Decades of comparative anatomical studies in ichthyology and herpetology have resulted in a rich body of ‘free-text’ data. As these data grow, they are increasingly hard to align and synthesize across taxonomic groups, and synthetic questions concerning the developmental and genetic basis of evolutionary changes in morphology cannot be easily or efficiently addressed. In order for this volume of comparative anatomical data to be analyzed in a developmental genetic context, it must first be rendered computable. One way to achieve this is to use ontologies. Using ostariophysan fishes as a prototype, the Phenoscape project has developed a system that includes ontologies representing expert knowledge of anatomy and taxonomy (the Teleost Anatomy Ontology and the Teleost Taxonomy Ontology), software for data curation (Phenex), and a knowledgebase that supports ontology-based reasoning about evolutionary phenotype data (PhenoscapeKB, http://phenoscape.org/kb). To date, over 5,000 characters from the phylogenetic literature have been annotated for 8,300 species, resulting in over eight million annotated phenotypes. PhenoscapeKB combines these evolutionary phenotypes with information about genetically characterized phenotype from ZFIN, the zebrafish community database. Through ontology-based reasoning over expert knowledge in taxonomy, comparative anatomy and developmental genetics, PhenoscapeKB can be used to address a host of questions spanning the domains of genetics, development and evolutionary biology, such as the nature of the genetic changes underlying phenotypic variation among taxa in nature.
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442 Fish Systematics I, Grand Ballroom II, Thursday 23 July 2009

Kohji Mabuchi¹, Thomas Fraser², Yoichiro Azuma¹, Mutsumi Nishida¹

¹Ocean Research Institute, The University of Tokyo, 1-15-1 Minamidai, Nakano-ku, Tokyo 164-8639, Japan, ²Mote Marine Laboratory, 1600 Ken Thompson Parkway, Sarasota, FL 34236, United States

Molecular Phylogeny of the Cardinalfishes (Apogonidae) and non-monophyly of Apogon sensu lato

Cardinalfishes (Apogonidae) are one of the most numerically dominant reef fish families, mostly nocturnal, and many known to be mouthbrooders. The family contains about 333 valid species with 24 genera and 15 subgenera recognized to date within the family. The genus *Apogon* sensu lato, historically, has been the most speciose genus. Some lists estimated the number of species to be about 200 species. Taxonomy of *Apogon* is currently unsettled. Ten subgenera were recognized in 1972. A few authors elevated some subgenera to genera following a doctoral dissertation on the cephalic lateralis system in 2004. While a molecular paper in 2006 indicated the non-monophyletic nature for the subgenus *Ostorhinchus*, monophyly of *Apogon* sensu lato is yet to be evaluated. Thus, we conducted a molecular phylogenetic analysis using about 100 species representing about 23 genera. Over fifty species of *Apogon*, representing about nine subgenera, were included in this study. Using three gobioids as collective outgroups, the monophyly of *Apogon* was evaluated phylogenetically based on DNA sequence data. Preliminary molecular phylogeny inferred by Bayesian method based on ca. 1500bp of mitochondrially encoded 12S and 16S rRNA genes demonstrated that the genus *Apogon* was polyphyletic with over 10 well-supported monophyletic groups being recognized from the genus. While some of the monophyletic groups corresponded to existing subgenera (e.g. *Pristiapogon*, *Zoramia*), some subgenera (e.g. *Ostorhinchus*, *Apogon*) were respectively divided into multiple independent groups, some forming well-supported monophyletic groups with non-*Apogon* species. The result supports revising the generic/subgeneric framework for the family.
Functional Morphology of Pelvic Fin Locomotion in Batoids

"Punting" is a form of benthic locomotion wherein a batoid (skate or ray) digs its pelvic fins into the substrate and thrusts itself forward. It was thought to be restricted to skates, but we have shown that it is widespread in Batoidea. By examining kinematic and pelvic fin musculature we previously revealed a continuum of punting ability with a corresponding continuum of pelvic fin musculature. True punters, such as Narcine brasiliensis and Raja eglanteria, use only their pelvic fins and possess more specialized and more robust muscles. Augmented punters, such as Urobatis jamaicensis and Dasyatis sabina, punt with assistance from their pectoral fins, and possess fewer and less substantial muscles. We also used three-point bending tests of the main skeletal element involved in punting, the propterygium, to test if flexural stiffness correlates with punting style. We found that propterygia of the true punters have approximately 80% greater flexural stiffness than the augmented punters (p<0.05). Moreover, propterygia of the augmented punters have almost twice the flexural stiffness of the non-punting pelagic stingray (Pteroplatytrygon violacea) (p<0.05). The concordance of musculature and skeletal stiffness with punting ability provides us with predictive power regarding the punting kinematics of other elasmobranchs based gross muscular examinations and skeletal material properties. By pairing our results with phylogenetic information, we can also gain a better understanding of the evolution and radiation of batoids.

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Natural History and Den Site Fidelity of Prairie Rattlesnakes (Crotalus viridis viridis) in Northeastern Colorado

Historically, Prairie Rattlesnakes on the eastern plains of Colorado relied on natural fissures and prairie dog towns as hibernacular sites, often reaching very high densities. With wide-scale changes to the habitat and loss of large dog towns, rattlesnakes now often utilize anthropogenic structures as retreats. On a large private ranch, two metapopulations of Prairie Rattlesnakes utilize railroad burms and culverts as den sites. From 2002-2008, in spring and fall, we collected as many snakes as possible, and PIT tagged, measured and extracted venom. Of 497 captures, 406 unique individuals were
tagged, and 96 repeat captures were recorded. The sex ratio was slightly male biased (1.06:1), and neonates are born in late August-early September. Snakes emerge from hibernacula in mid-March and return to den sites in mid-September; snakes remain in the vicinity of the den site and are surface-active until at least mid-October. The two den sites are approximately 1.5 km apart, but there was >95% site fidelity observed in recaptured snakes. Recorded predators include owls, badgers and humans. In summer 2004, the railroad blocked one of the culverts in an attempt to keep snakes away from the railroad right-of-way; shortly thereafter, snakes began to take up residence (hibernate) under a Level 3 communications building (approximately 100 m SE of the west den site). Prairie Rattlesnakes can respond relatively rapidly to negative changes in critical resource availability, provided that a suitable substitute is available. However, because snake:human interactions are now more frequent, the long-term stability of this population is uncertain.

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227  Evolution & Ontology Symposium, Grand Ballroom I, Saturday 25 July 2009

Anne Maglia¹, Jennifer Leopold¹, Susan Gauch², Analia Pugener¹

¹Missouri University of Science and Technology, Rolla, MO, United States, ²University of Arkansas, Fayetteville, AR, United States

Development of an Anatomical Ontology for Amphibians

Herein, we describe our ongoing efforts to develop a robust ontology for amphibian anatomy (www.amphibanat.org) that accommodates the diversity of anatomical structures present in the group. We discuss the design and implementation of the project, current resolutions to issues we have encountered, and future enhancements to the ontology. We also comment on efforts to integrate other data sets with the amphibian anatomical ontology.

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400 Herp Biogeography, Galleria North, Saturday 25 July 2009

James Mahaffy

Dordt College, Sioux Center, IA, United States

Historic Extensions of Rattlesnake Ranges (Timber Rattlesnake, Crotalus horridus and Massasauga, Sistrurus catenatus) from Five Counties in South-eastern and South-central Minnesota

Historic evidence suggests that the range of Minnesota rattlesnakes was originally more extensive than it is today. While their current (or recent historic) range is limited to eight counties along the Mississippi River, in the 1800's their range likely extended from those counties all the way to Mankato in south-central Minnesota. Strong historic evidence
from the late 1800's was found for rattlesnake populations in Dodge, Waseca, and Blue Earth Counties of Minnesota. Newspapers and an early history (Smith 1884) record several bites in Dodge County and also give descriptions of rattlesnakes (including the number of rattles) and their habitat. In many cases, these Dodge County snakes are clearly timber rattlesnakes. Waseca’s early history (Child 1905) and newspapers record several bites and one rattlesnake death. Also, two reports of fatal bites and descriptions of dense rattlesnake populations on the prairie were found in early newspapers from Blue Earth County. The rattlesnake populations in Mower County extended into eastern Freeborn County since newspapers record rattlesnake bites from London, Moscow, and Riceland Townships. In Dodge and Rice Counties, evidence suggests that some of the rattlesnakes were massasauga. Smith’s 1884 history indicates that massasauga were found in Dodge County, and the Mantorville Express of 1858 records a "massasauger bite" near Wäsiöja in Dodge County. Evidence for massasauga also comes from Rice County, where the description of an 1870 fatal rattlesnake bite in a marshy area is most consistent with a massasauga bite.

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645 Herp Development & Morphology, Galleria North, Sunday 26 July 2009; ASIH STOYE AWARD GENETICS, DEVELOPMENT & MORPHOLOGY

D. Luke Mahler

Harvard University, Cambridge, MA, United States

Convergence and Parallelism in the Evolution of *Anolis* Tail Length

In *Anolis* lizards, similar environments have spurred the evolution of similar species numerous times. But have these species evolved to look the same via the same mechanisms (parallelism), or has similarity been achieved through different evolutionary pathways (convergence)? Using data on a broad diversity of neotropical anoles, I investigated the relative roles of convergent and parallel processes in the evolution of long and short tails. Typically, in *Anolis*, grass dwelling lizards have relatively long tails whereas twig and branch specialists have short, but semi-prehensile tails. These repeated patterns are thought to reflect common locomotor solutions to similar ecological conditions. However, anole tail length may change as a result of two different developmental processes, namely serial addition (or subtraction) of vertebrae versus elongation (or shortening) of individual vertebrae (henceforth referred to as ‘addition’ versus ‘elongation’). I generated radiographs from more than one hundred Caribbean and mainland anole species to determine whether relatively long and short-tailed species achieved their tail lengths via addition or elongation. I examined these traits in the context of the anole phylogeny to ask: 1.) Is tail length convergence achieved through developmental convergence or parallelism? 2.) Are the strategies of addition versus elongation associated with particular clades? 3.) Do addition and elongation correspond with particular ecological or morphological specializations? This study has important implications for understanding the processes underlying the repeated evolution of ecomorphological similarity in anoles, and provides one assay of whether superficially convergent species have arrived at similar endpoints through similar or unique developmental means.
If you Build it, they will Come. Oviposition of Columbia Spotted Frogs in Man-Made Ponds in Eastern Oregon

Columbia Spotted frogs (*Rana luteiventris*) were once abundant throughout Oregon. Prior to 1940, it was found in portions of the Puget Sound. They now appear to be virtually eliminated from these areas. Major factors contributing to their loss include: modification to their habitat and introduction of non-native aquatic species. Columbia Spotted frogs prefer cold quiet waters in which to lay their eggs and to forage. McCoy creek, an upper tributary of the Grande Rounde River (located in Northeast Oregon) was canalized approximately 25 years ago. Farm crops were planted and cattle were grazed there until 1995. Beginning the summer of 1997, McCoy creek has been under active restoration. Between 1997-2000 work was preformed to restore the creek to its original path. The old channel was dammed and a series of "swimming pool" shaped ponds were established. During the summer of 2002, these ponds were reshaped. Starting in the 2003 spring breeding season, frogs began exploiting these ponds. Of the 12 ponds created, frogs deposited eggs in 8. Before this time, no oviposition occurred in the "swimming pool" shaped ponds. The only pond that was utilized by the frogs prior to the reshaping was one small Oxbow pond. Since 1999, the number of egg masses has increased from 5 egg masses to 183 egg masses.

Escape Responses in Young of the Year Spiny Dogfish

Most species encounter greater predatory pressure early in life, before maturation. To evade predators, the most common behavior an animal will use is an escape response. In this study, escape behavior is investigated in young of the year spiny dogfish, *Squalus acanthias*. Escape responses were elicited by gentle nudging of the tail region to represent a possible predatory event in seven individuals. The results were compared with published data on adult spiny dogfish escape responses. Similar to adult spiny dogfish, the young of the year exhibited C-type escape responses, characterized by a bend into a C shape in stage 1, followed by a return to a natural position in stage 2. Duration, center of mass speed, snout speed, turning rate, and turning angle were quantified for stages 1 and 2. Unlike spiny dogfish adults, young of the year spiny dogfish do not show a bimodal distribution in response type. Size corrected maximum velocity of the escape response is faster in the young of the year dogfish, with absolute values close to the values reported at the lower end of the spectrum of adult dogfish. Mean angular velocities in young of the year dogfish are similar to the faster values reported for
adults, and maximum angular velocity was faster than in adults. This is consistent with previous reports on greater maneuverability in smaller sized fish. Overall, young of the year spiny dogfish are competent in fast starts although modulation of response type is absent.

796 Fish Genetics II, Parlor ABC, Monday 27 July 2009
Tuuli Makinen¹, Gloria Arratia², Richard Broughton³, Chenhong Li⁴, Guillermo Ortí⁴, Andreś Lopez¹

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**Molecular Clocks and the Timing of Ostariophysan Radiations**

Modern molecular clock methods allow the estimation of clade divergence times despite the problems posed by variable rates of molecular evolution. These methods have the potential to enrich biogeographic and evolutionary interpretations of biological lineage histories, but there is still disagreement over the applicability and limitations of different models. Application of these methods to the ostariophysan radiations have produced new hypotheses on the timing of the origin and diversification of ostariophysan fishes. Initial molecular clock estimates of the age of the Ostariophysi and major ostariophysan clades have indicated that these groups originated significantly earlier than the first fossil occurrences of members assigned to the relevant lineages would suggest. Estimates based on mitochondrial DNA sequences place the origin of the group at 251 mya, while all identified fossils of this group are younger than 150 my. Differences of similar magnitude are found between the estimated ages of extant ostariophysan subgroups and their earliest fossil occurrences. We examine the evidence and methods underlying the new proposals. In our review of fossil records ascribed to the Ostariophysi, we found that some fossil calibrations points chosen for previous divergence time estimates were incorrect or of uncertain affinity. We conducted a series of divergence time analyses to show that choice of analysis method, fossil calibration points and taxon sampling have major effects both on the phylogenetic hypothesis and the estimated divergence times under a particular phylogeny. We discuss the choice of fossil calibration points and other possible ways of improving the analyses.

250 AES GRUBER AWARD I, Parlor ABC, Thursday 23 July 2009
Aleksandra Maljkovic, Isabelle Côté

Simon Fraser University, Burnaby, BC, Canada

**Hey, Where's My Dinner Gone? Fishing and the Trophic Consequences for Caribbean Reef Sharks**
Across marine ecosystems, the selective removal of large quantities of high trophic level species has been termed ‘fishing down the food web’. While the direct consequences of these fisheries are receiving much attention, the indirect impacts on the structure and functional integrity of marine communities remain far from understood. In this study, we quantify the indirect effects of coral reef-based fisheries on the trophic ecology of Caribbean reef sharks (*Carcharhinus perezi*) over a gradient of fishing pressures in the Bahamas. Using a combination of prey availability surveys, stable isotope analysis and remote acoustic telemetry, we show that reef sharks inhabiting un-fished and lightly fished sites feed at significantly higher trophic levels, and over smaller ranges, than sharks at heavily fished sites. The results suggest direct competition between reef sharks and fishers for the same resources, with potential costs to the sharks in terms of maintaining minimum energy requirements and/or optimal foraging. Human-mediated depletion of preferred prey species is likely to have wider ecosystem consequences than previously thought.

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309 Poster Session I, Exhibitor’s Hall, Friday 24 July 2009; AES CARRIER AWARD

Aleksandra Maljkovic, Isabelle Côté

*Simon Fraser University, Burnaby, BC, Canada*

**The Shark Feeding Debate: What Can the Sharks Tell Us?**

Feeding sharks as a tourist attraction is a hotly debated issue, yet many of the arguments both for and against the activity are based solely on anecdote and opinions alone. Shark-related tourism is a non-extractive alternative to other forms of commercial exploitation of sharks, and is often touted as an economic incentive promoting the conservation of many coastal species. However, to be sustainable in the long term, shark feeding activities must be undertaken with due regard for the ecology of both sharks and their habitat. As such, detecting changes in the feeding ecology and spatial dynamics of provisioned sharks is integral in predicting the potential effects of this activity on their functional role within the community. In this study we attempt to quantify the trophic and behavioural consequences of shark feeding for Caribbean reef sharks (*Carcharhinus perezi*) in the Bahamas. By combining 100+ hours of direct observation at shark feeds, stable isotope analysis of muscle tissue from fed and unfed sharks, and a remote acoustic telemetry study, we show that provisioned sharks exhibit significantly different trophic signatures and behavioral patterns than their un-provisioned conspecifics. The implications of these findings for the conservation of coastal shark species will be presented.

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Study Of The Velvet Belly Lantern Shark, *Etmopterus spinax*, Luminous System

Bioluminescence is the ability of living organism to produce visible light thanks to a chemiluminescent reaction. Widely distributed among marine organisms, this property is observed from bacteria to fish, the only luminous vertebrates. In fish, luminous osteichthyans and chondrichthyes representatives are known. Production of light in chondrichthyes is still poorly understood in terms of physiology, ethology and biochemistry mainly because of the difficulties to obtain living specimens. One species, the velvet belly lantern shark, *Etmopterus spinax* has recently attracted a lot of interest at ecological and populational levels. A new research program developed in our lab focused on various aspects (physiology, ethology and biochemistry) of bioluminescence of this shark. First biochemical results reveal that light production is based on a luciferin called coelenterazine. Repartition of the luminous compounds, luciferine and luciferase, in different organs of sharks of different sizes and sex were analysed. Test were carried out on free-swimming specimens as well as on embryos. Further characterisation of luminous compounds are required in order to confirm the hypothesis that (i) luminescence capabilities might be acquired by food chain; (ii) maternal transfert of luminescence to the embryo.

