Predation of birds by the Barn Owl (*Tyto furcata* Temminck, 1827) in four environments in southern Santa Fe province, Argentina

Depredación de aves por la Lechuza (*Tyto furcata Temminck,* 1827) en cuatro ambientes del sur de la provincia de Santa Fe, Argentina

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ABSTRACT
In this paper we present the birds that make up the diet of *Tyto furcata* in four environments in the south of the province of Santa Fe, where previous data were practically nonexistent. From this contribution, 37 individuals corresponding to three Orders and 10 Families could be established as part of the diet of this raptor. The family with the most predated representatives was Thraupidae (n=19) with three genera: Sicalis, Zonotrichia and Sporophila. The average body size of the prey was 17cm. The peri-urban/suburban (AP/S) environment had the greatest diversity of prey consumed. In all environments, the highest abundance occurred in the warm seasons (spring-summer), corresponding to the decrease in micromammal populations. This type of study demonstrates the effectiveness of pellet analysis as a tool to know the existing species in highly anthropized environments.

Key words: Tyto furcata, Santa Fe, pellets, predation, birds.

RESUMEN
En este trabajo se presentan las aves que componen la dieta de Tyto furcata en cuatro ambientes del sur de la provincia de Santa Fe, donde los datos anteriores eran prácticamente inexistentes. A partir de este aporte se pudo establecer que 37 individuos correspondientes a tres órdenes y 10 familias forman parte de la dieta de esta rapaz. La familia con más representantes depredados fue Thraupidae (n=19) con tres géneros: Sicalis, Zonotrichia y Sporophila. El tamaño medio del cuerpo de las presas fue de 17 cm. El entorno periurbano/suburbano (PA/S) presentó la mayor diversidad de presas consumidas. En todos los entornos, la mayor abundancia se produjo en las estaciones cálidas (primavera-verano), lo que se corresponde con la disminución de las poblaciones de micromamíferos. Este tipo de estudio demuestra la eficacia del análisis de egagrópilas como herramienta para conocer las especies existentes en ambientes

altamente antropizados.

Palabras clave: Tyto furcata, Santa Fe, egagrópilas, depredación, aves.

1 INTRODUCTION

The study of the diet of raptors can help to better understand the distribution, abundance, behavior and vulnerability of prey species (Fulk 1976, Martí 1987). The order Strigiformes has the largest number of diet studies of these birds worldwide (Bó *et al.*, 2007). In this branch of ecology, trophic studies on raptors are commonly conducted for the family Tytonidae, and the barn owl (*Tyto furcata*) stands out for being a top predator and being among the species with the highest number of descriptions of feeding habits (González- Calderón 2017).

In Argentina, most of the contributions documenting the diet of *Tyto furcata* were made in agroecosystems and/or open natural environments in the Pampean region in the province of Buenos Aires (Pardiñas and Cirignoli 2002; González Fischer *et al.*, 2012), in addition to works in the provinces of Misiones, La Pampa and certain regions of northern Patagonia (Chubut and Río Negro), among others (Pardiñas and Cirignoli, 2002). With respect to the south of the province of Santa Fe, little has been known so far, however, in recent years important contributions have been made by the authors of this research (Paiz *et al.*, 2019; Rimoldi, 2020; Rimoldi, 2021a; Rimoldi, 2021b; Rimoldi and Curti, 2021a; Rimoldi and Curti, 2021b).

Most studies describe this bird as an opportunistic raptor that preys mainly on small mammals such as rodents and marsupials (Bellocq 1990; González Acuña *et al.*, 2004; Hercolini 2007; Solaro *et al.*, 2012; d' Hiriart *et al.*, 2017), although other items have been reported in its diet, such as arthropods, lagomorphs, chiroptera, small reptiles, amphibians and birds (Noriega *et al.*, 1993; Ramírez *et al.* 2000, González Acuña *et al.*, 2004).

With respect to the latter group, there are few studies that work specifically on bird predation. We can mention those carried out by Massoia *et al*. (1989) "Mammals and birds preyed upon by *Tyto alba tuidara* in Arroyo Yabebyrí, Candelaria Department, Province of Misiones"; Morici, A. (1990) "Aves depredadas por *Tyto alba tuidara* en San Miguel, Partido de General Sarmiento, Prov. de Buenos Aires" and Dieguez and Corbella (1997) "Aves depredadas por *Tyto alba* en Reserva Natural La Felipa, Ucacha, Dto. Juárez Celman, Pcia. de Córdoba" among others.

It is for this reason that the contribution presented in this work is of great value with respect to the consumption of birds by *Tyto furcata* in an area where the lack of previous work allows us to lay the foundations on this subject.

