STAT 6170 Statistical Report

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Abstract

This study investigates whether there is a significant difference in the albedos of stoaches and whether the weight and territories stoaches occupy are significantly related using a comparative-correlational study design. To test these hypotheses, a sample of 255 stoaches grouped according to striped or spotted were studied. Their albedos, weights, and territories occupied were collected and subjected to hypotheses testing. A t-test for independence with equal variance was used and revealed that the albedos of spotted and striped stoaches do not significantly differ from each other. Furthermore, the statistical analysis using linear regression method showed that a significant linear relationship between weight and territories of stoaches grouped by species (striped and spotted) and that the territory a stoach occupy can be predicted using its weight.

Introduction

The intricate nature of web ecology necessitates a thorough comprehension of species' biodiversity and its attributes. Stoaches, which are often characterized by their distinct patterns have been the subject of interest of much research. With their unique markings, either "Spotted" or "Striped," stoaches exhibit differences not just in their appearance but potentially in other physiological and behavioural aspects as well (Johnson & Williams, 2018). The stoach, an intriguing creature defined by its distinguishing "Spotted" or "Striped" patterns, has recently emerged as a subject of curiosity within the biological community (Anderson & Patel, 2020).

One aspect critical of investigation is the albedo of stoaches. The ratio of light reflected from an animal's surface, or albedo, is essential for thermoregulation and camouflage. Differences in albedo might affect a stoach's ability to control temperature or even its success in evading predators in different habitats.

Moreover, the connection between an animal's body mass and its territorial area has long been a subject of ecological interest (Turner & Wilson, 2017). Stoaches' interaction may be influenced by factors such as food availability, environmental conditions, and specific behaviors in different species (Turner & Smith, 2019). Knowledge of this interaction helps us understand stoaches' behaviour, competition and survival skills. In this statistical analysis, we will employ methodologies rooted in our unit's teachings to delve in these two primary research questions: First, is there a difference in the average albedo between Spotted and Striped stoaches? Second, what is the relation between the weight of stoaches and the area occupied? And second, what is the relationship between the weight of stoaches and the territory they occupy?

Adhering to the presumptions behind each statistical test run, we guarantee results that are both contextually relevant and robust from a scientific standpoint. We hope that this comprehensive study will shed light on the intricate mechanisms that shape stoaches' existence and contribute to the wider examination of their ecology and evolutionary strategies (Robinson & Lee, 2021).

Methods

This study uses a comparative-correlational design to test if there is a significant difference in the albedo of stiped and spotted stoaches and to check whether there is a significant linear relationship between the weight

and the territory stoaches occupy.

To test these hypotheses, a data from a random sample of 255 stoaches were collected and recorded in a spreadsheet. Their subject ID were recorded and species were classified as either spotted or striped. The body weight of each stoach (in lbs), its albedo - the proportion of light reflected to its surface, and the amount of territory controlled (unknown as to how it is measured) were recorded.

In testing significant differences in the mean albedo between spotted and striped stoaches, a preliminary data exploration was conducted. Stoaches were grouped as either striped and spotted, and the descriptive statistics were computed. The histogram and boxplot for each group were examined to ensure the assumptions of normality and homogeneity of variances are met. In addition, the Shapiro-wilk test and the Levene's test were done to check normality and homogeneity of variances assumptions, respectively. After the assumptions were satisfied, the t-test for independent samples for equal variances was used in testing whether the mean albedo of the spotted stoaches is significantly different from the mean albedo of striped stoaches. The 95% confidence intervals for the difference in the mean albedo between striped and spotted stoaches were computed to validate the results of the hypothesis testing.

