Symposia and Oral Abstracts

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Molecular and morphological development of the shark head cavity

The vertebrate head is considered as an evolutionary novelty. However, the head mesoderm is regarded a derivative of anterior somites in the ancestral chordate. Although, our head mesoderm consists of mesenchymal cells, not epithelial segments like somites, and despite there are lots of reports about different gene expression patterns between the head mesoderm and somites, this hypothesis is widely accepted nowadays. The reason is that the shark head mesoderm contains three pair of epithelial segments called "head cavities", and there are definite morphological similarities between the head cavity and somites. Therefore, many comparative morphologists thought that the head cavity and somites were serial homologous. Is the head cavity the remainder of the somite that previously existed in the head? In order to address this question, the shark head cavity needs to be observed. Hence, we investigate whether the head cavity follows a somite like developmental process and analyze gene expression patterns, using cloudy dogfish, Scyliorhinus torazame. We found that the premandibular head cavity was not derived from paraxial head mesoderm, but from the prechordal plate, and the formation of this head cavity was later than the other two head cavities. The mandibular head cavity was recognized in the lateral sides of the endoderm, and the hyoid head cavity was seen in the dorsal part of it. On the other hand, all somites are originated from paraxial mesoderm from rostral to caudal. We also analyzed expression patterns of the muscle differentiation marker genes. We detected Pax3 expression in somites, but did not in head cavities, while, Pitx2 expression was seen in head cavities. These results suggest that head cavities are different from somites in terms of the developmental process and gene expression patterns.

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Could helminths drive geographic patterns in vertebrate eco-immunology?

Two nonexclusive hypotheses currently dominate research into the selective and mechanistic drivers of variation in vertebrate immune defenses: 1) costly immune responses must be traded-off with other life history traits and 2) higher pathogen exposure, at an evolutionary timescale, selects for higher immune responsiveness. We argue that a third nonexclusive hypothesis should be added to this list: current infection status drives the observed differences in immunological defense. In particular, infection with helminth worms can suppress many of the immune responses currently measured in eco-immunology. Here we present data from song sparrows (*Melospiza melodia*) showing negative correlations between worm burden and inflammatory immune responses, including sickness behaviors, fever, and pro-inflammatory cytokine activity, between populations and across individuals. These differences in immune function are also consistent with predictions based upon life history, suggesting that disentangling the contribution of these various hypotheses will require both experimental and statistical methods to control for worm burdens.

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To eat or not to eat: mechanisms of chemical deterrence in food rejection in the blue crab, Callinectes sapidus

Feeding behavior in the blue crab *Callinectes sapidus* involves finding food, handling it with pereiopods and mouthparts, biting, and swallowing small pieces. The decision to eat depends on the presence of appetitive and deterrent chemicals in the food. When the food is laced with chemical deterrents (*e.g.*, the ink from the mollusk *Aplysia californica*), one of the most obvious behavioral responses is a marked increase in the handling time, which may be followed by outright rejection of the food. As a first step toward understanding the mechanism of deterrence, we investigated the localization and specificity of the chemoreceptors responsible for rejection using behavioral and electrophysiological techniques. Behavioral observations and ablation studies revealed that the deterrent receptors are not located in the antennules, pereiopods, or maxillipeds. This is further supported by electrophysiological evidence showing that a fraction of *Aplysia* ink containing aplysioviolin and phycoerythrobilin, which are feeding deterrents, is not a good stimulus for maxilliped chemoreceptors. Two lines of evidence lead us to conclude that the chemoreceptors responsible for rejection are located inside the crabs' digestive tract. First, a piece of shrimp introduced inside a restrained crab's mouth will be consumed unless it is laced with a deterrent, in which case it is rejected through oesophageal dilation (*i.e.*, opening the oesophagus and retracting the labrum into the cavity formed). Second, a feeding deterrent applied by itself to the mouth evokes oesophageal dilation. We conclude that deterrence is mediated by receptors located in the oesophagus and are currently attempting to characterize them electrophysiologically. Funded by NSF IOS-1036742 and IOS-0614685.

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Evolutionary dynamics of the boxfish carapace II: functional diversity

The carapace is thought to confer both mechanical defense and hydrodynamic stability to aracanid and ostraciid boxfishes though little is known about the functional consequences of the conspicuous morphological diversity found within these clades. To test whether shape influences carapace strength we use finite element analysis to simulate dorso-ventral biting forces on 25 three-dimensional models representing the morphological diversity of extant boxfishes. To assess the influence of shape on hydrodynamic properties, we use computational fluid dynamics to simulate flow around our models under a range of angles of attack. Drag coefficients ranged between 0.129 (Ostracion cubicus) and 0.168 (Anoplocapros lenticularis). Frontal surface area was good predictor of the total drag force on volume-standardized while variation in viscous shear forces between the species was negligibly low. Phylogenetic comparative analyses reveal the functional properties of reconstructed ancestral carapace morphologies and evolutionary relationship between mechanical defense and hydrodynamic stability.