An unusual mortality of humpback whales in 2010 on the central-northern Rio de Janeiro coast, Brazil

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Introduction

We present data on an unusual peak in recorded mortalities of humpback whales (*Megaptera novaeangliae*) on the central-northern coast of Rio de Janeiro, south-eastern Brazil, during the breeding season of 2010. It is known that humpback whales use the ocean area off the south-eastern Brazilian coast, the so-called Campos Basin, during their migratory pathway between the feeding areas in the Antarctic Ocean and the reproductive ground in the Abrolhos Bank (around 18°S) (Siciliano, 1997; Zerbini *et al*., 2006; Andriolo *et al*., 2010). During the migration period, strandings of humpback whales are expected to occur. Such events have called the attention of several research groups since the early 1980's (*e.g*., Pinedo, 1985, Pizzorno *et al*. 1998, Pretto *et al*. 2009). An increase in beach monitoring along the Brazilian coast in recent years has yielded a large amount of new information on strandings. Furthermore, the general public, which have got increasingly interested in marine mammals, specially the charismatic humpback whales, have also been a source of information on this matter. The establishment of new research groups and the implementation of stranding networks have contributed to a relatively efficient coverage of strandings in Brazil in the last decade.

During 2010, an unusual number of humpback whale strandings along the coast of Brazil has called the general attention of the public, media and researchers. We decided to further investigate the reasons of such humpback whale strandings. Although there was an apparent increase in humpback strandings in 2010 elsewhere in Brazil, in this article we concentrated our analysis on dead, beach-cast humpback strandings on the coast of Rio de Janeiro. Bacteriological analyses were conducted on two live stranded humpback whales as an additional tool for inferring the probable cause of death. The results are of biological importance and since there is no background information on bacteria related to humpback whales in Brazil, It is recommended that they should be interpreted with caution. We believe that they can throw some light on humpback whale population biology and its relation to environmental conditions.

Methods

The "Grupo de Estudos de Mamíferos Marinhos da Região dos Lagos" (GEMM-Lagos; the Lagos Region Study Group on Marine Mammals) regularly patrols beaches in search of strandings along *ca*. 250 km of the central-northern Rio de Janeiro State coast between latitudes 21°18'S and 23°S approximately. Since 1999, the GEMM-Lagos maintains a regional reporting network and a database of marine mammal strandings which includes information on both live-stranded and dead, beach-cast cetaceans. Records of dead, beach-cast humpback whales from 1999 to 2010 were extracted from the GEMM-Lagos stranding database. The data included stranding date, location, gender, total body length and possible cause of death. Stranding response included a post-mortem examination and scientific sampling on a regular basis. Fresh specimens can provide evidence of interaction with fishing activity and other possible anthropogenic causes of death (*e.g.* net entrapment and boat collision).

In contrast, carcasses in an advanced state of decomposition are hard to manipulate, and in this situation researchers are prone to make only superficial observations on possible causes of death. In the study area, the humpback stranding season is coincident with the arrival of cold fronts and rough seas, and in many cases a necropsy was just impossible to be conducted due to the risks of manipulating a rolling beach-cast specimen in the breaking waves. Field procedures in most cases included the collection of samples of skin, muscle, blubber, barnacles and whale lice. Samples were frozen or preserved in alcohol. Swabs were collected for bacteriological analysis and their results used for inference on the possible *causa mortis*. For comparative purposes, we include in this article the bacteriological results concerning a humpback whale live-stranded on the coast of Rio Grande do Sul (29°40'S), southern Brazil, in August 2010.

Statistical analyses were carried out with the software R 2.13.0 (R Development Core Team, 2011); significance level was alpha = 0.05. Statistical tests concerning year and month were performed by means of approximate chi-square tests with the function *chisq.test* of the R software; in these tests, P-values were computed by a Monte Carlo procedure (Hope, 1968). The length distribution was compared among years by using the function *kruskal_test* (a permutation test) of the *coin* package of the R software (Hothorn et al., 2008). The length distribution calculated by pooling data from all years was compared to a uniform distribution by means of the function *ks.test* (one-sample Kolmogorov-Smirnov test) of the R software; exact P-values were computed (Marsaglia *et al*., 2003). To produce the figure showing the distribution of lengths, the lengths were truncated to integer values, *e.g*. a length of 5.7 m was included in the class 5 m; however, all statistical tests concerning length were carried out with the actual values.

Results.

