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DIET SELECTION OF SANDERLINGS (*CALIDRIS ALBA*) IN ISLA GUAMBLIN NATIONAL PARK IN THE CHILEAN FJORDS

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Resumen – **Selección de dieta del Playero blanco (*Calidris alba*) en el Parque Nacional Isla Guamblin en los fiordos chilenos. –** El conocimiento del comportamiento de alimentación de los Playeros blancos en sus sitios no reproductivos es muy escaso para las poblaciones del Pacífico Sur. Nosotros aportamos datos sobre la dieta y la selección de presas del Playero blanco invernando en el Parque Nacional Isla Guamblin en los Fiordos chilenos. Nosotros muestreamos macroinvertebrados, recolectamos heces de descansaderos monoespecíficos y colectamos bivalvos para la inspección de sus sifones. Aunque el anfípodo *Orchestoidea tuberculata* fue más abundante, las principales presas para el Playero blanco fueron el coleóptero *Phalerisida maculata* y los sifones de Almejas Machas *Mesodesma donacium*. De las almejas recolectadas, el 44,7% (n = 85) tenían uno o dos sifones comidos por los Playeros blancos. El Playero blanco depredó sifones de almejas de tamaño superior a 2 cm, sugiriendo que almejas de tamaño inferior no son presas rentables para esta especie. Nuestros resultados confirman la importancia de combinar métodos para los estudios de dieta y selección de presas y revelan la importancia de colectar bivalvos para la inspección de sus sifones cuando la identificación de presas en el campo es dificultosa.

Abstract. – Knowledge of feeding behaviour of non-breeding Sanderlings is very scarce for South Pacific populations. We report data on diet and prey selection by Sanderlings wintering in Isla Guamblin National Park in the Chilean fjords. We sampled macroinvertebrates, collected feces from monospecific roosting sites, and collected bivalves for inspection of their siphons. Although the amphipod *Orchestoidea tuberculata* was most abundant, main prey items for Sanderlings were the coleopteran *Phalerisida maculata* and surf clams (*Mesodesma donacium*) siphons. Of the surf clams collected, 44.7% (n = 85) one or both siphons had been eaten by Sanderlings. Sanderlings predated on siphons of surf clams above 2 cm, suggesting that smaller surf clams are not a profitable prey for this species. Our results confirm the importance of combining methods for studies of diet and prey selection and reveal the importance of collecting bivalves for inspection of their siphons when prey identification in the field is difficult.
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Key words: Sanderling, *Calidris alba*, diet selection, foraging, shorebirds, Isla Guamblin National Park.

INTRODUCTION

Detailed knowledge of diet and prey selection is fundamental in many ecological studies related to habitat selection, niche dimensions, or energetic balance and allows the estimation of the impact of any change in food availability, i.e., due to climate changes or to anthropogenic influences (Rosenberg & Cooper 1990).

Sanderling (*Calidris alba)* is a widespread, long-distance migrant which is present in the five continents (Piersma 1996). In the New World, Sanderlings nest principally on dry Arctic tundra and spend their non-breeding season over a wide latitudinal range (> 100º) from North to South America (Castro *et al.* 1992, Myers *et al.* 1990). Some wintering populations of Sanderlings spend the non-breeding season at beaches of Chile and Peru in the Pacific coast of South America. They migrate northward along the Pacific coast and through central North America to their Arctic breeding grounds (Myers *et al.* 1990, Sallaberry & Mann 2007).

The diet and feeding behavior of non-breeding Sanderlings have been widely studied in North America (see Macwhirter *et al.* 2002), but there has been little study of populations in the Southern Hemisphere (see Klesse 1995, Sallaberry *et al.* 1996).

Sanderling is a generalist feeder as its diet includes a large number of taxa; insects, mealworms, and worms are primary prey when breeding while mollusks, insects, worms, eggs of horseshoe crabs, and even algae have been identified as main prey items at wintering or stop-over grounds (Piersma 1996, Petracci 2002, Hernández & Bala 2005).

