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Biogeographic Insights from Molecular Phylogenetics of Pacific Northwest Sea Stars

Recently molecular phylogenetic analyses of the Asteroidea have produced comprehensive and well−resolved trees for the Forcipulatacea and the Valvatacea, two of the most taxonomically diverse and ecologically important groups of asteroids. Although our work is broadly concerned with higher level phylogeny, we have focused on projects across a diversity of scales and herein we present highlights from our work that emphasize interests relevant to asteroid taxa on the west coast of North America. Analysis of the Asteriidae shows it is composed of multiple clades corresponding to specific geographic/climatic regions. The boreal clade suggests endemism for asteriids occurring on the west coast of N. America and adjoining regions, including familiar genera such as *Pisaster* and *Leptasterias*. *Pycnopodia* and the deep−sea *Rathbunaster* were supported as sister taxa which presents at least 2 different hypotheses of relationship. The goniasterid *Hippasteria* includes 15 nominal species and is widely distributed in cold−water settings throughout the Atlantic, Pacific and southern Indian Ocean. In order to assess relationships and genetic structure, we sampled populations from throughout the world. Partial sequences for a mitochondrial gene (COI) and a nuclear gene (ATPS) were obtained for approximately 150 specimens. Our results showed little ongoing genetic exchange between trans−Arctic populations. Only 1 of 31 COI haplotypes and 4 of 16 ATPS haplotypes were shared among two or more ocean regions (N. Pacific, S. Pacific and N. Atlantic) despite sampling between 50−100 sequences per region. The widespread *H. phrygiana* identified from Atlantic, New Zealand, and Kerguelen Island populations and *H. spinosa* from the N. Pacific were all supported as one widely distributed global lineage, which has recently diversified.

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Neuromuscular modulation of kinematic performance in hovering hummingbirds

While producing the highest power output of any vertebrate hummingbirds must also precisely modulate muscle activity to vary wingbeat kinematics and modulate lift production. However, wingbeat kinematics can vary in different ways depending on whether increased lift requirements are the result of lifting greater mass or hovering in lower density air mixtures. It is possible that differences in drag on wings due to variation in air density and viscosity may affect wingbeat kinematics that result from given muscle activation profiles. We evaluated whether wingbeat kinematics varied in response to increased lift requirements differently in hypodense heliox gas mixtures compared to when birds were hovering while lifting small weights and whether any differences were solely a function of muscle activation patterning. To do this, we simultaneously recorded wingbeat kinematics and electromyograms (EMGs) from the pectoralis and supracoracoideus (responsible for the downstroke and upstroke, respectively) in ruby−throated hummingbirds (*Archilochus colubris*). As expected, increased lift was achieved through increases in stroke amplitude during both treatments. However, wingbeat frequency increased only during air density reduction trials. Overall relative EMG intensity was the best predictor of wingbeat frequency, stroke amplitude, and power output, while the relationship of kinematic features to spike number and EMG amplitude was less consistent. The relationship between EMG intensity and kinematics was quite similar between treatment types, suggesting wingbeat frequency did not change solely as a result of decreased drag on the wings. Despite the relative symmetry of the hovering downstroke and upstroke, the timing of activation and number of spikes per EMG burst were consistently different in the supracoracoideus compared to the pectoralis, likely reflecting differences in muscle morphology.

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Testing for exceptional among−island convergence in Greater Antillean Anolis: introduction and application of a novel comparative method

Replicated adaptive radiations suggest that diversification may be strongly deterministic, even over macroevolutionary timescales. However, species−rich clades are expected to produce many convergent species by chance alone, such that the convergence we observe among selected species pairs in replicated radiations may be nothing more than a by−product of extensive diversification. To date, there have been few studies of clade−wide convergence, and these have tended to examine only those species that are most obviously similar. It thus remains to be determined whether the similarity of these clades is due to deterministic adaptive convergence. To test this hypothesis, we investigated patterns of trait evolution in Greater Antillean *Anolis* lizards, a group famous for among−island convergence. We developed an Ornstein−Uhlenbeck method for detecting convergence of lineages to the same peaks on a shared macroevolutionary landscape, without requiring prior hypotheses about which lineages may have converged. This allows us to test for convergence in faunas with some non−convergent species, which must be ignored by alternative methods. Applying this method to island anoles, we found exceptional clade−wide convergence among islands, supporting the hypothesis that evolutionary radiation has deterministically produced similar outcomes in *Anolis*. Although not every species of Greater Antillean anole has a phenotypic match from another island, most do, and among−island convergence greatly exceeds expectations from evolutionary null models. Our results demonstrate that historical contingencies are insufficient to preclude the emergence of deterministic macroevolutionary patterns during diversification.

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How seahorses hang on to their life

Tail prehension is a common, although poorly studied behavior among seahorses. We investigate this behavior in the potbellied seahorse, *Hippocampus abdominalis*, and the longsnout seahorse, *H. reidi*. *Hippocampus abdominalis* has a slender tail and significantly higher number of tail segments (45−48) than *H. reidi* (33−37). We hypothesize that the tail of *H. abdominalis* would be more flexible than the shorter tail of *H. reidi*. We compared 3D grasping kinematics on a 1cm horizontal perch. In *H. reidi* the whole tail is involved in grasping with an increased range of motion towards the tip. In contrast, in *H. abdominalis* the most proximal third of the tail is not involved in grasping. Still, other kinematic variables are similar for the two species. In addition, both species show lateral bending during tail curling, an unexpected finding that might be important for modulation of grasping in substrates with different orientations, such as corals and seagrasses. Different artificial holdfasts were also tested in a preference study in *H. abdominalis*. Seahorses selected for vertical oriented, cylindrical and smooth holdfasts. However, color (sand vs. green) and holdfast diameter (1 and 1.5cm) were neutrally selected for. Preference for vertical holdfasts is likely a result of the relative abundance of similarly oriented substrates in the wild, and thus selection for lateral bending may have played a role in prehensile tail evolution in seahorses. Pot−bellied seahorses also selected negatively for rough and blade like structures, which is likely explained by increased contact area in smooth, cylindrical surfaces which should facilitate attachment. Negative selection for rough structures seems to indicate that friction mechanisms are not predominant, while selection for higher contact area suggests reliance on wet adhesion and muscular grasping.