Stranding data

There were a total of 41 recorded humpback dead, beach-cast strandings between 1999 and 2010 on the central-northern coast of Rio de Janeiro State. The distribution of the annual number of strandings among the years was significantly different from a discrete uniform one (Figure 1; approximate chi-square test, $P < 0.0001$, $N = 41$). The same analysis, when run with data only up to 2009, did not produce a significant result (approximate chi-square test, $P = 0.1972$, $N = 26$). We conclude that there was a higher number of strandings in 2010 than what should be expected on the basis of data from the other years. The distribution of strandings by month was not significantly different among the years (approximate chi-square test, $P = 0.2463$, $N = 41$). Pooling the data from all years, the distribution of strandings by month was significantly different from a discrete uniform one (Figure 2; approximate chi-square test, $P < 0.0001$, $N = 41$). Strandings tended to occur in the second half of the year, mainly around September–October. A total of 30 dead-stranded humpbacks had their body length measured. Body length was in the range of 4.6–16.0 m ($N = 30$; Figure 3). The body length distribution was not significantly different among the years (approximate Kruskal-Wallis test, $P = 0.9264$, $N = 30$). Pooling the data from all years, the distribution of lengths was not significantly different from a uniform one (one-sample Kolmogorov-Smirnov test, $P = 0.0658$, $N = 30$). Of the 30 humpbacks for which body length was available, 66.7% ($N = 20$) had body length up to 11 m, and 86.7% ($N = 26$) had length up to 12 m.

Bacteriological survey
Two live-stranded humpback whales were selected for a bacteriological survey of Vibrionaceae and Aeromonadaceae agents. They resulted in the first attempt to generate data on potential pathogens associated to humpback whales in Brazil. They were: GEMARS 1409 – a 12,7m male stranded during five days on the beach of Capão Novo (29°40'S), Rio Grande do Sul and GEMM 233 – a 12m male stranded during two days on a beach in Armação dos Búzios (22º 54', 43º 12') Rio de Janeiro. Isolated pathogens revealed the presence of *Vibrio fluvialis*, *V. alginolyticus* , *V. mediterranei*, *V. coralliilyticus*, *V. fisheri*, *Aeromonas hydrofila*, *A. caviae*, *A. schubertii* and *A. veronii sobria*. The blowholes were positively infected with *V. alginolyticus*, *V. coralliilyticus* and *Aeromonas hydrophyla* and *A. veronii sobria* (Table 1).

Discussion

Strandings of humpback whales along the central-northern coast of Rio de Janeiro are highly seasonal, observed during austral winter and spring, coinciding with the migration period (Siciliano, 1997; Pizzorno *et al*. 1998). As shown here, strandings peak in September and October evidencing the use of Campos Basin as part of a large breeding ground. There was possibly a shift in habitat use of Campos Basin by humpback whales in the last two decades. Siciliano (1997) has previously indicated Campos basin as a migratory corridor for humpbacks whales. As their numbers have increased (Andriolo *et al*., 2010), it is possible that humpback whales occupy seasonally the north coast of Rio de Janeiro as a secondary breeding ground, whereas Abrolhos, farther north off the southern coast of Bahia State (around 18°S), is a primary ground.

The majority of stranding records correspond to immature specimens, *i.e*., 66.7% (N = 20) had body length up to 11 m, and 86.7% (N = 26) had length up to 12 m. Recently, Santos *et al*. (2010) reported a total of 15 strandings of humpback whales on the coast of São Paulo between 1984 and 2009. In accordance to the results presented here, most records (80%) were of immature specimens. High levels of mortality of newborns and juveniles are expected in any mammal population, mainly due to predation, illness and loss of the mother, and also due to anthropogenic causes like fishing activities, ship collision, contaminants, debris and others. Baleen whales depend on their fat supply to conduct their long journey to breeding grounds. Failing to have a satisfactory amount of energy intake during the summer feeding season will certainly contribute negatively during their migration cycle.

During our study, only a few carcasses could be carefully investigated after the stranding. As pointed out before, there are considerable risks to researchers and technicians while manipulating a rolling carcass in the breaking waves. In addition, most carcasses strand in an advanced decomposition state. For these reasons, the opportunity for conducting a necropsy should be considered uncommon. Consequently, only incomplete evidence on the causes of death is usually available. Because of all these conditions, only one carcass investigated in 2010 had clear signs of entanglement in fishing gear. Deep cuts from a fishing net cable were visible around the head and peduncle of this whale.

Bacteriological results of the blowholes samples collected from specimen GEMM 233 raise signs of a possible unknown pathology, suggesting either malnutrition or an advanced infectious disease. Another stranded humpback whale on the southern Brazilian coast, specimen GEMARS 1409, which was extensively surveyed for bacteriological agents also revealed the presence of several potentially pathogenic agents. *Vibrio alginolyticus* has been isolated in sick and dead cetaceans, such as the Atlantic white-sided dolphin (*Lagenorhynchus acutus*), Atlantic bottlenose dolphin (*Tursiops truncatus*) and the beluga whale (*Delphinapterus leucas*) (Schroeder *et al*. 1997, Higgins, 2000). In addition, *V. vulnificus* and *V. cincinnatiensis* have been previously isolated from a humpback whale stranded in Rio de Janeiro in August, 2000 (Pereira *et al*. 2007), although this same specimen was not positive for *Aeromonas* and *Plesiomonas shigelloides* (Pereira *et al.* 2008).