Factors Influencing Success of a Marine Protected Area Network in Hawai‘i

As Marine Protected Area (MPA) Networks gain management support, the importance of documenting factors that affect their effectiveness increases. Previous work showed greater abundance of juvenile and adult fishes harvested for the aquarium trade in individual MPAs compared to adjacent control sites within the MPA Network on the western coast of the island of Hawai‘i (Tissot et al. 2004). The present study evaluated the relative contribution of habitat characteristics, adult abundance, and current exposure to the greater juvenile abundances observed within MPAs. Oceanographic, substrate and habitat characteristics were sampled with juvenile and adult fish abundances at three paired sites (MPA vs. control) along the western coast of the island of Hawaii. All three factors contributed to greater juvenile abundance of the study species, but differed in relative contribution among sites. We demonstrated the importance of selected factors to the effectiveness of a MPA network. Based on our
results, we emphasize the value of consideration of several factors that potentially influence success of the defined goals for specific MPAs or networks.

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440 AES Functional Morphology Symposium, Grand Ballroom II, Friday 24 July 2009; AES GRUBER AWARD

Kyle R. Mara, Philip J. Motta

University of South Florida, Tampa, FL, United States

Evolution and Function of the Hammerhead Cephalofoil I: The Evolution of Cranial Form

The head must contain structures associated with feeding, respiration, neural integration, sensory reception, and musculoskeletal support. Functional and morphological trade-offs are particularly important within spatially limited structures such as the head. The sphyrnid head presents an excellent model for investigating these potential trade-offs. Carcharhinus acronotus, Eusphyra blochii, Sphyrna lewini, S. mokarran and S. tiburo were chosen to represent differences in head form through phylogeny. A combination of surface based geometric morphometrics and computed tomography volumetric analysis was utilized to investigate implications of change in head form. The more basal E. blochii has small anteriorly positioned eyes. Through phylogeny the relative size and position of the eyes changes, such that derived species have larger more medially positioned eyes. The position of the external nares is highly variable, showing no phylogenetic trend. Mouth size and position are conserved, remaining largely unchanged, however upper and lower jaw volume is variable. Relative to carcharhinid outgroups, the feeding muscles, nasal capsule, olfactory tract, braincase, and chondrocranium all increase in relative volume in the hammerhead sharks, potentially indicating a release in spatial constraint. However, within sphyrnid sharks jaw cartilages and jaw closing muscles show variable yet parallel changes in volume, and the volumes of the upper jaw protruding muscles increase while the volumes of the braincase, nasal capsule, and eye remain constant through phylogeny. These data indicate that much of the head is morphologically conserved, however the jaw cartilages and their associated muscles vary and account for much of the internal morphological diversity within the clade.
Photographic Identification of Individual Foothill-yellow Legged Frogs (*Rana boylii*) Using Chin Mottling Patterns: An Effective Method for Long-term Studies

We identified individual foothill yellow-legged frogs (*Rana boylii*) using pattern mapping of chin mottling patterns by visually matching digital photographs from two separate field studies in California. Photographs were collected from adult (>40 mm SUL) and subadult frogs from Hurdygurdy Creek (Humboldt Co.; 2002-2004) and the North Fork Feather River (Butte Co.; 2004-2008). A total of 1,239 individuals have been identified to date from both studies; PIT-tags were inserted into a subset of 341 individuals, 78 of which were recaptured and verified that no two individuals had identical markings and that markings did not change with growth. We found this method useful for determining movement and breeding patterns and estimates of longevity; preliminary results indicate that females live at least 8 years in the wild and may breed for at least 5 years. This method offers a reliable, non-invasive way to conduct mark-recapture studies on *R. boylii*, and has great potential to be applied to other western ranid species.

Observations on the Reproductive Biology of the Chilean Round Ray, *Urotrygon chilensis* From the Southern Gulf of California, Mexico

The Gulf of California (GOC) is a highly productive area with considerable ichthyofaunal diversity that forms the basis of several commercial fisheries. The largest batoid fishery in Mexico operates in the GOC, and bycatch in the regional shrimp trawl fishery is also substantial and may rival directed landings as a source of mortality. Close monitoring of this and other of non-commercially important batoid species is necessary to update or confirm their conservation status (i.e., IUCN Red List assessment). Despite
the great diversity of elasmobranchs in the GOC, little life history information is available for most species. To address this lack of critical biological information, the reproductive biology of the Chilean round ray, *Urotrygon chilensis*, was investigated based on specimens obtained by fishery independent trawl surveys of the Instituto Nacional de Pesca. Maturity stages were assigned by visual inspection of the development of claspers and testes for males, and by measurements of the oviducal gland, largest ovum diameter, and uterus width for females. Fitting a logistic regression to binomial data (0=immature, 1= mature) yielded median size at fifty percent maturity values of 15.2 (15.1-15.7 cm) cm DW and 14.6 (14.1-15.3 cm) cm DW for males and females, respectively. Pups typically born during spring after a gestation period of approximately 5-6 months. Mean fecundity was estimated to be 1.8 (range 1-5, s.d. = 1.0) with a 1:1 sex ratio. Size at birth ranged from 6 to 9 cm DW. Gravid females were typically found in shallow subtidal waters (< 10 meters).

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51 Herp Ecology, Galleria North, Monday 27 July 2009

David Marsh

*Washington and Lee University, Lexington, VA, United States*

**Season and Size-specific Demography of a Terrestrial Salamander**

Northern red-backed salamanders (*Plethodon cinereus*) have been important models for the study of community ecology and sociobiology, and they are regularly monitored to assess forest health. However, because Red-backed salamanders are often underground and are recaptured infrequently, surprisingly little is known about their demography. I used a mark-recapture dataset from over 3000 animals to estimate demographic parameters for *P. cinereus* and to examine variation in these parameters among seasons, sexes, and size classes of salamanders. Survival was strongly size-dependent, with larger animals having much higher survival rates. Almost all growth of salamanders occurred between the spring and the fall, but almost all the mortality also occurred during this period. Mortality was surprisingly low over three successive winters. These findings generally confirm the suggestions of previous researchers about the demography of terrestrial salamanders though this study is the first to rigorously quantify these parameters.

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103 Clark Hubbs Symposium, Galleria South, Saturday 25 July 2009

Edie Marsh-Matthews

*University of Oklahoma, Norman, OK, United States*

**Clark Hubbs’ Contribution to Fish Life History Ecology**
Among his many contributions to fish ecology, Clark Hubbs published numerous papers on reproductive ecology of darters, silversides, poeciliids, and other species. His studies of fish life history ecology were particularly important because they not only described basic reproductive and early developmental characteristics of the individual species, but also focused attention on variation within species. This emphasis on intraspecific variation and its underlying causes provided invaluable data on geographic variation, maternal effects, and phenotypic plasticity. These topics were barely acknowledged (and mostly ignored) in the 1970s and early 1980s when modern life history theory was emerging, but their importance is now widely recognized and they have become foci of modern studies. Clark’s approach to life history ecology of fishes was to become a standard for the field.

102  Live-Bearing Fish Symposium, Grand Ballroom I, Sunday 26 July 2009

Edie Marsh-Matthews

*University of Oklahoma, Norman, OK, United States*

**Incipient Matrotrophy: Potential Roles in Offspring Provisioning in Lecithotrophic Poeciliids**

Many poeciliid species that were once thought to provision offspring solely through yolk sequestered in a large egg have been found also to transfer nutrients to developing embryos. This typically low level of nutrient transfer has been called “incipient matrotrophy” and has been largely ignored as part of the overall offspring provisioning. Recent studies, however, have demonstrated that levels of incipient matrotrophy vary with maternal and embryo characteristics and with resources available to the mother. These findings suggest that incipient matrotrophy may allow females to alter post-fertilization provisioning to affect both maternal and offspring fitness. Potential roles of incipient matrotrophy range from supplementation of yolk stores, to maternal manipulation of offspring size or gestation time, to cryptic female choice. Evidence for these and other potential roles of incipient matrotrophy in *Gambusia* species will be discussed.

1040 Clark Hubbs Symposium, Galleria South, Saturday 25 July 2009

F. Douglas Martin, Adam Cohen

*University of Texas, Austin, TX, United States*

**Amazon Molly: Is It An Invasive Species?**

The gynogenetic species, *Poecilia formosa*, is thought to be native from the Nueces River of Texas to Río Tuxpan in Mexico. This species is known to have been introduced into upper reaches of the San Antonio River and the San Marcos River where it has become
very abundant. Recent sampling has found this species in the Aransas River drainage, the Mission River and coastal plains reaches of the Brazos River in Texas. We have begun a program to examine whether these new records are the results of recent introductions, natural range extension or whether they have simply been overlooked in the past.
Stock Assessment With Citizen Scientists: Trends and Trajectories for Populations of California Grunion

Sandy beaches in California are prime recreation areas for humans, and they are also critical habitat for many unique endemic species. One of these, the beach spawning California Grunion, is a marine silverside that completely emerges from the waves to spawn on shore. Its Essential Fish Habitat is in some of the most populated coastal areas of California. Human impacts on this species include a popular recreational fishery, shoreline armoring, habitat loss, and vehicular traffic over the intertidal nesting sites. California Grunion, *Leuresthes tenuis*, cannot be assessed with traditional fishery methods. The unique spawning behavior provides a vital window onto the population size, because this fish is rarely seen at any other time. As a result there have been few attempts to understand the population size or dynamics over time for this species. Over the past 8 years, local residents of coastal communities have volunteered to be citizen scientists, monitoring spawning runs of this charismatic silverside. The volunteer Grunion Greeters have provided substantial data on locations, strength, and duration of spawning runs over much of the species habitat range. These data show changes over the course of the year and over the course of different tide series. Runs reported across different beaches on the same night are highly variable, and the runs change over the course of the season. Comparisons are made across the years of the program, and to historical accounts of grunion runs, in order to improve management of this vulnerable natural treasure.

Phylogenetic Survey of Urinary Bladder Compliance in Anurans

Relatives of amphibians were the first tetrapods to make the transition from an aquatic to the terrestrial world. Occupying a terrestrial environment meant that free water sources may be limited and evaporative water losses would be high. It is well known that the dilute urine contained within the urinary bladder, a ventral out-pocketing of the cloaca, can be used to replenish water lost by evaporation and the urine volume stored is greater in terrestrial species (Ruibal 1962; Shoemaker 1964; Bentley 1971; Jorgensen 1997). Previous assessments of bladder capacity have used either periodic bladder draining or in vitro bladder filling to make interspecific comparisons. Each of these methods has intrinsic difficulties with assessing actual interspecific anatomic differences. Urinary bladder compliance (D volume/D pressure), determined in vivo, is an objective measure of bladder anatomic differences since it eliminates behavior, yet includes the impingement of other anatomic organs (lungs, reproductive and digestive...
organs) and body wall musculature on bladder volume. In a comparison of *Chaunus marinus*, with *Lithobates grylio*, the more terrestrial toad had a significantly more compliant urinary bladder than the more aquatic frog 4440 and 2050 ml kPa⁻¹ min⁻¹ respectively (Martin and Hillman 2009). A more comprehensive phylogenetic analysis of bladder compliance needs to be conducted to understand what fraction of known interspecific differences in stored urine volume is the result of differences in bladder compliance, an integrated measure of bladder anatomy in concert with the organs and pleuroperitoneal cavity that surround it versus behavioral differences.

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**825 Poster Session III, Exhibitor’s Hall, Sunday 26 July 2009**

Natalie Martinez-Takeshita, Michael P. Franklin, Larry G. Allen

*California State University Northridge, Northridge, CA, United States*

**The Global Genetic Diversity of *Seriola lalandi* (Yellowtail)**

The Yellowtail (*Seriola lalandi*), one of the most important sport and commercial species off southern California, is the largest member of the Jack family (*Carangidae*). These cosmopolitan fish can be found in subtropical and temperate waters. *Seriola lalandi* are commercially fished, recreationally fished, and farm raised in the regions they occupy, thus providing an important food source and a sizeable economic impact for the people in these countries. DNA samples were collected from California (Channel Islands, Catalina Island & San Clemente Island), the Pacific Coast of Baja California, the Gulf of California, New Zealand, and Chile. Further sampling will also include Japan and South Africa. A mitochondrial DNA analysis using the d-loop will be used to determine the population structure and genetic variation between distinct sites. It may also be possible to identify subspecies and changes in population structure due to fishing pressures, as well as, migratory patterns of this global species. The genetic analysis will provide valuable information to help properly manage and sustain these fish populations in the future.

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**218 Herp Reproduction & Behavior, Broadway 1&2, Friday 24 July 2009**

Glenn Marvin

*University of North Alabama, Florence, AL, United States*

**Sexual and Seasonal Dimorphism in the Cumberland Plateau Woodland Salamander (*Plethodon kentucki*)**

Previous studies revealed sexual dimorphism in terrestrial plethodontid salamanders of the genus *Plethodon* for greater snout-vent length (SVL) at first reproduction and maximum SVL in females, presence of a mental gland in males, larger vomeronasal organ (VNO) in males, and greater internarial width in males. Here I describe
additional sexual dimorphism as well as seasonal (i.e., breeding versus non-breeding) dimorphism in *Plethodon kentucki*. I measured morphological variables on preserved specimens of adult individuals that were collected during the breeding season \((n = 26\) females and 30 males) and non-breeding season \((n = 29\) females and 30 males). Residuals from regressions of morphological variables on SVL (all \(\log_{10}\)-transformed) and a principal component analysis on the residuals demonstrate that body mass, trunk length, and tail width are greater in females. These female features may be associated with selection for greater fecundity and increased fat storage to enhance reproductive success. The head is relatively larger in males and has a longer snout with a broader tip. Such dimorphism for the snout increases during the breeding season. Sexually dimorphic features in males may be associated with selection for increased mating success in terms of finding reproductive females (i.e., the enlarged snout may be related to a larger VNO and enhanced chemo-sensory function) and increased competitive ability during competition for mating opportunities (i.e., the larger head may result from selection for better fighting ability). An increase in vent length for both sexes may facilitate the indirect transfer of sperm during the breeding season.

538 Snake Reproduction Symposium, Grand Ballroom II, Saturday 25 July 2009

Robert Mason

*Oregon State University, Corvallis, OR, United States*

**Chemical Ecology of Snakes: From Pheromones to Receptors**

We study chemical communication systems in vertebrates by examining both the diversity of chemical signals and underlying physiological mechanisms mediating their production, expression, and reception. Reproduction in reptiles, snakes in particular, is dependent on the production and perception of sex pheromones. One of the few vertebrate pheromones isolated, characterized, and synthesized is the sex pheromone of the Red-sided Garter Snake, *Thamnophis sirtalis parietalis*. When males encounter females expressing pheromones, they exhibit stereotyped courtship behaviors including chin-rubbing and rapid tongue-flicks. The pheromone, a nonpolar, hydrophobic blend of 13 long-chain \((C_{29}-C_{37})\) saturated and monounsaturated methyl ketones, is insoluble in aqueous solutions. This pheromone is detected by the vomeronasal organ (VNO), which is specialized for the reception of nonvolatile chemical cues. Male garter snakes deprived of a functional vomeronasal (VN) system are unable to detect or respond appropriately to pheromones. But the mechanism by which the hydrophobic pheromone gains access to the aqueous environment of the VNO remained unknown. Results to date indicate that the Harderian glands’ (HG) secretions, which duct exclusively into the VNO in snakes, contain pheromone-binding proteins. For over 300 years, the function of the cephalic HG of vertebrates has been the subject of speculation. Our studies in garter snakes demonstrate that the HG serves as a mediator in providing access for the female sex pheromone to the VNO of male garter snakes. In addition, feeding involves detection of prey chemicals by the vomeronasal system as well, and may require carrier molecules to deliver prey proteins to the vomeronasal organ.

The wattle-necked softshell turtle, *Palea steindachneri*, is IUCN listed as Endangered in its native China and Vietnam where its survival is doubtful due to continued exploitation. *Palea steindachneri* was introduced to Kauai and Oahu by Chinese immigrants during the mid 1800s, and appears to be established in Kauai. This creates an interesting conservation puzzle, as this species is both endangered in its native range and a potentially harmful invasive outside its native range. Little is known about the distribution, abundance and effects that *P. steindachneri* may have on Hawaiian aquatic ecosystems. In 2007 CSU Chico biology classes began research with two goals: 1) to evaluate the Kauai population as a viable option to prevent the global extinction of this species; and 2) to understand the impact that this and other invasives have on Hawaiian aquatic ecosystems, which have no large native predators. Here we present preliminary results on the status and ecology of *P. steindachneri* on Kauai based on data collected by CSU Chico biology classes between 2007-09 and compilation of two decades of observations by Kauai DAR personnel. DAR observations and DNA sequences confirm the widespread establishment of *P. steindachneri*. CSU classes captured, PIT tagged and released ten turtles from three watersheds recapturing one and have collected tissue samples for DNA and stable isotope analysis and feces for diet studies. These limited data indicate that the turtle is locally abundant but has a spotty distribution, and feeds on a wide variety of invasive prey. Isotope analysis is ongoing.

