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Debris recorded in ice free areas of an Antarctic Specially Managed Area (ASMA): Admiralty Bay, King George Island, Antarctic Peninsula

Lixo registrado em áreas livres de gelo em uma Área Antártica Especialmente Gerenciada (AAEG): Baía do Almirantado, ilha Rei George, Península Antártica

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Abstract

The Protocol on Environmental Protection to the Antarctic Treaty, or Madri Protocol - 1991, was created with the objective of preventing the contamination of the Antarctic environment and to guarantee the preservation of its natural resources. From the past to the presented time the Antarctic is considered a special area for conservation because it has exclusive environmental characteristics. Admiralty Bay, located on King George Island (South Shetland), is an Antarctic Specially Managed Area (ASMA) and, at the moment, there are five international stations located there. Since the beginning of its human occupation in 1819, with the arrival of the first sailors a lot of environmental changes can be register. This paper makes the first register of debris in this area, based on studies carried out during the summers of 2002/2003, 2003/2004 and 2004/2005. In total, 186 items were recorded as debris. In our study the majority of the debris was composed of wood (49%), followed by synthetic materials: metal (18%), plastic (16%), miscellaneous (16%) and cement (1%). However, what we can observe is that most of the recorded debris for Admiralty Bay comes from research activities (38%), resulting from remaining construction debris of research support; or equally, abandoned experiments, whose structures were not removed.

Key words: South Shetland Island, Admiralty Bay, waste, pollution, environmental impact.

Resumo

O Protocolo sobre Proteção Ambiental do Tratado Antártico, ou Protocolo de Madri, foi criado com o objetivo de prevenir a contaminação do meio ambiente antártico e garantir a preservação dos seus recursos naturais. Desde o passado e ainda no presente, a Antártica é considerada uma área especial para a conservação devido às suas características ambientais únicas. A Baía do Almirantado, localizada na ilha Rei George (Shetland do Sul), é uma Área Antártica Especialmente Gerenciada (AAEG) e, até o presente, tem cinco estações científicas internacionais localizadas na região. Desde o início da ocupação

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humana em 1819, com a chegada dos primeiros caçadores de baleias, muitas alterações ambientais vêm sendo registradas. Este artigo faz o primeiro registro do lixo encontrado nesta área, baseado em estudos desenvolvidos durante os verões de 2002/2003, 2003/2004 e 2004/2005. No total, 186 itens foram registrados como lixo encontrado na área. A maioria do lixo encontrado foi composta por madeira (49%), seguida por materiais sintéticos: metal (18%), plástico (16%), material variado (16%) e cimento (1%). Foi constatado que a maior parte do lixo registrado em nosso estudo na Baía do Almirantado resulta de atividades científicas, sendo composto de restos de construções para suporte à pesquisa e também oriundos de experimentos científicos abandonados, nos quais a estrutura não foi removida após o fim do experimento.

Palavras-chave: ilhas Shetland do Sul, Baía do Almirantado, lixo, poluição, impacto ambiental.

Introduction

The Antarctic Continent is considered a special area for conservation because it has exclusive environmental characteristics; consequently, the worry with debris generated by the human presence has increasing importance (Torres and Jorguera, 1995), especially the consequences of contamination and other dangers to the wildlife (Walker *et al.*, 1997). Impacts have been observed since the beginning of the exploration of the continent, for example, through the release of waste from ships, from whaling activities or the establishment of research stations.

The Madrid Protocol 1991 (Protocol on Environmental Protection to the Antarctic Treaty), was created with the objective of preventing the contamination of the Antarctic environment and to guarantee the preservation of its natural resources. According to the Madrid Protocol all signatory members are obliged to clean-up contaminated sites, but only if remediation measures do not create additional impacts. It involves quantification of impacts already present, so that monitoring can be undertaken to ensure that additional impacts are not created and remediation goals have been achieved (Stark *et al.*, 2006).

Aside from the visual pollution generated by debris, there is a great worry about the dangers it can represent to marine mammals and birds by the way of its ingestion and/or entanglement (Fowler, 1987; Ryan and Jackson, 1987; Robards *et al.*, 1995). A considerable number of studies show increasing evidence of impact on Antarctic and sub-Antarctic seals and seabirds (Bonner and McCann, 1982; van Franeker and Bell, 1988; Croxall *et al.*, 1990; Arnould and Croxall, 1995; Huin and Croxall, 1996; Petry and Fonseca, 2002; Auman *et al.*, 2004).