Evidence has shown that certain microorganisms are involved in diseases of marine mammals that occur as a normal microbiota and transient in wild populations of healthy mammals. Circumstances that lead from the transition to the state of sickness or stranding involvement are

less clear (Reynolds and Odell, 1991. In conclusion, the results provided by the bacteriological survey on two specimens may lead us to believe that those humpback whales were sick or suffering from malnutrition since the beginning of their migration period. Our interpretation of such unusual event should be linked up to the complex dynamics of humpback whale population biology and its relation to environmental conditions.

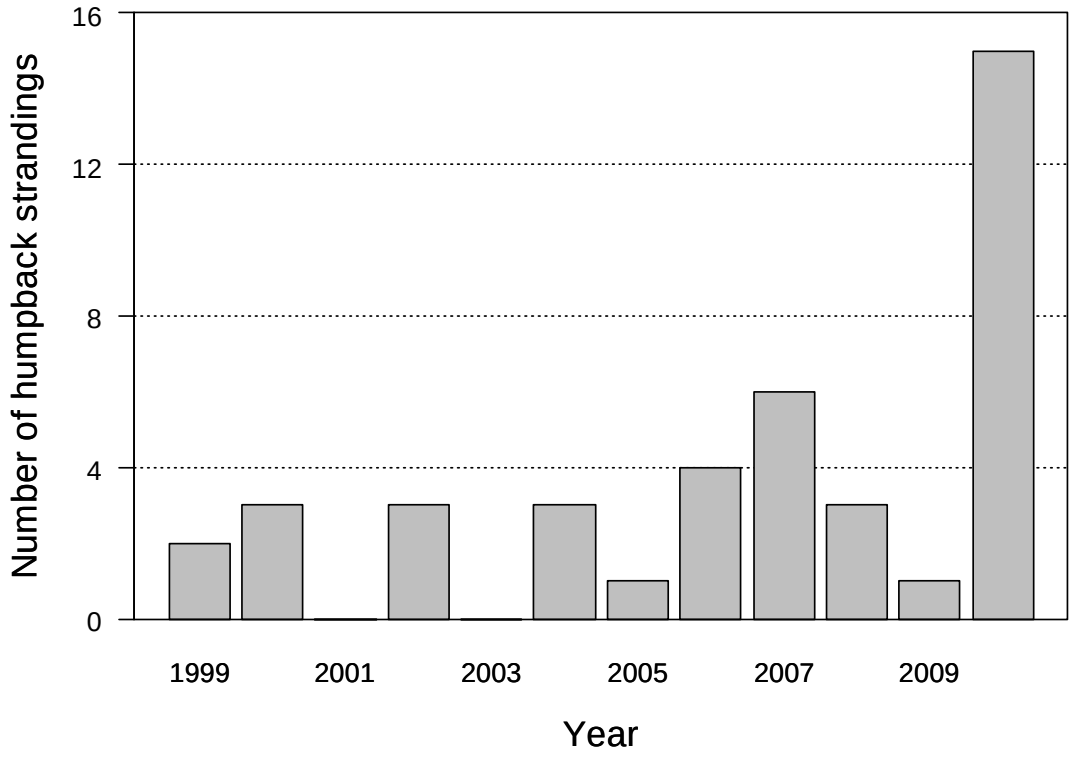

Fig. 1. Humpback strandings by year on the central-north coast of Rio de Janeiro State, Brazil, 1999-2010, by length class, 1999–2010, 1999–2010 (N = 41).

