

## Trace elements concentrations in Buff-breasted Sandpiper sampled in Lagoa do Peixe National Park, Southern Brazil

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### Abstract

Cadmium, cobalt, chromium, copper, manganese, nickel, zinc and lead concentrations were detected in feathers of Buff-breasted Sandpipers (*Calidris subruficollis*) captured during the non-breeding season and analyzed with relationship to body mass. Of these metals tested for, only copper levels (2.28 µg/g) were positively correlated with bird body mass. Zinc levels showed higher concentration (67.97 µg/g) than the other metals, and cadmium levels showed the lowest concentration (0.14 µg/g). Trace element concentrations were below toxicity levels for all tested chemicals and we suggest that this probably reflects that essential elements are maintained there by normal homeostatic mechanism and that no excessive environmental exposure to these elements during migration or on the wintering area is suggested by these results.

**Keywords:** Charadriiformes, contaminants, body mass, wintering area, shorebirds.

### Concentração de elementos-traço em maçarico-acanelado amostrados no Parque Nacional da Lagoa do Peixe, Sul do Brasil

#### Resumo

As concentrações de cádmio, cobalto, cromo, cobre, manganês, níquel, zinco e chumbo foram detectadas em penas de Maçarico-acanelado (*Calidris subruficollis*) capturados durante o período de invernada e analisados em relação a massa corporal. Destes metais analisados, somente os níveis de cobre (2,28 µg/g) foram correlacionados positivamente com a massa corporal dos indivíduos. Níveis de zinco apresentaram-se mais altos (67,97 µg/g) que outros metais e os níveis de cádmio apresentaram as menores concentrações (0,14 µg/g). As concentrações dos elementos-traços estão abaixo dos níveis de toxicidade em todos os testes químicos e sugerimos que isto provavelmente ocorre pela manutenção dos elementos essenciais através do mecanismo normal de homeostase e não reflete a exposição destes elementos durante a migração ou nas áreas de invernada.

**Palavras-chave:** Charadriiformes, contaminação, massa corporal, área de invernada, aves costeiras.

#### 1. Introduction

Habitats selected by shorebirds along their migration routes are diverse and vary in quality with relation to species eating requirements, availability and productivity of food resources, and foraging tactics), as well as risk of predation while on the site (Lunardi et al., 2012). During the migration, birds are more susceptible to contamination, given that they are exposed to different environments along the flyway (Hargreaves et al., 2010; Torres-Dowdall et al., 2010). They can be contaminated through direct contact with heavy metals (Warnock and

Takekawa, 1996; Lanctot et al., 2002), or by the consumption of contaminated prey (Burger et al., 2001; Kim and Koo, 2008). High level contamination by trace metal elements may negatively affect the reproduction and the general health of some birds (Dauwe et al., 2004), as well as may cause death of individuals (Bull et al., 1983). In this way, anthropogenic factors, such as chemicals and pollutants, can contribute to causing continental level declines of migrant shorebird populations (Zöckler et al., 2003).

Buff-breasted Sandpiper (*Calidris subruficollis*), (Vieillot, 1819) has continued a population decline which began with commercial hunting in the last century, and has continued that decline in the present century due to habitat loss and to contamination from spilled oil, gas and other toxic agents (Lanctot et al., 2010; Andres et al., 2012; Cosewic, 2012; Lounsberry et al., 2013) leading to the species being currently classified as “Near Threatened Status” (Birdlife International, 2014). The species migrate from their breeding grounds in Alaska and Canada to winter in the pampas of South America (Lanctot et al., 2002; Norling et al., 2012), at places such as Lagoa do Peixe National Park (LPNP) and surrounding sites (Resende and Leeuwenberg, 1987; Scherer and Petry, 2012; Harrison et al., 2013). The LPNP is an important reserve because protects one of South America’s most outstanding refuges for long-distance migrants (WHSRN, 2014). One of the main reasons that high concentrations of shorebirds use the lagoon is presumably the availability of food resources and sites for replacement, where individuals can gain weight to complete the migration process between hemispheres.

Feathers are useful for measuring levels of trace elements in birds without causing harm to the individual (Furness and Greenwood, 1993). This makes it possible to use them for studies correlating trace elements with individual body mass (Burger et al., 1993; Lucia et al., 2012). The goal of this study was to determine trace element levels of six metals in Buff-breasted Sandpiper and attempt to correlate them with birds body mass.

