NICHE OVERLAP OF SPHENISCIDAE ON ELEPHANT ISLAND, ANTARCTICA

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Abstract: Stomach content samples were collected from Gentoo Penguin and Chinstrap Penguin in order to analyze the diet and the niche overlap on Elephant Island, Antarctica. A total of 56 Gentoo Penguin samples and 71 Chinstrap Penguin samples were collected, during the two austral breeding seasons, 2010/11 and 2011/12, on the Stinker Point region. *E. superba* was the most abundant prey, (69% FO and 98% FO) for Gentoo and Chinstrap Penguin, respectively. Nine species of fish and one species of cephalopod, were identified by specific level. We observed a niche overlap of species, by the use of the same food resources, since these species occurs sympatrically in the same region. This study also demonstrated that the specific variation of trophic niches occupied by the species may be defined by the foraging behavior and by the selection of the food resources.

Keywords: Chinstrap Penguin, Ecological Niche, Elephant Island, Gentoo Penguin

Introduction

The Antarctic breeding seabirds have been considered bioindicators of ecosystems variability in the region. Individuals of Spheniscidae are considered one of the sentinel species for the study of environmental changes, composing about 90% of the total seabird's biomass for the area. Gentoo Penguin *Pygoscelis papua* and Chinstrap Penguin *Pygoscelis antarcticus* breed on the Antarctic Islands and Peninsula (Croxall *et al.*, 2002). They have as their primary resource the Antarctic krill (*Euphausia superba*) and share their breeding sites.

Some authors suggest that the seabird populations suffer fluctuations due to decrease of offspring. This reduction study indicates in response to low availability of food instead of adult mortality by predation or hunting (Reid & Croxall, 2001; Trivelpiece *et al.*, 2011). According to Croxall (1984), all species of penguins are the main consumers of marine resources, particularly the Antarctic krill. Thus, many studies have been made about predator-prey interaction, where the Antarctic krill is the prey of greater importance

(Hinke *et al.*, 2007; Miller *et al.*, 2010; Lynch *et al.*, 2012). Antarctic krill is considered a fundamental key in the Antarctic ecosystem and serves as main part in the transfer of energy through the trophic web (Nicol, 2006; Miller & Trivelpiece, 2007). In this way, there is a particular interest in the study of the interrelation of krill with predators, since their populations have declined in recent years, due to loss of sea ice (Siegel *et al.*, 2002). The diet and foraging ecology of species determine their location within a trophic network and define its role. Therefore, the aim of this study is to investigate the feeding preference and assess the trophic niche overlap of *P. papua* and *P. antarcticus*, which reproduce sympatrically in the Stinker Point region on Elephant Island.

Materials and Methods

The field work was carried out on Stinker Point region, Elephant Island (61°13'20.5"S 55°21'35"W), during the austral summer 2010/2011 and 2011/2012. The stomach contents were collected from breeding adults following

CCAMLR (2004). Discriminant analysis was used to analyze the differences in the use of food resources among the species. The niche overlap was applied through the EcoSim 7.0 software, using the total biomass of each resource item, varying between 0-1, (0) zero no overlap between species and (1) one, total overlap.

Results

General diet composition

A total of 56 stomach contents samples of Gentoo and 71 samples of Chinstrap were collected on Elephant Island. *E. superba* was the most abundant prey compared with other food items (69% FO for Gentoo and 98% FO for Chinstrap). Besides *E. superba*, were also recorded two more species of krill, *E. chrystallorophias* (8% and 11% FO to Gentoo and Chinstrap, respectively), while *E. frigida* (4% FO), was only registered for Chinstrap Penguin. In addition to crustaceans, 21 cephalopods beaks were identified as *Pareledone turqueti*. Nototheniidae was the most frequent fish family recorded, with six identified species: *Trematomus newnesi* (1,78% FO), *Lepidonotothen nudifrons* (7,14% FO), *Pleuragramma antarctica* (5,36% FO), *Lepidonotothen squamifrons* (3,57% FO), *Notothenia rossi* (8,93% FO) and *Pseudonotothen loennbergii* (1,78% FO), while the family Myctophidae is represented by *Electrona antarctica* (1,78% FO), Harpagiferidae by *Harpagifer antarcticus* (14,28% FO) and the family Channichthyidae, represented by *Champocephalus gunnari* (14,28% FO) found in Gentoo Penguin.

Trophic niche overlap

The Discriminant analyses resulted in 1 function, which explained the 100% of variation of data (Canonical Correlation = 0.631, $p < 0.001$) and is represented by the variables *E. superba* (-0.622), *E. chrystallorophias* (-0.347), *E. frigida* (-0.207), *L. nudifrons* (0.331), *P. antarctica* (0.405) and *H. antarcticus* (0.793) (Figure 1). The frequency distribution of scores resulted from the Discriminant analysis also shows that there is a slight overlap between species, which is corroborated by the niche overlap analysis. The observed overlap index (0.48) was significantly

($p < 0.001$) higher than expected by simulation (0.084), in other words, if the use of items was random, the overlap between species would be close to zero.

Discussion

The diet of the two penguin species studied was based on Antarctic krill *E. superba* (69% Gentoo Penguin and 98% Chinstrap Penguin), as well as in other Islands of South Shetlands Island's Archipelago (Trivelpiece *et al.*, 2003; Miller *et al.* 2010; Polito *et al.*, 2011) and South Orkney (Rombolá *et al.*, 2012). Besides Antarctic krill, the *Pareledone* octopose's genera are endemic and distributed largely on the Antarctic Ocean (Allock & Piertney, 2002). However, there are no records of prey *P. turqueti* in the penguin's diet, probably due to the scarcity of studies and to recent discoveries to the genus *Pareledone*, on the Antarctic region (Allock *et al.*, 2007), causing difficulty in identification. The Nototheniidae species were the prey with greater representativity on the Gentoo Penguin's diet, also can be found in the diet of other seabird species, such as *Phalacrocorax atriceps* (Casaux & Barrera-Oro, 1996; Casaux & Ramon, 2002).

The trophic niche overlap through interspecific competition predicts that a total overlap can lead to unsustainable competition, and as a result, one of the populations might fail (Hardin, 1960). However, the overlap at smaller levels allows the interspecific competition to be softened, so that there is a partition of resources by the species. Specifically, the Gentoo and Chinstrap Penguin share the same habitat for building nests and consume mainly Antarctic krill (Trivelpiece *et al.*, 2003; Miller *et al.*, 2010). According to Miller *et al.* (2010), these features indicate, substantially, that there is an overlap in the ecological niche between these two species. It is therefore expected that there was an overlap of trophic niche of species, as these species occur sympatrically in the same region. Yet, the authors point out that the populations have been governed by environmental changes and, therefore, these species are suffering a distinct trajectory of realized niche (Miller *et al.*, 2010).

Figure 1. Biomass (g) of the most frequent food resources in the diet of penguins on Elephant Island, Antarctica. Discriminant analysis with the average biomass of food items. The resulted centroides were 0.577 and -1.139 to Gentoo and Chinstrap Penguin, respectively. Gentoo correlates positively with the variables *L. nudifrons*, *P. antarctica* and *H. antarcticus* (blue colours), while Chinstrap is positively correlated with *E. superba* and *E. crystallophias* and *E. frigida* (orange colours).

Conclusion

This study demonstrates that the specific variation of trophic niches occupied by the species can be set by the foraging behavior and the selection of food resources of each species. The recommendation of these species as indicators of environmental quality is important, in addition to issues such as local variability, because the trophic niche can change over time as well as the amount and availability of prey can also change.

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