Unique thermosensitive trajectories of urogonadal genome-wide gene expression evolved in turtles with sex chromosomes, distinct from turtles with temperature-dependent sex determination

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Background

Chrysemys picta (CPI) and *Apalone spinifera* (ASP) are turtles that demonstrate two extremes of the sex determination continuum: temperature-dependent (TSD) and genotypic (GSD), respectively. CPI thus shows plasticity in this trait while ASP does not.

Here we tested for differences in genome-wide developmental gene expression patterns **to investigate the molecular basis for phenotypic plasticity in these lineages**. This remains a poorly understood phenomena, but is critical for understanding the development and evolution of phenotypes.

References

Adams DC and Collyer ML. 2009. *Evolution* 63(5): 1143-1154.

Huang X. 2016. *BMC Genomics* 17(523).

Radhakrishnan S *et al*. 2017. *Epigenetics and Chromatin* 10: 28.

Valenzuela N. 2008. *Sexual Development* 2: 64-72.

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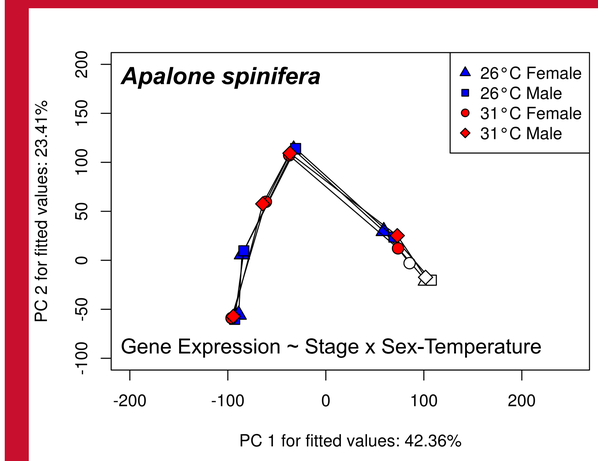
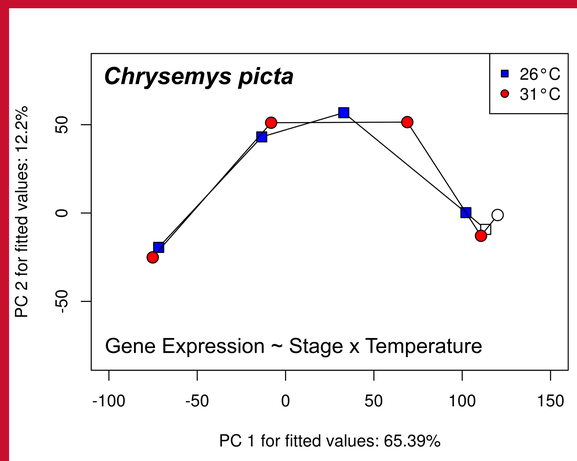
Gene expression patterns for sex determination are different between a turtle with sex chromosomes and a turtle with temperature-dependent sex determination, but the turtle with sex chromosomes still has some sensitivity to temperature. #BetterPoster





Trajectories quantify multivariate differential gene expression patterns in hyperspace. Models are shown. Each point represents a developmental stage with latest stage indicated by open shape.

Methods

1. CPI & ASP embryos incubated & collected at male- & female-producing temperatures for 5 stages of development & RNA-sequenced.
2. Transcriptomes assembled with RNA-seq data using Trinity & TransPS.
3. Differential expression analysis performed with Kallisto & DESeq2.
4. Trajectory analysis modeling with RRPP.

Results

Sexual development trajectories differ between temperatures for CPI and between temperatures and sexes for ASP.

Species	Trajectory Distance	Trajectory Angle	Trajectory Shape
C. picta	■ ● Z = 3.45	■ ● Z = 4.72	■ ● Z = 2.63
A. spinifera	NS	▲ ◆ Z = 4.48 ■ ● Z = 4.40 ● ◆ Z = 5.21	▲ ● Z= 3.53 ▲ ◆ Z = 2.54

Statistical comparison of trajectory geometries reported above for adjusted pvalue <0.05. Effect sizes are provided. Colored shapes represent trajectory identity and respective comparisons as shown in figures.

Discussion

- Sex and temperature effects on sexual development were detangled in ASP revealing thermal plasticity despite GSD status, suggesting evolutionary potential for TSD reversal.
- Sexual development trajectories in CPI revealed genomic responses differed between temperature treatments through development.
- These data support the role of developmental systems drift underlying the diversity of sex determination mechanisms in turtles.