Admiralty Bay, located on King George Island (South Shetland), is an Antarctic Specially Managed Area (ASMA) and, at the moment, there are five stations located there (Figure 1). The permanent stations are the Polish "Henryk Arctowski" and the Brazilian "Comandante Ferraz"; while, the seasonal stations are American, Ecuadorian (hut), and Peruvian (Rakusa-Suszczewski and Krzyszowska, 1991). The Polish station receives frequent visits from tourists interested in learning how it functions and who are curious to see the area and its ecosystems (Donachie, 1993). The same, but in smaller proportions, happens in the Brazilian station. The area of Admiralty Bay on King George Island started suffering considerable modifications since the beginning of its human occupation in 1819, with the arrival of the first sailors.

The present study was carried out during the summers of 2002/2003, 2003/2004 and 2004/2005 in Admiralty Bay. We visited all ice-free areas to register and collect the debris, with the objective of characterizing and identifying them.

Materials and methods

The coast of Admiralty Bay goes from Demay Point to Harnasia Hill, totalizing

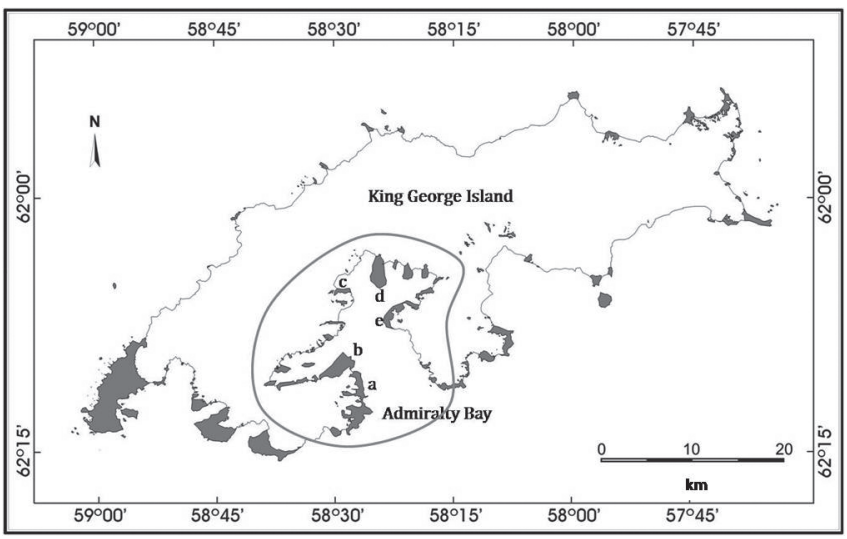

Figure 1. Admiralty Bay location and its scientific stations: American (a), Polish (b), Peruvian (c), Brazilian (d), and Ecuadorian (e). The dark gray color represents the ice-free areas.

91 km of extension (Jablonski, 1986). About 30.4 km^2 constitute the ice-free areas (Figure 1).

During the summers of 2002/2003 (November and December), 2003/2004 and 2004/2005, all ice-free areas in Admiralty Bay were visited and debris (only of anthropogenic origin) was identified together with its location (with a GPS). All information was recorded in a specific spread sheet. The material considered waste was photographed and classified according to (i) composition (type of material): wood, metal, plastic, cement or miscellaneous items; and (ii) source (origin): old expeditions, recent scientific experiments, abandoned construction debris (fixed constructions in the soil, like the ones located near the Brazilian Station in the Keller Peninsula, old Base G) and unknown. The material classified as unknown did not have an identified origin. To establish the difference between recent and old material, the decomposition degree was considered, being the old ones more affected than the recent ones as a result of a longer exposition.

Results

In total, 186 items were recorded as debris. Of the total, 54% were registered in the 2004/2005 austral summer; about 29% in 2002/2003; and 17% in the austral summer of 2003/2004. Most of the materials were physically modified by being exposed to the environment.

The percentage of the debris recorded according to its composition can be seen in Figure 2 and the percentage of debris according to its origin, in Figure 3. The wood, proceeding specially from old expeditions and abandoned construction debris, represents the majority of debris recorded (49%). In Miscellaneous items we included, for example, some cigarette stumps that were located near the scientific stations. In accordance with the origin of the debris, 38% (Figure 3) of the records were classified as proceeding from the old expeditions. Some of these structures were abandoned by countries that practiced whale hunting.

Discussion and conclusions

In our study the majority of debris recorded was composed of wood (49%), followed by synthetic materials: metal (18%), plastic (16%), miscellaneous (16%) and cement (1%). In other studies about debris and marine debris, including reports from the South Atlantic/Southern Ocean, the majority of items found during the survey was plastic (Ryan and Watkins, 1988; Torres and Jorguera, 1995; Walker *et al.*, 1997). Probably in these regions the great occurrence of fishing ships that discard nets and other synthetic materials is responsible for the difference in the data. In these studies, especially Torres and Jorguera (1995), data collectors did not consider wood, because although strange to the environment, it is not a synthetic material.

