MORPHOMETRIC ANALYSIS OF SHELLS OF *Nacella concinna* PREDATED BY GULL *Larus dominicanus* IN THREE ISLANDS OF THE SOUTH SHETLANDS: KING GEORGE, PENGUIN AND ELEPHANT – ANTARCTICA

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Abstract: The gastropod *Nacella concinna* is common in the littoral zone of the Antarctic Peninsula. This invertebrate has great importance in terms of biomass for the region, being a potential prey for the Kelp gull *Larus dominicanus*. They have a tendency to opportunism, but can select large shells when they are available. This study aims to evaluate *Nacella concinna* shells morphometry and access whether the length, width, height and the apex differ significantly between sampling sites. Shells were collected manually in three islands of the South Shetlands: Elephant, Penguin and King George, at Kelp gull breeding and feeding points. The shells measurements were made with a caliper at the laboratory. Shells morphometric variables were compared between the three islands through discriminant analysis, with the function generated by it, an ANOVA was made. There were significant differences ($p < 0,001$) among the samples measured. All shell measurements were higher for Elephant Island. The variation found in shells among the three islands may have been influenced by differences in environmental conditions.

Keywords: Gastropod, Morphometry, Prey, Discriminant Analysis

Introduction

The mollusk of the class Gastropoda *Nacella concinna* is one of the most common invertebrates found in the coastal zone distribution from South Georgia to the Antarctic Peninsula (Picken, 1980; Davenport, 2001). For the region of the Antarctic Peninsula two morphotypes of this mollusk are recognized: one occurring on the coast and the other in subtidal zone (Aranzamendi *et al.*, 2010). In the South Shetlands, the Kelp Gull *Larus dominicanus* is an important predator of the species in the mesolittoral zone (Shabica, 1976; Favero *et al.*, 1997). About 90% of the bird's diet consists of Antarctic *N. concinna* (Favero *et al.*, 1997; Barbieri, 2008). In the King George Islands, Penguin and Elephant, diverse gastropod shells are found in the feeding and nesting areas of Gull. This study aims to assess whether

the differences between the morphometric variables of *N. concinna* are significant between areas of Antarctica (King George Island, Penguin and Elephant), where the collections were made from the shells predated by *L. dominicanus* and what factors may be contributing to such an occurrence.

Materials and Methods

For the study, shells of *N. concinna* predated by *L. dominicanus* were collected manually on three islands of the South Shetlands: King George, Penguin and Elephant. In each of the islands the sampling focused on the points of nesting and foraging of *L. dominicanus*, between November 2009 to March 2010 and December 2010 to March 2011. The shells collected were measured with a caliper, always

by the same investigator. The variables evaluated in the shells were: length, width, height and apex. The choice of such measures followed four of the variables adopted in the study of Tablado & Gapa (2001). For data normalization measures of variables were log-transformed. Discriminant analysis was performed to study the differences between the samples (shells) of the three study groups. Afterwards an ANOVA was performed with a function generated by discriminant analysis, to see if the variables of each island differ significantly. We admitted the existence of a significant difference when $p < 0.05$. All statistical analyzes in this study were performed with the SPSS software 18.0.

Results

A total of 1.781 shells were measured. From the discriminant analysis two discriminant functions F1 and F2 were obtained that indicated how the variables are correlated. The Wilks' Lambda to the function F1 was 0.488 while for the function 2 was 0.960 both with $p < 0.001$. The eigenvalue of F1 was 0.968 and of F2 was 0.0429. This data indicates that proportionally analyzed the function F1 was able to discriminate the data 22.56 times more than the function F2 (Figure 1). The findings of the factorial ANOVA for the function F1 show a significant difference between the shells of the three islands with a $p < 0.001$. The value of F for the analysis was 584.307 (Figure 2).

Figure 1. Graphical representation of the discriminant analysis performed with the variables measured in the shells of the islands: King George, Penguin and Elephant.

Figure 2. Graphical representation of factorial ANOVA analysis performed for function 1.

Discussion

Significant difference found between the morphometric variables of shells collected on the three islands can be attributed to some biotic and abiotic factors, among them we highlight the ecological conditions of each island as food availability, amount of calcium, temperature, salinity and pH. The existence of these factors in each study area has an influence on the development of *N. concinna* and may be different between the Islands: Elephant, Penguin and King George, which could explain the difference in sizes of shells due to an adaptation to the environment to which they are subjected. Another factor to be considered is the environmental contamination. Although the Antarctic continent is less susceptible to anthropogenic influences,

in the Antarctic Peninsula, the number of activities is increasing, such as scientific research vessel traffic, vehicles and tourism, which demands greater investment in logistics, therefore, the human presence modifies the natural characteristics of the local environment in the South Shetlands.

Some studies highlight the existence of traces of metal such as chromium, manganese, zinc, nickel and vanadium, on sediments at Penguin and King George islands (Guerra *et al.*, 2011; Santos *et al.*, 2005) and concentrations of polycyclic aromatic hydrocarbons (Barroso, 2010). These mollusks suffer more than other organisms from the action of environmental pollutants because they are filter feeders. Another factor to be considered is the availability

of larger shells in places which have higher values for the morphometric variables evaluated. Favero *et al.* (1998) reported in their studies that *L. dominicanus* shows selectivity for large shells when they are available. Although considered generalist, a study analyzing the selectivity of shells of *L. dominicanus* in these three islands can reveal whether this difference can be explained by selection by birds or other factors characteristic of each environment. The analysis of pollutants directly on samples taken from living shells of different sizes in the Gull breeding area would corroborate this study.

Conclusion

We conclude that precisely in the islands with higher anthropogenic activity the Gull predated the smallest shells, and offered them to their chicks. On Elephant Island, where there is less human activity in relation to other islands,

was where the largest shells were preyed upon. The size difference of the shells between the three islands studied was significant.

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