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Effects of Social Stress on Telomere Length and Telomerase Activity in Astatotilapia burtoni

Telomeres, the end regions of eukaryotic chromosomes, preserve integrity. Short telomeres will lead to cellular senescence, thus telomeres must be maintained and elongated by the telomerase enzyme. Chronic stress correlates with heightened oxidative stress and DNA damage. Our subjects, *Astatotilapia burtoni* cichlid males, form a strict primarily size-based social hierarchy. We maintained the social status of individual *A. burtoni* males for the first 6 months of life. Then by manipulating the relative size of tank mates, they were either forced to switch social status or allowed to maintain it for 4 more weeks. Brain, liver and gut tissues were then assayed for absolute telomere length and telomerase activity. This design allows us to assess both the chronic and acute effects of stress on telomeres. It's hypothesized that always dominant males will have higher telomerase activity due to constant growth, while always subordinate males will have lower telomerase activity due to limited growth. For those that descend social status, telomerase activity will decrease; for those that ascend social status, telomerase activity will increase with resumed growth. Within 4 weeks, no dramatic change in telomere lengths is expected even with changes in telomerase activity. However, it is difficult to predict the chronic effects of stress on telomere length in fish because they have indeterminate growth, meaning they can delay growth when necessary. Due to growth suppression, always subordinate fish may not suffer a reduction in telomere length that would otherwise be predicted for reduced telomerase activity; likewise, due to increased growth and cell division, always dominant fish may suffer reduced telomere length despite elevated telomerase activity. All possible results will provide further insights into the mechanism of cellular aging and how social stress influences organisms on a molecular level.

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Using your head! Finite Element Analysis of head-first burrowing Pygopodids (Gekkota)

Pygopodids are limb-reduced, miniaturized geckos found across Australia and New Guinea. Pygopodids are mainly terrestrial; however, Aprasia species are highly fossorial and further miniaturized, converging on similar ecology and morphology to typhlopid snakes. Additionally, Aprasia from eastern/central and western Australia exhibit distinct skull shapes, possibly due to the functional demands of burrowing in different soil types. Another pygopodid genus, Ophidiocephalus, also was described as fossorial with morphology most similar to eastern Aprasia species, and thus may experience a similar pattern of cranial stress when digging. The burrowing mechanics of pygopodids have never been studied; however, we propose that mechanical stress is distributed outwardly as a shell across the expanded nasals, rather than along an anterior-posterior central column as suggested for other head-first burrowing squamates. To test how differences in morphology may be related to differing functional demands, Finite Element Analysis was implemented by applying and comparing both face loads and point loads of 20N onto 3D solid meshes of the skulls of one eastern/central and one western Aprasia, and one Ophidiocephalus. The resulting stress and strain were low in all taxa and appeared to be evenly spread out across each axis; however, Ophidiocephalus experienced slightly higher average stress than either Aprasia. Although anatomically divergent, each lineage appears to have independently converged on a similar level of biomechanical performance.

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Omics in Non-Model Species: Closing the Loop Among Genes, Molecular Systems, and Phenotypes to predict Adverse Outcomes to Environmental Stress

Omics technologies have been instrumental in characterizing the impacts of environmental stressors and stressor combinations in non-model species of concern to the US Army. The use of omics investigations has provided mechanistic and systems-level understanding of stressor impacts for species ranging from birds, lizards and amphibians to fish and coral. Recent results include functional transcriptomics expression correlations with clinical toxicological phenotypes in Western fence lizards which demonstrated the remarkable robustness of immune responses to lizard malaria infection under combined stressor exposures to food limitation and trinitrotoluene exposures. Additionally, meta-transcriptomics investigations among coal and commensal algal zooxanthellae coupled with histochemical analyses indicated heightened sensitivity to 1,3,5-trinitro-1,3,5 triazine (RDX) exposure in the zooxanthellae compromising energy production within the coral holobiont. As a final example, transcriptomics, proteomics, lipidomics and *in vitro* assays conducted across non-model species (birds and fish) and model species (rodent and human) were integrated to establish a robust Adverse Outcome Pathway (AOP) connecting molecular initiating events, key metabolic, cellular and physiological events to the adverse outcomes of lethargy and weight loss caused by nitrotoluene exposure; the mechanisms of which had remained elusive for over 100 years prior. Overall, omics-based experimental investigations have accelerated expression-to-phenotype discoveries in stressor biology providing unprecedented robustness in systems-level screening for non-model organisms.

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Vocal activity is coupled to partner proximity and mating during pair-bonding in a monogamous rodent

Prairie voles (*Microtus ochrogaster*) are one of the few mammalian species to form stable attachments, or pair bonds, between mating partners. A great deal is known about the function of vole tactile social behaviors (e.g., mating, huddling) in establishing pair bonds, but the role of conspicuous behaviors like ultrasonic vocalizations (USVs) remains a mystery. Here, we quantify the temporal dynamics of vocal activity during pair-bond formation and map these dynamics onto other measures of affiliation like partner proximity and mating. Following 4-5 days of social isolation, subjects were paired with either a familiar same-sex sibling or a novel opposite-sex mating partner for up to 22h while we continuously tracked their movements and vocalizations. For both sibling and mating pairs, time courses of vocal activity and partner distance were strongly correlated in that higher USV rates occurred when pairs were separated. Moreover, mating pairs produced higher USV rates than sibling pairs, with peaks in vocal activity linked to the male initiation of mating. Preliminary results reveal that USVs associated with mating are acoustically distinct from USVs that occur when isolated, suggesting that USVs can function both as courtship signals and contact calls. Taken together, our results suggest that prairie vole USVs function to re-establish contact with social partners and promote mating interactions that are critical for pair-bond formation.