Sanderling is a threatened species in the Western Hemisphere and is considered a species of "high concern" (USSCP 2004). In this study we report the diet and prey selection of Sanderlings wintering in Isla Guamblin National Park, in the Chilean fjords, the southernmost distribution of this species in the Pacific. We hope this information will improve the knowledge of the foraging preferences of this species, which could help to understand patterns of habitat distribution in order to predict how birds will respond to habitat changes.

STUDY AREA AND METHODS

This study was carried out in Isla Guamblin National Park (44°50'S, 75°07'W) which belongs to the Chilean fjords system. This island is the most oceanic island of the Chilean fjords and has a 16 km sandy beach (Fig. 1).

The island was visited from 1 to 16 February 2007. We found altogether 120 Sanderlings regularly feeding along about 500 m of a narrow portion of the beach (Fig. 1). We made behavioral observations using a telescope (20 x 40) and hidden by a sand dune ~100 m apart from the feeding zone of Sanderlings. We sampled macroinvertebrates of the intertidal section of the beach to estimate potential prey and collected feces at monospecific roosting site to identify prey taken by Sanderlings. A random sampling was selected due to the small sampled area and the homogeneous characteristics of the beach. Three sampling units of three cores each were taken at the mid point between high and low tides, i.e., 4 h before high tide, at a time when birds were consistently feeding. A corer (inner area = 78.5 cm^2) was used to take samples to a depth of 20 cm. This depth includes prey available for small-sized wader species (Masero *et al.* 1999). Sediments were sieved through a 500 μm mesh and preserved in buffered 10% sea-water solution of formaldehyde. In laboratory, specimens were transferred to a 70% ethanol solution. All macrofauna samples were sorted in the laboratory using a dissecting microscope. We watched Sanderlings feeding very close to us (~ 50 m) and we could identify that they were preying on bivalve siphons. To assess the importance of this predation we collected all the bivalves we found (n = 85) from a 250 m^2 intertidal section which were preserved in 10% formalin for latter inspection of their siphons.

Feces samples (n = 29) were taken at a high tide roosting site and preserved frozen

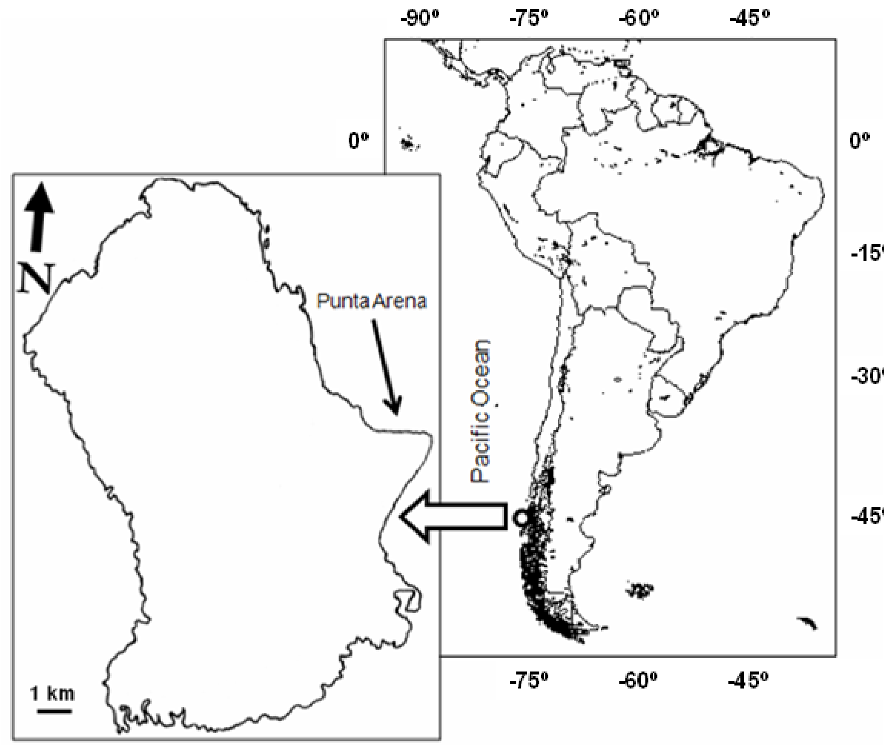

FIG. 1. Map of Isla Guamblin National Park in the Chilean fjords. The arrow indicates the portion of the beach where Sanderlings fed.

for later identification of non-digested parts under a binocular microscope.