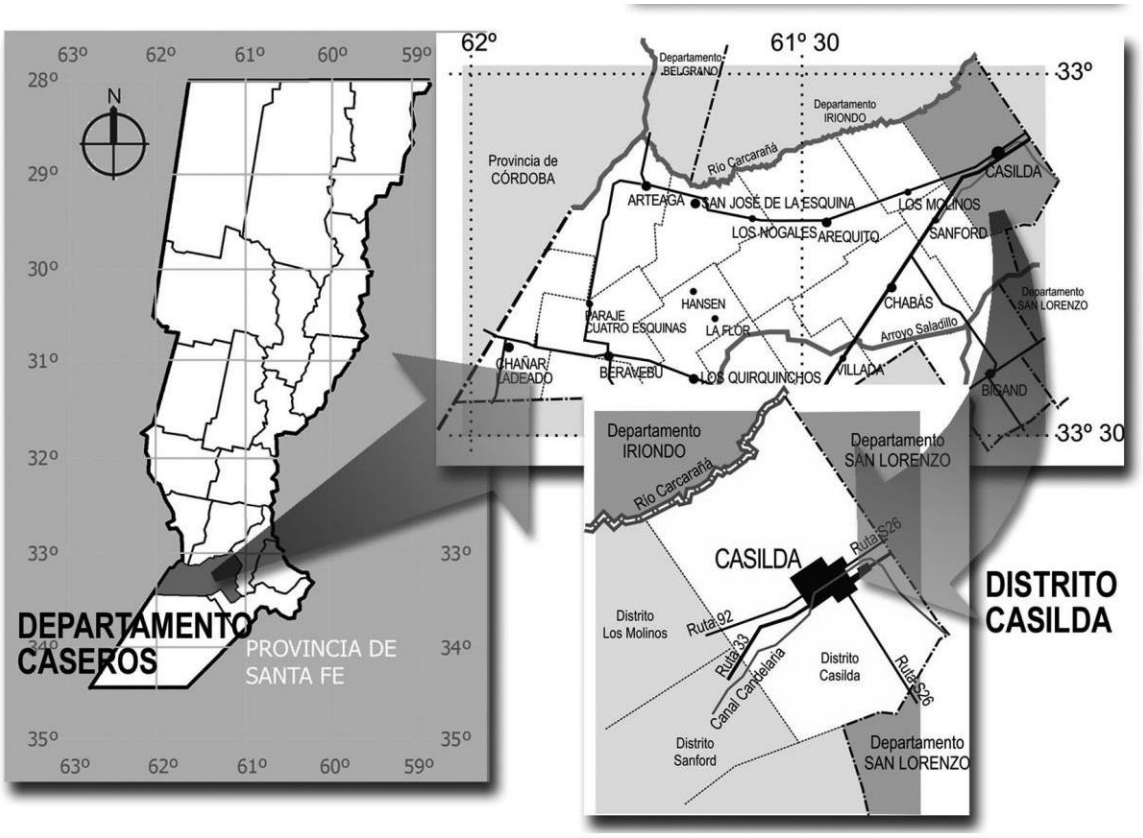
2 MATERIALS AND METHOD

2.1 STUDY AREA

Casilda is a locality of the south of the province of Santa Fe, head of the department Caseros. Located between 33° 02′ 39″ south latitude and 61° 10′ 05″ west longitude, it is bordered on the north by the Carcarañá River, on the south by the Sanford and Fuentes districts, on the west by the Los Molinos district and on the east by the San Lorenzo Department, Pujato district and Carcarañá district (Fig. 1).

The total area of the Casilda district is 38,400 hectares (384 km2), of which 1,200 hectares correspond to urban area and the remaining 37,200 hectares to rural area, thus becoming the dominant matrix of the landscape.

Figure 1: Detail of the Casilda district, Caseros Department, southern Santa Fe province, Argentina.



2.2 CHARACTERIZATION OF THE TERRITORY IN RELATION TO TYPE OF LAND USE

The type of land use, although there may be certain arbitrariness, responds to some normative criteria and to what has been established by the state (in this case the province) which determines the institutional framework to regulate the administration of the land and the activities that are developed on it. Although the original criterion is a tax classification, its practical consequence in the territory is the type of activity that is exercised in it and the modifications that it implies.

Given that this institutional framework defines the activity, and that anthropic activity is the factor that modifies the support, the type of land use permitted is the factor that imposes new conditions on the territory and, consequently, on the ecosystems.

For this reason, and for the purposes of this work, the criterion of land use type was adopted to characterize the territory determined as the study area and thus establish the sampling sites.

