Two-Way ANOVA Lab Report

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The purpose of this report is investigating whether mother lizards deposit and antifungal microbiome onto eggshells during oviposition and how different treatments of eggs affect hatchling fitness. The data exploration section will discuss about the type of this research study and the variables in the dataset. The analysis section describes the two way analysis of variance and apply detailed comments with graphs. The conclusion section provides results briefly and summarize the confidence intervals and effect sizes.

1 Data Exploration

The dataset comes from a research study conducted by Prof. Stacey Weiss. This experiment tests whether lay or dissect eggs out of the mom influence the mass of hatchling babies by controling the fungal-inoculated environment. The format of the data (see Table 1) and the information of variables (see Table 2) gives the basic ideas to build the two-way ANOVA model.

Case	egg.trmt	inc.envmt	inc.time	HatchBmass	HatchSVL
1	Dissected	sterile	47	0.40	23.9
2	Dissected	fungus	48	0.39	23.8
3	Dissected	fungus	48	0.37	23.3
12	Dissected	sterile	40	0.33	22.2

Table 1: The data format shown with the first four rows of the dataset.

Data Variables	
Name	Description
Case	The number for eggs
egg.trmt	Dissected or induced
inc.envmt	Sterile or fungal-inoculated environment
inc.time	Incubation time in days
HatchBmass	Hatchling body mass in grams
HatchSVL	Hatchling body length in mm

Table 2: The name of variables shown in the dataset with their description.

The response variable is the body mass in grams, the blocking is the environment with two levels (fungus or sterile), and the explanatory variable is the treatment of eggs (either laid or dissected).

1.1 Visualization

The boxplot (see Figure 1) of treatments assigned to different environments shown side-by-side makes the additive effects model is reasonable. Also, the boxplot (see Figure 2) of treatment:environment groups shows that the overall mass in induced group is higher than that in dissected group.

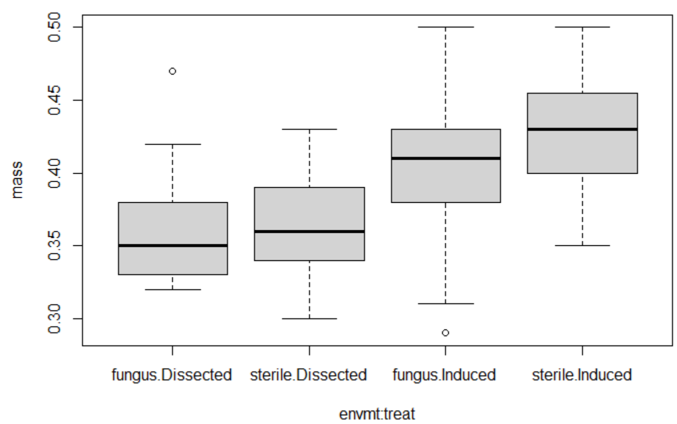

Figure 1: The boxplot of mass with groups of environment:treatment. The side-by-side plots provides the evidence of additive effects model.

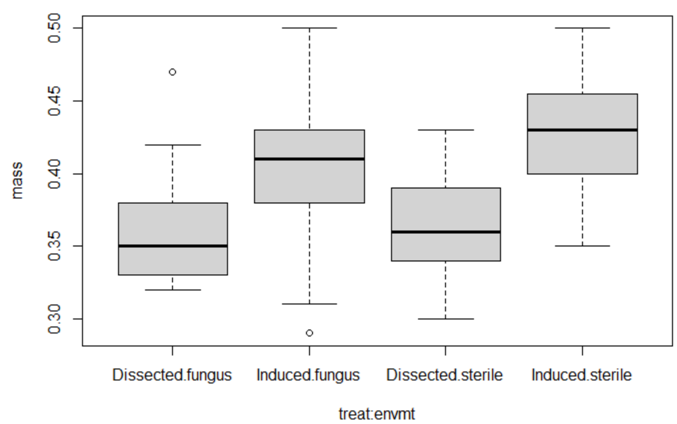

Figure 2: The boxplot of mass to groups of treatment:environment. The similar variance of each group does not suggest any transformations. The induced groups have higher values of mass.

2 Analysis

2.1 Fit the Model

The table (see table 3) shows the values of grand average, environment effects and treatment effects. It seems fungus environment and dissected treatment group effect are lower than the grand average, and sterile and induced group effects are higher than the grand average.

Grand Average	0.388842105	
	fungus	sterile
Environment Effect	-0.005581236	0.005239527
	Dissected	Induced
Treatment Effect	-0.027102975	0.025443609

Table 3: The table of group effects.

