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Heavy metal and arsenic content in seabirds affected by the Prestige oil spill on the Galician coast (NW Spain)

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Abstract

Seabirds are top consumers in marine foodchains which offer opportunities to detect and assess the toxicological effects of different inorganic elements on the marine ecosystem. In order to provide baseline data concerning trace element levels in seabird species from NW Spain, zinc, copper, arsenic, chromium, lead, cadmium and mercury concentrations were analyzed in liver of three different seabird species (common guillemot, Atlantic puffin and razorbill) affected by the Prestige oil spill in September 2002 on the Galician coast. In general, with the exception of mercury, levels of all the analyzed elements were similar or lower in comparison with those reported for the same species in other Atlantic areas, and did not exceed levels indicative of increased environmental exposure.

Keywords: Metal; Prestige; Seabird; Liver; Zinc; Copper; Arsenic; Chromium; Lead; Cadmium; Mercury; Galicia

1. Introduction

Among all the potentially toxic substances which can affect the oceanic fauna, inorganic elements are of particular interest, constituting a potential hazard to marine species (Hernández et al., 1999). Metals are commonly found in the environment all around the world, their presence being due to natural occurrence or as a result of anthropogenic activities (Fan, 1996), although human-related inputs are in general more relevant than natural sources in their biogeochemical cycles (ICES ACME Report, 2001). Some of them are essential elements, required to support biological activities, although there are also nonessential metals, with unknown biological functions, like Pb, Cd and Hg (Pérez-López et al., 2003). In all cases, these inorganic elements are known to be toxic in high concentrations (Thompson, 1990), they can hamper the reproductive output or even cause death (Sanpera

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et al., 2000), and in this sense metals constitute a serious threat to the survival of wild bird species (Hernández et al., 1999).

Monitoring the presence of environmental persistent pollutants effectively requires the use of bioindicators, i.e., organisms that accumulate contaminants even at trace levels so as to allow the detection of levels significantly above background earlier than would be possible from abiotic samples (Spahn and Sherry, 1999). As top predators and consumers in the marine foodchains, seabirds accumulate environmental contaminants that can be measured easily in eggs, feathers or internal organs, offering opportunities to detect and assess the biological effects of changes in physical and chemical parameters of the marine ecosystem (Diamond and Devlin, 2003). Consequently, seabirds have been used in Ecotoxicology as monitors of ocean pollution by a great variety of xenobiotics, like heavy metals (Burger, 1993), demonstrating both significant temporal and geographical trends (Stewart et al., 1997). Seabirds have thus been recognized as integrators over space and time for contaminant levels in the marine environment (González-Solís et al., 2002). It must be considered that the levels of trace elements may vary widely among different seabird species depending on the bird's feeding ecology, intensity and timing of exposure in foraging areas, as well as their physiology and biochemical characteristics (Savinov et al., 2003). When developing biomonitoring programs, the use of seabird species in Ecotoxicology studies is of great interest, as they are widely distributed species, and possess a high position in the food chain. The detailed knowledge of general seabird ecology, number and productivity of many populations makes them particularly appropriate as a choice of biomonitors (Savinov et al., 2003).

Some environmental studies have demonstrated that contaminant levels in seabirds have lower coefficients of variation than in fish or marine mammals, and the confidence interval obtained from those analyses is as small as that obtained from a larger sample of fish or mammals (Gilbertson et al., 1987). Accumulation of metals in oceanic seabirds has been increasingly studied during the last years, due to the elevated concentrations of some essential as well as nonessential toxic elements (Kim et al., 1998), as the result of biomagnification of xenobiotics up the food chain. As those inorganic substances bioaccumulate over time, they can be directly related to harmful effects on bird populations (Thompson et al., 1992), which are at risk from both lethal and sublethal effects, and their body burdens increase (Gochfeld, 1997). However, sampling of oceanic seabirds in the wild can be very complicated and poses serious ethical problems, especially with rare, endangered or threatened species, which cannot be collected easily (Burger and Gochfeld, 1997). This fact leads to most studies being conducted with seabirds that have died rather than with fresh material, or by using nonsacrificial sampling by means of renewable tissues, like feathers, blood or guano (Spahn and Sherry, 1999).

The coastal area of Galicia (NW Spain) is of great ecological interest because it is a highly productive ecosystem, which constitutes a main area for reproduction, migration and wintering of over 40 different seabird species (including alcids, cormorants and gulls), some of them relictic and situated on the southern area of distribution in Europe (SEO/Birdlife, 2003). Nevertheless, during the last decades this area has been increasingly inhabited, and in many cases human activity has seriously affected natural resources and ecological status (Pérez-López et al., 2003). Due to this situation, in recent years all seabird populations (with the exception of gulls) have suffered a dramatic decline, and in this sense, very limited data indicating heavy metal content in seabirds from these geographical area have been observed.

With these considerations, the main objective of the present study was to clarify the specific accumulation of some heavy metals in liver of three different seabird species, evaluating the concentrations of both essential and toxic elements among these avian species, and evaluating the use of such samples to biomonitorize the general status of this ecosystem. Biological samples were obtained by using all the animals that died as a result of the dramatic oil spill caused by the Prestige in September 2002, offering the possibility of analyzing a great amount of samples which is not normally possible to obtain.

2. Materials and methods

Metal concentration was determined in seabirds belonging to three different species: Common Guillemot (*Uria aalge*), Atlantic Puffin (*Fratercula arctica*)