The Positive Correlation Between Wing Length and Tail Length in Modern Bird Species

Mykal Daniel

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ABSTRACT

Birds have undergone evolutionary changes since their arrival during the Jurassic period. They are characterized by many attributes, but most importantly by their flight abilities. Their bodies have evolved to be the aerodynamic machines they are today, and one might infer these traits are proportional across species because of selection. Using a set of 391 species from the Tyrannidae Family, we tested the correlation between wing length and tail length. The results support the hypothesis that wing length and tail length are positively correlated in bird species as a potential adaptation to improve flight.

INTRODUCTION

There are many questions surrounding the appearance of modern birds on planet Earth. Most fossil records propose birds arose 60 million years ago after the Cretaceous period. However, molecular evidence leads us to believe now that modern birds originated in the Jurassic period (*Modern Birds Existed Before Dinosaur Die-Off*, 2008). Modern birds are believed to have evolved from a theropod dinosaur during this time. Their entire anatomy has spent millions of years evolving into the more than 10,000 species we recognize today (Brusatte et al., 2015). Birds come in a variety of sizes but most all have the same characteristics. These traits include feathers, wings, beaks or bills, egg laying, and an adapted skeleton for flight to keep birds light in weight. Flight ability is an important characteristic of birds, as it is their primary method of transportation. Their body shapes have adapted to reduce air resistance and be appropriately sized in areas for muscle attachment (*Birds*, n.d.) The contrasts of bird flight lie with lift and drag. Together these factors must be in harmony to allow smooth flight. Flight is only possible by their feathers, and the length of their wings will increase to support more feathers (“The Flight of Birds,” 2015). The tails of birds are also overlooked while they are also detrimental to flight. The tail feathers guide, stabilize, switch directions, and balance the birds. The tails can be compared to rudders on a boat or airplane (*Tail-or Made For Flight | Bio-Aerial Locomotion*, n.d.). Birds can survive without their tails; however, they seem to be placed at a greater disadvantage than those with their tails (Writer, n.d.)

Asymmetry of the wings and tails of birds has known to be costly in flight affecting their aerodynamic abilities (Thomas, 1993). The hypothesis could be proposed that wing length and tail length will show a positive correlation because of adaptations to provide symmetrical, successful flight. A way to test this would be measuring the lengths of the wings and tails in species of modern birds and evaluating the correlation between these two traits. The species used in this experiment come from members of the Tyrannidae family. The reason for this specific family is due to the fact they are the known to be the largest family of birds and reside in the two American continents (*Tyrannidae Family – Surcos Tours*, n.d.). With this many species of birds from large geographical areas, we can collect and analyze enough evidence to test the hypothesis that the two phenotypic traits will positively correlate.

METHODS

The data used from this experiment was accessed using the AVONET database on the Figshare repository which contains functional trait data of bird species. The first trait selected was wing length which measured the length from the carpal joint to the tip of the longest primary on the unflattened wing in millimeters. The second trait selected was tail length which measured the distance between the tip of the longest rectrix and the point where the two central rectrices protrude from the skin in millimeters (*AVONET*, n.d.). The 449 species and traits were added to a separate CSV and read into R Studio.

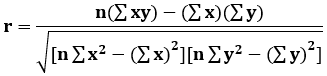
A phylogeny was created using BirdTree’s Phylogeny Subsets tool (*Phylogeny Subsets*, n.d.). Multiple species held different scientific names between each resource and were excluded from this experiment. This allowed for the most accurate matching of species names between the two resources and left us with 391 birds to run our tests on. This data was also read into R Studio, and using this application the two traits were plotted against each other and the phylogeny was included within the phylomorphospace plot. A Pearson’s correlation coefficient also ran testing the statistical relationship between two continuous variables (*Pearson’s Correlation Coefficient*, n.d.).

RESULTS

The wing length and tail length plotted against each other showed a positive slope on the phylomorphospace plot.

Chart

Description automatically generated*Figure 1*. The Wing and Tail Lengths of 391 Bird Species Plotted with their Phylogenetic Tree.

A Pearson’s correlation coefficient was run between the two length variables. This uses the formula, , to test the strength of the correlation (“Pearson Correlation Coefficient,” 2019). The value of our correlation coefficient was r= 0.7352425.

DISCUSSION

For a Pearson’s correlation coefficient, the values received indicate how strong the two variables are positively or negatively correlated. A value of 1 shows a perfect positive correlation, values of 0.9-1 show a very high positive correlation, and 0.7-0.9 show a high positive correlation (*Correlation Coefficients*, n.d.). With our data showing r= 0.7352425, it can be confidently said that these two variables show a high positive correlation. The phylomorphospace plot shows a large clump of the data with a positive slope, which additionally confirms our hypothesis that wing length and tail length will show a positive correlation. It was interesting to look at the outliers above the large group of data. There were about 8 species showing distant ancestral relation to the rest of the birds, as well as tail lengths being long in proportion to wing lengths. This would open questions as to if there are any flight costs to birds with long tails and why it occurs on an evolutionary level. The data also supports the claims known that bird flight is nearly unfeasible without a tail or a tail too short. There were no significant, noticeable outliers below the clump of data like we see above the data of those with longer tails. This shows that there are no bird species in this study that have extremely short tails unsymmetrical to their wing length.

After analyzing the results, the data appears to show a positive correlation between wing lengths and tail lengths in the selected bird species which supports our hypothesis. This study has also found supporting evidence of proportional wing length and tail length being selected for across many modern bird species. These two characteristics have likely been selected to improve flight, and the adaptation is being displayed across many species. This experiment was only evaluating the traits on the phenotypic level which can only support these claims, not confirm them. The study could be improved by using additional bird species. With the addition of other species, we could find if these results hold true across more families of birds. In this study, we assumed that the data provided through AVONET is accurate for each bird species used. Any error in that data could change the results of our correlation test. There are possibilities of this positive correlation occurring for reasons other than improving flight that could also be prevalent.

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