Damselfly Response to Global Warming

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1 Interpreting the explorative figures

1.1 Principle Components Analysis

Figure 1 shows the distribution of samples across temperature and latitude for the two largest principle components. The plot shows that PC1 separates the samples. PC2 weakly separates the northern samples by temperature, but does not separate the southern samples.

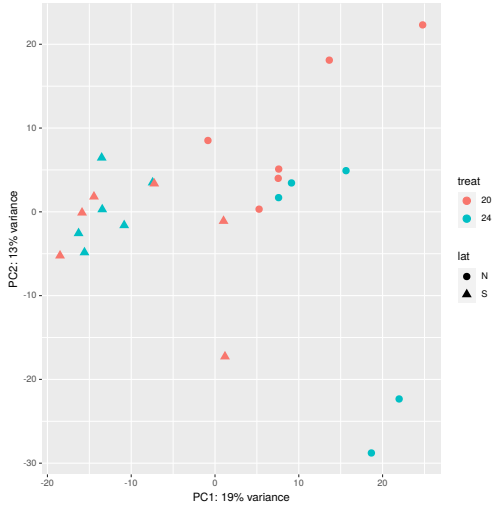

Figure 1: PCA showing distribution across temperature and latitude for the first two principle components

1.2 MA Plots

MA plots are given below showing differentially expressed genes for both temperature and latitude contrasts. Note that there are significantly fewer differentially expressed genes for the temperature contrast in the south (see Figure 3) than in the other plots. This fits with our analysis above that the principle components could not separate the southern samples by temperature. There is little variance between the samples at different temperatures in the south.