Reproductive Effort of the Common Garter Snake (*Thamnophis sirtalis*) in South Dakota

In late May 2008 we collected 50 gravid common garter snakes (*Thamnophis sirtalis*) from one den site located at Lake Traverse, South Dakota. These snakes were kept in the Black Hills State University animal care facility until they gave birth to their offspring beginning on August 21st until the project was terminated on September 10th. Snout-vent length, weight and sex were recorded for the offspring. Mothers were measured once and weighed several times during their pregnancies and immediately following birth of the young. A total of 1406 neonates from 44 mothers were recorded for this project. I
calculated SVL and mass means for the live, developed offspring (n=1217), as well as clutch size and relative clutch mass (RCM) of all offspring from mothers that completed birth (mothers = 40, offspring =1368). Mean SVL +/- 1 std. dev. for live, normal young was 156.370 (+/- 9.899) mm with a mean mass +/- 1 std. dev. of 1.782 (+/- .029) grams. The clutch size +/- 1 std. dev. for the 40 mothers that completed birth was 34.2 +/- 9.97. Litters ranged in size from 16 to 64 young. Mean RCM +/- 1 std. dev. was .67 (+/- .1576), ranging from .3911 to 1.065.

533 ELHS/LFC General Ichthyology II, Broadway 1&2, Saturday 25 July 2009
Ann C. Matarese, Morgan S. Busby, Deborah M. Blood
NOAA/NMFS/Alaska Fisheries Science Center, Seattle, WA, United States

Identification of Larvae and Early Juveniles of Pricklebacks (Perciformes: Stichaeidae) in the Northeastern Pacific Ocean and Bering Sea

Fishes of the family Stichaeidae, commonly known as pricklebacks, are mostly intertidal and subtidal fishes occurring in the North Pacific Ocean (NPO) and Bering Sea (BS) with a few species in the Arctic and North Atlantic Oceans. Aspects of the early life histories of these fishes are poorly known mostly due to their lack of commercial importance, small size, inshore distribution, and cryptic habits. In this ongoing study, we examined larvae and/or juveniles of 23 of 27 species reported from the NPO and BS. Of these, developmental series of 12 species are described for the first time. For comparative purposes, 11 more are added, incorporating additional illustrations and augmented descriptions of new specimens. As available, representative larvae for each taxon have been measured and cleared and stained for morphological, meristic, and osteological analyses. Based on 30 + years of ichthyoplankton sampling in the NPO and BS, abundance and distribution maps are provided for many taxa. Stichaeid larvae can be distinguished from other slender-bodied zoarcoid/percomorph larvae by a combination of characters including counts of median fin-elements and vertebrae (myomeres), morphology, and pigmentation. Snout to anus length is a particularly useful morphological character for distinguishing stichaeid genera. Distinguishing larvae of the tribe Lumpenini, comprising the nominal genera Lumpenus, Anisarchus, and Leptoclinus, remains problematic using pigment characters alone, but meristic features appear to be helpful in distinguishing the species. The potential utility of larval characters in phylogenetic analyses of stichaeid fishes will also be discussed.
Early Larvae of *Zesticelus profundorum* (family Cottidae) Identified Using DNA Barcoding

Genetic information obtained using DNA barcoding methods has been used successfully in recent years to answer some complex issues regarding taxonomic identification of species and phylogenetic relationships of fishes. Combining morphological characters with these powerful genetic tools can be helpful in solving difficult problems in the identification of early life history stages. For more than 10 years, we have been collecting a rare, unknown larva during ichthyoplankton surveys in the Gulf of Alaska and Bering Sea. Based on general morphological characters, it resembles other scorpaeniform larvae, but assigning a family level identification has been problematic. Major gaps still persist in our knowledge of the early life history stages of the Scorpaeniformes, especially of larvae among the families Scorpaenidae, Liparidae, and Cottidae. In this study, we sequenced 605 bp of cytochrome c oxidase subunit I to positively identify preflexion larvae of *Zesticelus profundorum*, the flabby sculpin; a rare deep-water member of the family Cottidae. Adults of *Z. profundorum* occur in marine waters from the Bering Sea and Aleutian Islands to northern Baja California and to southeastern Kamchatka, but only a few specimens have been reported from waters of Alaska where these larvae were collected. Preflexion larvae of *Z. profundorum* are heavily pigmented over the entire head, gut, body, and dorsal and anal finfolds, and have 26 or 27 myomeres. This work provides the first description of preflexion larvae of *Z. profundorum* and is an example of our success applying genetics in our field program.

Variation in Otolith Microchemistry Fingerprints of French Grunt (*Haemulon flavolineatum*) and Schoolmaster (*Lutjanus apodus*) in Nursery Habitats in Puerto Rico and St. Croix (USVI)

Juveniles of French grunt (*Haemulon flavolineatum*) and schoolmaster (*Lutjanus apodus*) were captured in mangrove and seagrass habitats in St. Croix and Puerto Rico in 2006 and 2007 to determine if their nursery areas can be discriminated by otolith chemical signatures. Concentrations of Rb, Co, Na, Mg, Ca, Mn, Mg, Sr, Ba, Pb, and Cu were determined in regions of YOY fish otoliths representing the post-settlement period (30-
60 days) using laser ablation inductively coupled plasma mass spectrometry (LA-ICPMS). \(^{18}O\) and \(^{13}C\) isotopic signatures were also analyzed. Elemental signatures for both species differed significantly (P<0.001) among distinct mangrove and seagrass nurseries within Puerto Rico and St. Croix. Concentrations of six elements (Sr, Ba, Cu, Mg, Co, Na) and the two stable isotopes \(^{18}O\) and \(^{13}C\) for both species within each year differed significantly among mangrove and seagrass nurseries within islands (ANOVA, P<0.001). Classification success for French grunt and schoolmaster nursery stations within St. Croix for 2006 and 2007 ranged from 87 to 92% and from 76 to 77%, respectively, whereas in Puerto Rico, classification success for French grunts and schoolmaster for the two years ranged from 80 to 84% and 84 to 87%, respectively. When stations were combined among habitats, classification success between mangrove and seagrass habitats in Puerto Rico for French grunt ranged from 84 to 91%, and for schoolmaster ranged from 94 to 99%. In St. Croix, classification success for French grunt was 95 to 96%, and for schoolmaster was 86 to 89%.

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**338 Live-Bearing Fish Symposium, Grand Ballroom I, Sunday 26 July 2009**

Mariana Mateos

*Texas A&M University, College Station, TX, United States*

**Phylogeography of Poeciliids in Western Mexico**

The Trans-Mexican Volcanic Belt (TMVB) is recognized as a dispersal barrier for freshwater and other taxa. Phylogeographic studies of freshwater fishes have identified vicariant events in the western TMVB. Herein, I review our current knowledge of phylogeography of this region and examine the phylogeography of additional Poeciliid taxa. My results indicate that the TMVB is either a permeable barrier to some species or that there has been recent human mediated-dispersal. Implications for the study of Poeciliid biogeography are discussed.

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**282 Clark Hubbs Symposium, Galleria South, Saturday 25 July 2009**

William Matthews, Edie Marsh-Matthews

*University of Oklahoma, Norman, OK, United States*

**Clark Hubbs’ Contributions to Ichthyology in Oklahoma**

From 1970 to 1984, Clark Hubbs taught in summers at the University of Oklahoma Biological Station at Lake Texoma. Approximately 200 students from high schoolers to senior graduate students gained extensive experience from him in lectures and on field trips, and from individual research projects under his direction. Clark did his own research in Oklahoma on ecology of *Menidia*, and combined with students for studies on Lake Texoma or its fishes. His important papers from Oklahoma addressed diel activity
of fish; stratification of Lake Texoma; and (with Jimmie Pigg) a thought-provoking review on the effects of reservoirs on endangered fishes. Numerous students published papers from their projects in Clark's Oklahoma classes, and many students in those classes went on to make important contributions in ichthyology. As Clark's GTA in Biology of Fishes in 1976, WJM was introduced to many new concepts in fish biology, and to field locations in Oklahoma that we continue to sample to assess long-term changes in fish assemblages. Late in his life we had the privilege of accompanying him to streams in south Oklahoma where we and our graduate students helped run "the machine", seined fish for him to count, and witnessed his uncanny ability to record all these data on voluminous yellow pads. Clark Hubbs left an indelible impression on all who experienced him, and his legacy to fish biology in Oklahoma is indeed large.

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391 Poster Session II, Exhibitor’s Hall, Saturday 25 July 2009

George M. T. Mattox

Instituto de Biociências - Universidade de São Paulo, São Paulo, SP, Brazil

Historical Biogeography of Neotropical Characiformes (Teleostei, Ostariophysi): an Approach Using Brooks Parsimony Analysis

Neotropical freshwater fishes include a vast species diversity representing interesting models for historical biogeography because of their life histories restricted to freshwater environments. Although this diversity is not completely known, general biogeographic patterns can be accessed using appropriate analytical tools and phylogenetic data published in the last 25 years. Brooks Parsimony Analysis was used to infer relationships among 29 Neotropical drainages, based on systematics and distribution datasets of 17 clades of Characiformes, totaling 247 characters representing the distribution of extant taxa and their hypothetical ancestors. The analysis yielded 282 equally most parsimonious trees (L=466; CI=0.53, RI=0.65). The strict consensus cladogram presents a basal dicotomy between transandean (Madalena, Maracaibo and Western drainages) and cisandean clades. The latter has a basal politomy involving rivers of the Atlantic Coast and Rios Paraguay, Paraná, São Francisco, Uruguay, and a clade with the northern drainages of the continent. The latter is composed by sequential less inclusive clades separating Northeastern Atlantic drainages, Guianas coastal rivers, Essequibo, Branco, a clade with Rios Negro and Orinoco, and a clade with the remaining Amazonian drainages. Some nodes could be related to known geomorphological events and their vicariant effects while homoplasies were investigated to find general patterns of dispersion and extinction. The complex diversity of the Neotropical region is once again attributed to a mosaic of historical events including terrain uplifts, headwater capture, fluctuations in sea level, among others. Although different taxa are expected to respond differently to environmental changes, it seems that general patterns can be detected.

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Phylogenetic Study of the Characinae (Ostariophysi, Characiformes, Characidae): Preliminary Results

One of the main challenges in modern Neotropical ichthyology regards the systematics of Characidae, a family with approximately 950 species, two-thirds of the diversity of Characiformes. It was recently suggested that subunits of Characidae should be first recognized for a better understanding of the its systematics. Characinae is one such subunit holding special importance for including Charax, type-genus of Characidae. Twelve genera and 78 species have been assigned to Characinae, but the subfamily still lacks a proper phylogenetic definition. A preliminary cladistic analysis of Characinae based on 126 characters from external morphology, myology and skull osteology resulted in 48 most parsimonious trees (L=583; CI=0.30; RI=0.72). In the strict consensus cladogram, Characinae as traditionally recognized is not monophyletic. Alternatively, these genera resulted in two separated clades, each one more closely related to different subunits of Characiformes. Seven genera form the first clade (Phenacogaster((Charax Roeboides)(Acanthocharax(Acestrocephalus(Cynopotamus Galeocharax)))))) with eight synapomorphies, sequentially more related to Tetragonopterus, Gymnocorymbus and Astyanax. The second clade includes the Heterocharacini ((Heterocharax Hoplocharax)Lonchogenys), which is sister-group to Gnathocharax followed by Roestes, a genus of Roestinae currently included in Cynodontidae. The clade (Roestes (Gnathocharax Heterocharacini)), with six synapomorphies, is more related to the clade (Aphyocharax (Exodon(Bryconexodon Roebexodon))). The twelfth genus, Priocharax, comprises two miniature species related to the Heterocharacini based on morphology of pseudotympanum and teeth. Due to its highly modified anatomy potentially related to ontogenetic truncations, Priocharax could not be confidently positioned in the cladogram, but ongoing anatomical studies of Priocharax may provide additional evidence regarding its phylogenetic relationships.

Life History Aspects of Two Bering Sea Skate Species, Bathyraja lindbergi and B. maculata

The eastern Bering Sea is an area of high skate abundance and diversity. Relative to their abundance, however, little is known about the basic life history traits for most of the
skate species living there. Researchers from the Pacific Shark Research Center are continuing their efforts to collect, analyze, and synthesize important life history information, including age, growth, and reproduction, used for fisheries management. The two species in the current study are the Commander Skate, *Bathyraja lindbergi*, and Whiteblotched Skate, *Bathyraja maculata*. Samples were collected during NOAA Fisheries survey cruises in the eastern Bering Sea and through the National Marine Fisheries Service Alaska Fisheries Science Center observer program. Age estimates from two vertebral preparation techniques, gross sectioning and histology, will be compared. Preliminary results indicate histological preparation of vertebrae may be the preferred technique for these two species. Therefore, the following results are based solely on counts from histological preparation. Maximum age estimates for *B. lindbergi* females is 33 years and for males is 31 years, and for *B. maculata* females and males, 33 and 36 years, respectively. Thorns will be examined as a possible non-lethal ageing structure. Age at 50% maturity for *B. lindbergi* females is 21 years and for males is 20.7 years, and for *B. maculata* females and males, 26 and 24 years, respectively.

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**389 Amphibian Ecology II, Pavillion West, Monday 27 July 2009**

William Mautz¹, Richard Hughes², Paul Klawinski³, Rebecca Ostertag¹

¹University of Hawaii at Hilo, Hilo, HI, United States, ²USFS Pacific Institute of Pacific Island Forestry, Hilo, HI, United States, ³William Jewell College, Liberty, MO, United States

**Tracking a Nitrogen Fixing Tree δ15N Signature Through a Hawaiian Coqui Frog Population**

On Hawaii Island, a continuously distributed population of invasive coqui frogs (*Eleutherodactylus coqui*), is layered on an earlier ongoing invasion of albizia tree (*Falcateria moluccana*) dominated forest in the process of outcompeting a native ohia tree (*Metrosideros polymorpha*) dominated forest. In contrast to ohia, albizia is a nitrogen fixer, its forest type is host to many additional invasive plant species, and the invasive forest has increased primary productivity. The δ¹⁵N isotope signature of albizia forest litter was shifted 4.0‰ units from ohia-dominated forest litter across a forest boundary with an average of 250 m between sample sites. δ¹⁵N increased through trophic levels in each forest type, and the difference between forest types persisted with 2.7‰ units between herbivorous invertebrates, 2.2‰ units between predaceous invertebrates, and 3.2‰ units between coqui frogs. Organisms in the food chains of these forest types were relatively sedentary, remaining isotopically well distinguished across the boundary of these two forests. Although albizia-dominated, compared to ohia-dominated, forest was characterized by increased litterfall and increased nitrogen content of litter, these differences did not fuel significant differences in coqui frog population densities between the forest types. Supported by NSF DEB-0445267.
Cypriniformes Tree of Life: A Supermatrix Approach to Inferring the Phylogenetic Relationships of the North American Species of the Family Cyprinidae

Species of the North American Cyprinidae comprise the most diverse family and are attractive to various fields of comparative biology for in-depth investigations. Severely limiting researchers from pursuing such studies is a continuing lack of a historical framework of species relationships within which to cast such studies. While this cyprinid fauna is one of the best known cypriniform faunas of the world and has received attention from various researchers since the early 1980’s with respect to species relationships using phylogenetic methods and morphological and/or molecular characters, considerable uncertainty remains as to species relationships and classification of some members of the fauna. Various studies have produced a variety of separate molecular studies involving mitochondrial and/or nuclear genes. In this study we employ a supermatrix approach using variation in these genes to approximate the phylogenetic relationships of most of the fauna. The approach we use provides a more comprehensive view of the fauna and clearly identifies where new research is needed for a comprehensive study to finally resolve a classification for the family. Our analysis involves an initial first-level phylogenetic reconstruction of only those taxa for which all genes are available. This is followed by a second-level analysis, including all taxa wherein sequences for at least one gene are available, with a constraint tree from the first-level analysis. The latter analysis necessarily contains many samples with missing data. These different analyses are compared and a proposal for a future approach involving both morphological and molecular characters is advanced.

Predicted Climate Change May Spark Box Turtle Declines

How will organisms deal with climate change? Ectotherms such as reptiles and amphibians are especially at risk due to their metabolic ties to the environment and their general inability to migrate with changing climates over short time frames. We modeled the growth response of Three-toe Box Turtles (Terrapene carolina triunguis) to fluctuations
in ambient temperature and precipitation. Then we extrapolated this model to climate conditions expected in 2100. We predict that there is less than 20% possibility of hatchling turtles growing during their first year. Reduced annual growth rates during later years may cause earlier termination of growth, smaller standard carapace lengths, and reduced fecundity. These responses are typical of those that stimulate an extinction vortex. These findings provide for a general understanding of how this species and other terrestrial reptiles may respond to climate change. Without reduction in greenhouse gas emissions we could face catastrophic declines in many ectotherms as temperature and rainfall patterns.