Based on the above, the categories were established as follows:

- Urban environment.
- Suburban or peri-urban environment.
- Rural environment

1. Anthropized (agricultural-livestock field). Ecosystems whose functioning is based on fuel energy consumption.
2. Non-anthropized or semi-natural (where edaphic or geomorphologic limitations do not allow agriculture or livestock raising, presenting characteristics different from their environment).

Taking into account what has been described for this research, four (04) types of environments belonging to dry land ecosystems within the Casilda district were established:

Established environments for the district of Casilda according to land use			
Urban	Peri-urban or suburban	Rural	
		Anthropized	Non-anthropized or natural

- **Urban environment (AU)** (33°02'01.4 "S 61°10'20.6 "W): It is characterized by the location of the houses occupying the perimeter of the block, leaving spaces occupied by vegetation consisting of grass, trees and shrubs.
- **Peri-urban/suburban environment (AP/S)** (33° 03' 21" S, 61° 09' 11" W): Some structures linked to urban activities that modify the rural agricultural landscape stand out in this environment. The Faculty of Veterinary Sciences of the National University of Rosario is located on National Route 33. Its property covers approximately 240 hectares and was declared a "Natural Protected Area" in 2007 (CD Resolution Nº 188/07) due to its role as a refuge for wildlife in a purely agricultural area.
- **Anthropized Rural Environment (ARA)** (33° 02' 17" S, 61° 16' 15" W): This is a field characterized by the expansion of wheat-soybean double cropping to the detriment of crop-livestock rotations. The conventional tillage system has been replaced by no-tillage using transgenic soybean varieties resistant to the herbicide glyphosate. Ninety-five percent of the surface area is used for this production system.
- **Non-Anthropized or Semi-Natural Rural Environment (ARNAN)** (32° 55' 02" S, 61° 13' 27" W): The physiognomy of the landscape is characterized, unlike the

predominant environment (farmland), by notable variations in relatively small spaces. Determined by the course of the Carcarañá River as an axis, an area of variable ecosystemic and regional landscape value is developed.

2.3 DATA COLLECTION AND ANALYSIS

Pellets were collected from perches occupied by different specimens of *Tyto furcata* in the different sampling points previously established, between 2018 and 2020. In all cases, the total was collected leaving the perch clean.

The pellets were placed in labeled paper bags (with the name of the environment surveyed, coordinates, date and quantity) and then in hermetically sealed polyethylene bags, respecting all Biosafety measures (use of latex gloves and a mask during collection) until the material was dried in the laboratory with an oven at 70°C for 48 hours (Muñoz-Pedreros and Yañez, 2004). Each pellet was processed, using dissection instruments to extract the skulls of the different birds. The captured prey were compared with samples identified in osteological collections and specialized literature to obtain the specific richness (Fig. 2).

Figure 2. **A)** *Tyto furcata* specimen. **B)** Pellet samples. **C)** Recognition of birds. **D)** Laboratory work.

3 RESULTS AND DISCUSSION

The results of this study made it possible to establish the richness of birds that make up the diet of *Tyto furcata* in four environments in the south of the province of Santa Fe, where previous data were practically non-existent.

A total of 2316 pellets were collected and the mean (± *SD*) per environment was 579 ±125. 5384 prey were detected, the mean number of prey per pellet was 2.21 ± 0.75 (*mean* ± *SD*). The number of pellets regurgitated by the raptor had a mean (± *SD*) in the different environments of 1.6 (± 0.34) with an average weight of 2.97 g (± 0.70).

The trophic habits of *Tyto furcata* in the four environments showed a diet based mainly on small mammals (97.21%), followed by amphibians and reptiles (2.09%) and birds (0.70%).

Available information on the feeding habits of the barn owl in Argentina suggests that prey consumption patterns are aimed at active searches for small mammals, preying mainly on rodents (Bellocq, 1988; Polop and Busch, 2010; Fraschina, 2011; Guidobono, 2013; Massa, 2015). The results of this research are consistent with this pattern.

On the other hand, the number of individuals per pellet found in the present work was very similar to that observed in central Chile (average of 1.81; Begall, 2005), in Antioquia, Colombia (average of 2.0; Delgado and Cataño, 2004), in Valdivia, Ecuador (average of 2.2.; Moreno, 2010), in Central Oaxaca, Mexico (average of 1.88; Lavariega *et al.,* 2016) and in agrarian ecosystems in the province of Buenos Aires, Argentina (average of 2.4; Bellocq 1988). Regarding the amount of pellets regurgitated per day the results were within the expected since it is in agreement with what was mentioned by Bellocq 1988 (average 1.7), Hercolini 2007 (average 1.4) and Massa 2015 (average 1.4) for different sites of the Pampas ecoregion. Similar to what has been mentioned so far occurs with the weight per pellet, which is within the range of what has been documented in other research related to the trophic habits of this raptor (average weight 2.17gr Bellocq, 1988; 3.8gr Gonzáles-Calderón, 2017).