The summary of the two-way ANOVA model is the mass with blocking variable environment and the explanatory variable treatment. The formula is shown below:

$$Observed = GrandAverage + Environment + Treatment + Residuals$$

The p-value of environment is 0.217 and that of treatment is 2.35×10^{-8}. The p-value of the explanatory variable treatment is much smaller than 0.05. Thus, we can conclude that the treatment is statistically significant and influence the mass much more than the environment.

2.2 Assess the Model

The graph of fitted values v.s. residuals (see Figure 3) displays a zero mean of distributed points. The boxplots (see Figure 4) shows good distributions of data based on groups. The normal quantile-quantile plot (see Figure 5) displays a kind of linear trend. The densityplot (see Figure 6) provides a perfect normal distribution.

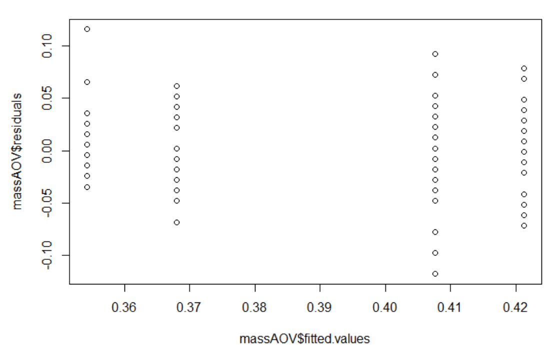

Figure 3: Graph of fitted values v.s. residuals. The dots seem have a zero mean.

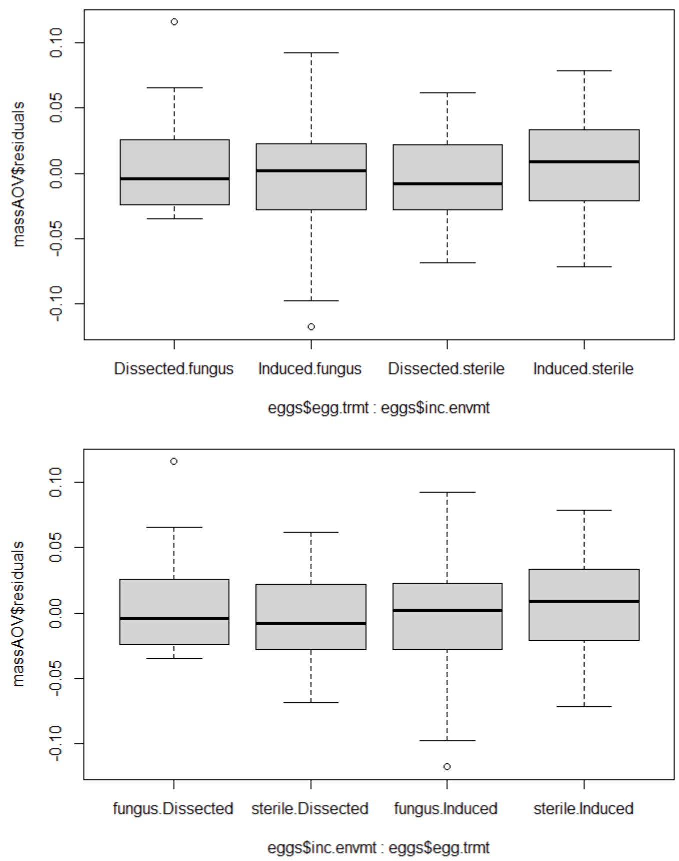

Figure 4: The boxplots of model residuals to groups. Providing less differences with good distributions.

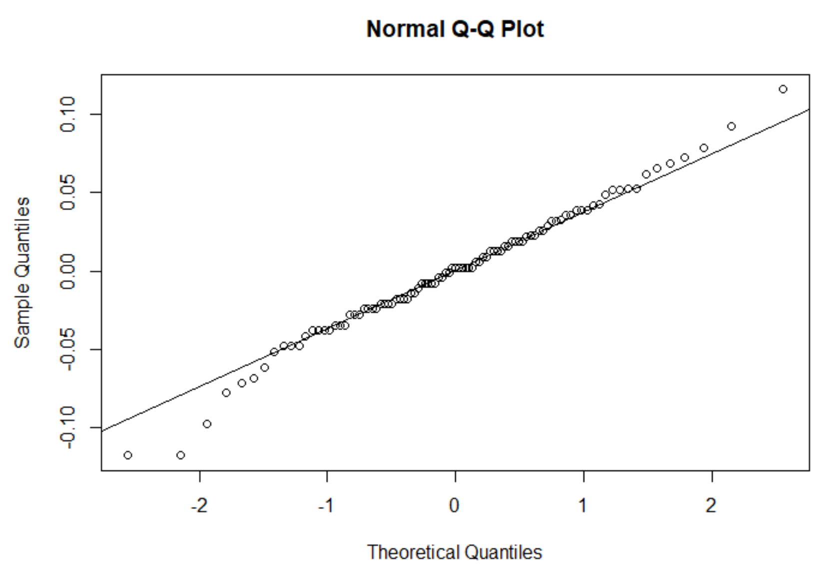

Figure 5: The normal quantile-quantile plot with a linear trendline.