226 Fish Ecology II, Pavillion East, Sunday 26 July 2009

Jennifer McClain, Steve Ross

University of North Carolina Wilmington, Wilmington, NC, United States

Trophic Structure of Midwater Fishes over Cold Seep Areas in the Gulf of Mexico

Midwater fishes provide insight into energy utilization and movement through the water column. This study examined whether cold seep chemosynthetic communities impacted the trophic structure of fish species in the overlaying water column. Intensive discrete depth sampling was conducted in August 2007 over three cold seep habitats (> 1000 m) in the north-central Gulf of Mexico using Tucker trawls, yielding 8,703 juvenile and adult fishes from 27 families. Zooplankton and phytoplankton were also collected using plankton nets and by filtering seawater, providing reference material for stable isotope analyses (SIA). Stomach contents were analyzed for the most abundant species collected (18 species from 5 families: Gonostomatidae, Myctophidae, Phosichthyidae, Sternoptychidae and Stomiidae). Fishes mainly consumed copepods and ostracods, with the exception of Chauliodus sloani (Stomiidae) whose diet was dominated by fishes. SIA (δ¹³C and δ¹⁵N) complimented stomach analyses and aided efforts to determine the potential for chemosynthetic input into the water column. A total of 246 isotope samples were analyzed, from 5 fish families (same as stomach contents), 13 invertebrate families, phytoplankton, Sargassum and detritus. Isotope results supported findings from stomach analyses, with most diets composed of zooplankton. No distinct chemosynthetic signature was detected in SIA; however, Myctophum affine (Myctophidae), exhibited a stable isotope range slightly lower than phytoplankton and values for C. sloani were inconclusive, requiring further investigation. Despite the current lack of evidence supporting midwater fishes utilization of chemosynthetic energy, midwater fishes are important components of the midwater community, providing a trophic link between the surface and lower depths.
Detection of *Batrachochytrium dendrobatidis* in Amphibians from the Forest Floor to the Upper Canopy of an Ecuadorian Amazon Lowland Rainforest

Eighty-six individuals from 31 species of amphibians were collected from the forest floor (~0 m), the shrub/sub-canopy (0-4 m) and mid- to upper canopy (4-38 m) of a Neotropical lowland rainforest near the Tiputini Biodiversity Station (TBS) - Universidad San Francisco de Quito in the Upper Amazon Basin of eastern Ecuador, and analyzed for *Batrachochytrium dendrobatidis* (*Bd*) using a nested PCR protocol. *B. dendrobatidis* was detected on 17 of the 86 individuals (20%), with positive samples collected from each of the vertical strata. Infection was found to be significantly higher in the fossorial/floor and canopy groups, showing 25% and 33% of individuals infected, respectively, than in the shrub/sub-canopy group with only one individual (3%) infected. Thus, *Bd* was non-randomly distributed along the vertical axis, suggesting that microhabitat conditions in the different strata can potentially have an influence in host-pathogen dynamics. To our knowledge this is the first examination of *Bd* infection in amphibians found in the forest canopy and the first record of a symptomatic anuran infected with *Bd* in lowland tropical rainforests of the Upper Amazon Basin.

Characterizing the Private Boat Recreational Fishery for Highly Migratory Species in Florida

In 2008, approximately 5,700 private recreational vessels in Florida were federally permitted to fish for Highly Migratory Species (HMS), which include billfish, sharks, tunas, and swordfish. Despite the popularity of HMS fishing, catch and effort estimates for most HMS species remains poor due to a lack of accurate fisheries statistics data. The primary method for monitoring recreational fisheries in Florida is the Marine Recreational Fisheries Statistics Survey (MRFSS); however, observations for many HMS species in this survey are rare. One potential reason is that substantial portions of HMS trips are not covered by MRFSS dockside sampling because many return at night and are operated out of private access sites. These temporal and spatial biases create a significant data gap that precludes managers from accurately assessing the impact of the recreational fishery on these species. This pilot study was conducted as part of the Marine Recreational Information Program to estimate the relative scope and magnitude of HMS recreational fishing by private anglers. Additionally, we collected baseline
information on unknown aspects of this segment of the recreational fishery to guide implementation of an improved data collection method in the southeastern United States. The 12-month study entailed a bi-weekly telephone survey that utilized the HMS permit registry as a sample frame. Effort estimates for each HMS species group were produced and each permit-holder’s fishing activities were characterized to determine HMS species preference, estimate directed catch and bycatch rates of HMS species, and ascertain the spatial and temporal patterns of the HMS-directed fisheries.

639 ELHS/LFC Connectivity Symposium I, Grand Ballroom I, Thursday 23 July 2009

Robert McDowall

National Institute of Water and Atmospheric Research, Christchurch, New Zealand

Diadromy, Recruitment, Expatrial Dispersal and Colonization in the Fish Faunas of Island Streams

Diadromy is a fundamental attribute of the life histories of most of the stream fishes of small oceanic islands, especially in the tropics and sub-tropics. The mechanisms that permit self recruitment to the fish populations of streams on small, isolated, oceanic islands are poorly understood, but appear likely to involve massive amounts of expatrial dispersal. The stream fish populations of some islands may be ecological sinks that make no contribution to maintenance of the populations. It would intuitively seem likely that such expatrial dispersal would attract very strong negative selection but this may be compensated for by the role of diadromy in providing for the ‘rescue effect’ that rejuvenates populations adversely affected by perturbations such as active volcanism and historic dewatering that may be characteristic of island streams. Very inefficient recruitment may be the cost of these islands having any stream fishes at all. A corollary of this is the potential that such expatrial dispersal has for populating the streams in newly formed islands. The benefits of the ability of diadromous species to (re)colonise island streams may counterbalance the high populations costs of persistent expatrial dispersal.

993 Fish Conservation II, Pavillion West, Sunday 26 July 2009

Jan McDowell, John Graves

Virginia Institute of Marine Science, Gloucester Point, VA, United States

Genetic Analysis of Bluefin Tuna (Thunnus thynnus) Population Structure

Atlantic bluefin tuna (Thunnus thynnus) are thought to comprise two distinct stocks with spawning grounds in the Gulf of Mexico and Mediterranean Sea. Previous genetic studies using both mitochondrial and nuclear gene regions have shown significant
heterogeneity between young-of-the-year (YOY) bluefin taken from the western and eastern Atlantic, as well as adults taken from the Gulf of Mexico and Mediterranean Sea during the spawning season. Recent electronic tagging studies and investigations of otolith stable isotopes indicate considerable mixing of the two stocks throughout the North Atlantic. In this study, we use genetic signatures of YOY and spawning bluefin tuna from the Gulf of Mexico and Mediterranean Sea to estimate the contribution of eastern and western stocks to collections of school bluefin tuna (1 – 4 year old) and giant bluefin tuna (8+ years old) collected off the U.S. Atlantic coast in multiple years. Complete microsatellite genotypes have been obtained for more than 800 samples at 14 variable loci and control region sequences have been generated for about 650 individuals. Using YOY bluefin tuna as well as adults taken from breeding grounds during spawning season as baseline samples, we are assessing the utility of various methods for assigning individuals to and excluding individuals from source populations based on their multilocus genotypes. We are also performing maximum likelihood estimates of mixture proportions in different age classes. Finally, we are using a cluster analyses to test the assumption of two stocks based on genetic data without prior information about location of capture.

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1038 Herp Physiology, Galleria North, Monday 27 July 2009; ASIH STOYE AWARD PHYSIOLOGY & PHYSIOLOGICAL ECOLOGY

Matt McElroy

University of California, Berkeley, Berkeley, CA, United States

Comparative Thermal Ecology and Physiology of Two Cryptic Skinks on Mo’orea, French Polynesia

The thermal dependency of physiological function is crucial to the ecology of any ectothermic organism. Comparative studies of thermal ecology are important to understand species-specific responses to climate warming and subsequent effects on community structure and competitive interactions. I studied the habitat selection and thermal ecology of two cryptic South Pacific skinks (*Emoia cyanura* and *Emoia impar*) in order to determine whether or not differences in physiology influence habitat partitioning. Several measurements of field and laboratory-based thermal ecology point towards physiological differences between the species. Compared to *E. impar*, *E. cyanura* primarily inhabited areas with open canopy cover, and selected significantly warmer substrates in both field and laboratory settings. *E. cyanura* also had a significantly higher preferred body temperature than *E. impar*. While there was no statistical difference between the species’ critical thermal minimum, *E. cyanura* had a significantly higher critical thermal maximum. *Emoia impar* ran faster at cool temperatures relative to *E. cyanura*; a finding consistent with it being more common at higher elevations. These results indicate that differences in physiology underpin habitat partitioning between *E. impar* and *E. cyanura*, and are consistent with the emerging view that climate warming will affect the community structure (i.e. habitat selection, competition, fitness) of tropical ectotherms.
Characterization of the Swordfish Recreational Fishery of Florida

A popular recreational fishery for swordfish once existed in the Florida Straits during the 1970s. Interest in the fishery declined rapidly as catches decreased by the early 1980s, with the fishery essentially becoming dormant over the next two decades. The closure of the Florida Straits to pelagic longlining in the spring of 2001 marked a significant event in the revitalization of the recreational fishery. Within 6 months of the closure, anecdotal reports of recreational swordfish catches quickly spread throughout the recreational fishing community of southeast Florida, stimulating renewed interest in the fishery. Over the next several years, the fishery was actively promoted throughout the state via a wide range of media outlets. Development of new fishing methodologies expanded the initially night-only fishery to daytime fishing, further increasing participation. It is estimated that several thousand vessels now actively participate in the swordfish recreational fishery, resulting in significant landings.

Monitoring the recreational fishery has been extremely difficult due to the limitations in the primary monitoring program conducted in Florida, the Marine Recreational Fishing Statistics Survey (MRFSS). Compliance with mandatory reporting requirements with NOAA fisheries has also been poor and difficult to enforce. As a result, pilot studies that entailed targeted telephone and field intercept surveys were initiated in 2008-2009 through the Marine Recreational Information Program (MRIP). Their objectives were to address sampling biases associated with the MRFSS and improve the collection of catch and effort data for swordfish and other highly migratory species. Preliminary data for these pilot studies are presented.


Over the past 30 years, recreational anglers have accounted for a substantial proportion of the total shark harvest throughout the United States. Florida has been the epicenter for both recreational and commercial fisheries targeting large coastal sharks (LCS) and small coastal sharks (SCS) in the western Atlantic and Gulf of Mexico. After peaking in the early 1990s, commercial shark landings have steadily decreased due to more restrictive quotas and increased number of prohibited species. Recreational landings have decreased concomitantly; although this decline may be attributed less to regulatory changes, and more to social changes throughout the recreational fishing community. Catch disposition data collected by the Marine Recreational Fishing Statistics Survey (MRFSS) from 1981 to 2008 show a significant shift towards catch and release by recreational anglers. Throughout the 1980s, recreational anglers historically landed 54.1
and 58.5% of the total recreational LCS and SCS catches, respectively. The proportion of the total recreational shark catch that was harvested declined to 26.7 and 22.5% during the 1990s when management actions were first implemented, and further declined to 14.2 and 11.4% through the current decade. Despite these changes, segments of the recreational fishery continue to target sharks with sufficient regularity that their impact may not be adequately accounted for by the MRFSS. These directed recreational fisheries may result in significant mortality for some shark species, including blacktip, bull, scalloped hammerhead, great hammerhead, and bigeye thresher. Recommendations for improvements in monitoring efforts and public outreach are presented.

67 SSAR SEIBERT SYSTEMATICS & EVOLUTION AWARD, Galleria North, Friday 24 July 2009

David McLeod

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Of Least Concern? Cryptic diversity in the Limnonectes kuhlii complex

Widely distributed throughout East and Southeast Asia, the dicroglossid frog, Limnonectes kuhlii, has been informally considered a complex of species by multiple authors, but no study has explicitly evaluated the taxonomy of L. kuhlii, nor estimated relationships among lineages within this group. I will present a phylogenetic analysis of molecular and morphological characters to define the major lineages within the Limnonectes “kuhlii” complex. Results of this study reveal that Limnonectes “kuhlii” is not one widely distributed taxon but most likely a diverse clade of numerous species, some of which are range-restricted and probably in need of attention by conservation biologists.

375 General Ichthyology I, Pavillon East, Saturday 25 July 2009; ASIH STOYE AWARD GENERAL ICHTHYOLOGY

Caleb McMahan

Southeastern Louisiana University, Hammond, LA, United States

Molecular Systematics of the Mountain Mullet, Agonostomus monticola (Teleostomi: Mugilidae)

The mountain mullet (Agonostomus monticola) represents an understudied species that is allopatrically distributed along the Pacific and Atlantic Coasts of North, Central, and northern South America, as well as the Caribbean. Populations occur in inshore and freshwater habitats from the Gulf of Mexico to Venezuela in the Atlantic Basin, and from Baja, Mexico to Colombia in the Pacific Basin. This species is also found throughout the
No study has assessed morphological or genetic variation throughout the range of this monotypic taxon. However, multiple researchers have suggested that the species is more diverse than currently recognized. The objective of this study was to conduct a phylogeographic study of Agonostomus monticola. Sequence data (cytochrome b) has been gathered from 37 sites and nearly 60 individuals from throughout the distribution of this species. Phylogeographic relationships strongly support the monophyly of three distinct clades: a Gulf of Mexico clade, a Caribbean Sea clade, and a Pacific clade. Genetic distances between each of the clades are high (> 7.0% cytochrome b; 3% S7-intron 1) which is indicative of a long period of isolation. Future work will include the addition of additional nuclear markers as well as assessing morphological variation between the three divergent clades recovered for this species.

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259 ELHS/LFC Ecology II/Condition, Broadway 1&2, Sunday 26 July 2009; ELHS SALLY RICHARDSON AWARD

Kelton McMahon¹, Marilyn Fogel², Travis Elsdon³, Simon Thorrold¹

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Patterns in Carbon Isotope Fractionation of Amino Acids Between Diet and Consumer in a Model Fish Species

Stable isotope analysis has become a routine component of diet and trophic studies in ecology. However, significant variability in the trophic fractionation ($\Delta^{13}$C) of bulk tissue between diet and consumer has prompted a call for studies that examine the biochemical and physiological underpinnings of stable isotope ratios of specific tissues. We reared the mummichog (Fundulus heteroclitus) on four isotopically distinct diets to examine $\Delta^{13}$C of bulk muscle and individual amino acids for a model fish species. Consumer muscle exhibited a range of diet-specific bulk $\Delta^{13}$C values, with the plant diet treatment ($\Delta^{13}$C = 3.0 ± 0.1‰) having significantly larger $\Delta^{13}$C values than the animal diet treatments (1.0 ± 0.4‰). Modest bulk muscle $\Delta^{13}$C values represented an averaging of large trophic fractionations for many non-essential amino acids (NEAAs) and little to no fractionation for most essential amino acids (EAAs). $\Delta^{13}$C values of NEAAs from the animal diet treatments suggested a greater reliance on lipid-derived carbon for biosynthesis, while carbohydrates likely dominated the bulk carbon pool for NEAA biosynthesis in the plant diet treatment. NEAA $\Delta^{13}$C values showed evidence of both biosynthesis and direct isotopic routing from dietary protein, providing significant insight into the metabolic processing of amino acids through the tricarboxylic acid cycle. EAAs are acquired directly from diet and have $\delta^{13}$C values that reflect the dietary isotope signatures. EAA $\delta^{13}$C values provide a promising way to determine carbon sources when reconstructing diets in studies of trophic dynamics.

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Resources and Energetics Determined Dinosaur Maximal Size

Some dinosaurs reached masses that were about 8 times those of the largest, ecologically equivalent terrestrial mammals. The factors most responsible for setting the maximal body size of vertebrates are resource quality and quantity, as modified by the mobility of the consumer, and the vertebrate’s rate of energy expenditure. If the food intake of the largest herbivorous mammals defines the maximal rate at which plant resources can be consumed by an individual in terrestrial environments and if that limit applied to dinosaurs, then the large size of sauropods occurred because they expended energy in the field at rates extrapolated from those of varanid lizards, which are ca. 22% of the rates in mammals and 3.6 times the rates of other lizards of equal size. That is, of two species having the same energy income, the species that uses the most energy for mass-independent maintenance of necessity has the smaller body size. The presumptively low energy expenditures of dinosaurs permitted Mesozoic communities to support dinosaur biomasses that were about five times those found in mammalian herbivores in Africa today. The maximal size of predatory theropods was approximately 8 tons, which if it reflected the maximal capacity to consume vertebrates in terrestrial environments, corresponds in predatory mammals to a maximal mass less than a ton, which is what is observed. A preoccupation with the distinction between ectothermy and endothermy is inappropriate at the masses found in large dinosaurs because these states may be difficult to distinguish in resource-limited environments.

Effects of Atrazine and Carbaryl on Spotted Salamander (Ambystoma maculatum) Embryo Hatching and Survival

Chemical contaminants, such as pesticides, are considered to be a great risk to amphibians, but their impact on salamander species is poorly understood. Atrazine is the second most commonly used herbicide in the U.S. agricultural market and carbaryl is the second most commonly used insecticide in the U.S. home and garden market. Pools that spotted salamanders (Ambystoma maculatum) rely upon for reproduction are being threatened by contamination with these pesticides. This study aims to determine how spotted salamander embryos are affected by atrazine and carbaryl. Ten spotted salamander egg masses were collected in Oxford, Ohio. The jelly coat of the egg mass was removed, but the sac surrounding the embryo was left intact. Embryos were housed in beakers in 1.5L of dechlorinated water at a density of 5 embryos per beaker. We exposed half of the larvae to 0, 5, 50, or 500 µg/L of atrazine and the other half to 0, 20,
200, or 2000 µg/L of cabaryl. These concentrations represented a realistic exposure concentration in the environment. Salamanders' hatching success, time to hatching, and mass at hatching were monitored; additionally, we monitored the presence or absence of a symbiotic algae on the embryonic sac. We hypothesize that hatching success and mass at hatching will decrease in embryos that are exposed to pesticides and that time to hatching will increase in animals that are exposed. Understanding how pesticides may affect amphibians in the embryonic stage will help determine which amphibian life stage is at greatest risk to contaminants.

