey	**Nº**	**F (%)**
Agrotis spp. (L)	49	80
Dalaca palens (L)	3	30
Hylamorpha elegans (L)	5	40
Forficula auricularis (a)	2	20
Lumbricus spp.	5	30
Asilidae (L)	4	30
Carabidae (a)	15	80
Curculionidae (L)	2	20
Curculionidae (a)	19	80
Elateridae (L)	14	40
Arachnida (a)	4	30
Diptera (a)	2	30
Lepidoptera (a)	3	20
TOTAL	**127**	

The diet was expressed as the number of prey consumed and frequency of occurrence, *i.e*., the number of samples in which a particular food type appears (Rosemberg & Cooper 1990). Prey preferences were evaluated by applying a Chi-square Goodness-of-fit Test by comparing the frequency distribution of prey in the diet and in the field (Jaksic 1979). Statistically significant values were interpreted as Southern Lapwing exhibiting prey selection ("preferring" or "avoiding") some prey. Because Chi-square does not determine which individual prey species was selected, we constructed confidence intervals for each species, using the Simultaneous Bonferroni Confidence Intervals (Neu *et al*. 1974, Byers *et al*. 1984). If the intervals included the expected proportion it was concluded that the bird does not exert any preference, but if the expected proportion of prey was not included in the intervals it was concluded that it was preferred.

RESULTS

During the winter season Southern Lapwing preyed on invertebrates, with insects as the most numerous prey specially in the larval form. Individually, cutworms (*Agrotis* spp.) were the most important prey in all the stomachs, with earthworms (*Lumbricus* spp.) scarcely represented (Table 1). The most abundant prey available in the sampled pastures was also earthworms and cutworms larvae. However, by wet weight the southern green chafer *Hylamorpha elegans* and earthworms contributed with the greatest biomass in the study area (Table 2). Other insect larvae were also abundant in the field such as larvae of *Dalaca palens*, Curculionidae and Elateridae (Table 2). Adult insects were less represented than larval stages. The relative abundance of prey by using pitfall traps was not possible to evaluate. Only four prey items were captured by this method. Diptera was the most

Table 2. Prey availability in pastures of Chahuilco, Osorno, southern Chile, expressed as prey number (Nº) and mean biomass ± SD (g), obtained with 40 earth core samples in August 1999. (L) = Insect larval stages; (a) = Insect adult stages.

Available prey	Nº	Biomass (g) x ± S.D. (n)
Agrotis spp. (L)	54	0.07 ± 0.02 (52)
Dalaca palens (L)	17	0.08 ± 0.07 (16)
Hylamorpha elegans (L)	31	0.69 ± 0.21 (24)
Lumbricus spp.	429	0.36 ± 0.35 (382)
Asilidae (L)	7	0.08 ± 0.01 (7)
Carabidae (a)	6	0.03 ± 0.02 (6)
Curculionidae (L)	13	0.06 ± 0.06 (13)
Elateridae (L)	18	0.03 ± 0.02 (17)
Gastropoda	2	0.05 ± 0.03 (2)
TOTAL	**577**	

Table 3. Prey preferences of Southern Lapwings evaluated by Bonferroni Simultaneous Confidence Intervals for the proportion of prey consumed in the study area during August 1999. (L) = Insect larval stages; (a) = Insect adult stages; * = statistically significant differences at 0.05; (-) = consumed less than expected by chance; (+) = consumed more than expected by chance.

$x^2 = 1872.86$; $p = 0.001$

Prey	**p-Observed**	**p-Expected**	**Bonferroni Intervals**
Agrotis spp. (L)	0.41	0.09	0.286 ≤ p3 0.531 * (+)
Dalaca palens (L)	0.03	0.03	0.000 ≤ p2 0.064
Hylamorpha elegans (L)	0.04	0.05	0.000 ≤ p4 0.092
Lumbricus spp.	0.04	0.72	0.000 ≤ p1 0.092 * (-)
Elateridae (L)	0.12	0.03	0.037 ≤ p5 ≤ 0.197 * (+)
Carabidae (a)	0.13	0.01	0.042 ≤ p6 ≤ 0.208 * (+)
Curculionidae (a)	0.16	0.00	0.067 ≤ p7 ≤ 0.249 * (+)
Other Prey	0.08	0.04	0.014 ≤ p8 ≤ 0.0152