We compared mean lengths of siphons of intact and predated bivalves through a Student t-test using Statistica version 6.0 (Statsoft 2001).

RESULTS

We made altogether 720 min of observations. Sanderlings fed in a compact group on the intertidal section of the beach, about 50 m wide. They fed running along tide line, running ahead of incoming waves to the high tide line, and then following receding waves. In this cycle, Sanderlings fed by pecking when feeding at the high tide line and by probing when feeding in the surf zone.

Three invertebrates were identified in the intertidal flat: sand crab (*Emerita analoga)*, surf clam (*Mesodesma donacium*), and amphipods (*Orchestoidea tuberculata)*. Table 1 shows prey density and body size information of these species. After digestion, these three species leave remains that can be later identified. Although the amphipod *Orchestoidea tuberculata* was the most abundant prey, Sanderlings fed on them in very low frequency (Tables 1, 2). Analyses of non-digested parts from feces showed that the coleopteran *Phalerisida maculata* was an important prey item (Table 2). Mollusk remains were found in less than 25% of feces (Table 2).

We found that 44.71% of the 85 surf clams collected had either one or both

TABLE 1: Mean size and density of invertebrates found in the macroinvertebrates intertidal sampling carried out in Isla Guamblin National Park.

Taxa	Size (mm)	Density (ind./m^2)
Mollusca		
Surf clam *Mesodesma donacium*	12.87 ± 2.92	83.33 ± 33.33
Crustacea		
Sand crab *Emerita analoga*	30.90 ± 12.25	88.88 ± 38.49
Amphipoda		
Orchestoidea tuberculata	3.05 ± 0.37	304.76 ± 231.81

TABLE 2: Occurrence (%) of prey remains in feces collected (n = 29) of Sanderlings in Isla Guamblin National Park, Chilean Fjords.

Taxa	Recognized parts	Occurrence (%)
Mollusca		
Bivalves	Shell fragment	24%
Insecta		
Coleoptera *Phalerisida maculata*	Mandibles, head, legs, elytra	67.85%
Amphipoda	Exoskeleton	7.14%

siphons eaten by Sanderlings. The length of surf clams without siphons was significantly longer than siphon length of non-predated clams (Student t-test; $t_{82} = 3.12$, $P = 0.003$). Sanderlings preyed on surf clams above 2 cm length (Fig. 2).

DISCUSSION

Sanderling preyed mainly on the coleopteran *Phalerisida maculata* and surf clam siphons in Guamblin Island National Park. Amphipods, however, were the most abundant prey in the intertidal zone. Therefore, we can conclude that amphipods were not a favoured prey for Sanderlings, but we are uncertain whether coleopteran or surf clam siphons were preferred. The most abundant remains in feces corresponded to coleopteran, but siphons do not leave remains in feces. Many studies on diet selection are based on the results derived from feces analyses (Rosenberg & Cooper 1990). Nonetheless, studies of diet based on feces analysis have to assume that all potential prey species leave identifiable parts after digestion (Rosenberg & Cooper 1990, Dekinga & Piersma 1993). Problems arise if, for example, worms and bivalve siphon ingestion are confused in the field. Feces analysis alone may lead to erroneous conclusions given the fact that only worms leave remains in feces and the researcher may infer from the feces analysis that all the feeding observations revealed worms while some parts were clam siphons (Moreira 1996). In this case, feces analysis alone is not a suitable method to infer the diet selection of a bird.