## 2. Material and Methods

Shorebird catches were conducted in pasturelands in the Lagoa do Peixe National Park (LPNP) (31° 15' 19" S, 050° 58' 19" W) in spring 2011. In the field, Buff-breasted Sandpipers were weighed; a blood sample collected, and one primary and a few breast feathers were collected from each bird and stored in sealed plastic bags. We analyzed cadmium, cobalt, chromium, copper, manganese, nickel, zinc, and lead according methods used by Barbieri et al. (2010). All element concentrations ( $\mu\text{g/g}$ ) in feathers were expressed as dry weight basis. Genomic DNA was extracted from red blood cells using the standard

phenol/chloroform and proteinase K extraction followed by ethanol precipitation (Sambrook et al., 2001). Thereafter, the gene CHD1 (chromo-helicase-DNA-binding 1) was amplified by polymerase chain reaction (PCR), using primers P2 and P8 (Griffiths et al., 1998) to identify sex of each bird. A Pearson correlation test was performed to analyse element correlations with weight. The significance level was set at  $p < 0.05$  for analyse.

## 3. Results

We analyzed feathers of 29 Buff-breasted Sandpiper, being 7 males, 17 females and, 5 undetermined. Concentration levels of trace elements tested for in feathers were below toxicity levels for all individuals and average values are presented in Table 1. Nickel and chromium concentrations were below the detection level for all samples. Pearson correlation tests showed that copper was positively correlated with Buff-breasted Sandpiper body mass ( $r = 0.375$ ,  $p = 0.045$ ).

## 4. Discussion

All trace element levels found in this study were below the toxic range reported in the literature (Vermeer and Castilla, 1991; Puls, 1994; Burger et al., 2001; Barbieri et al., 2007; Kim and Oh, 2013). Essential elements are present in all living organisms and necessary for regulation of body functions and are usually maintained by homeostasis mechanisms, which act in the removal of excess and maintenance of normal bodily concentrations (Kim and Oh, 2013). Therefore, low levels of these components result from a good intrinsic regulatory system, and it is suggested that this process can regulate chromium, cobalt, copper, manganese, nickel, and zinc. Significant copper levels correlation with body mass may reflect that these shorebirds, when compared with other birds, may use more energy by keeping higher metabolic rates (Colwell, 2010) and ingest higher prey mass. Thus, copper level being correlated with body mass may have arisen from bioaccumulation via species-specific metabolism and it is thought to be unlikely reflect pollution or higher natural background level of copper in their habitats (Kim et al., 1996).

**Table 1.** Values of trace elements concentrations (mean  $\pm$  SD,  $\mu\text{g/g}$ ) in feathers of Buff-breasted Sandpiper (n = 29) and other bird species.

Cd	Co	Cu	Mn	Pb	Zn	Species	Source
0.15 $\pm$ 0.10	3.31 $\pm$ 1.10	2.29 $\pm$ 0.95	3.72 $\pm$ 4.19	2.18 $\pm$ 0.63	67.97 $\pm$ 8.45	<i>C. subruficollis</i>	Present study
0.072	4.49	13.30	11.36	7.54	68.97	<i>Larus dominicaus</i>	Barbieri et al. (2010)
0.09	-	-	1.10	1.25	-	<i>Haematopus bachmani</i>	Burger et al. (2008)
0.07	-	14.93	-	2.79	207.97	<i>Limosa limosa</i>	Roodbergen et al. (2008)
0.70	-	-	2.96	2.26	-	<i>Calidris pusilla</i>	Burger et al. (1993)

Levels of non-essential elements such as cadmium and lead were found in individuals. According to Scherer et al. (unpublished data), cadmium levels found in sediment of LPNP were about 0.02 µg/g. Therefore we cannot say with certainty where this exposure occurred, but what we can say, is that in our study, the individuals all evidenced low cadmium concentrations and that their exposure does not reflect levels of bioaccumulation during wintering in the park, suggesting that the levels found in individuals are not sufficient to cause damage to them. According to Burger et al. (2001), for terns, the toxicity levels must be above 2 µg/g before sublethal effects are noted, and the individuals in our study showed concentrations far below this (0.15 µg/g). Another hand, according to Clark and Scheuhammer (2003), lead concentrations between 2.0 and 10.0 µg/g are associated with exposure to lead pollution. Although low lead concentrations were found in our study (2.18 µg/g), this level is indicative of exposure of these individuals to this metal, but without toxicological risk, and thus it could be considered as the background level (Kim and Oh, 2013). Our study is the first to evaluate trace elements in Buff-breasted Sandpiper in LPNP and contributes valuable information because we showed that metallic trace element levels found in the birds captured in park are below the range of considered toxic, and do not show excessive bioaccumulation, thus retaining normal traces element levels. Further studies in regularly used shorebird wintering areas will be important to determine the degree of heavy metal contamination on a timescale, as well as whether some of these sites might interfere in birds' health and population stability. Performing studies like this can serve as an important tool for monitoring wintering areas, serving as a conservation tool for both habitats and for species that use them.

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