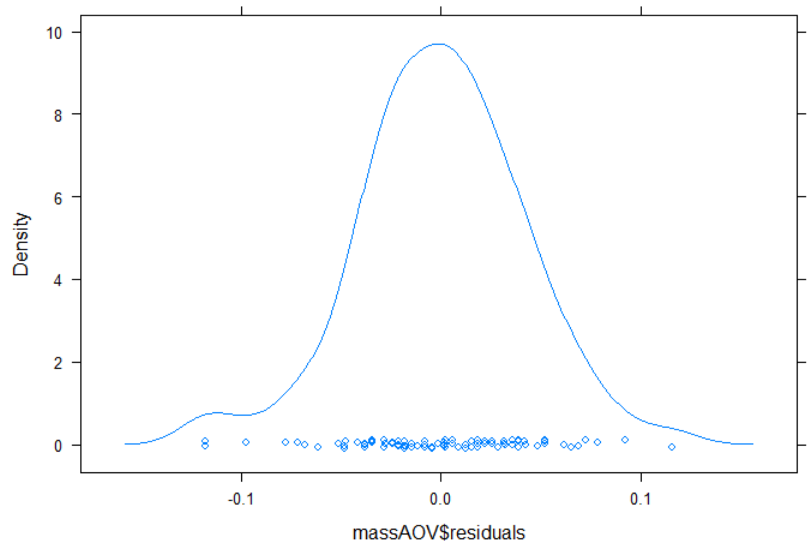

Figure 6: The densityplot of two-way ANOVA residuals with a great normal distribution.

3 Conclusion

3.1 Results

The F-statistic of the explanatory variable, egg treatment, is 37.350. This is a large value and is good. This means a clearer difference between means in the two sample situations inside the treatment groups. The p-value of egg treatment is 2.35×10^{-8}, less than 0.05, suggest us rejecting the null hypothesis and then accept the alternative hypothesis, which indicates a clear trend exists. For another variable, the F-statistic of the blocking variable, sterile or fungal-inoculated environment, is 1.545, and the p-value of this variable is 0.217. These values do not provide evidence that we can say the environment will affect the values of mass statistically significantly.

3.2 Confidence Intervals

For the explanatory variable egg treatment, We calculate the 95% confidence interval (see table 4), which is [0.03583727, 0.07041766]. Its p-value is 0, which is much smaller than 0.05. This tells us the the mass for groups of induced and dissected are different with the difference of 0.05312747 grams. The difference is very small. Also, the p-value for the blocking variable egg environment is 0.2170421. This tells us the mass difference between the groups of sterile and fungus is not as clear as that between groups of egg treatment.

Egg Treatment	Difference	Lower	Upper	p adj
Induced-Dissected	0.05312747	0.03583727	0.07041766	0

Table 4: The 95% confidence interval shown with lower, upper values and difference values. The p-value is 0.

3.3 Effect Sizes

The effect sizes (see Table 5) also show that the hatchling body mass is affected much more by the groups of egg treatment (dissected or induced) rather than the groups of egg environment (fungus or sterile). The absolute number of the ratio for the groups of environment effect sizes are around 0.1, which is pretty small. However, the absolute value of the ratio for the groups of treatment effect sizes are around 0.6. This value tells us the groups of the egg treatment will influence the mass much more.

fungus	sterile
-0.1316174	0.1235592
Dissected	Induced
-0.6391460	0.6000146

Table 5: The ratio shows effect sizes of each groups based on blocking variable environment and explanatory variable treatment.

3.4 Weakness

This whole experiment only explores the effect of the environment as the blocking variable and the spawning method for testing their effect on mass of the hatchling babies. Not each block is assigned all treatments so we cannot 100% say this is a complete block design experiment. In addition, still some unconsidered variables exists which can affect the mass, such as the time of hatching and the temperature. Those unconsidered variables might also affect the values of hatchling body mass, and these effects are ignored. Furthermore, the experiment does not explore different lizard species, so we could not extend our model results to the situation in general and then relate the results about the effect of the spawning method on mass.