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Making macho males by transgenic overexpression of a mitochondrial antioxidant enzyme

Many environmental stressors generate reactive oxygen species and a substantial body of work indicates that key life history traits from mating performance and sexual selection to longevity are mediated by oxidative stress. Here, we test the hypothesis that transgenic overexpression of a key antioxidant enzyme reduces oxidative damage and enhances mating performance in the context of oxidative stress. We have previously shown that females choose males with higher levels of antioxidant enzyme activity when exposed to oxidative stress prior to mating in the Caribbean fruit fly, *Anastrepha suspensa*, a species with a highly demanding lek mating system. Here we generated seven transgenic Caribbean fruit fly lines that overexpress mitochondrial superoxide dismutase (MnSOD), a key antioxidant enzyme that metabolizes damaging superoxide radicals. After exposure to severe oxidative stress, two of the lines with intermediate MnSOD overexpression showed enhanced mating performance relative to sterilized wild type males. In these two lines, improvements in mating performance and climbing corresponded with a reduction in oxidative damage to lipids, indicating that MnSOD overexpression protects flies from oxidative stress at the cellular level. Taken together, our results show a clear link between oxidative stress, antioxidant capacity and male performance, and our work shows promise for applications using transgenic approaches to enhance the efficacy of insects released as components of area-wide pest management strategies such as the sterile insect technique.

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Physiological Development of Locomotor Muscles Influence Diving Capacities in Free-Ranging Bearded Seals

Seals must store and efficiently use oxygen while diving and foraging at depth. Like all mammals, they store oxygen in their lungs, blood, and muscle, but the physiological properties of skeletal muscles play a disproportionately large role in defining diving capacities. Further, pups are not born with the same physiological abilities as adults, with muscle oxygen stores typically beginning to develop at the onset of independent foraging. Bearded seals (*Erignathus barbatus*) are large ice-dependent Arctic seals. They dive to the seafloor to search for and consume benthic fish and invertebrates, and use sea ice as a platform to rest between foraging bouts. In this study, we examined the physiological development of bearded seal locomotor muscle (longissumus dorsi). Samples were obtained from subsistence harvested bearded seals (n = 37) of different ages collected at Point Hope, Alaska. All muscle samples were analyzed for both myoglobin content and non-bicarbonate buffering capacity. We found clear and progressive ontogenetic trends in skeletal muscle physiology, which indicate that young bearded seals are at a physiological disadvantage in diving and foraging ability when compared to adults. These data provide insight into potentially sensitive life-stages, during which individuals are likely constrained in their behavior. Ultimately, defining age-specific diving capacities and physiological limitations can inform understanding of bearded seal habitat use and aid in predicting behavioral responses to environmental change.

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Masticatory Jaw Movements in Pigs, Where and When Does Variation Occur? Insights with Functional Data Analysis

Mastication is a mammalian motor behavior used to reduce and mix food with saliva before swallowing. During mastication, the jaw moves rhythmically through openings and closings, tracing a three-dimensional path. Variability in these movements results primarily from variation in food properties; however, feedforward and feedback mechanisms work to reduce the variation. Most mastication studies are based upon measurements taken at a finite set of heuristic time points in the continuous movements. This omits considerable information content in the movements. We hypothesize that critical food- and individual-specific variation occurs during times that are not typically analyzed. We employ functional data analysis (FDA) to test this hypothesis. FDA transforms complete movements into basis functions, which serve as observations for statistical analyses. We used masticatory jaw movements from four omnivorous pigs fed three foods, viz., almonds, carrots, and apples. Time series representing jaw movements were provided by Dr. Susan Williams' lab as part of a collaborative project. Functional analysis of variance (fANOVA) was used to test main effects of individual pig and food and two-way interactions. Results demonstrate that significant differences exist in time points that are rarely if ever analyzed with traditional methods. Thus, FDA is a useful approach for understanding the dynamics of complex, continuous movements in functional morphological and motor control studies.

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Interrogating the Evolution of Epidermal Growth Factor (EGF) Pathway Ligands in Insects

The EGF pathway is a conserved and ubiquitously used cell signaling cascade in animal development. In the highly studied insect *Drosophila melanogaster*, four ligands (Vein, Gurken, Spitz and Keren) are used to activate the pathway, and the protein Argos represses activation of the EGF pathway by binding to the EGF receptor. An arthropod-centered phylogenetic analysis showed that the genes encoding the ligands Vein and Argos were present in the last common ancestor of all arthropods. However, this analysis showed the genes encoding Gurken evolved in the last common ancestor of the Diptera, the clade including flies. Our analysis also provides evidence that spitz and Keren are the result of a gene duplication event in the Tephritid flies. In an attempt to determine the ancestral role of the *spitz/Keren* gene in the context of insect development, we used RNA interference targeting the orthologues of the genes in two separate lineages, Orthoptera and Hemiptera. These lineages are represented by the cricket *Gryllus bimaculatus* and the milkweed bug *Oncopeltus fasciatus* respectively.