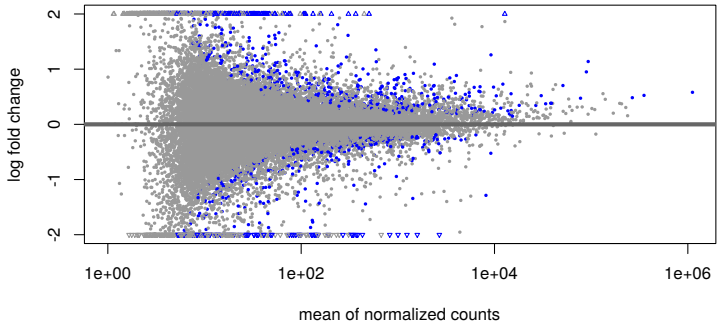

Figure 2: MA plot for N24 vs N20

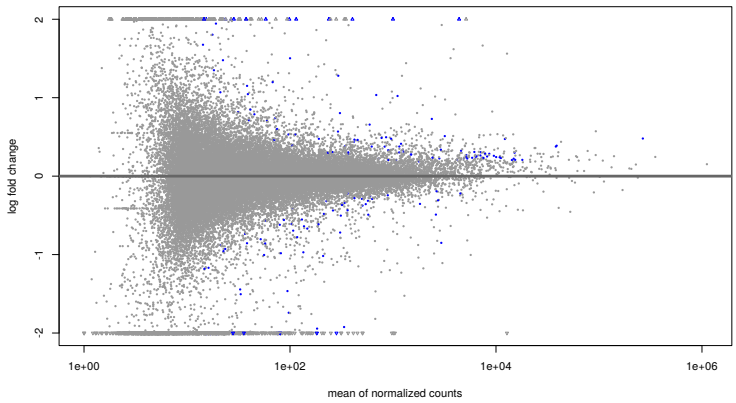

Figure 3: MA plot for S24 vs S20

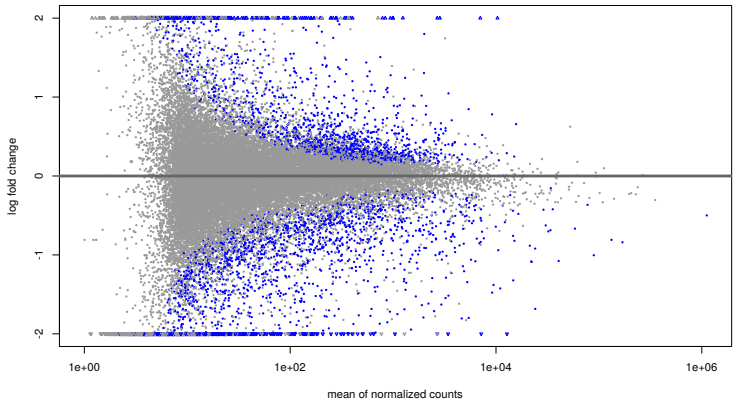

Figure 4: MA plot for S24 vs N24

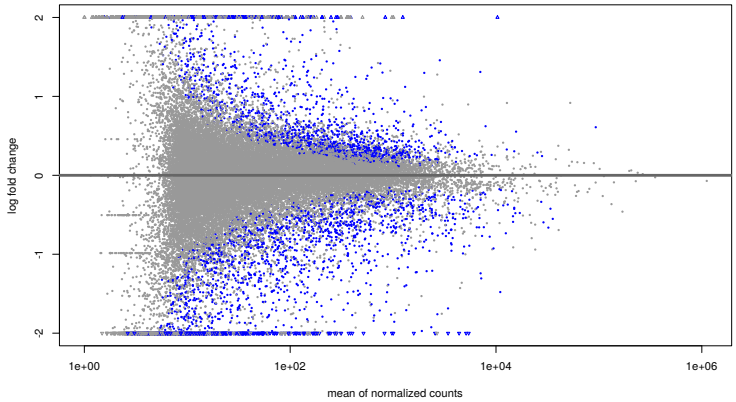

Figure 5: MA plot for S20 vs N20

1.3 Volcano Plots

Volcano plots showing differentially expressed genes for both temperature and latitude contrasts. For each plot, genes above the threshold log fold-change (LFC) and p-value are highlighted. What can we

see from these plots? Looking at Figures 8 and 9 it is clear that there are more differentially expressed genes between samples at different latitudes. This again fits with our observation that the first principle component separates the samples according to latitude. Furthermore, we can see that at 20 degrees, more genes are down-regulated in the south compared to the north. This pattern can also be seen in the heatmap given below.