An instance of the latter could have happened in the study by Hernandez & Bala (2005) on the Atlantic coast of southern Argentina. They found that Sanderlings did not prey on bivalves although the latter were the most abundant invertebrates in the feeding zone. The study was based on feces and

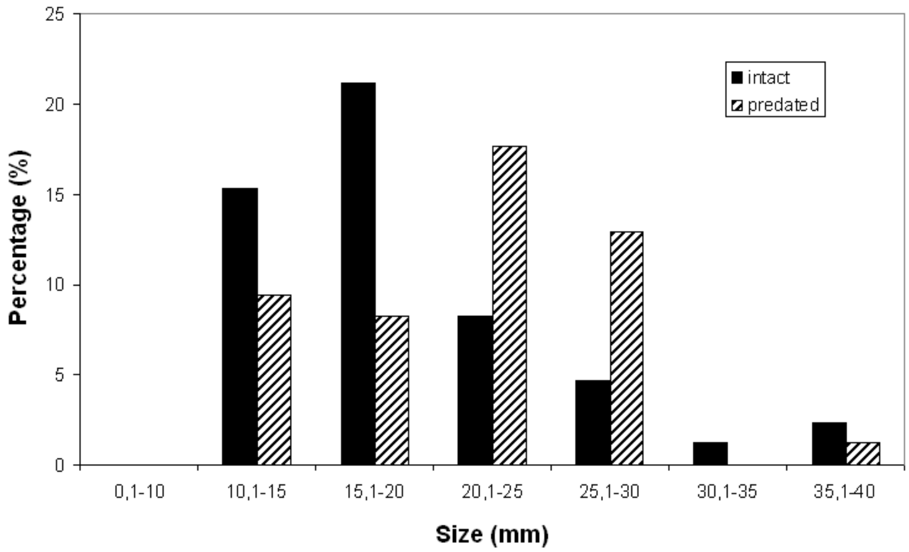

FIG. 2. Size class percentage of intact and predated surf clams from a bivalve sample (n = 85) collected in the feeding zone of Sanderlings in Isla Guamblin National Park.

the authors made no behavioural observations or inspections of bivalve siphons. Sanderlings could have preyed on bivalve siphons, but whether this was the fact remained undetected by the feces analysis alone.

For small-sized waders, we suggest collecting bivalves for inspection of their siphons combined with observations and feces analysis to assure the identity of prey items.

Waders (but not including Sanderlings) have been reported feeding on bivalve siphons in the Tagus estuary in Portugal (Moreira 1996, 1997). In this study, Sanderlings took siphons of bivalves larger than 2 cm long. Foraging theory predicts that an individual should select prey to maximize energy ingestion per unit time (Stephens & Krebs 1986) and, consequently, the profitability of a prey item can be defined as the biomass ingested per second of handling (Zwarts & Wanink 1993). We did not measure handling time in our study but our observations suggest that siphons of surf clams larger than 2 cm long give enough energy per second of handling while smaller clams may be less profitable for Sanderlings.

We did not find the beetle *Phalerisida maculata* in our invertebrate sampling, probably because this species is found buried in the uppermost beach levels during the day (Jaramillo *et al.* 2000). We recommend including this additional beach level in future studies on the diet selection of wintering Sanderlings or other waders. We think that Sanderlings preyed on the beetle when feeding by pecking in the uppermost zone of the beach and on bivalve siphons mainly when feeding by probing.

Predation on bivalve siphons has important negative effects on bivalve condition and survival (Bonsdorff *et al.* 1995). Surf clams are extracted by shellfishers in Chile and have an important economic value in some regions (www.sernapesca.cl), thus sub-lethal predation by waders would have siginificant consequences not only on bivalves populations and on energy fluxes across the ecosystem but also on the regional economy.

Isla Guamblin National Park is expected to be used by Sanderlings regularly, as non-breeding Sanderlings are strongly philopatric to their wintering sites (Castro *et al.* 1992, Macwhirter *et al.* 2002). There are other unexplored beaches in the Chilean fjords that could maintain wintering waders, but no study has been done on the use of Chilean fjords by long-distance migrants, such as waders. As stated in the introduction, Sanderling is endangered in the Western Hemisphere mainly due to several threat factors (habitat loss, human disturbance, pollution) during the non-breeding season (Brown *et al.* 2001, USSP 2004). We ask for more studies on the southernmost species' range which could help us to understand future population movements in view of a global climate change scenario.

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