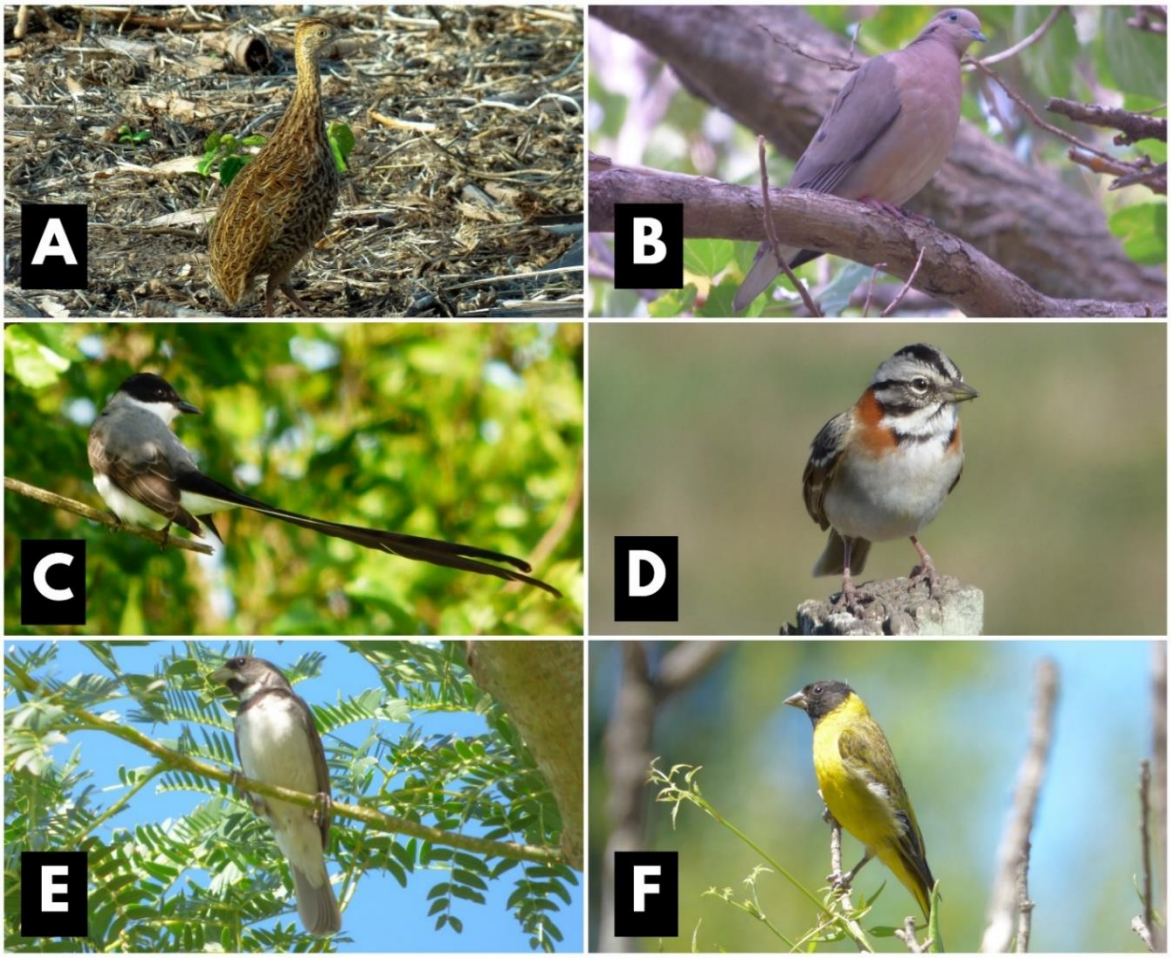
Regarding the birds consumed (n=37) (see Table 1) (see Fig. 3), it can be mentioned that the family with more representatives predated was Thraupidae (n=19) with three genera: Sicalis, Zonotrichia and Sporophila. The average body size of the total prey was 17

centimeters (based on the approximate measurements mentioned by de la Peña, 2016). The largest being *Nothura maculosa (*22.5 cm) and an average weight of 250 gr. and the smallest represented by the genera Serpophaga, Troglodytes, Polioptila and Sporophila (11 cm) and an average weight of 9 gr.