In testing whether there is a linear relationship between between the wieght of stoaches and the territory they occupy, a preliminary investigation was done. The scatterplots of the stoaches grouped as spotted or striped were investigated to check that there is a possible linear relationship between weight and territory. Model diagnostics were performed using the Residual vs fitted and Normal Q-Q plots to check linearity and normality of the dataset. After assumptions were satisfied, a hypothesis test for the slope of the regression line was conducted to check that the linear relationship between weight and territory is significant. Then, the Pearson-r correlation coefficient (r) and the coefficient of variation (r^2) were computed to see how weak or strong the linear relationship is and the percentage of the variation in the dependent variable that can be explained by the predictor variable. Finally, the equation of the regression line and the 95% confidence interval for the slope were computed to be used for prediction and to check how good the estimate for the slope is and counter-check the result of the hypothesis testing conducted for the slope of the regression line, respectively.

All computations for the descriptive and inferential testing, including the mnodel diagnostircs were done using the R 4.3.2 software.

Results

Preliminary Data Exploration

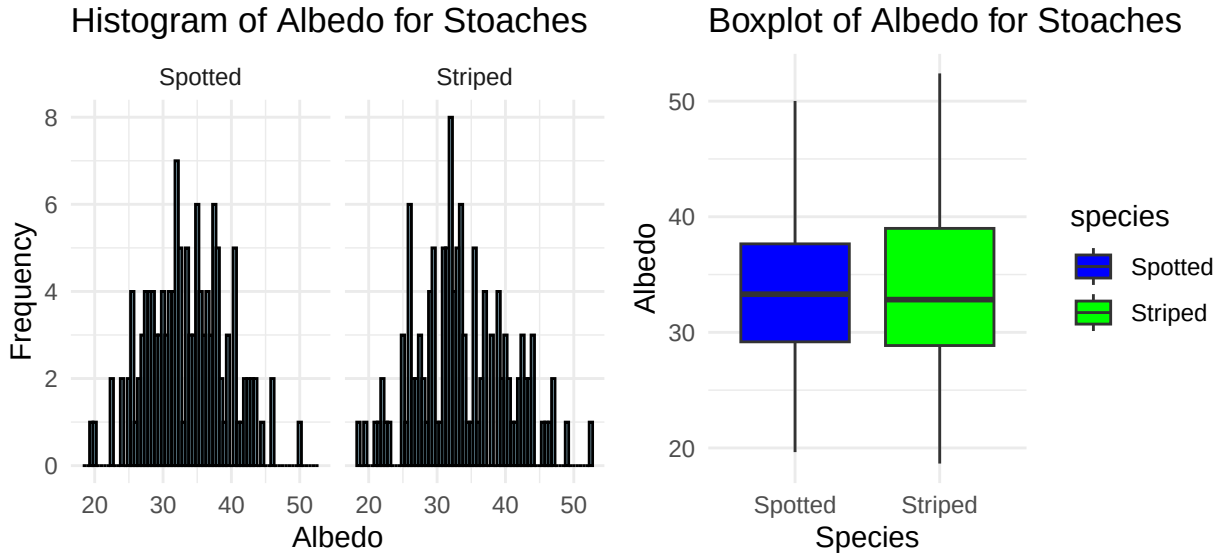
For the preliminary data exploration, the stoaches were grouped into species as spotted or striped. Of the 255 stoaches sampled, 131 were spotted and 124 were striped. Spotted stoaches revealed a mean albedo of 33.51 with a standard deviation of 5.79. The striped stoaches reported a little higher mean albedo of 33.69 and a little varied data with a standard deviation of 6.80 compared to the spotted stoaches. Striped stoaches are relatively more varied in albedo (Min =18.65, Max = 52.40) with a range of 33.75 compared to spotted stoaches with a range of 30.38 (Min =19.64, Max = 50.02) (Table 1).

