Cross pHox RNAseq results summary

Potential title: The heritability of adaptive plasticity phenome wide

Aim and approach: Integrating RNAseq, performance, and pedigree data from Cross pHox, I identified differential expression induced by developmental upwelling that positively or negatively affected performance. I then measured additive genetic variance and heritability of transcript abundance and differential expression for all DEGs. Lastly, I modeled the heritability of DE as a function of transcriptional plasticity's fitness effect (e.g., how strongly DE was associated with adaptive or maladaptive plasticity).

Major result: DE was more strongly associated with maladaptive plasticity and adaptive DE was significantly less heritable than maladaptive DE. As the adaptive effect of DE increased, its heritability decreased.

Conclusions: The limited heritability of adaptive plasticity may constrain the evolution of plastic responses critical for resilience to environmental perturbation.

Greater heritability of maladaptive plasticity demonstrates that more genetic material is available for negative rather than positive directional selection on plasticity.

Significance: Numerous reviews and theoretical papers point to the heritability of adaptive versus maladaptive plasticity as a potential constraint on the evolution of adaptive organismal responses to environmental change. Many studies have estimated the heritability of plasticity for single phenotypes that are either maladaptive or adaptive, but synthesizing these results across diverse taxa and trait types is a challenge. By measuring the heritability of thousands of gene expression and plasticity traits yielding a continuum of adaptive-maladaptive effects on performance, we've resolved a phenome-wide picture of how genetic variation for plasticity constrains its evolution.

(Results below)

Results:

1. Developmental upwelling induced more DEGs and stronger fold change than parental upwelling, with pervasive downregulation of transcripts (Fig. 1).