Table 1. List of birds predated by *Tyto furcata* in each type of environment surveyed in the Casilda District, southern Santa Fe province. References: **ARNAN**: Non-anthropized rural or natural environment; **AP/S**: Peri-urban/suburban environment; **ARA**: Anthropized rural environment; **AU**: Urban environment. **O**: Autumn; **I**: Winter; **P**: Spring; **V**: Summer.

SPECIES	ARNAN				AP/S				ARA				AU			
	O	**I**	**P**	**V**	**O**	**I**	**P**	**V**	**O**	**I**	**P**	**V**	**O**	**I**	**P**	**V**
STRUTHIONIFORMES																
Tinamidae																
Nothura maculosa	-	-	-	-	-	-	-	-	-	-	**1**	-	-	-	-	-
COLUMBIFORMES																
Columbidae																
Columbina picui	-	-	-	-	-	-	-	**2**	-	-	-	-	-	-	-	-
Zenaida auriculata	-	-	-	-	**1**	-	-	-	-	-	-	-	-	-	**1**	**1**
PASSERIFORMES																
Furnariidae																
Furnarius rufus	-	-	-	**1**	-	-	-	**1**	-	-	-	-	-	-	-	-
Tyrannidae																
Serpophaga sp.	-	-	**1**	-	-	-	-	-	-	-	-	-	-	-	-	-
Tyrannus savana	-	-	-	-	-	-	**1**	-	-	-	-	-	-	-	-	-
Troglodytidae																
Troglodytes aedon	-	-	-	-	-	-	-	-	-	-	**1**	-	-	-	-	-
Polioptilidae																
Polioptila dumicola	-	-	**1**	-	-	-	-	-	-	-	-	-	-	-	-	-
Thraupidae																
Sicalis sp.	-	-	**2**	-	**4**	**2**	-	**3**	-	**3**	**2**	-	-	-	-	-
Zonotrichia capensis	-	-	-	-	-	-	-	**2**	-	-	-	-	-	-	-	-
Sporophila caerulescens	-	-	-	-	-	-	-	-	-	**1**	-	-	-	-	-	-
Fringillidae																
Spinus magellanicus	-	-	-	-	-	-	-	-	-	-	**1**	-	-	-	-	-
Passeridae																
Passer domesticus	-	-	-	-	-	-	**1**	**2**	-	-	**1**	-	-	-	-	-
Icteridae																
Molothrus sp.	-	-	-	-	-	-	-	**1**	-	-	-	-	-	-	-	-

Figure 3. Example of some birds predated by *Tyto furcata* in the different environments studied: **A)** *Nothura maculosa*, **B)** *Zenaida auriculata*, **C)** *Tyrannus savana*, **D)** *Zonotrichia capensis*, **E)** *Sporophila caerulescens*, **F)** *Spinus magellanicus*.



Although active bird consumption was observed in all the environments studied, three patterns can be established. **1)** Bird consumption was highest in the warmer months. As with other Strigiformes, the seasonal variation in the diet of *Tyto furcata* in the four environments studied could be explained by the seasonal cycles of abundance of rodent prey. In this case, bird consumption tends to increase numerically during spring and summer due to the decrease in rodent populations as a result of mortality caused by climatic factors, the decrease in trophic resources and predation (Rimoldi and Curti, 2021b). **2)** The highest diversity, understood as the relationship between specific richness and relative abundance, occurred in the peri-urban/suburban (PA/S) environment. Being a complex (vertical variation) and heterogeneous (horizontal variation) environment, an important diversity of birds is observed, since it contains diverse microhabitats that can be occupied by species with different requirements. A similar situation was expected to be found in the Rural Non- Anthropized or Semi-Natural (ARNAN) environment considering the characteristics of the landscape. The low number of bird species consumed in this environment may be due to the high diversity of small mammals that inhabit the site and are the main prey item of this raptor (Rimoldi and Curti 2021a). **3)** Most of the species found in the samples were observed in environments

close to the roosts. Considering that it is a species categorized as opportunistic, it can be assumed that *Tyto furcata* consumed those prey items that were present in more abundant concentrations and easily accessible at the time of capture within its territorial range.

On the other hand, the dominance of *Zenaida auriculata* stands out in urban (AU) and peri-urban/suburban (AP/S) environments which is in agreement with references regarding the abundance of this species in highly anthropized areas (Bucher, 2016; Gastaudo et al., 2019).

The present contribution demonstrates the importance of continuing this type of exploratory descriptive studies in order to develop actions aimed at increasing research on key, threatened and ecologically relevant species present in the area, in order to incorporate effective strategies in conservation proposals that lead to the sustainable management of resources in the region.

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