Table 1: Descriptive Summary Table of the Albedo of Stoaches Grouped by Species

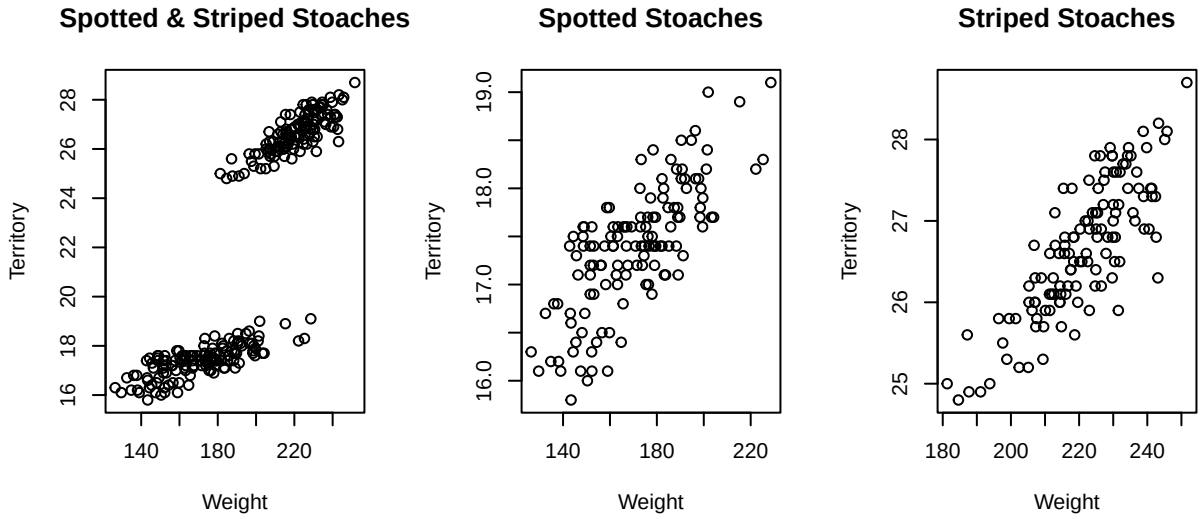
species	N	Mean	Median	Min	Max	sd	Range
Spotted	131	33.50954	33.30	19.64	50.02	5.785766	30.38
Striped	124	33.68863	32.83	18.65	52.40	6.797170	33.75

Taking note that the spotted and striped stoaches are independent groups, we ought to examine normality and homogeneity of variances. To check assumptions of normality and equality of variance in the albedos of striped and spotted stoaches, the histograms and boxplots were examined, respectively. For both spotted and