In Cape Shirreff, Livingston Island, 92% of the total debris was constituted of plastic, 3.5% of metal, 3.4% of glass and 1.1% of paper (Torres and Jorguera, 1995). Analyzing only synthetic materials for Admiralty Bay we got the following percentages: metal (50%), plastic (23%), miscellaneous (23%) and cement (4%).

One of the biggest concerns of the researchers in the Antarctic Continent relates to the damages that can be caused by tourists in the region (Bonner, 1990; Jonhston and Madunic, 1995). However, what we can observe is that most of the recorded debris for Admiralty Bay come from research activities, resulting from remaining construction debris utilized as research support; or of abandoned experiments, whose structures were not removed (Figure 3). This is the most worrying result about the origin of the debris. Human activity is one the greatest

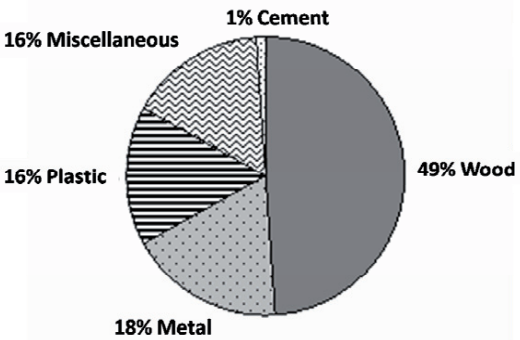

Figure 2. Percentage of the five collected groups of debris in Admiralty Bay, King George Island, Antarctica.

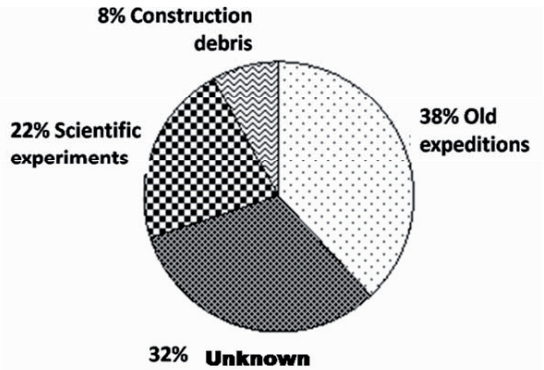

Figure 3. Percentage of the four origin classes of debris recorded in Admiralty Bay, King George Island, Antarctica.

causes for the changes in nature. Even in areas visited by trained and conscientious people, debris is present. Even having constant monitoring in the areas with scientific stations, most of the recent material was recorded in their surroundings. The greatest accumulation of debris originating from the sea occurs in the entrance of the Bay. These materials are characteristically composed of old items, such as wood from old boats used in whale hunting.

Aside from the visual pollution generated by the debris, there is a major concern about the dangers it represent to marine mammals and birds by the way of its ingestion and/or entanglement (Fowler, 1987; Ryan and Jackson, 1987; Robards *et al.*, 1995). A considerable number of studies show increasing evidence of impact on Antarctic and sub-Antarctic seals and seabirds (Bonner and McCann, 1982; van Franeker and Bell, 1988; Croxall *et al.*, 1990; Arnould and Croxall, 1995; Huin and Croxall, 1996; Petry and Fonseca, 2002; Auman *et al.*, 2004).

Monitoring the accumulation of debris on beaches is likely to provide the only realistic indicator of the amount and type of debris present in the marine environment of the Southern Ocean, because measuring the amount of man-made debris at sea is not practicable (Waker *et al.*, 1997). Other pieces of information that can be obtained through the monitoring of the beaches in Antarctic regions where sea deposition does not occur are the agreement of the origin of recorded debris and a real evaluation of the measures of pollution prevention in this region.

The most evident impact regarding the local fauna is the accidents that can involve the marine mammals and other organisms, such as the birds. Ropes and nets, for example, can trap the animal's body and cause damages to their health, even causing death. There is also the danger related to the ingestion of the debris when they are in the sea, because debris could be mistaken for its preys. When an animal ingests debris, there is an energy expense for the capture with no energy returning to the organism and, moreover, many of these objects could be deposited in their stomach or gastric cavity occupying a considerable space disturbing the digestion and the absorption of the alimentary resources. There are also some registers that have been done in the use of synthetic staple fibre used by the birds in their nests; and in the use by mammals of remaining portions of cloth, nets and plastic bags as an isolating substratum during the rest (Torres and Jorguera,1995). In some nests, during the analyzed periods, we could observe the use of wood, bamboo and cloth. In these cases it was not possible to analyze the advantages for the birds that make use of these materials in relation to other natural materials.

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