222 Fish Ecology III, Pavillion West, Monday 27 July 2009

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Coexistence of Kuhliid fishes in the Hawaiian Islands is Facilitated by Differences in Juvenile Habitat Use

Patterns of juvenile habitat use and selection by two species of Kuhliid fishes on the Island of Hawai‘i were examined. These fishes, which are of considerable importance in Hawai‘i's recreational fishery, were recently split taxonomically. Their habitat use has not been previously studied, but Kuhliid species are often euryhaline. Kuhlia xenura were observed in freshwater streams, low-salinity estuaries, on reef flats, along rocky shorelines, and in tidepool habitats. Kuhlia sandvicensis only occurred in marine habitats. Principal components analysis indentified non-random microhabitat selection by juvenile K. sandvicensis only; juveniles selected microhabitats that were higher in temperature and salinity and nearer to the open ocean than were areas randomly available to them. Kuhlia sandvicensis also showed nonrandom microhabitat selection of relatively deep microhabitats with higher water velocities. Although the distributions of juvenile K. sandvicensis and K. xenura overlapped in marine habitats, the microhabitat use patterns of each species were distinct. Along rocky shorelines, K. sandvicensis used microhabitats that were characteristic of high energy surge zones - deep areas with high water velocities and high salinities. Conversely, K. xenura typically inhabited protected rocky shorelines with relatively low water velocity, shallower depths, and low salinities. A similar pattern was observed in tidepool habitats, with K. sandvicensis using microhabitats typical of surge zones, while K. xenura utilized protected tide pools located relatively long distances from crashing waves. Marked differences between the two species with respect to the habitats they utilize as juveniles likely facilitate their coexistence in Hawaii. The information presented highlights a variety of inshore habitats as important for the conservation of juvenile Hawaiian kuhliid fishes.
Evaluating Methods of Estimating Species Trees: An Empirical Approach Using the Thamnophiini

Phylogeny is central to evolutionary biology, and an accurately estimated phylogeny is a crucial requirement for understanding the evolution of any clade, as well as for comparative studies to account for biases due to relatedness among taxa. Homoplasy due to convergence and reversal events can bias estimates of phylogeny, and thus comparative studies using these estimates. An example of a well-studied group whose phylogeny remains to be confidently resolved is the Thamnophiini, the North American garter snakes, water snakes, and their allies. Here, we present a novel estimate of phylogeny for the Thamnophiini, using several approaches that account for discordance among gene trees due to stochastic, coalescent processes, incorporating multiple unlinked nuclear loci. Results of this data are broadly concordant with current estimates, however some relational and taxonomical issues remain unresolved. Our estimation will ultimately benefit comparative analyses, and adds to the body of evidence that suggests widespread convergence and reversal in this taxonomic group.

Long-term Growth and Natural History of a Population of Desert Tortoises (Gopherus agassizii) in Southern Nevada

We measured the growth of a cohort of 17 semi-wild desert tortoises (Gopherus agassizii) located in Rock Valley, Nevada over a 47 year period beginning in 1963. The tortoises were initially marked as hatchling and juvenile animals between 1963 and 1965 and ranged in size from 47 to 77 mm in plastron length. We assigned ages of 1-4 at initial capture based on their body size. These tortoises were recaptured, measured, and weighed approximately annually since their initial capture. Growth of male and female tortoises did not differ until animals began to reach sexual maturity (17-20 years of age). Annual tortoise growth was correlated with the production of ephemeral vegetation (P < 0.01) while accounting for size, sex and repeated measurements of the animals, and the interval between measurements. However, the production of annual plants was likewise highly correlated (non-linearly) with "winter rainfall" (October-March) R² = 0.92, P < 0.001. Stochastic predation events over the past 5 years have decimated this cohort of tortoises. The tortoises suffered from mountain lion predation in 2003 and 2007 and smaller predators likely kit fox and/or coyotes preying upon individual tortoises during 2005. The average age of the long-term surviving tortoises from this cohort was 43 years with a range of 39-47 years. Twelve of the tortoises survived to the age of 39 years and
11 of the 12 reached 40 years at which time predation began to take a toll on the population.

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761 Herp Biogeography, Galleria North, Saturday 25 July 2009

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Phenotypic Evolution in Insular Speckled Rattlesnakes (Viperidae: Crotalus mitchelli)

Populations of speckled rattlesnakes are known to occupy multiple islands off the coast of Baja California, Mexico. Two of these populations (Angel de la Guarda and El Muerto) have been recognized as subspecies based primarily on size divergence from putative mainland ancestral populations; however, a survey of morphological variation from other islands inhabited by these snakes has not previously been reported. We examined variation in body size, size-adjusted multivariate phenotype, and island physical parameters among two mainland clades and 12 island populations and demonstrate through partial set correlations that speckled rattlesnakes tend to dwarf as an inverse function of island area on islands smaller than approximately 20 km². Body size was not significantly related to measures of island isolation. Furthermore, divergence in size-adjusted multivariate phenotype was associated with divergence in body size rather than any of the island physical parameters. These results suggest that overall morphological divergence in insular speckled rattlesnakes with respect to putative mainland source clades resulted primarily from directional selection for body size evolution. With one exception (Isla Partida Sur), island populations were more similar in phenotype to their geographically most proximate mainland clade. Morphological divergence in this dwarfed population is best explained by convergence towards a similar morphospace with other dwarfed populations.

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403 Poster Session I, Exhibitor’s Hall, Friday 24 July 2009

Manuel Mendoza-Carranza¹, Juan Carlos Pérez-Jimenez², Christian Carolina Hernández-Lazo¹, Iván Mendez-Loaeza²

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The San Pedro’s Artisanal Fishery: a Non Regulated Activity in a Shark Nursery Ground in Western Campeche Bank

Gulf of Mexico shallow waters, specially the Campeche Bank, seems to present optimal characteristics to function as nursery ground for several shark species. This area sustains
the fishery activity of the artisanal fleet of San Pedro’s Port in Tabasco State, composed
by 150 fiberglass outboard motor vessels (8m long). The bottom long-line (500-3000
hooks) is the most common fishing gear. Monthly samplings, during 24 months,
determine that captures were composed by 13 shark species, 6 rays and 18 teleosts,
from a 531 km² fishing area (10-50m depth range). All shark species were captured as
neonates and/or juveniles (77% of all individuals sampled), most abundant juvenile
were *Rhizoprionodon terraenovae* (65±10cm) and *Sphyrna lewini* (78±24cm), which account
for the 76% of all juvenile sharks. Seven percent of the total sample were neonates of:
*Carcharhinus falsiformis* (79±9cm), *C. leucas* (72±7cm), *C. limbatus* (66±7cm), *C. plumbeus*
(65±3cm), *R. terraenovae* (36±0cm) and *S. lewini* (51±4cm). Twenty three percent of total
sharks recorded were adults, *S. tiburo* (80±10cm) were the most abundant adult (72% of
adults) with the 30% being pregnant females. The western Campeche Bank is a
important nursery ground for sharks, and is necessary to intensify and extend the
geographic area of sharks’ research to generate information that support management
programs.

1004 AES Conservation & Management II, Parlor ABC, Saturday 25 July 2009

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**Does Southern Stingray *Dasyatis americana* Sustain the Artisanal
Elasmobranch Fisheries in Western Campeche Bank?**

The diminishment of shark volume captures has conducted to a crescent capture of less
valuable commercial elasmobranch species like several rays species. This increases is
reflected in official statistics. However, exist a scarce knowledge about fisheries,
population dynamics and biology of this species, which precludes the generation of
management programs. In western Campeche bank, specifically in the San Pedro’s port
fleet, (composed by 150 fiberglass outboard motor vessels of 8m long) the stingray
*Dasyatis americana* is the second in abundance among 18 teleost, 13 sharks and 3 ray
species. *Dasyatis americana* CPUE (kg/100 hooks*hour) show no significant differences
among depth range (5 to 50m). Seasonal *D. americana* CPUE variation was achieved,
maximums was during February 2006 (3±1.3) and February 2007 (2.5±1.5). Adult
Male:female proportion was 1:1.14. Males’ size was from 30 to 60cm of disk width (DW)
and the females were from 60 to 120cm DW. The size at maturity of males and females,
estimated with maturity ogive, was 52 and 84cm DW respectively. Gravid females were
scarce (7% of total). Sex proportion of embryos was 1:1, average size for males and
females were 12±9 and 16±12cm DW respectively. No correlation was achieved among
embryos size and ovocite diameter this can indicate an asynchrony reproductive cycle.
The high relative abundance and frequency of *D. americana* in the captures of artisanal
fisheries in Western Campeche Bank indicates an important distribution area of this
species, due to this more research about fisheries biology and ecology is necessary.
Olfactory Thresholds of Elasmobranchs

The olfactory capabilities of elasmobranchs are legendary. Although elasmobranchs are reputed to demonstrate remarkable olfactory sensitivities, this is based on surprisingly little empirical evidence. Olfaction in elasmobranchs is thought to mediate several life history functions, such as prey localization. Amino acids are known to be particularly effective odorants for aquatic organisms; however, olfactory thresholds to these compounds have been assessed for only three species of elasmobranch using a limited number of amino acids. Literature values for amino acid thresholds in these species are approximately $10^{-8}$ to $10^{-6}$ M with neutral amino acids being particularly stimulatory, similar to the findings for teleosts. The objective of this study is to determine the amino acid olfactory thresholds of five phylogenetically diverse elasmobranch species (Dasyatis sabina, Urolophus jamaicensis, Raja eglanteria, Negaprion brevirostris, and Sphyra tiburo) in order to develop a more representative picture of the olfactory sensitivity of elasmobranchs. The electro-olfactogram (EOG) technique was used to assay the thresholds of these species to twenty amino acids. Both the relative stimulatory effectiveness of the tested amino acids and their estimated thresholds ($\sim 10^{-7}$ to $10^{-9}$ M) for all five species were similar. These results indicate that elasmobranch species do not demonstrate greater olfactory sensitivity than teleost fishes.
with four replicates (n=36 mesocosms). Larval toads were reared to metamorphosis and measured, weighed and examined for malformations. Survival to metamorphosis in each mesocosm was calculated and statistical comparisons among treatments were conducted for the dependent variables. Our study supports mounting evidence that these disposal systems pose significant ecological risks by attracting wildlife from surrounding areas.

522 AES Behavior & Morphology, Galleria South, Thursday 23 July 2009

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First Use of Mobile Peer-to-Peer Network (MP2P) Technology on a Marine Animal

Mobile peer-to-peer (MP2P) technologies offer new opportunities for characterizing interactions between animals and retrieving data about these events. The key attribute distinguishing the MP2P approach from traditional biotelemetry is the exchange of information between individuals (peers) rather than exclusively and directly from individuals to a base station such as a tracking receiver. We equipped 4 Galapagos sharks (Carcharhinus galapagensis) with prototype MP2P technology (Vemco™ ‘Business Card Tags’ - BCTs) which used ultrasonic encoding to exchange unique identification codes between host animals during spatial encounters. During the experiment, the island of Oahu was surrounded by an array of 24 stationary receivers (Vemco VR2Ws) capable of detecting both BCTs and conventional coded transmitters. Before the BCTs were deployed, 32 sharks (Galapagos, sandbar and tiger) were captured at the study site and equipped with conventional coded acoustic transmitters (Vemco V16). Thus the experimental design allowed BCT-equipped sharks to: (1) detect one another, (2) detect other sharks equipped with conventional transmitters, and (3) be detected by fixed receivers stationed around the island of Oahu. Two BCTs were recovered after 20 and 132 days at liberty respectively. Recovered BCTs had recorded 4,506 and 4,875 detections of 28 and 30 transmitter-equipped sharks each, and had detected all 3 other BCT-equipped sharks on multiple occasions. Integration of both mobile (V16 and BCT-equipped sharks) and fixed peers (VR2 receivers) provided greater insight into shark behavior than would have been derived independently from either method. This study represents the first use of MP2P technology on a marine animal.
446 Amphibian Pathogen Ecology, Broadway 1&2, Thursday 23 July 2009

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Ominous Tadpoles: American Bullfrogs are Suitable Hosts of *Escherichia coli* O157:H7

*Escherichia coli* O157:H7 is a zoonotic pathogen that can be transmitted to humans through contaminated beef and vegetables. Amphibian larvae may function as a spill-over reservoir for *E. coli* O157:H7 in aquatic environments used by livestock. We tested whether American bullfrog (*Lithobates catesbeianus*) tadpoles could become naturally infected with *E. coli* O157:H7 via exposure to this pathogen in outdoor aquatic mesocosms. Cattle feces inoculated with *E. coli* O157:H7 (10⁶ CFU g⁻¹) were added daily at environmentally relevant levels to mesocosms that included bullfrog tadpoles, and tadpoles were euthanized and tested for infection. After 7, 14 and 28 days of exposure, 23, 35 and 51% of tadpoles tested positive for *E. coli* O157:H7. Maximum likelihood estimates revealed a 12% linear increase in the predicted odds of infection with each consecutive week of continuous pathogen exposure. Further, we determined that survivability of *E. coli* O157:H7 in mesocosm water was minimal beyond 3 days, suggesting that tadpoles can become infected quickly after exposure. We also found that 25% of the tadpoles that metamorphosed prior to the end of the experiment tested positive for *E. coli* O157:H7, providing preliminary evidence that infected metamorphs may transport the pathogen overland during dispersal. Together, our results suggest that American bullfrog tadpoles, and perhaps other amphibian larvae, could serve as a spill-over reservoir for *E. coli* O157:H7. Given that ruminants are the primary reservoir for this foodborne pathogen, we recommend that livestock are fenced when possible from water sources where amphibian larvae are present.

998 HERPETOLOGISTS’ LEAGUE GRADUATE RESEARCH AWARD II, Galleria North, Sunday 26 July 2009

Kimberly Miller

*Victoria University of Wellington, Wellington, New Zealand*

Maintaining Genetic Diversity in Reintroduced Populations of Skinks and Tuatara

Translocation provides one of the most powerful tools for species conservation, but reintroduced populations are often founded by a small number of individuals and generally have low success rates. The loss of genetic diversity in a small reintroduced population may reduce the probability of establishment and persistence. Maximising genetic diversity is therefore central to the success of reintroduced populations. Using population modelling and empirical data from reintroduced populations of skinks and
tuatara, I examined factors that influence inbreeding dynamics and the long-term maintenance of genetic diversity in translocated populations. The translocation of gravid females aided in increasing the effective population size after reintroduction. Models showed that supplementation reduced the loss of heterozygosity over ten generations in species with low reproductive output, but not for species with higher output. Harvesting from a reintroduced population for a second-order translocation accelerated the loss of heterozygosity in species with low intrinsic rates of population growth. Male reproductive skew also accelerated the loss of genetic diversity over ten generations, but the effect was only significant at small population size. These results improve translocation planning by offering guidelines for maximising genetic diversity in founder groups and managing populations to improve the long-term maintenance of diversity. For example, founder groups should be larger than 30 for reintroductions of species with low reproductive output, high mortality rates after release, and highly polygynous mating systems.

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797 Poster Session II, Exhibitor’s Hall, Saturday 25 July 2009

Melissa Miller, William Lutterschmidt

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Comparative Skin Permeability in Two Sympatric and Congeneric Pitvipers: Does Physiology Influence Habitat Partitioning?

Evaporative water loss (EWL) is a limiting factor in habitat selection for many ectotherms. Numerous studies on reptiles demonstrate negative correlations between EWL and habitat aridity. Cutaneous water loss (CWL) is the primary component contributing to total EWL in many squamates, with epidermal lipids governing skin permeability and resulting CWL. Heterospecific studies have documented EWL in regard to habitat selection for many snake taxa. However, fewer studies have examined congeneric comparisons of EWL in relation to differences in habitat preference. We examined skin permeability through measures of CWL and skin lipid content in two sympatric congeners, the western cottonmouth (*Agkistrodon piscivorus leucostoma*) and the southern copperhead (*A. contortrix contortrix*). Though closely related, and widely sympatric throughout much of their distribution, *A. piscivorus* and *A. contortrix* are not syntopic (i.e. they utilize different microhabitats). *A. piscivorus* occupies primarily an aquatic microhabitat while *A. contortrix* is more terrestrial. CWL and lipid content were determined from shed epidermis from each species for statistical comparisons. Samples of shed epidermis were also taken from multiple regions along the dorsal and ventral integument to examine potential variation in skin permeability and lipid content among different regions along the body. Potential species-specific differences in CWL and lipid content will be discussed with how these physiological differences may influence species partitioning of microhabitat use.
Perspectives on the Population Connectivity of Tropical Diadromous Fishes

Catadromous, anadromous, and amphidromous fishes are present in the tropics, but catadromy appears to be the dominant form of diadromy. These diadromous fishes include anguillid eels, mullets, shads, gobies, and kuhliids, and population genetic or pelagic larval duration studies on a few species of catadromous eels and amphidromous gobies provide some information about the possible connectivity of these fish populations. The majority of anguillid eel species are found in tropical areas, and some species of tropical anguillids show much shorter spawning migrations than temperate species, and have multiple spawning areas and different populations. Anguilla celebesensis appears to have two spawning areas within its species range in the northern Indonesia region, and the most widely distributed anguillid eel, Anguilla marmorata, appears to have five or more populations or metapopulations across its species range in the Indo-Pacific region. Amphidromous gobies of the subfamily Sicydiinae are also found in tropical areas, with most species being endemic or having limited distributions, except for Sicyopterus laogocephalus, which is widely distributed across the Indo-Pacific and appears to have regional population structure. Both amphidromous gobies and tropical anguillids have marine larval durations of > 90 days, but the presence of endemic species or regional populations of these fishes indicate that their long larval durations do not always result in large-scale dispersal. More studies on the life histories and population structures of tropical diadromous fishes are needed to better understand the connectivity of these poorly known fishes.