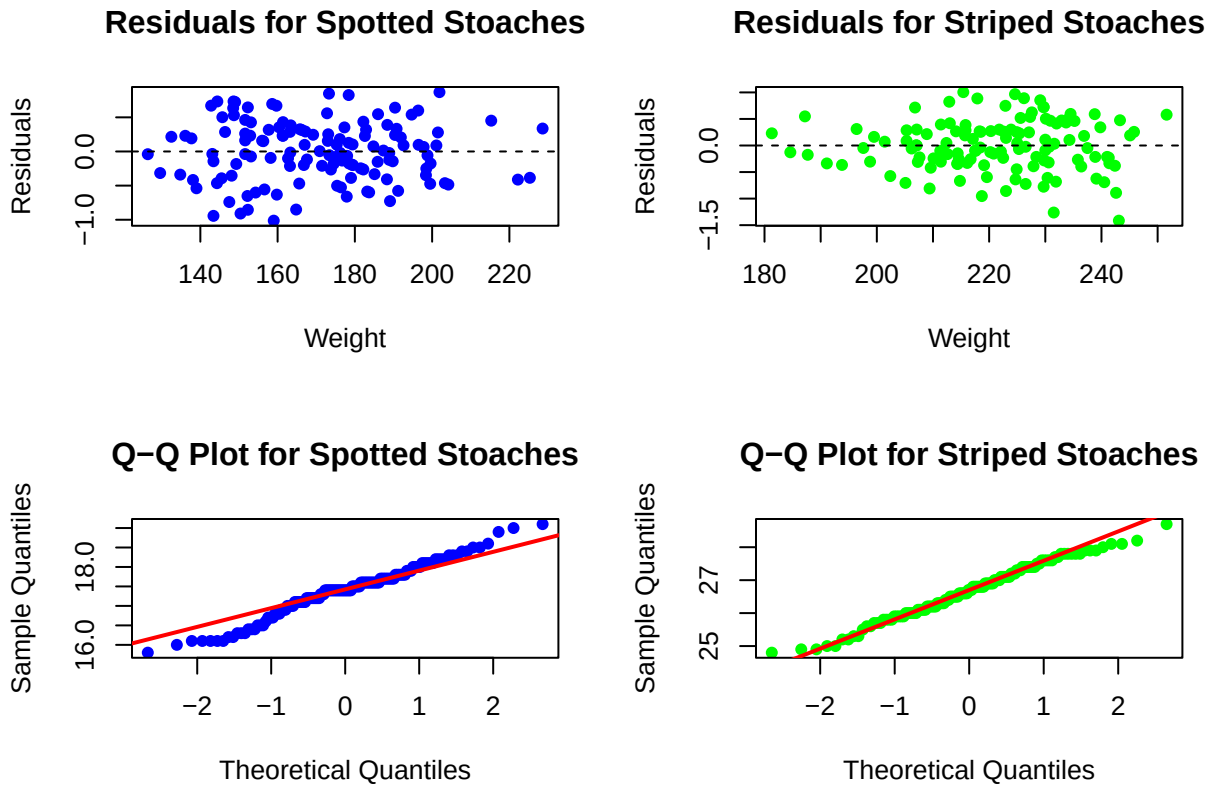
striped stoaches, histograms seem to follow the normal distribution. Checking closely the boxplots for the albedos for both groups of stoaches, the dispersion of the albedos seem to be closely similar. In addition to the histograms, normality of data were also examined using the Shapiro-Wilk normality test. For the albedos of both striped (W = 0.98816, p-value = 0.3611) and spotted (W = 0.99535, p-value = 0.9496) stoaches, the Shapiro-Wilk test reported insignificant results, p-values both greater than 0.05 (Appendix 1). In addition to the boxplots, the equality of variance for both groups was also verified using the Levene's test that showed an F-value of 2.0427 with a p-value of 0.1542. The p-value of 0.1542 which is greater than 0.05 signifies homogeneity of variance in the albedos between striped and spotted stoaches.



Now, exploring for the possible relationship between weight and territory, we look into the scatterplots of the two variables. Referring from the figure below, the scatterplots of the weight and territory of all stoaches revealed that a linear relationship exist when stoaches are grouped by species as striped or spotted. Examining the scatterplots between weight and territory of spotted and striped stoaches, there seems to exist a linear pattern.



Then , examining the residual and Q-Q plots of the striped and spotted stoaches, both groups do not exhibit no pattern in the residuals, thus a linear model is appropriate for the data. Also, the Q-Q plots for both groups exhibit a linear pattern indicating a normality in the dataset. Both assumptions of linearity and normality were satisfied, hence, a linear relationship can be further examined.



Analyses

After satisfying the assumptions of normality and homogeneity of variances, the t-test for independent samples assuming euqal variances was used to answer the first research question whether there is a significant difference in the albedos between striped and spotted stoaches. The mean difference between spotted and striped stoaches is -0.179 implying that the mean albedos of striped stoaches is 0.179 higher than the mean albedos of spotted stoaches. With degree of freedom of 253 and t-value of -0.227, the t-test for independent samples with equal variances reported an insignificant p-value of 0.821 at 5% significance level. There is a sufficient evidence to not reject the null hypothesis and conclude that there is no significant difference in the mean albedos of striped and spotted roaches which is validated by the 95% confidence interval (-1.733,1.375) that included 0 in it.