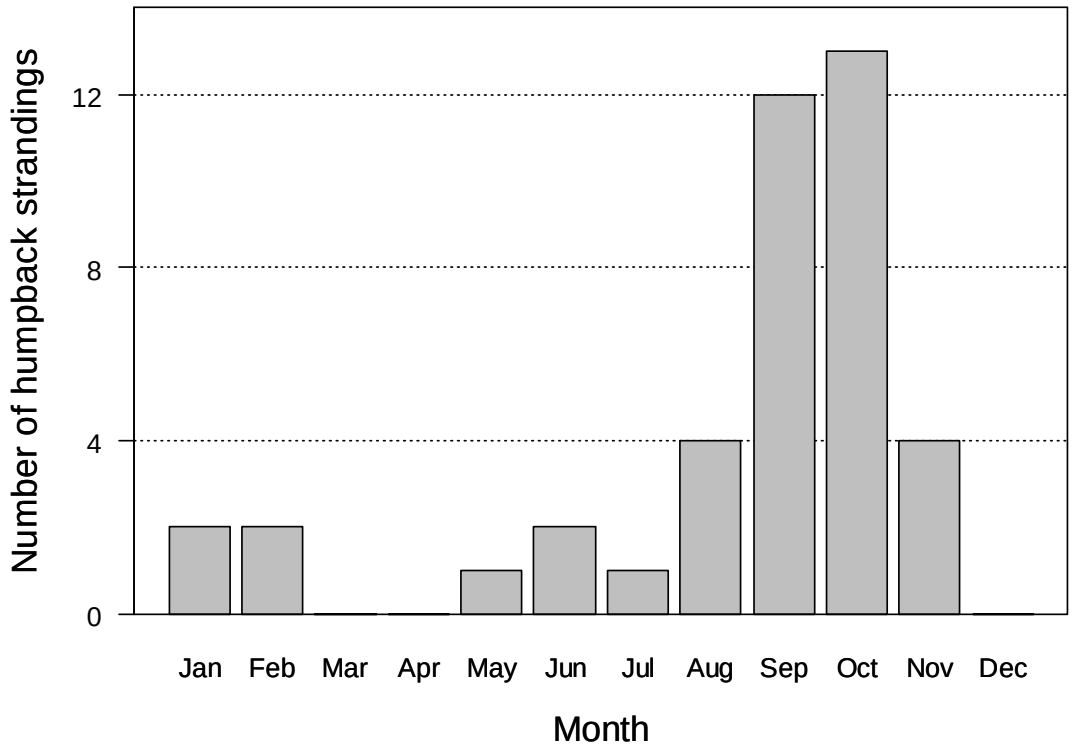

Fig. 2. Humpback strandings by month on the central-north coast of Rio de Janeiro State, Brazil, 1999-2010, by length class, 1999–2010, 1999–2010 (N = 41).

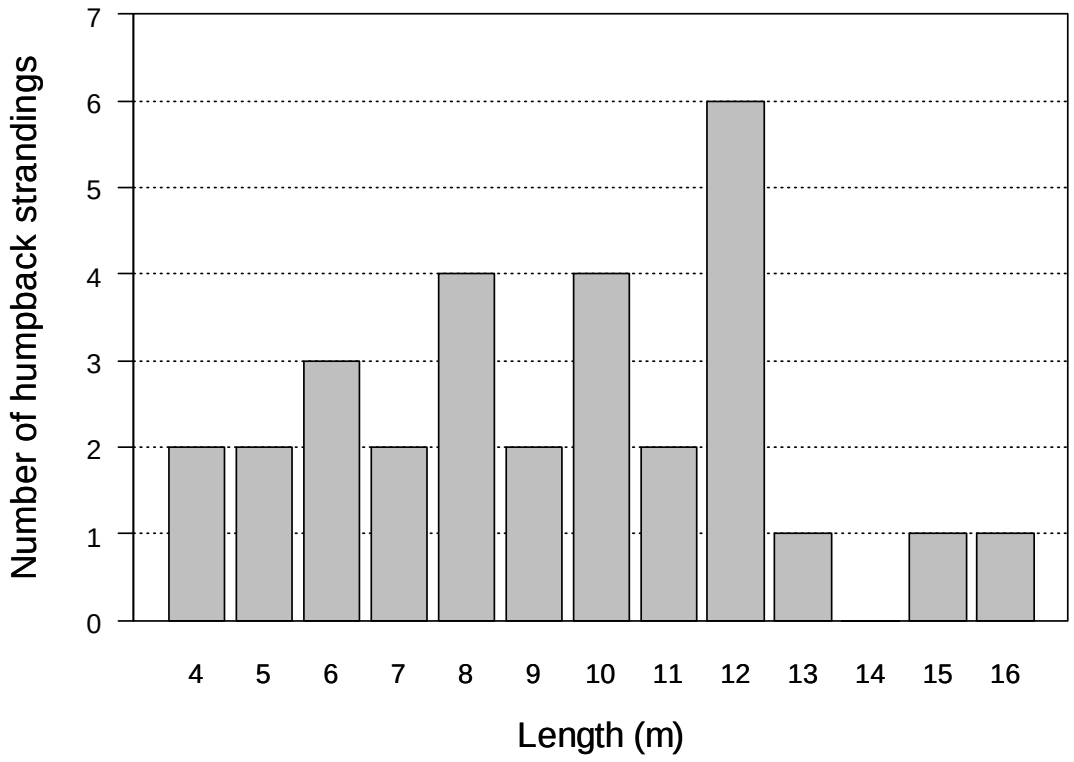

Fig. 3. Humpback strandings on the central-north coast of Rio de Janeiro State, Brazil, 1999-2010, by length class, 1999–2010 (N = 30).

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