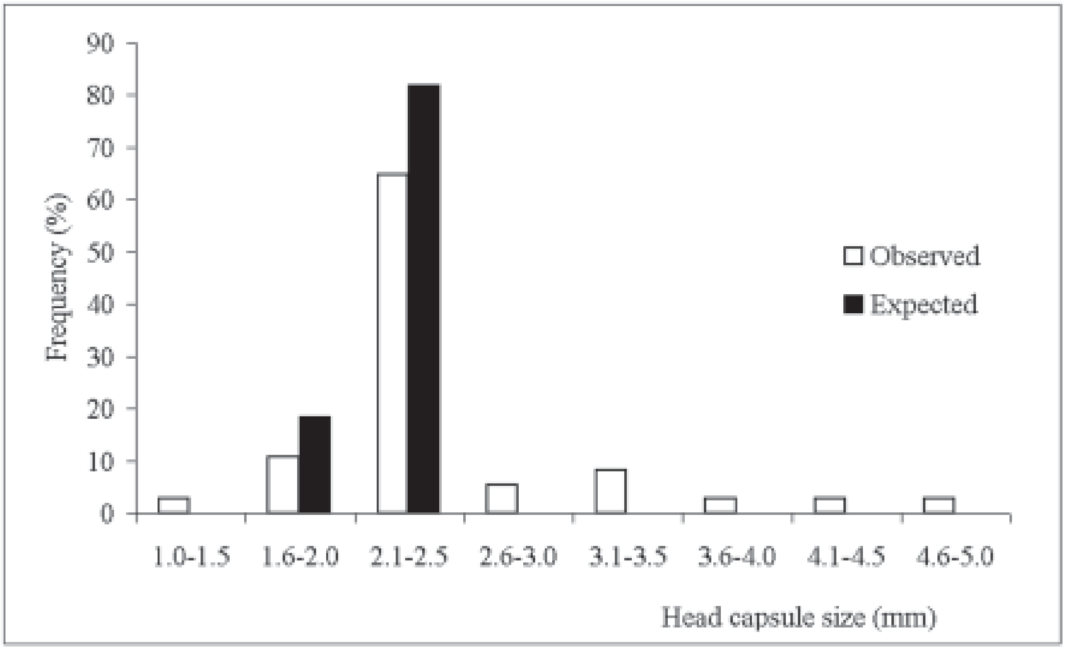

Figure 1. Frequency distribution of head capsule size of *Agrotis* spp. larvae, consumed by Southern Lapwings (observed distribution) and from specimens collected in the field (expected distribution).

abundant prey (78.8% of the total prey number) followed by Curculionidae (12.2%). Arachnida and cutworms larvae made up less than 10% of all prey captured. Although the adult stage of Diptera was the most abundant prey on the ground surface, only two Diptera prey species were found in the stomachs of the Southern Lapwings.

Southern Lapwing consumed relatively small prey and the size of cutworms in the diet was proportional to their size in the field (Figure 1). It was not possible to analyze the size frequency distribution of other prey because of their scarce representation in the stomachs and the high fragmentation of their head capsules.

The Bonferroni confidence intervals showed that Southern Lapwing preyed upon, at least, five different prey items (Table 3). Four prey items (two larvae and two adult stages) were consumed more than expected by chance, so they were preferred by this bird species. Instead, despite their higher abundance in the field, earthworms were negatively preferred (*i.e.*, avoided) and consumed less than expected by chance.

DISCUSSION

The diet of Southern Lapwing during the winter season in the pastures of the study area was mainly insectivorous and selective for some prey type. Our results agree with earlier and anecdotal reports (Johnson 1965) that pointed out that this bird has a highly varied diet but in pastures consume mainly earthworms and insects.

There are many factors that influence the decisions of predators in selecting their prey. These can be energetic considerations and also behavioural constraints such as the search and handling cost among others explanations factors (Ellis *et al*. 1976, Krebs 1978, Morse 1980). Our results suggest that the Southern Lapwing did not select prey according to body size, although given that only the head capsule of one prey species (*Agrotis* spp.) could be measured, this affirmation cannot be considered to be conclusive. Further, it was determined that prey species in the study area with greatest contribution in terms of biomass were earthworms and the southern green chafers. Nevertheless, Southern Lapwing consumed these prey species in the same proportion that was expected by chance.

The most important prey species in the diet (*Agrotis* spp. larvae) is found near the ground surface (<5 cm depth) and is vulnerable to predation by this bird. However, during the night *Agrotis* spp. larvae emerge onto the ground surface to feed on tender grass shoots (Artigas 1972). Thus, the high representation of this larvae in stomachs would suggest that *V. chilensis* could also be a nocturnal predator. The phenomenon of nocturnal feeding has been well documented in Charadriforms (McNeil *et al*. 1993), and in Europe a congeneric species (*Vanellus vanellus*) has a nocturnal feeding capability, which reinforces its efficiency in habitat exploitation (Cramp 1983).

The other preferred prey: adult stages of Curculionidae and Carabidae, use the surface of the ground between grass blades and few of them were flying insects (González 1989, Eladio Rojas, personal communication) making them more prone to predation by Southern Lapwings. Both the use of the ground surface by these two prey species, and their proportions in the diet, would indicate that they are easily captured by this bird, suggesting that Southern Lapwings has shown preferences for these prey because they are easy to capture, saving time and energy to capture them.

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