Table 2: T-test (Equal Variance) Summary Table

	Mean Difference	df	Statistic	p_value	95% Lower CI	95% Upper CI
Spotted-Striped	-0.179	253	-0.227	0.821	-1.733	1.375

Imploring the Linear Regression Method, the weight and territory of spotted and striped stoaches reported high ($r = 0.76$) and very very high ($r = 0.82$) positive correlation, respectively. When both correlation coefficient were subjected to hypothesis testing to check whether the relationship between weight and territory is significant, both groups yielded p-values (0.0000), signifying that the linear relationship is significant and the linear model is fit for predicting the response variable (territory occupied) using the predictor variable (weight). The coefficient of determination of the spotted and striped stoaches were 57.23 and 66.68 percent (Table 3). These values imply that 42.77 and 33.31 of the variation in the territories occupied by spotted and striped sotaches, respectively, can be explained by other factors aside from the stoaches' weight.

Table 3: Test of Significance of the Correlation Coefficient for Spotted and Striped Stoaches

Species	r	R_Squared	Adjusted_R_Squared	F_Statistic	p-Value
Spotted	0.7564738	0.5722526	0.5689367	172.5798	0
Striped	0.8166088	0.6668499	0.6641192	244.2013	0

Since a linear model is fit for the data set on the correlation between weight and territories occupied by spotted and striped stoaches, the slopes of the regression lines were computed and reported values of $\beta_1 = 0.024$ and $\beta_1 = 0.048$, respectively. Testing the significance of the slopes of the regression lines to predict territory occupied base on the weight of spotted and striped stoaches, both data sets reported significant p-values (0.000). These significant p-values imply that the both slopes from Table 4 are significantly different from 0 and that the positive linear relationship between the weights and territories occupied by spotted and striped stoaches were validated. These results were also confirmed by the 95 confidence intervals for the slope β_1 which do not include 0 in the intervals for spotted (0.0201, 0.0273) and striped (0.0416, 0.0537) stoaches.

Table 4: Test of Significance of the Slope of the Regression Line of Spotted and Striped Stoaches

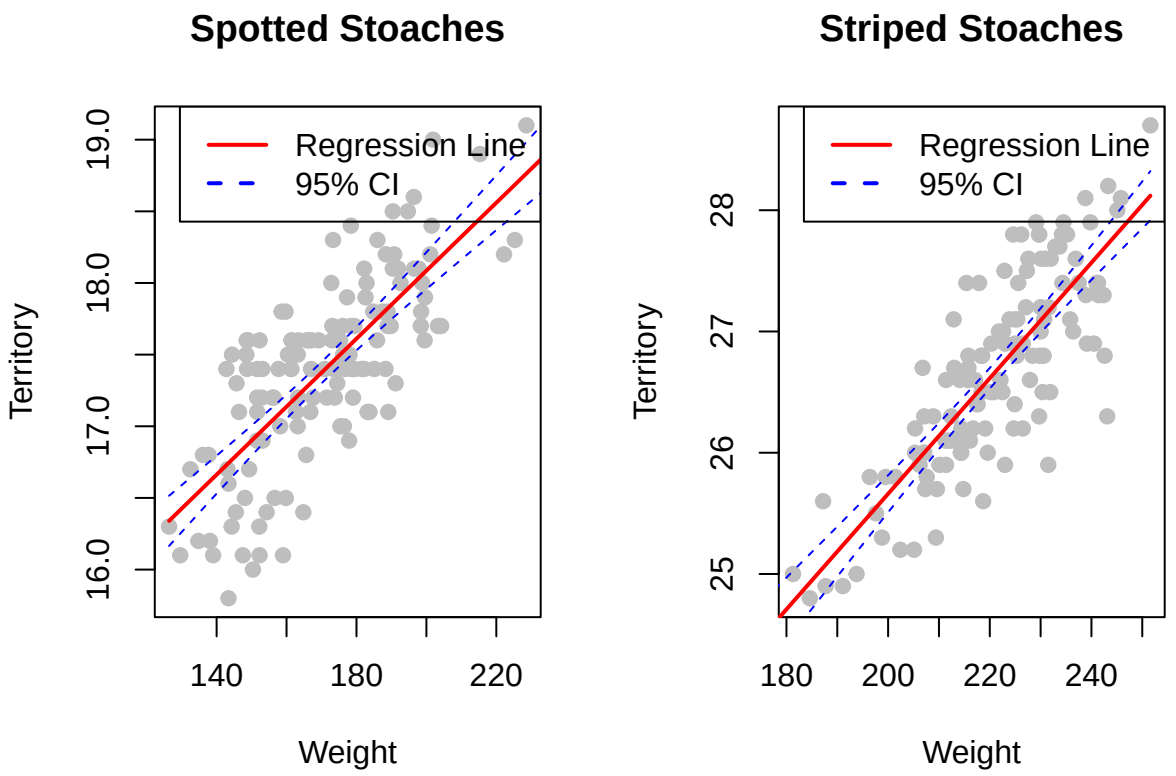
Species	Slope	Intercept	Std Error	t_value	p-Value	95% Lower CI	95% Upper CI
Spotted	0.0237180	13.34201	0.0018054	13.13696	0	0.0201459	0.0272902
Striped	0.0476463	16.13214	0.0030490	15.62694	0	0.0416106	0.0536821