Ecology of Anguilliform Leptocephali in the Western North Pacific Subtropical Gyre

Surveys for leptocephali have been conducted along the edge of the Kuroshio Current, which is the western boundary current of the western North Pacific subtropical gyre, in the Kuroshio Extension along the northern margin of the gyre, and within the gyre, that provide new information about the possible spawning areas and larval dispersal patterns of marine eels in the region. Many species of marine eels of the Congridae, Muraenidae, and Ophichthidae, and a few species of the Nettastomatidae and Synaphobranchidae were found to spawn near the edge of the outer shelf of the East China Sea near the western edge of the Kuroshio, and some of these leptocephali appear to be transported offshore into the Kuroshio Extension. Other congrids such as Bathycongrus retrotinctus, and Ariosoma major, appear to migrate to the east of the
Kuroshio to spawn so their leptocephali can use the Kuroshio Extension recirculation gyre for a larval development area. The leptocephali of *Ariosoma major* reach large sizes > 200 mm and seem to also use the larger subtropical gyre for development, because their large-size leptocephali are consistently collected in the westward flowing North Equatorial Current where the Japanese eel, *Anguilla japonica*, and giant mottled eel, *Anguilla marmorata*, spawn. Countercurrents at higher latitudes within the gyre may also transport leptocephali offshore from the west. Future studies are needed to determine the extent to which some marine eels have evolved specific spawning locations and larval recruitment strategies based on the surface currents in the western North Pacific subtropical gyre.

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**855 Fish Behavior, Parlor ABC, Monday 27 July 2009**

*Carlos Mireles, Christopher Lowe*

*California State University Long Beach, Long Beach, CA, United States*


In California, populations of nearshore reef fish inhabit shallow areas of deep offshore petroleum platforms. With platforms offering unique habitat that extends from the benthos to the surface, it is not known to what extent these relatively shallow occurring species utilize the continuous vertical habitat available to them. We used acoustic telemetry to monitor the depth utilization of four economically important fish species inhabiting one shallow (50 m) and one deep (225 m) platform located 12 km off the coast of Long Beach. Adult Cabezon (*Scorpaenichthys marmoratus*), California Sheephead (*Semicossyphus pulcher*), Grass Rockfish (*Sebastes rastrelliger*), and Kelp Rockfish (*Sebastes atrovirens*) were monitored for 1.5 years. Trends in depth distribution were similar on both platforms, with grass rockfish, and kelp rockfish preferring shallow depths (10-20 m) and cabezon preferring deeper regions (30-55 m). Sheephead displayed three distinct behavior patterns associated with movement from shallow (15-20 m) to deeper (30-55 m) areas. Cabezon and sheephead displayed seasonal shifts in depth preference between warm and cold periods. Cabezon primarily reside deep (40-188 m) and sheephead shallow (15-20 m) during summer periods, while displaying an overlapping depth distribution (30 m) during winter. Individuals tagged on the deeper platform did utilize depths greater than those available on the shallow platform; however, cabezon was the only species to utilize depths greater than 100 m. Based on these findings, patterns of depth distribution are species specific with species utilizing deeper habitat when it is available.
Using Site Occupancy Models to Infer the Response of the Coachwhip (Masticophis flagellum) and Striped Racer (M. lateralis) to Land Use Change in Coastal Southern California

We used detection data from a regional, on-going reptile-monitoring program conducted by the U.S. Geological Survey to measure the effect of landscape connectivity, urbanization, and habitat composition on the probability of site occupancy and local extinction for the Coachwhip (Masticophis flagellum) and Striped Racer (M. lateralis) in coastal southern California. Likelihood-based occupancy models implemented in program PRESENCE indicated a differential response by the Coachwhip and Striped Racer to land use change, with Coachwhip populations showing a much greater sensitivity to the isolation and urbanization of sites. Striped Racer occupancy responded more strongly to habitat composition, favoring scrub dominated sites over more open habitats. Large differences in the recovered annual rates of local extinction and detectability between the two species likely explain much of the observed difference in sensitivity to the isolation of sites. Movement data on the Coachwhip and Striped Racer supports interpretation of the results, with the Coachwhip described as a wider-ranging species. Observed differences in habitat use and specificity are also supported by telemetry studies and corroborate existing knowledge of historical patterns of occurrence. Collectively, the results suggest widespread loss of the Coachwhip from the region. Preliminary genetic analyses show significant phylogenetic structure among local Coachwhip populations suggesting the regional decline of the species has important conservation implications.
Cypriniformes Tree of Life: A Mitochondrial Phylogenomic Approach Based on 363 Sequences

Fishes of the order Cypriniformes are almost completely restricted to freshwaters and comprise over 3400 species placed in six families, each with poorly-defined subfamilies and/or tribes. After publication of the mitochondrial phylogenomic study by Saitoh et al. (2006) based on 53 sequences, we newly determined over 300 whole mitogenome sequences for cypriniforms and this study represents the second step towards resolution of the higher-level relationships of the clade based on more extensive taxon sampling from 355 cypriniforms (including phylogenetically enigmatic Psilorhynchus, Ellopostoma and Paedocypris). Unambiguously aligned, concatenated mitogenome sequences from 13 protein coding (11,286 bp), two rRNA (2198 bp) and 22 tRNA (1463 bp) genes were divided into five partitions (1st, 2nd, and 3rd codon positions, rRNA and tRNA), with the entire 3rd codon positions converted into R (purine) and Y (pyrimidine) to take into account only transversional changes. Phylogenetic analyses based on partitioned maximum likelihood method using RAxML 7.04 were conducted and the resultant phylogenies were largely congruent with previous findings in Saitoh et al. (2006), although the addition of 302 new sequences provided a much more detailed picture of cypriniform relationships even at the generic level. As for the most unusual taxa, Psilorhynchus is the sister group of the subfamily Cyprininae (sensu lato); Ellopostoma is closely related to the subfamily Balitorinae (not Nemacheilinae as previously thought); and Paedocypris occupied a position sister to all the remaining members of the family Cyprinidae (not a rasborin as previously demonstrated). Also Sundadanio represented a unique lineage, independent of other rasborin taxa.
Aposematism has been a focus of attention for biologists since the 1800’s (Darwin 1887; Wallace 1889), but theories regarding its origin and maintenance remain controversial. Animals advertise their unprofitability to potential predators with conspicuous coloration, occasionally in combination with other aposematic traits. Theory posits that selection on such “functionally interrelated aposematic traits” promotes unidirectional evolution of them, resulting in an increase or decrease in the effectiveness of the signal, and it has been examined on macro- and microevolutionary scales. However, this prediction does not always fit what is observed in nature. In this study, I investigated aposematic coloration and behavior of the newt, Cynops pyrrhogaster, sampled from 44 sites ranging over 800 km of latitude. I demonstrated that newts on islands displayed more conspicuous aposematic signals, both morphologically and behaviorally, than those on the mainland. Also I found a mismatch of geographic variation between aposematic traits, namely, there was a latitudinal gradient only in coloration, but not in aposematic behavior. Aposematic coloration of newts at low latitude exhibited more conspicuous and distinctive differences between islands and the mainland than that at high latitude. Based on the analyses examining the effects of biotic and abiotic variables on variation in aposematic traits, I discuss the possibility that latitude-dependent abiotic variables might constrain the color expression but not behavioral trait, and that these variables might also influence the evolutionary response to predation pressure on coloration that increases the effectiveness of aposematic signals.

830 Poster Session III, Exhibitor’s Hall, Sunday 26 July 2009
Shabnam Mohammadi, Krista McCoy, Alan Savitzky
Old Dominion University, Norfolk, VA, United States

A Comparison of Adrenal Glands in Toad-eating and Nontoad-eating Snakes

Toads are chemically defended by bufadienolides, cardiotonic steroids synthesized in their parotoid glands. When ingested by a predator, bufadienolides bind to Na+,K+-ATPase (NKA), disabling the sodium pump. Bufadienolides are lethal to most predators, including many snakes. However, several snake species are resistant to bufadienolides and readily consume toads. We hypothesize that toad-eating snakes possess modified adrenal glands that play a role in the snakes’ resistance to bufadienolides. Adrenal glands produce steroids and catecholamines that play various roles in the control of NKA production and activity and thus are important for the maintenance of heart rate and blood pressure. We therefore expect adrenal glands to play an important role in countering the negative effects of toads on toad-eating snakes. Indeed, the toad-eating specialist Heterodon platirhinos is known to possess enlarged adrenal glands. In this study, we used phylogenetically independent samples to investigate various aspects of adrenal morphology in snakes that primarily eat toads (bufophagus), facultatively consume toads, or do not eat toads (nonbufophagus). We compared adrenal size and histology of steroidogenic and catecholaminergic tissues among some of these species. Preliminary results suggest that bufophagous snakes possess enlarged adrenal glands relative to facultative toad-eaters and nonbufophagus snakes.
Using Rattlesnake Shaker Muscles to Test How Long Tendons Affect the Energetic Cost of Contraction

In this project we are using the shaker muscles in the tails of western diamond-backed rattlesnakes (Crotalus atrox) to test the hypothesis that muscles with long have a lower energetic cost of contraction than muscles with short or no tendons. Muscles that have long tendons often shorten less than muscles with short tendons, which suggests that they have a lower cost of contraction. However, in most muscles it is difficult to separate the effects of fiber type and tendon length on contractile cost. Rattlesnake shaker muscles are good models for this study because they vary in tendon length along the tail but have a uniform fiber type, which provides a natural control that is lacking in typical muscles, and because the segments with long tendons shorten significantly less than segments lacking tendons, which suggests different contractile costs. By selectively denervating shaker muscles while measuring oxygen consumption, we can partition the cost of contraction between muscles that have long tendons and no tendons. Our early results indicate that (1) shaker muscles have metabolic rates that are high enough to allow selective paralysis without loss of metabolic signal strength, (2) denervation of the distal-most muscles segments does not alter the activation or contractile strains of more proximal, intact segments, and (3) the cost of contraction in segments with long tendons is lower than in segments without tendons. These results are probably representative of other fast muscles, which occur in diverse lineages of animals, as well as typical skeletal muscles.

Love on the Rocks: Seasonal Monogamy, Multiple Paternity, and Large-Male Advantage in Tuatara

Investigating the mating system of a population provides insight into the evolution of reproductive patterns, and can inform conservation management of threatened or endangered species. Combining behavioral and genetic data is necessary to fully understand the mating system and factors affecting male reproductive success, yet behavioral data are often difficult to collect for threatened species. We use behavioral data and paternity analyses to characterize the mating system of a high density population of a long-lived, ancient reptile (tuatara, Sphenodon punctatus) on Stephens Island, New Zealand. We further investigate the phenotypic traits (including body size, body condition, tail length, and ectoparasite load) that affect male reproductive success.
Our behavioral data reflect a seasonally monogamous system with low levels of polyandry and polygyny that are consistent with male mate guarding. Male reproduction is highly skewed (only 25-30% of males are successful), and body size is the primary predictor of male reproductive success. Based on the genetic data, multiple paternity was found in only 8% of clutches, and paternity results showed monandrous clutches from socially polyandrous females. Our behavioral and genetic results revealed complexities in female mating patterns that support the potential for cryptic female choice or sperm competition. This warrants further experimental investigation into the mechanisms underlying reptile fertilization and the disparities between social and genetic polyandry in wild populations.

977 AES Conservation & Management II, Parlor ABC, Saturday 25 July 2009

Johnny Moore1, Dewayne Fox1, Bradley Wetherbee3, Camilla McCandless4

1Delaware State University, Dover, DE, United States, 3University of Rhode Island, Kingston, RI, United States, 4NOAA/National Marine Fisheries Service, Narragansett, RI, United States

Critical Habitat for Sand Tiger Sharks During their Summer Residency in Delaware Bay

The population of sand tiger sharks (Carcharias taurus) along the US East coast has declined over the past several decades and recovery of stocks is limited by low reproductive rates coupled with continued take as bycatch in various fisheries. Identification of essential habitat is critical for enhanced recovery of sand tiger stocks. Delaware Bay is one of the most important areas used by this species on the US East coast. We have been using acoustic transmitters and an array of receivers in Delaware Bay to identify critical habitat of sand tigers during their Delaware Bay summer residency. We monitored the movements and habitat use of 69 sand tigers in the summers of 2006 - 2008. Males and females were segregated, with males more commonly found in the lower salinity middle portion of the bay and in shallower waters, whereas females were more common in deeper, higher salinity waters near the mouth of the bay. Habitat use varied between years with significantly shallower depths used in 2007 than in 2008. The importance of Delaware Bay as summer habitat for sand tigers is demonstrated by relatively high interannual site fidelity with 50% of sharks tagged in 2006 returning in 2007, and 60% tagged in 2007 detected in the bay the following summer of 2008. This study has been very successful in identifying habitat of high use within Delaware Bay and providing information for protection of discrete portions of the bay that are vital to the recovery of this imperiled species.
Movement Patterns, Home Range and Habitat Use of Western Spiny Softshells (*Apalone spinifera hartwegi*) in the Upper Missouri River, Montana

The disjunct population of Western Spiny Softshells (*Apalone spinifera hartwegi*) in the Upper Missouri River of Montana is separated from the nearest downstream populations by hundreds of miles. It is the most upstream population in the Missouri River and is listed as a Species of Concern in Montana due to its restricted range. For these reasons, movement patterns, home range, and habitat use were investigated between 2007 and 2009. Fourteen females and eight males were fitted with radio-transmitters and tracked from between one week and 20 months. Mean home range size for females did not differ from males and both varied widely in size. Turtles had significantly larger home ranges during the high water year (2008) than during the low water year (2007). Nesting was not documented for any tagged females. However, two female concentrations during the nesting season were documented in reaches characterized by a highly braided channel with slower moving/stillwater side channels and sandy/gravelly banks. Similarly, three hibernacula sites were used by ten of the 18 turtles located during the winter. These sites consisted of main-channel margins with slow to moderate flows and silt, sand, and/or gravel substrates. Suitable nesting and hibernacula sites are juxtaposed in our study area and it is unclear why several individuals made movements greater than 20 km during the study. Conservation of this relatively natural portion of the Missouri River is essential to the maintenance of this isolated population.

Population Assessment of the Dusky Shark in the Northwestern Atlantic Ocean Using an Age Structured Model

The objectives of this study were to build an age-structured model to assess the effects of fishing on population trends for dusky shark. This model included sensitivity analyses to assess the effects of time/area closures, reduced mortality as a result of reduced soak times for the bottom longline fishery, full selectivity of age-zero animals, combined CPUE series for all catch rates and changes to other model parameters on overall population sizes. Results showed that the impacts of fishing already imposed on the dusky shark will be difficult to overcome even with the implementation of time/area closures.
closures, gear modifications and/or catch and discards being reduced for another 20 years. Results of the base case, all scenarios and sensitivity analyses indicated that the population of dusky sharks in the northwestern Atlantic Ocean is at 9 to 50% of virgin biomass. Recent publications have shown that the Maximum Sustainable Yield (MSY) for dusky sharks may be well above 50% of the carrying capacity. Fisheries managers must determine whether the high depletion rates reported in these models suggest this species is overfished, and would therefore require long-term targets for population recovery to sustainable levels.

155 Fish Conservation I, Parlor ABC, Sunday 26 July 2009

Ray Morgan

UMCES_AL, Frostburg, MD, United States

Effects of Road Salt on Fish Assemblages in Maryland

Road salt usage ensures safe winter driving conditions on high traffic volume highways and secondary roads. However, there are often excessive and repetitive applications of road salt, depending on storm severity and frequency. I used the Maryland Biological Stream Survey (MBSS) data base to examine water quality collected during the MBSS Spring Index period and fish assemblage data from the MBSS Summer Index period for Maryland. Statistical analyses indicated that there are significant changes in fish assemblages in first, second and third order streams, with simpler assemblages (2-3 tolerant fish species) present in streams with high chloride levels. The number of intolerant fish species declines significantly at chloride levels greater than 100 mg/L, along with decreases in fish assemblage diversity and the Maryland Fish Index of Biotic Integrity. Road salt is an important stressor to fish assemblages, and needs to be considered in conservation of intolerant Maryland fish species and stream biodiversity.