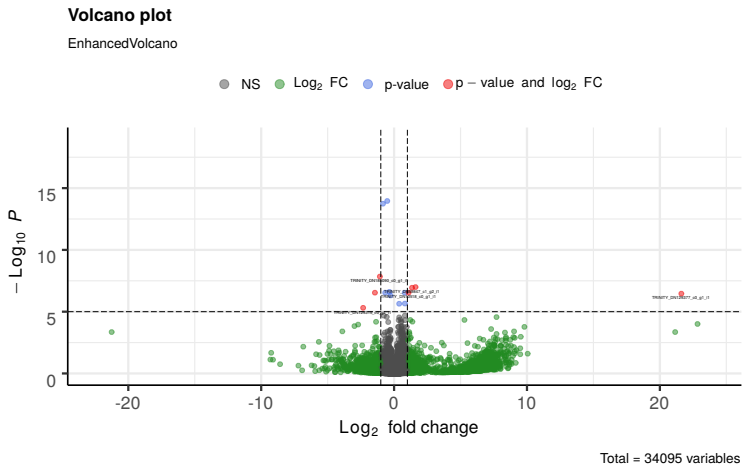

Figure 6: Volcano plot for N24 vs N20

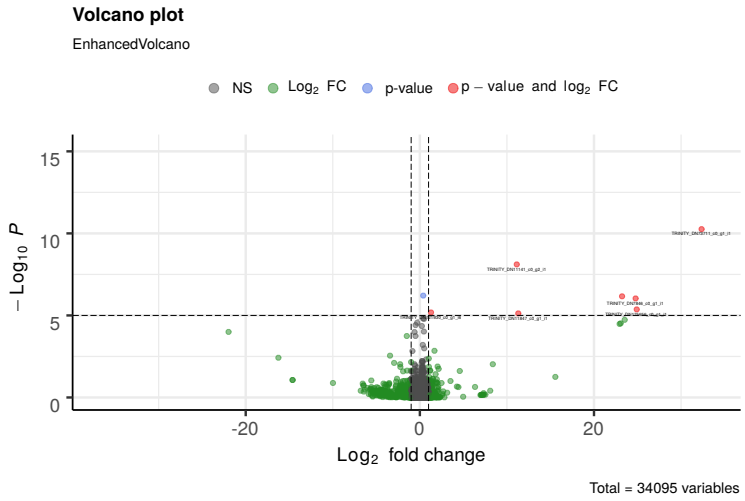

Figure 7: Volcano plot for S24 vs S20

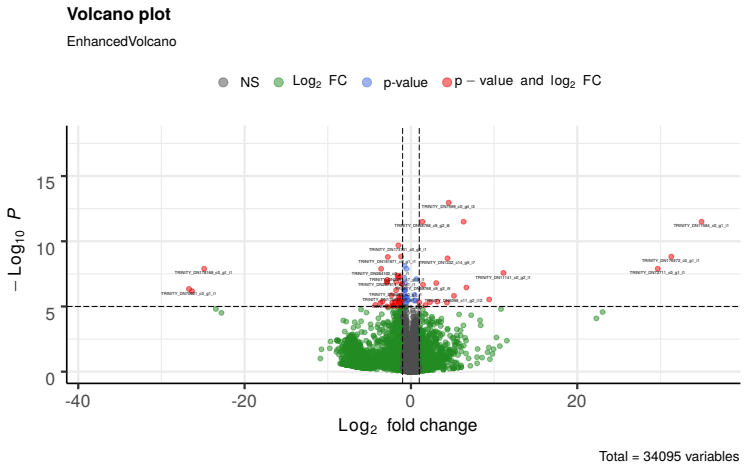

Figure 8: Volcano plot for S24 vs N24

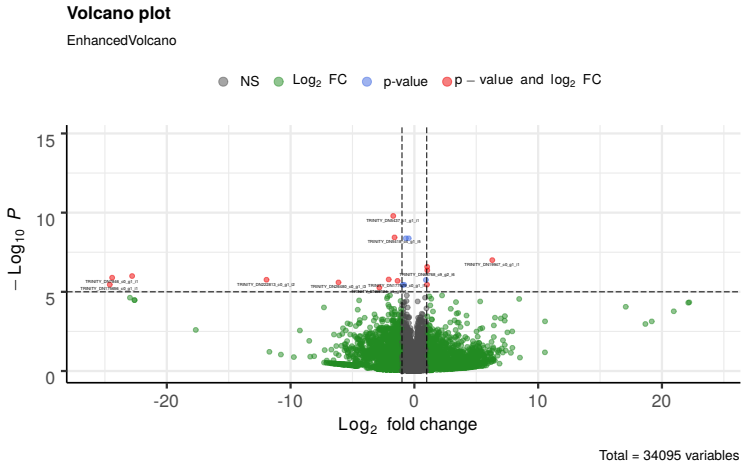

Figure 9: Volcano plot for S20 vs N20

1.4 Heatmap

Figure 10 shows a heatmap with up- and down-regulated genes for different temperatures at different latitudes. The heatmap shows that in the north, differential expression between samples is more effected by temperature than in the south. This fits with each of the figures given previously. Also, we can see that for populations at 20 degrees, there are more significantly downregulated genes in the south than in the north, which fits with the volcano plots analysed above.

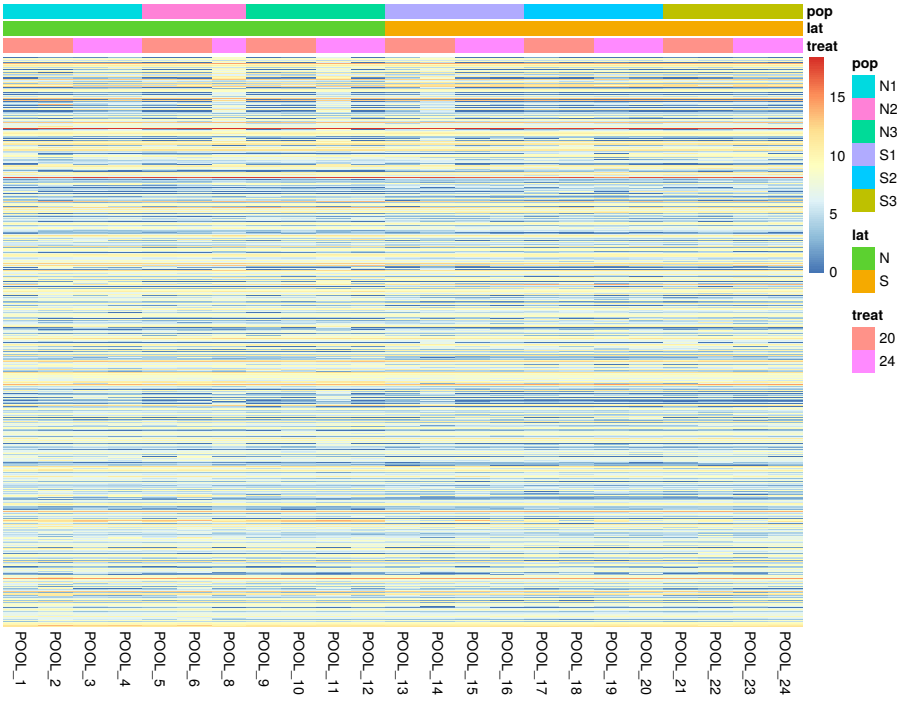

Figure 10

2 Venn diagrams

The Venn diagrams given in Figures 11 and 12 show that

- For temperature contrasts, there is little overlap between latitudes and there are far more differentially expressed genes in the North (as discussed earlier).
- For latitude contrasts, there is a larger overlap in differentially expressed genes. This suggests that samples are better split by latitude than by temperature, which we highlighted when discussing the PCA plot. Neither temperature has more differentially expressed genes for temperature contrasts.

