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Ecological and biological determinants of trace elements accumulation in liver and kidney of *Pontoporia blainvillei*

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Abstract

The present work tested whether ecological and biological variables have an influence on the assimilation of trace elements by the tissues of a cetacean from the Western South Atlantic Ocean. No significant differences were observed in the concentrations for both sexes. As individuals from the two sampling areas belong to distinct genetic and morphological populations, animals of similar body length were older on the southeastern than on the southern coast. The liver showed the highest concentrations of mercury, whereas the highest levels of cadmium were found in the kidney. Hepatic mercury, cadmium and selenium in individuals from the south coast were about four times as high as those from the southeast coast. However, arsenic in the liver and kidney were similar in both coastal areas. Hepatic mercury, cadmium and selenium concentrations increased with body length in individuals from the southeastern coast, although no significant correlations ($P > 0.05$) were observed between body length from either area and the renal and hepatic As concentrations. A significant positive linear relationship was observed between molar concentrations of Hg and Se in the liver of all individuals from both areas ($r^2 = 0.93$; $P < 0.001$), presenting Se:Hg ratios close to 4. Differences found among the concentrations of Hg, Cd and Se in dolphins from both areas were probably due to the preferred prey, bioavailability of elements in each marine environment, and environment variables (water temperature, net primary production). As a consequence, concentrations of trace elements in the tissues of this species can be considered to be a result of the surrounding environment.

Keywords: Mercury; Cadmium; Arsenic; Selenium; Franciscana; Latitudinal gradient; South Atlantic

1. Introduction

Marine mammals are very sensitive to environmental changes and have been considered good bioindicators of environmental contamination (Capelli et al.,

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2000). These organisms have high potential for accumulating some trace elements, such as mercury (Hg), selenium (Se), arsenic (As) and cadmium (Cd), since they have relatively long life spans, and generally occupy a high trophic level in the marine food chain (Caurant et al., 1994; Kubota et al., 2001; Kunito et al., 2004). The analysis of tissues from different species of whales and dolphins has been used as a tool for the assessment of marine pollution by trace elements (Leonzio et al., 1992; Caurant et al., 1994; Hobson et al., 2004).

Trophic transfer of trace elements along marine food chains has been recognized as an important process influencing metal and metalloid bioaccumulation and geochemical cycling (Fisher and Reinfelder, 1995). It has been shown that the food chain is the major pathway for selenium, arsenic, cadmium and mercury bioaccumulation in aquatic animals (Shibata et al., 1992; Bustamante et al., 1998; Kubota et al., 2001).

Selenium and arsenic are recognized as micronutrients for animals, acting in the activities of enzymes (Shibata et al., 1992). Conversely, cadmium and mercury are exogenous and harmful elements, which accumulate during growth (Feroci et al., 2005). Some experiments have investigated the reduction in bioavailability of some trace elements, such as arsenic, mercury and cadmium, by selenium (Sasakura and Suzuki, 1998; Feroci et al., 2005). Selenium and arsenic can affect the physiological role of other elements as well as some metabolic pathways, inducing other effects on aquatic organisms (Shibata et al., 1992).

It has also been reported that the liver of aquatic organisms may act as an organ for demethylation and/or the sequestration of both organic and inorganic forms of mercury (Wagemann et al., 2000; Endo et al., 2002; Kehrig et al., 2006a), and that selenium is involved in both of these mechanisms (Palmisano et al., 1995; Caurant et al., 1996; Ikemoto et al., 2004).

It is known that not only the longer life of cetaceans is responsible for the mechanism of metal bioaccumulation, but also a number of physiological factors such as the diet of cetaceans seem to be responsible for enhancing this process (Monaci et al., 1998). Marine mammals assimilate contaminants mainly by ingestion, which may vary according to the species consumed. Squids are the main source of cadmium for cetaceans as they are naturally rich in this metal (Bustamante et al., 1998). Fish prey is generally the main source of selenium and mercury, including methylmercury, for cetaceans, whereas it is known that crustaceans are an important source of arsenic for them (Kubota et al., 2001; Monteiro-Neto et al., 2003).

These mechanisms are better studied and understood in marine mammals from the Northern Hemisphere (Leonzio et al., 1992; Caurant et al., 1994; Dietz et al., 1996; Wagemann et al., 1996; Capelli et al., 2000; Anan et al., 2002; Szefer et al., 2002; Watanabe et al., 2002; Roditi-Elasar et al., 2003). However, it is also essential to understand these patterns for species from the Southern Hemisphere, where studies are limited (*e.g.* Kemper et al., 1994; Marcovecchio et al., 1994; Junin et al., 1998; Gerpe et al., 2002; Lailson-Brito et al., 2002a,b; Bustamante et al., 2003; Monteiro-Neto et al., 2003; Kunito et al., 2004; Kehrig et al., 2004).

Pontoporia blainvillei (Gervais and D' Orbigny, 1844) is a small coastal cetacean endemic to the Western South Atlantic, distributed from the Gulf San Matias (42°10′S), Península Valdés, Argentina (Crespo et al., 1998) up to Itaúnas (18°25′S), southeastern Brazil (Siciliano, 1994). This dolphin is at the upper level of the marine food chain and inhabits mainly shallow waters (up to around 30 m or a little further) (Secchi et al., 2003b), therefore it is particularly vulnerable to anthropogenic activities, specially fisheries (Secchi et al., 2003a). It has a restricted home range and feeds mainly on teleost fish (up to 10 cm) and cephalopods (Di Beneditto and Ramos, 2001; Danilewicz et al., 2002).

Genetic studies have identified at least two different populations of franciscanas, one of smaller individuals *ca.* 18°–27°S and another of larger organisms *ca.* 28°–42°S (Secchi et al., 1998; Ott, 2002; Lázaro et al., 2004). In the southeastern coast individuals attain sexual maturity between 2 and 3 years old, and between 115 cm (male) and 130 cm (female) in length (Di Beneditto and Ramos, 2001), while in the southern area sexual maturity is reached at about 3.5 years of age and at a much larger size for both sexes (Danilewicz, 2003; Danilewicz et al., 2004).

The present study aimed at answering the following question: do different environmental conditions and biological characteristics influence the assimilation of trace elements by the liver and kidney of cetaceans? Thus the hypothesis tested here is that for *P. blainvillei*, different environmental conditions (tropical and sub-tropical waters) and biological characteristics (sex, age and population) lead to different accumulations of trace elements in their organs.

2. Materials and methods

2.1. Samples

Liver and kidney samples of 31 individuals of franciscana incidentally caught in fishing nets were freeze