893 Poster Session II, Exhibitor’s Hall, Saturday 25 July 2009

James Morley¹, Jeffrey Buckel¹, Thomas Lankford²

¹North Carolina State University, Raleigh, NC, United States, ²University of North Carolina at Wilmington, Wilmington, NC, United States

Development and Tests of Predictive Models to Estimate Muscle and Liver Energy Content of Bluefish

The positive correlation between percent dry weight and energy density has been documented for many fish species, including bluefish (Pomatomus saltatrix). When processing larger fish, considerable effort can be saved if the energy content of the whole fish can be estimated from tissue samples. Both muscle and liver tissue are known to be important energy storage depots in bluefish. In this study we developed predictive
models for bluefish between energy density in muscle tissue and percent dry weight (%M_D), and total liver energy content and dry weight of whole livers (L_D). Soxhlet extraction was used to determine energy content of tissues dissected from 870 juvenile bluefish from three year-classes. Each year-class was sampled from the fall through the spring during its first winter. Six candidate models were fit to each year-class and tissue type. For muscle, a piecewise linear model provided the best fit for each year-class, with a mean breakpoint of 22.8%M_D. This piecewise relationship results from a shift in lipid:protein storage ratios at the breakpoint, indicated by a doubling of the slope value. For liver, an exponential model best described the relationship between energy content and L_D for each year-class. For both muscle and liver energy estimation, models without a year effect (pooled years) had more support than models with a year effect. Thus, these relationships are temporally consistent and can be used to predict energy content of bluefish from estimates of dry weight.

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896 Fish Ecology III, Pavilion West, Monday 27 July 2009

James Morley¹, Jeffrey Buckel¹, Thomas Lankford²

¹North Carolina State University, Raleigh, NC, United States, ²University of North Carolina at Wilmington, Wilmington, NC, United States

Seasonal Changes in Prey Abundance and Temperature Dependent Capture Success Affect Winter Feeding in Bluefish

Our previous work has shown that bluefish (Pomatomus saltatrix), under experimental conditions, exhibit a reduction in temperature specific consumption and growth rates during winter months. This suggests a physiological adaptation to poor feeding and growth conditions during winter. Here we examine if this seasonal adaptation is a result of decreased prey abundance and a reduction in capture success at low temperature. First, we examined spatial overlap between juvenile bluefish and their prey using trawl survey data off North Carolina from November – June. Moderate declines in prey abundance and increasing spatial variability of prey density were observed during winter. However, trawl specific gut fullness levels of bluefish showed only weak correlation with prey catch, suggesting bluefish are not prey limited. Second, we experimentally examined the effect of temperature on capture success of bluefish preying on bay anchovy. Twenty-minute feeding trials were conducted at five temperature treatments. Feeding trials were recorded using a two-camcorder set up that allowed us to quantify movement and location in three dimensions. The number of attacks by individual bluefish decreased at low temperature. Also, capture success of bluefish was reduced at low temperatures due to bluefish experiencing a greater decline in burst swimming speed. A reduction in the ability to find prey during winter, coupled with decreases in a predators ability to capture prey, both likely contribute to the seasonal adaptations in metabolic rate seen in fishes. This reduction in metabolic rate during winter leads to a reduction in consumption and feeding motivation.

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Feeding ecology of Two Hake Larvae: Merluccius merluccius from NW Mediterranean and Merluccius gayi from Central Chile. Ontogeny versus Environmental Conditions

Trophic relationships and food habits of larvae of two species of Merlucidae were examined, Merluccius merluccius from the NW Mediterranean and Merluccius gayi from Central Chile, in two different environmental conditions: vertical stratification versus mixed period (NW Mediterranean) and upwelling versus reversal upwelling period (Central Chile). Examined larvae ranged from 2.5 to 8 mm Standard Length (SL). Both species have similar morphology characterized by big mouths and large looped-guts. Mouth growth showed a positive allometry in relation to SL. Feeding incidence was very high in both species (>90%). The prey number was high, with a significant increase along growth and with differences between the periods in both ecosystems. Prey size increased also significantly along development, without differences between species periods. Both species start to feed on big preys (width size>150 µm) from first feeding, with the Mediterranean larvae preying on bigger preys than the Chilean ones. The dominant prey in Mediterranean hake larvae was adult female of Clausocalanus sp. (>75% of the copepods) followed by p-calanus and Ctenocalanus sp. in June and by Paracalanus sp.>Centropages sp.>Aetideidae> Oncaea sp.> p-calanus in November. On the other hand, the most important prey for the Chilean hake larvae was Paracalanus sp., although there were differences between the two periods, with a higher dominance of this prey in the diet of the larvae collected in March (80% of the copepods) whereas in November diet was more diversified (36% Paracalanus sp.>Calanidae>Oithona sp.>Euterpina sp.). Chesson index for prey selection was also analysed in each species.
Filter Feeding in the World’s Largest Fish: Form, Function and Diet

Filter feeding is employed by the largest elasmobranchs. Among these the whale shark *Rhincodon typus*, utilizes ram and suction filter feeding. Archived satellite tag data and aerial observations indicate sharks ram filter feed near the surface approximately 7.5 hours per day in dense aggregations (4.5 g/m$^3$) of plankton off Quintana Roo, Mexico from May through September. With swimming speeds averaging 1.1 m/s, computational fluid dynamics indicates the effective flow rate into the partially submerged mouth is 0.99 m/s. Calculated filter rates, based on mouth morphometrics and swimming speeds, combined with plankton tows and energetic analysis of the plankton, estimate consumed biomass of 11 kg/day for a 476 cm TL shark, and 20 kg/day for a 631 cm shark, equating to an approximate intake of 3,565 and 6,464 kcal/day, respectively. These estimates are compared to dietary intake of captive whale sharks and the filter-feeding basking shark. The novel filtering apparatus of the whale shark consists of a series of twenty filtering pads that lie dorsally and ventrally on either side of the pharynx. These pads, which overlay and completely occlude the branchial arches, have a mesh with holes averaging 1.2 mm in diameter, considerably smaller than the majority of their prey. A mechanism of crossflow filtration whereby particles are entrained and passively transported posterior to the pads is proposed. After passing through the pads an elaborate system of channels directs water through what appear to be collimator vents, and over the gill lamellae before exiting the pharyngeal slits.
weight can be used without appreciable negative impacts. However, this has rarely been tested. We conducted a study of male crested anoles to determine how additional weight from a faux transmitter impacted the anole’s home range size, vertical habitat use, body condition, and jumping ability. Information on the location and vertical position of 33 males was recorded each time an individual was seen. In mid-study, individuals that had at least 10 resightings were caught, re-processed, and assigned to a weight treatment group that ranged from 0 to 20% of that individual’s body weight. A second round of visual recaptures was then recorded. At the end of the study, lizards were caught and measured again, then each underwent five consecutive jump-distance tests from a standard height post. We did not find a difference in home range size or vertical habitat use. However, there was a significant decrease in body weight over the season for individuals carrying as little as an additional 5% of their body weight. Jump distance was also significantly decreased in weighted individuals. It has traditionally been accepted that transmitters weighing up to 10% of an individual reptile’s body weight could be used without appreciable negative impacts to the normal behavior, physiology, reproduction, or locomotion of that organism. Our data suggest that the 10% standard rule may be inappropriate for some reptilian species.

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862 Poster Session I, Exhibitor’s Hall, Friday 24 July 2009

Hendrik Mueller

1Jena University, Department of Comparative Zoology and Evolutionary Biology, Jena, Germany, 2Harvard University, Museum of Comparative Zoology, Cambridge, MA, United States

Egg Deposition and Embryonic Development in Plethodontid Salamanders

Plethodontid or lungless salamanders are the largest group of the Urodela and are unmatched not only in terms of species number but also for the diversity of reproductive modes across the group. These range from paedomorphic species and species with a biphasic life history with long larval periods, to species with a very abbreviated larval stage, to direct developing species without a larval form. Recent research has further suggested that some species of Desmognathus have regained an aquatic larva from a direct developing ancestor. To gain a better understanding of the evolution of the different life history modes, the available information on egg deposition site was reviewed. Field collected embryonic material of various species representing several lineages, together with published information, further enabled an assessment of the state of development at hatching. While there is a strong correlation between developmental mode and degree of development at hatching in most plethodontids, Desmognathus deviates from this pattern in having externally well developed hatchlings in both direct developing species and species with larval development. Data on egg deposition site show a variable pattern when compared to life history mode in plethodontids. These findings are discussed in light of a potential regain of an aquatic larva in some species of Desmognathus.
188 Poster Session I, Exhibitor’s Hall, Friday 24 July 2009

Sarah Muffelman¹, Renee Collini¹, Frank Hernandez, Jr.¹, Keith Bayha², Sean Powers³, William Graham¹

¹Dauphin Island Sea Lab, Dauphin Island, AL, United States, ²University of California-Merced, Merced, CA, United States, ³University of South Alabama, Mobile, AL, United States

Spatial and Temporal Distributions of Vermilion Snapper (Rhomboplites aurorubens) and Red Snapper (Lutjanus campechanus) Eggs and Larvae in the Northern Gulf of Mexico

Ichthyoplankton surveys can be used to infer the location and timing of adult fish spawning events. This information can be used by fisheries resource managers to assess the relative value of different spawning habitats and as fisheries-independent data for stock assessment models. Unfortunately, the identification of fish eggs and larvae of many species from the Gulf of Mexico remains problematic. Here we present preliminary results from a study utilizing frequent ichthyoplankton surveys combined with molecular techniques developed by us to identify the cross-shelf and vertical distribution patterns of red snapper (Lutjanus campechanus) and vermilion snapper (Rhomboplites aurorubens) eggs and larvae off the coast of Alabama (USA). Depth-discrete ichthyoplankton samples were collected during multiple cruises (n=13) in 2007 and 2008 (May-September) at three stations across the continental shelf representing a range of water depth and artificial habitat complexity. In addition, vertical net hauls were collected during cruises (n=10) in 2008 (May-September) at eighteen stations along the same transect line. Using a TaqMan multiplex Real-Time PCR assay, we were able to successfully identify red snapper and vermilion snapper eggs and early larval stages. The relative abundance of red snapper and vermilion snapper eggs and larvae were compared with respect to their spatial (across the shelf) and temporal (date of collection) distributions. In addition, depth-discrete samples were analyzed to determine differences in larval fish and egg vertical distributions (e.g., center of mass) between the two species. The results from this study provide the first description of distributions for these previously unidentifiable stages.

943 Herp Systematics, Pavillion West, Thursday 23 July 2009

Daniel Mulcahy¹, Brice Noonan², Travis Moss¹, Ted Townsend³, Tod Reeder³, Sarah Smith⁴, Caitlin Kuczynski⁴, John Wiens⁴, Jack Sites, Jr.¹

¹Brigham Young University, Provo, UT, United States, ²University of Mississippi, University, MS, United States, ³San Diego State University, San Diego, CA, United States, ⁴Stony Brook University, Stony Brook, NY, United States

Basal Relationships Among Squamate Reptiles Based on 25 Protein-coding Nuclear Loci
The ‘Deep-Scaly’ project is part of the NSF-funded Assembling the Tree of Life (AToL) program, intended to address higher-level phylogenetic relationships among squamate reptiles. Squamates include snakes, “lizards,” and amphisbaenians, which are characterized by possessing hemipenes (paired copulatory organs), among many other synapomorphies. Traditional morphology-based hypotheses of squamates illustrate a progression of tongue evolution that place the Iguania, with a relatively fleshy tongue used for food gathering, as the sister taxon to all remaining squamates. This transition depicts the gekkotans evolved next, with partly chemoreceptive tongues, and finally the autarchoglossans, which include the scincomorphs and anguimorphs evolved snake-like tongues used primarily for chemoreception. Recent molecular analyses using mitochondrial and nuclear DNA sequence data place the Iguania in a more nested position, closer to snakes and anguimorphs. However, these analyses were based on few gene regions and small numbers of nucleotide characters. Here we present results of the Deep-Scaly project from 25 nuclear protein-coding loci, approximately 19kb in total, from 64 taxa representing the major clades of Squamata. Parsimony, likelihood, and Bayesian analyses largely agree the molecular studies. We also estimate dates of divergence for major clades of squamates with fossil-based calibrations using two commonly used methods (r8s and BEAST) based on our entire dataset. We then evaluate differences in these methods by comparing smaller iterations of our data (e.g., 5, 10, 15, and 20 loci) to the overall estimated dates of divergence.

780 Poster Session II, Exhibitor’s Hall, Saturday 25 July 2009

Daniel Mulcahy¹, Tyler Williams¹, Joseph Mendelson III², Jack Sites¹

¹Brigham Young University, Provo, UT, United States, ²Zoo Atlanta, Atlanta, GA, United States

Phylogenetic Relationships Among Mesoamerican Bufonids

Phylogenetic hypotheses among species can be important in helping to direct conservation efforts focused on protecting biodiversity. For instance, upland forests in Mesoamerica are becoming threatened because of increased human populations. Many species occur in these upland areas and are isolated from their closest relatives by lowland habitats. Toads offer a unique opportunity to study natural history, morphological variation, and biodiversity because they offer an array of chemical compounds which are used for defense and have a wide variety of reproductive and life history strategies. Amphibians are experiencing global declines in populations and species numbers, which are largely caused by the recent spread of a unique form of chytrid fungus. Therefore, understanding the evolutionary relationships of toads before they experience more declines should be a top conservation priority. In this study, we combine mitochondrial and nuclear sequence data with morphological data (39 characters) to conduct phylogenetic analyses for most species of Mesoamerican bufonids. We examine sequences from 46 individuals representing 34 species, including four South American species and one North American species as outgroups. We collected 3,757 bp of sequence data: 568 bp 16S, 933 bp 12S, and 675 bp cyt b (total 2,176 mtDNA characters). The nuclear data consists of 717 bp from the CXCR4 gene and 864 bp from the RAG1 gene (1,581 bp total nuclear). Our study will help us to answer
evolutionary questions such as monophyly of the *valiceps* and *coccifer* groups, genetic diversity of the upland species, and an evolutionary framework for the entire group.

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971 Poster Session III, Exhibitor’s Hall, Sunday 26 July 2009

Cristopher Mull\(^1\), Christopher Lowe\(^1\), John O’Sullivan\(^2\)

\(^1\)California State University, Long Beach, CA, United States, \(^2\)Monterey Bay Aquarium, Monterey Bay, CA, United States

**Heavy Metals and Trace Elements in Juvenile White Sharks (Carcharodon carcharias) from the Southern California Bight**

Evidence suggests that the white shark (*Carcharodon carcharias*) in the eastern north Pacific utilize the southern California bight (SCB) as a nursery ground. Due to the proximity of highly urbanized locations a large amount of anthropogenic contaminants are introduced to the system, and juvenile white sharks are potentially exposed to relatively high levels of trace elements. To assess potential exposure levels, concentrations of 17 elements, including arsenic, selenium, cadmium and mercury were measured from the muscle and liver tissue of juvenile white sharks using inductively coupled plasma mass spectrometry (ICP-MS). Samples were collected from incidental mortalities of juvenile white sharks in the southern California gill net fishery. There was no significant difference in concentration of arsenic, selenium or cadmium between muscle and liver. Average mercury concentrations were significantly higher in muscle (2.74 ± 0.61 µg/g dry weight) than liver (0.42 ± 0.07 µg/g dry weight) (p<0.05). Dry weight concentrations of mercury and selenium are comparable to levels in adults of other shark species for which trace elements have been analyzed (*Galeocerdo cuvier*; *Prionace glauca*) and due to the young age of the sharks suggest a high level of dietary exposure or the potential for maternal offloading during reproduction.

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289 ELHS/LFC Connectivity Symposium I, Grand Ballroom I, Thursday 23 July 2009

Philip Munday

ARC Centre of Excellence for Coral Reef Studies, and School of Marine and Tropical Biology, James Cook University, Townsville, Australia

**Ocean Temperature, Global Warming And Population Connectivity Of Tropical Marine Fishes**

Tropical species are predicted to have narrower thermal tolerance limits and live closer to their thermal optimums than temperate species because they have evolved in a more thermally stable environment. Water temperature can affect a wide range of biological factors important to population connectivity, including: duration of the spawning
season, reproductive effort, pelagic larval duration, larval growth rate, larval survival and behaviour. Therefore, we might expect that there will be differences in connectivity patterns between cold and warm water species. Narrower tolerance limits might also make tropical species more susceptible to increased sea surface temperatures from global warming. Here I update existing analyses of the relationships between temperature and life history traits of marine larvae to show that, in general, tropical species tend to have longer spawning seasons, faster larval growth and shorter pelagic durations than temperate species. Shorter larval duration should reduce the proportional mortality of cohorts of tropical larvae compared to temperate larvae, but higher energetic demands are expected to increase the risk of starvation. Therefore, the nett effects on larval survival are difficult to determine. I then present new experimental evidence that the reproductive and larval stages of some coral reef fishes are sensitive to small increases in water temperature and consequently that the connectivity of reef fish populations could be significantly affected by global warming.