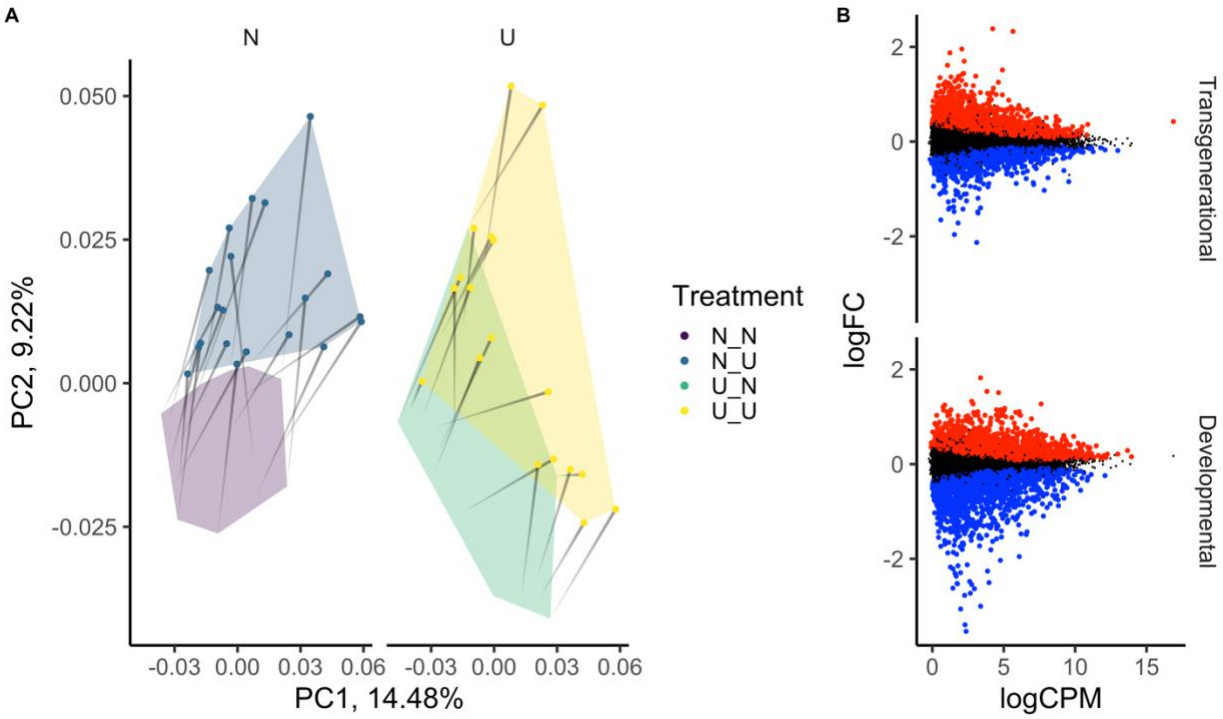

Figure 1 | *Differential expression in response to parental and developmental exposure to experimental upwelling*. (A) Loading of RNAseq samples to major principal component axes. Columns represent parental nonupwelling (N) and upwelling treatments (U). Point and shade color depict parental x developmental treatments groups. Paths connect full sibling replicates and depict their movement across PCA axes in response to developmental upwelling. (B) LogFC's of differential expression are plotted across baseline transcript abundance (logCPM). Significant upregulation is depicted in red and downregulation in blue.

2. Differential expression had stronger maladaptive effects on the plasticity of abnormality, spicule length, and body length. The plot below depicts this effect on body size and reflects patterns seen for abnormality and spicule length.

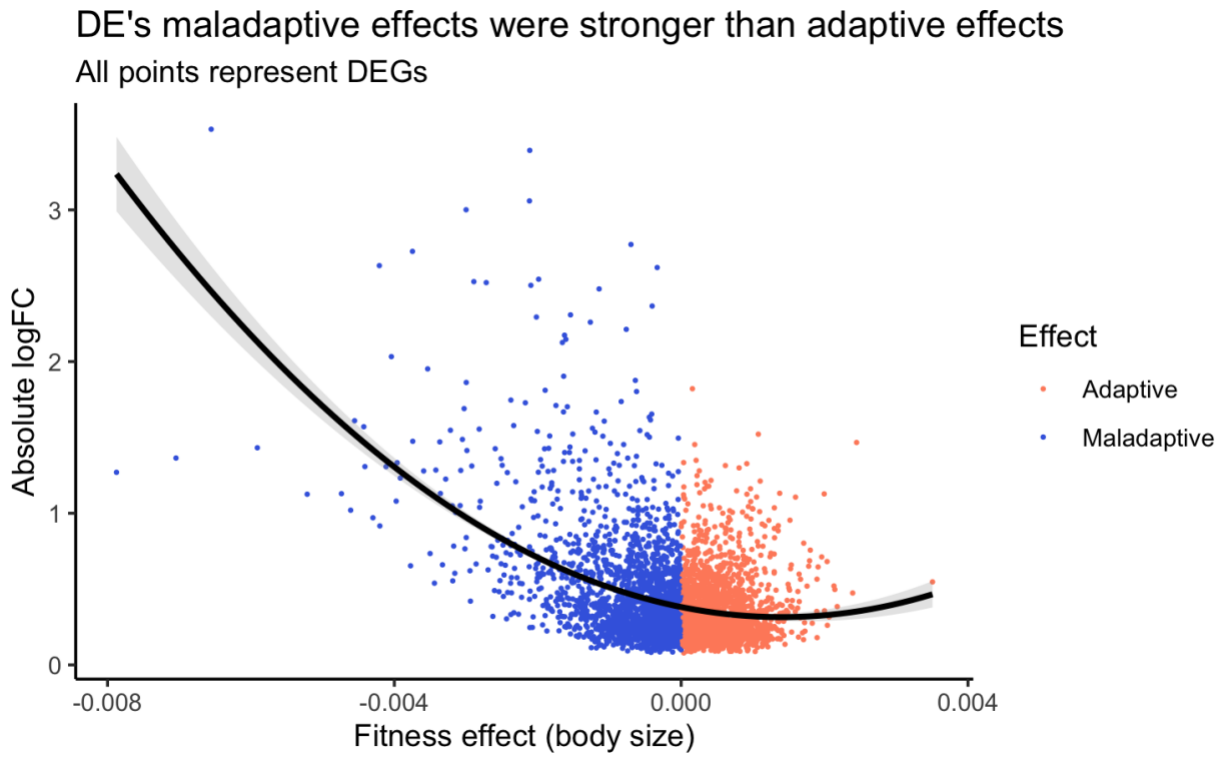

Figure 2 | *DE induced by developmental upwelling yielded stronger maladaptive effects on the plasticity of body size than adaptive effects*. Negative fitness effects (blue) represent DE's association with smaller body size in response to upwelling, while positive effects (red) depict DE's association with greater body size in response to upwelling. All points depict significant DEGs induced by developmental upwelling.

