Professor Notes on 1-Way ANOVA Homework 4

- At the end of the first question, say something like "All of the assumptions were not met on the original scales; thus the response variable must be transformed."
- In the second question, there is no need to make a statement about independence again as transforming the data does not change independence.
- In the third question, you must use the ANOVA table p-value and you must note that the differences are in the "mean log" values. Don't just say that there is a difference, be specific about what the difference is in.
- In the last question, the confidence intervals constructed on the log scale should be back-transformed to the original scale. This back-transformation changes the interpretation from referring to the difference in mean logs (i.e., the first sentence in the last question) to one about the ratio of means on the original scale (i.e., the second sentence in the last question). You DO NOT want to make any conclusions with the unstransformed data ... you proved in the first question that the assumptions were not met on that scale; thus, all results from the untransformed data are not appropriate. The proper way to make conclusions on the "original scale" is to back-transform from the log-scale (do note, though, that this can only be done with the log-transformation).
- Either define or spell out abbreviations. Don't assume that the reader knows that "am" stands for "*Amnicola* spp."
- Please refer to your figures and tables (why go through the trouble of labeling them if you are not going to refer to them), give them proper labels ("Table 1. ANOVA table for the data." is NOT a proper label), and note that figures and tables go BELOW the paragraph where they are first mentioned.
- One sentence does not make a paragraph. Put similar topics together (i.e., the assumption check can be done with one concise paragraph relating to one concise figure).

Crayfish and Periphyton Abundance

1. The individuals appear to be independent, both within and among treatments, because the arenas were placed randomly and two treatments were not placed on a single tile. There is weak evidence for a non-constant variance (Levene's $p = 0.0790$) and the residuals do not appear to be normally distributed (Anderson-Darling $p = 0.0101$; Figure 1). There is also evidence for a significant outlier (outlier test $p = 0.0001$). The assumptions do NOT appear to be met on the original scale.

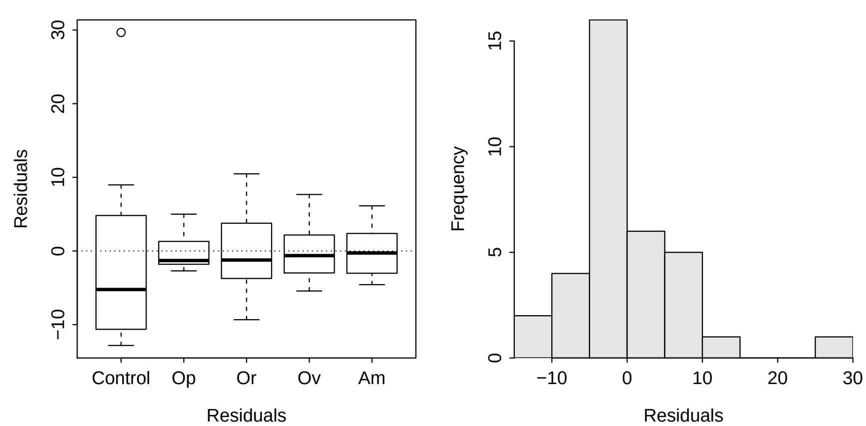

Figure 1. Residual plot (left) and histogram of residuals (right) from the one-way ANOVA of grazing level by treatment. Note that Op=Orconectes propinquis, Or=O. rusticus, Ov=O. virilis, and Am=Amnicola spp.

2. A log transformation for the response variable was selected through a trial-and-error method (i.e., using `transChooser()`). With this transformation, the variances are approximately equal (Levene's $p = 0.5112$), the residuals are approximately normal (Anderson-Darling $p = 0.9172$), and there are no significant outliers (outlier test $p > 1$).

3. The 1-way ANOVA results show strong evidence for a difference in mean natural log of algal biovolumes among the five treatments ($p = 0.0001$; Table 1).

Table 1. Analysis of variance table for log-transformed crayfish grazing by treatment.

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
group	4	7.2149	1.80372	9.1656	5.818e-05
Residuals	30	5.9038	0.19679		

4. Dunnett's results show that all grazers significantly reduced the algal biovolume relative to the control treatment ($p \leq 0.0499$; Figure 2).

Table 2. Dunnett's multiple comparison results for the log-transformed crayfish levels by treatment.

	Estimate	Std. Error	t value	p value
Op - Control = 0	-0.8712119	0.2371216	-3.674115	3.369182e-03
Or - Control = 0	-0.6114657	0.2371216	-2.578701	4.992083e-02
Ov - Control = 0	-1.2460645	0.2371216	-5.254960	3.961543e-05
Am - Control = 0	-1.1904029	0.2371216	-5.020221	8.015826e-05

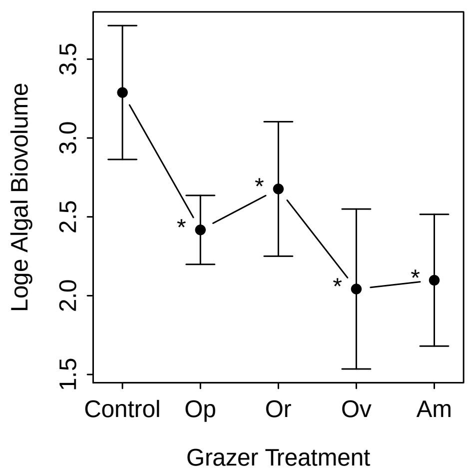

Figure 2. Plot of mean (with 95% CI) natural log algal biovolume by grazer treatment. Asterisks indicate a significant difference of the grazer treatment from the control treatment. Treatment abbreviations are in Figure 1.

5. *Orconectes virilis* has between an average of 0.63 and 1.86 *less* algal biovolume than the control group on the **natural log scale** (Table 3). The *ratio* of mean algal biovolume for *Orconectes virilis* relative to the control treatment is between 0.16 and 0.53. Thus, the *Orconectes virilis* appears to have removed between 47 and 84% of the algal biovolume.

Table 3. Dunnett's corrected confidence intervals for the difference in mean log-transformed crayfish levels by treatment.

	Estimate	lwr	upr
Op - Control	0.4184441	0.2270764	0.7710862
Or - Control	0.5425551	0.2944275	0.9997912
Ov - Control	0.2876346	0.1560902	0.5300374
Am - Control	0.3040987	0.1650248	0.5603767

R Appendix

```
library(NCStats)
setwd("c:/biometry/")
d <- read.csv("Periphyton.csv")
d$group <- factor(d$group,levels=c("Control","Op","Or","Ov","Am"))
lm1 <- lm(ab~group,data=d)
leveneTest(lm1)
residPlot(lm1)
adTest(lm1$residuals)
transChooser(lm1)
d$logdata <- log(d$data)
lm2 <- lm(log.data~group,data=d)
levenesTest(lm2)
residPlot(lm2)
adTest(lm2$residuals)
outlierTest(lm2)
anova(lm2)
mc2 <- glht(lm2,mcp(group="Dunnett"))
summary(mc2)
exp(confint(mc2))
fitPlot(lm2,xlab="Grazer Treatment",ylab="Loge Algal Biovolume")
addSigLetters(lm2,c("","*","*","*","*"),pos=c(2,2,2,2,2))
```