

Sexual Dimorphism in Penguin Bill Length Across Species

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Introduction

Sexual dimorphism, or biological differences between males and females of the same species, is a widespread phenomenon with important implications for ecology, evolution, and biodiversity (Tsuji and Fukami 2020). In birds, variation in bill morphology often reflects ecological specialization, sexual selection, or niche differentiation between sexes (Bolnick and Doebeli 2003, Temeles et al. 2010). Among penguins, bill morphology is a critical functional trait associated with foraging ecology, mate choice, and species recognition, making it a valuable feature for studying dimorphism (Gorman et al. 2014). The palmerpenguins dataset (Horst et al. 2020) provides high-quality, standardized morphometric data for Adelie, Chinstrap, and Gentoo penguins from the Palmer Archipelago. These data allow for direct comparisons of bill length across sexes and species.

This study examines whether bill length consistently differs between males and females, and whether the magnitude of dimorphism varies among closely related species, potentially reflecting species-specific ecological pressures (e.g., diet, habitat). I hypothesized that males would exhibit longer bills than females within each species, with the degree of dimorphism differing by species. Analysis of the palmerpenguins dataset supports this hypothesis: males generally possess longer bills than females, with Chinstrap penguins showing the greatest mean bill length (~51 mm), followed by Gentoo penguins (~49 mm), while Adelie males have much shorter bills on average (~40 mm).

Methods

The palmerpenguins dataset was collected in the Palmer Archipelago (2007–2009) and released in a cleaned, teaching-friendly format (Horst et al., 2020; Gorman et al., 2014). A Two-way ANOVA with linear model was used to compare bill length differences between males and females across species. Data was analyzed in Rstudio using mainly the tidyverse package

Results

Table 1: Mean bill length ($\pm 95\%$ CI) by species and sex

species	sex	n	mean	sd	se	ci95_low	ci95_high
Adelie	female	73	37.26	2.03	0.24	36.78	37.73
Adelie	male	73	40.39	2.28	0.27	39.86	40.92
Chinstrap	female	34	46.57	3.11	0.53	45.49	47.66
Chinstrap	male	34	51.09	1.56	0.27	50.55	51.64
Gentoo	female	58	45.56	2.05	0.27	45.02	46.10
Gentoo	male	61	49.47	2.72	0.35	48.78	50.17

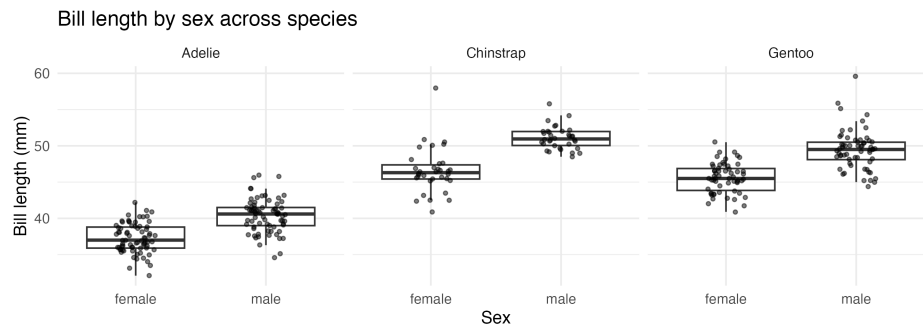


Figure 1: Figure 1. Bill length by sex across Adelle, Chinstrap, and Gentoo penguins. Males generally exhibit longer bills than females, with the greatest differences observed in Chinstrap penguins.

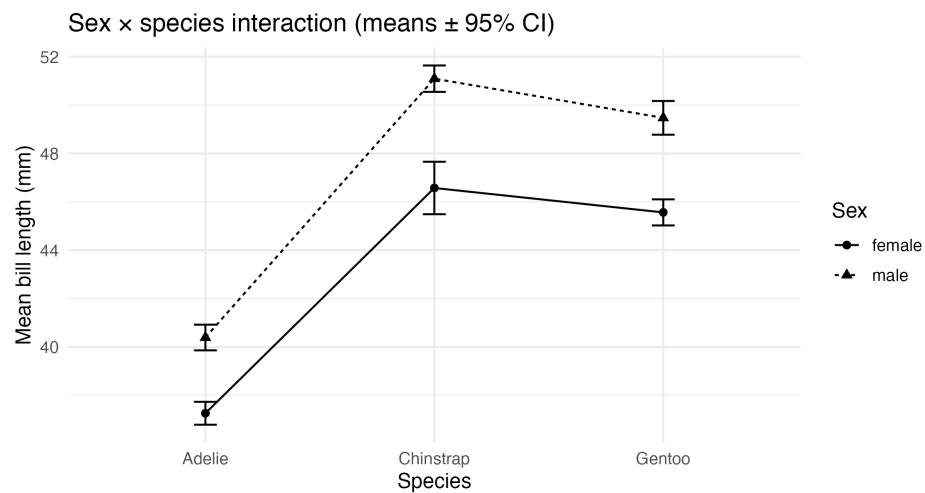


Figure 2: Figure 2. Interaction plot showing mean bill length (\pm 95% CI) by species and sex. The effect of sex on bill length varies among species, with Chinstrap penguins showing the largest difference between males and females

References

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