3. Adaptive transcriptional plasticity was significantly less heritable than maladaptive DE (Fig. 3A). As the adaptive effect of DE on abnormality, spicule length, and body size increased, its heritability decreased (Fig 3B). The results shown below hold true the heritability of DE influencing abnormality and spicule length as well.

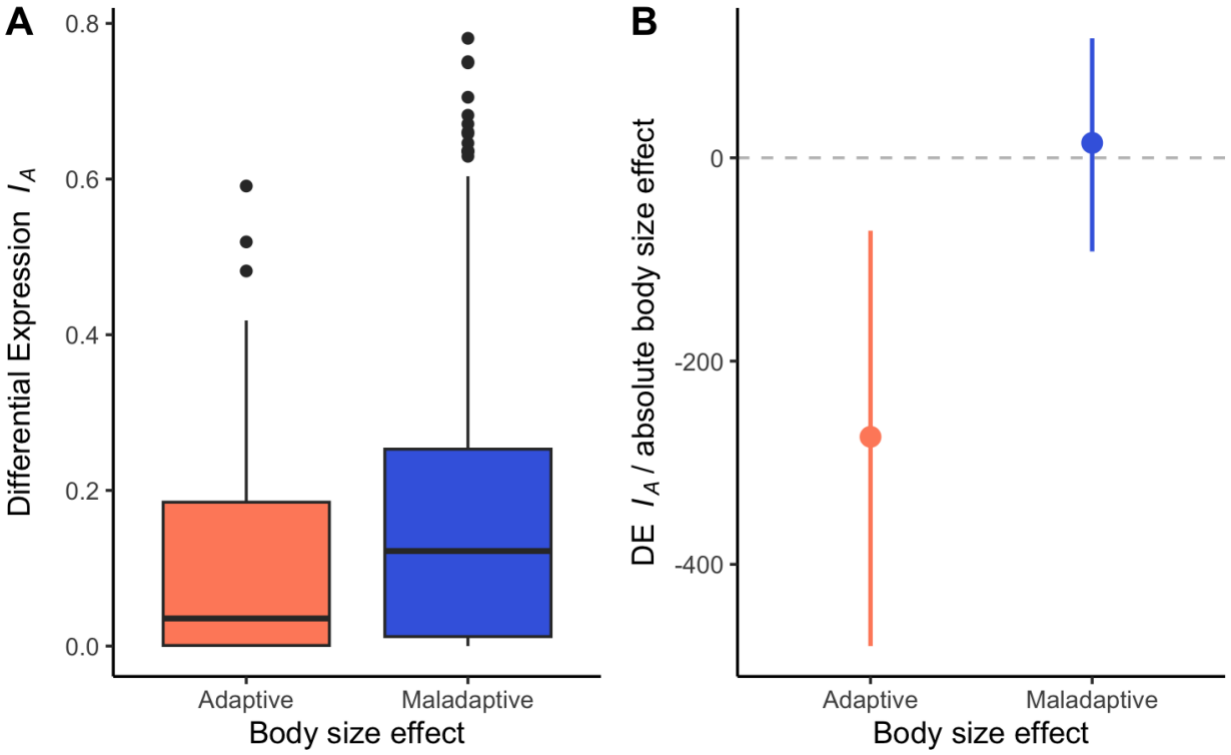

Figure 3 | *Adaptive differential expression exhibits limited heritability*. (A) Box whisker plots of DE's mean standardized heritability (I_A) for among genes whose plasticity yielded significant adaptive effects on body size (red) or maladaptive effects (blue. (B) DE's mean standardized heritability as a function of DE's absolute body size effect, grouped by adaptive versus maladaptive effects on performance.