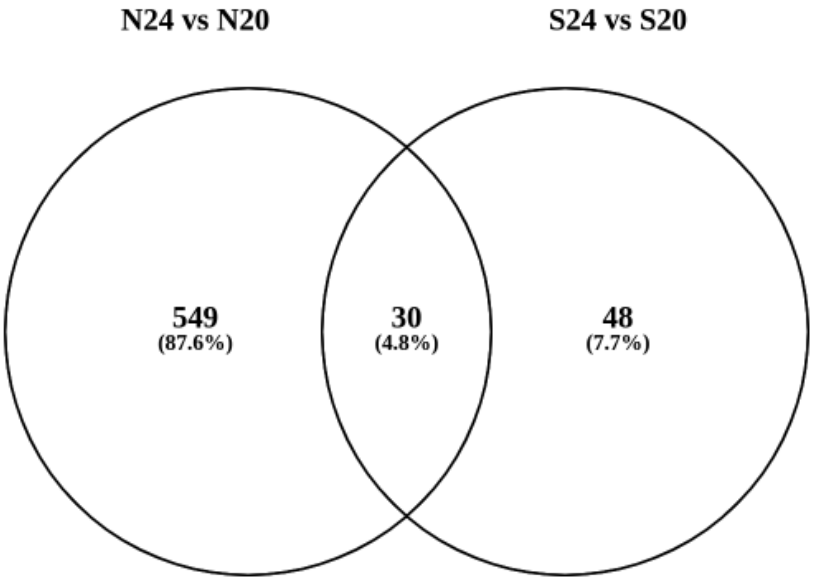

Figure 11: Venn diagram showing overlap of differentially expressed genes for temperature contrasts

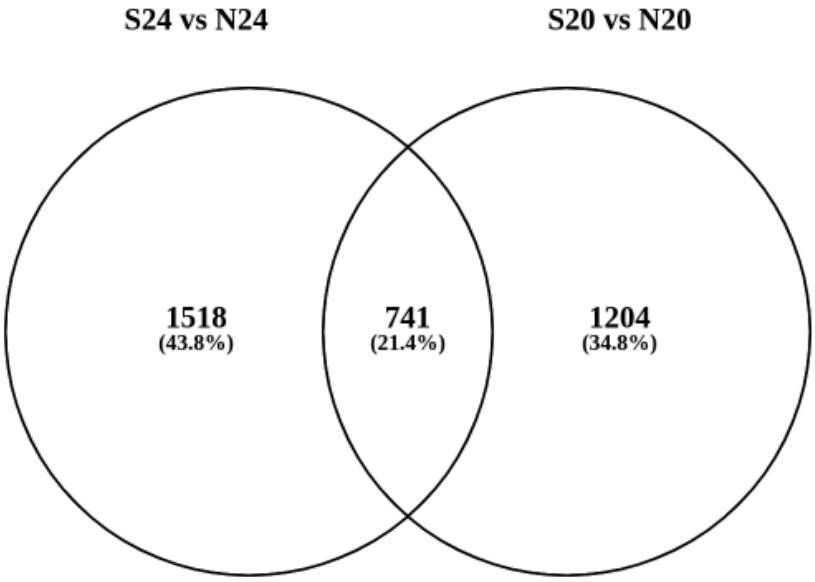

Figure 12: Venn diagram showing overlap of differentially expressed genes for latitude contrasts

3 Interpreting the results in context

Populations from different the different latitudes respond differently to a 4 degree temperature increase. In the south, a number of genes are significantly upregulated. In the north, some genes are up-regulated and some are down-regulated, but there is no bias toward up- or down-regulation. This could potentially be due to the fact that daily temperature variations are greater in in the south compared to the north, which leads to heat-tolerant populations in the south being selected for.

How do you expect populations from the north to cope with rising global temperatures? Looking at the pattern observed in southern populations, I would expect the northern population to evolve via genetic compensation to occur and a shift in their phenotype to be more similar to the southern populations.

References

[1] Swaegers, J., Spanier, K. I., and Stoks, R. Genetic compensation rather than genetic assimilation drives the evolution of plasticity in response to mild warming across latitudes in a damselfly. *Molecular Ecology* (2020).