Using the computed slopes and intercepts for the spotted and striped stoaches, we get the best of line fit or the regression lines to be $y = 13.342 + 0.024x$ and $y = 16.132 + 0.044x$, respectively. Fro mthe regression equations, for every unit increase in weight, there is 0.024 units increase in the territory occupied of spotted stoaches. On the other hand, for striped stoaches, for every unit increase in weight, there is 0.048 units increase in the territory occupied

Table 5: Regression Equations for Spotted and Striped Stoaches

Species	Regression Equation
Spotted	territory = 13.342 + 0.024 * weight
Striped	territory = 16.132 + 0.048 * weight

From the regression equations or the lines of best fit (in red lines), we computed the 95% confidence intervals for the prediction values (in blue broken lines) and fitted with the data set between weight and territory for both spotted and striped stoaches as shown in the figure below.



Conclusion

Based on the comprehensive analysis and data exploration conducted in this study, we can conclusively state that there is no significant difference in the average albedo of spotted stoaches compared to striped stoaches. This suggests that albedo, as a distinguishing characteristic, does not provide a clear differentiation between the two species. Furthermore, our findings affirm a notable positive correlation between the weight of stoaches and the territory they inhabit. This relationship underscores the potential influence of a stoach's weight on its territorial dominance or preferences. The development of two distinct regression lines for spotted and striped stoaches offers a valuable tool for future predictions and insights regarding territory occupation based on weight. This research not only contributes to our understanding of stoach behavior and characteristics but also offers a foundation for future studies aiming to delve deeper into the intricacies of these species' habitats and interactions.

References

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Appendix

Appendix 1: Normality Test

```
##
##  Shapiro-Wilk normality test
##
## data:  data$albedo[data$species == "Spotted"]
## W = 0.99535, p-value = 0.9496
```

```
##
##  Shapiro-Wilk normality test
##
## data:  data$albedo[data$species == "Striped"]
## W = 0.98816, p-value = 0.3611
```

Appendix 2: Equality of Variance Test

```
## Levene's Test for Homogeneity of Variance (center = median)
##        Df F value Pr(>F)
## group   1  2.0427 0.1542
##       253
```

Appendix 3: Computation for Correlation Coefficient

```
##
##  Pearson's product-moment correlation
##
## data:  data$weight[data$species == "Spotted"] and data$territory[data$species == "Spotted"]
## t = 13.137, df = 129, p-value < 2.2e-16
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.6721647 0.8214167
## sample estimates:
##       cor
## 0.7564738
```

```
##
##  Pearson's product-moment correlation
##
## data:  data$weight[data$species == "Striped"] and data$territory[data$species == "Striped"]
## t = 15.627, df = 122, p-value < 2.2e-16
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.7479889 0.8679557
## sample estimates:
##       cor
## 0.8166088
```