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150 ELHS/LFC Ecology II, Broadway 1&2, Sunday 26 July 2009

Philip Munday, Jennifer Donelson, Danielle Dixson

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Ocean Acidification Affects Larval Growth and Olfactory Discrimination of a Marine Fish

Almost nothing is known about how fishes will respond to the increased levels of dissolved CO$_2$ and reduced seawater pH that are predicted to occur over the coming century. We reared larvae of the orange clownfish, Amphiprion percula, in seawater simulating ocean acidification scenarios for the next 100-150 years. Elevated CO$_2$ and reduced pH had no detectable effect on embryonic duration, but did influence the growth of larvae. By the time of settlement, larvae in reduced pH treatments were larger than larvae reared in control water, although the differences in size between treatments were smaller than variation among clutches. Larval clownfish reared in control seawater discriminated between a range of cues that could help them locate reef habitat and suitable settlement sites. This discriminatory ability was impaired in larvae reared in conditions simulating ocean acidification. Larvae became strongly attracted to olfactory stimuli they normally avoided when reared at pH7.8/1000ppm CO$_2$ and they no longer responded to any olfactory cues when reared at pH7.6/1600ppm CO$_2$. These results indicate that larval growth and development might not be adversely affected by ocean acidification, but that the disruption of larval sensory abilities could have profound effects on population replenishment and connectivity patterns of many marine species.

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Records of Deep-sea Spiny Eels from the Hawaiian Archipelago and Emperor Seamounts, Including a First Report of Lipogenys gillii (Notacanthidae: Albuliformes)

Deep-sea spiny eels (Notacanthidae) were previously reported from the Hawaiian Islands only in species lists, from collected specimens and submersible observations, but without detailed information to confirm their identity. We now provide the collection and observation data for those records. We report the first central Pacific specimen of Lipogenys gillii, traditionally placed in the monotypic family Lipogenyidae, but more recently included in the Notacanthidae. The report of Notacanthus abbotti from the Hancock Seamounts north of Kure Atoll is confirmed. We reevaluate reports of Notacanthus chemnitzi and find those from submersible observations to be based on sightings of L. gillii. The identification of specimens of N. chemnitzi from Maui is discussed. The Hawaiian records of notacanthids are the only reports of the family from the Pacific tectonic plate. However, deep-sea fishes are poorly sampled elsewhere in the central Pacific, thus making it premature to speculate about the distribution of the family in this ocean.

A Review of the Genus Taenioides (Gobiidae: Amblyopinae)

The genus Taenioides is in need of revision. Taenioides is diagnosed amongst Gobiidae by the proximal radial of anterior second anal-fin pterygiophore being spatulate, which is equivalent to the Y-shaped, second anal-fin pterygiophore observed and reported from radiographs. Taenioides spp. have raised dermal ridges bearing sensory papillae on the head and body as well as barbels on the underside of the head arranged in several different patterns. Based primarily on barbel patterns and meristics, we recognize four species, two of which are wide ranging. Taenioides anguillaris and T. gracilis have overlapping distributions and are found from the east coast of Africa, throughout southeast Asia, to China and Japan. Taenioides kentalleni is known only from a single specimen collected from the east coast of Saudi Arabia whereas T. purpurascens is known from many localities in Australia and, possibly, the Philippines. The status of nominal
species such as *T. buchanani*, *T. jacksoni*, *T. limicola*, *T. nigrimarginatus* and *T. sumatranus* will also be discussed.
Tales from the Underground Amazon: Diversity and Evolution of *Phreatobius* (Siluriformes, Ostariophysi)

*Phreatobius* is a peculiar genus of subterranean catfishes inhabiting hyporheic and phreatic ecosystems in the Amazon. A taxonomic revision of *Phreatobius* shows that at least seven species exist: *Phreatobius cisternarum*, *Phreatobius dracunculus*, *Phreatobius sanguijuea*, *Phreatobius* sp. "Anapixi", *Phreatobius* sp. "Jaú", *Phreatobius* sp. "Tarumanzinho", *Phreatobius* sp. "Viraú". An identification key based on morphological plus diagnostic molecular characters is provided. RAG-2 gene sequence were obtained from different species of *Phreatobius* and were combined with equivalent sequence from representatives of Heptapteridae, Pimelodidae and Pseudopimelodidae, plus several other siluriform families from the genebank. The total data set was analyzed by MP and resulted in 172 trees, with 5213 steps. The results strongly indicate that *Phreatobius* forms a monophyletic group (supported by 33 molecular synapomorphies) with Pseudopimelodidae and Pimelodidae plus *Conorhynchos*+Heptapteridae. Previous hypotheses indicating *Phreatobius* exclusively with Heptapteridae or any other individual siluriform family were not supported. Results suggest that *Phreatobius* be allocated in its own family, Phreatobiidae (already available at subfamilial level). A hypothesis of relationships within *Phreatobius* shows that *P. cisternarum* is sister-group of a clade composed of (*P. sp. "Viraú" (*P. dracunculus + P. sp. "Tarumanzinho"*). Phylogenetic mapping shows that phreatic environment was invaded twice. The new species are the first vertebrates reported to inhabit the hyporheic zone, defined as an interstitial habitat bounded above by surface water in the river channel and by the groundwater below. The hyporheic and sedimentary aquifers habitats worldwide have just recently begun to be investigate, and is yielding unexpected biodiversity, until now only of invertebrate taxa.
accurate predictors of population marginality? In the proposed study reproductive allometry will be used comparatively among three populations of Alligator mississippiensis in both southeastern Texas and coastal Louisiana. This study will test the hypothesis that allometric correlations are strongest in core populations. If the allometric correlations are stronger in more core populations, than this methodology may be an effective way to comparatively analyze crocodilian populations (within all 23 species).

324 Herp Conservation II, Grand Ballroom II, Monday 27 July 2009

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Complex Spatial Dynamics Maintain High Genetic Diversity in the Face of Climate Variation

Understanding spatial and temporal dynamics of amphibian metapopulations is critical to evaluating how species respond to anthropogenic as well as natural disturbance. In most amphibian metapopulation studies, the breeding pond is considered as the basic spatial unit used to delineate subpopulations of larger metapopulations. However, this "ponds-as-patches" view of metapopulations presents an oversimplification of spatial dynamics that can lead to a loss of focus on other ecosystem components critical to amphibian conservation and metapopulation dynamics. In an effort to better understand pitfalls associated with applying a "pond-as-patches" approach to amphibian metapopulations, we explored the genetic structure of the northern leopard frog (\textit{Rana pipiens}) in an area of its range subjected to significant climate variation, the Prairie Pothole Region (PPR) of the northern Great Plains. Under a classic "pond-as-patches" metapopulations approach, we expected to find low genetic diversity due to frequent extinction events associated with the periodic drying of wetlands during reoccurring droughts. Thus, we hypothesized that heterozygosity (\(H_e\)) for northern leopard frogs in the PPR would be low compared to regions with less dynamic climates. To test our hypothesis we collected genetic material from 40 leopard frogs at each of 12 wetlands in North Dakota. We used microsatellite markers to explore genetic structure within our study area. Contrary to the original hypothesis, we found high \(H_e\) in all breeding wetlands sampled compared to other regions of the species. We believe this resulted from a complex system of migration and gene dispersal inadequately represented using a "pond-as-patches" view of amphibian metapopulations.
Scientists who accept public funds to support their research have an obligation to share their findings with the public and to advocate the proper application of their findings to help solve problems. For example, Florida recently has placed significant restrictions on the harvesting and exportation of turtles largely in response to the efforts of a group of turtle biologists, who were able to convince regulators that the characteristic life history of turtles is not conducive to extensive harvesting. More personally, we have drawn upon our research experience with the Gopher Tortoise to aid the Florida Fish and Wildlife Conservation Commission in its efforts to uplist the species to threatened in Florida, and have leant our expertise with the Florida Sand Skink to design research specifically to help this threatened species recover. We use research on the Gopher Tortoise and Florida Sand Skink to illustrate how targeted research with the aim of helping species move away from the edge of the extinction vortex, and subsequent advocacy for the proper use of the results by regulatory agencies, need not compromise good science. We also use the case of URTD in the Gopher Tortoise to show how raw advocacy based on incomplete science can lead to unwanted results; in this case, to the deaths of thousands of individuals.

Survival with Disease: Toad Populations in the Rocky Mountains

Chytridiomycosis has played a role in the decline of many species of amphibians worldwide, but the degree to which it impacts demographic parameters has not been investigated thoroughly. We used capture-recapture data from three populations of boreal toads (*Bufo boreas*) in the Rocky Mountains, U.S.A. to examine a priori hypotheses about the effect of the amphibian chytrid fungus (*Batrachochytrium dendrobatidis*, *Bd*) on apparent survival probability (*φ*) and population growth (*l*). Probability of survival was lower (*φ* = 0.53 - 0.64) at the two sites where *Bd* was present relative to the site where the disease was not detected (*φ* = 0.77). We found that estimates of survival probability for individuals that tested positive for *Bd* were >20% lower than for individuals that tested negative but that *Bd* was not lethal to all toads. Although the average prevalence of *Bd* in
diseased populations was 57%, these populations were declining by only about 5% per year over the 6 years of the study. These data provide evidence that Bd does not always cause rapid population declines, although they also suggest that Bd may act as an additional mortality factor in populations coexisting with the disease.

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413 ELHS/LFC Connectivity Symposium II, Galleria South, Friday 24 July 2009

Ivan Nagelkerken

Radboud University Nijmegen, Nijmegen, Netherlands

**Intermediate Habitat Use by Post-Settlement Tropical Coastal Fishes**

Some species of tropical coastal fishes use intermediate habitats located in estuaries and lagoons during their early juvenile life phase. Movement of larval and adult fish thus results in connectivity between near-shore nurseries and offshore adult habitats. The use of estuarine and lagoonal habitats by early juveniles purportedly lowers mortality and increases growth rates. Although the number of species adopting this strategy is relatively low compared to the complete species array of tropical coastal fishes, it often concerns species that occur in high densities. The exact degree to which intermediate habitats are used by tropical coastal fishes is difficult to quantify, as a result of factors such as (i) few quantitative studies focusing on the life phase directly following settlement, (ii) variation in definition of habitats, (iii) a predominant focus on Caribbean fish species, (iv) confounding effects of shelf size, variation in (a)biotic variables, seascape configuration, and island vs. mainland setting, (v) the possibly independent effect of estuarine dependence, and (vi) differences in methodologies, approaches and research questions among studies. This has led to different results and perspectives regarding habitat connectivity. These issues make a comparison with other temperature-defined zones more challenging. Intermediate habitat use by tropical fishes will be evaluated in the light of these problems. Aspects of temperature-related effects on habitat use by fish in the wider tropical zone are discussed.

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334 Poster Session I, Exhibitor’s Hall, Friday 24 July 2009; ELHS BLAXTER AWARD

Shin Nakayama, Alfredo Ojanguren, Lee Fuiman

*The University of Texas at Austin, Port Aransas, TX, United States*

**Habitat Competition Among Young Red Drum**

The extended reproductive season of red drum creates a varying size structure of conspecific larvae in nursery habitats during the spawning season. Size variability in nursery habitats is small when the first cohort settles, but it increases as successive cohorts arrive. We hypothesized that: (1) new settlers may not be able to occupy
preferred habitats because earlier arriving and larger conspecifics (occupants) out-compete them; (2) the magnitude aggressive interactions explains the resulting habitat choice, and (3) the presence of food in the preferred habitat alters habitat utilization of new settlers as a result of a trade-off between food and aggressive interactions with occupants. We tested these hypotheses in experiments, using the preference of red drum larvae for a well-lit habitat. We placed a small fish (about 8 mm SL) into a wide tank with a horizontal light gradient alone or with either a small or a big (about 17 mm) fish, and recorded the position of the focal fish, behavioral interactions between the two fish, and the distance of any escapes resulting from aggression. After adding a small amount of food to the light area of the tank, we made the same observations. We tested whether the size of conspecifics explains the number of aggressive interactions and the escape distance, which would explain why small fish change their habitats in the presence of big fish.

Intraspecific Competition among Early Life Stages and the Optimal Spawning Strategy of Red Drum

Competition has received little attention in studies of early life stages, yet recent laboratory experiments demonstrate significant potential for interference competition among larvae. When competition among early life stages affects their survival, parental reproductive traits that reduce temporal and spatial overlap among early life stages should be favored. We used an individual-based model to investigate the optimal spawning interval and batch fecundity for a fractional spawning fish (red drum, \textit{Sciaenops ocellatus}) at different magnitudes of interference competition among early life stages. The model simulated the spawning of individual females and the subsequent hourly growth, mortality, and movement of their offspring on a 100 x 100 spatial grid of habitat cells that differed in prey abundance and predation pressure. Each female was assigned a spawning interval and number of batches, and super-individuals were used to represent each batch of eggs. Pelagic larvae developed based on temperature, and post-settlement fish were followed hourly through feeding, growth, mortality, and movement. Feeding was based on individuals selecting between copepods and mysids. Laboratory experiments quantified the size-specific effects of competition on search volume. Competition was modeled as a function of the density and sizes of fish in the same cell and resulted in reduced search volume, and thus reduced feeding and growth rate. Individuals then moved to the cell within a neighborhood of cells that offered the highest growth to mortality ratio. We simulated the survival of individuals to 25 mm under different combinations of spawning traits and degrees of interference competition.
Conservation of the *Plethodon stormi* complex: Management in a Changing Climate

*Plethodon stormi* and *P. asupak* are two endemic species found in small portions of the Rogue and Klamath River watersheds in Northern California and Southern Oregon. These species, particularly *P. asupak*, exist under relatively dry conditions and appear vulnerable to the effects of timber harvest and climate change. Management of these species has been controversial. A petition for listing both species under the Endangered Species Act was considered not warranted by the US Fish and Wildlife Service. Both species are considered Threatened by the State of California although attempts to remove protection under the California Endangered Species Act have been initiated by the California Department of Fish and Game. Federal agencies have created a Conservation Strategy for the northern portion of the range of *P. stormi* that identifies high priority sites for conservation and prescribes management for these sites. Currently, *P. asupak* may be at risk due to proposed timber harvest on private lands. We are using data developed by the Intergovernmental Panel on Climate Change to assess the impacts of a changing climate of the persistence of these unique species. We plan on integrating these data with geographically explicit models of species distribution and habitat to guide management in a changing climate.

Threatened Long-lived Species with TSD will rely on Management to Cope with Global Warming

Global warming may result in biased hatching sex ratios for reptiles with temperature-dependent sex determination (TSD), with consequences for long-term population viability. However, negative impacts of global warming are not assured. Species with wide geographic ranges may exhibit local adaptations e.g. genetic variability in pivotal temperatures, different temperature ranges across which eggs hatch successfully, and/or exhibit behavioural responses to environmental signals e.g. nesting in open or shaded locations, allowing responsiveness to changing circumstances. In addition, reptiles thrived and diversified during warmer climates in the past. We investigated the effect of temperature on sex ratios of tuatara (*Sphenodon*), a lineage which emerged about 230 million years ago. Once widespread, tuatara are now limited to 38 offshore islands of New Zealand, with 9 of these populations resulting from repatriation efforts. Tuatara exhibit a rare form of TSD, where males result from incubation temperatures above 21.7°C, with 1°C separating production of 100% females from 100% males. The pivotal
temperature does not appear to vary with latitude. Sex determination in tuatara takes place within the first third of embryonic development, when environmental temperatures are hottest. Warm years produce a male-bias in hatchlings, but hatchling sex ratios vary among rookeries. Long-term viability of tuatara is likely to be limited by habitat constraints within their current distribution and their k-selected life history characteristics with respect to the speed of global warming. Management techniques, for example, translocations, will be needed to increase the opportunities for threatened long-lived reptiles with TSD.

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116 ELHS/LFC Connectivity, Galleria South, Friday 24 July 2009; ELHS SALLY RICHARDSON AWARD

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Sources and Patterns of Variation in Natal Otolith Trace Element Signatures: Experimental Insights and Statistical Considerations

Trace element signatures recorded within the cores of otoliths that form during egg and larval development may characterize natal populations of reef fish, enabling researchers to trace larvae, settlers and adults back to their natal habitat. While this approach holds great promise, environmentally influenced signatures need to vary over appropriate spatial scales and remain relatively consistent through time if they are to be robust indicators of natal populations over useful time- and spatial scales. Furthermore, maternal effects on trace element composition may overlap with environmental signatures of natal locations, complicating inference on putative larval source populations. Here I report on spatial and temporal variability in otolith signatures of the common Triplefin (Forsterygion lapillum) in the Cook Strait Region of New Zealand. Statistical issues are examined and a few remedies such as optimal scaling and improved linear discriminant analysis are discussed. I further present experiments evaluating the relative importance of environmental vs. maternal influences on natal otolith chemistry. A better understanding of the mechanisms that underlie trace element signatures may enable us to track dispersal in a marine fish metapopulation, and evaluate patterns of connectivity among local populations including those within several no-take marine reserves in the Cook Strait region.

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Examining the Effects of Atrazine on Embryos of Turtles from Two Deeply Divergent Cryptodiran Families (Emydidae and Trionychidae)

The effects of atrazine and similar endocrine disrupting chemicals are being examined extensively in several taxa, but the impact on reptiles is still poorly understood. How this common herbicide affects organisms with a common ancestry but different adaptive strategies is still an enigma. To elucidate this relationship, we chose representative turtle species from the Family Emydidae (*Graptemys pseudogeographica*) and the Family Trionychidae (*Apalone mutica*) that occur sympatrically and utilize the same riverine habitat, nesting beaches, and food sources. Despite their similarities, these two taxa have developed highly divergent physiologies and morphologies. For example, *Apalone mutica* have a semi-permeable cartilaginous carapace and the eggs are rigid-shelled. *Graptemys pseudogeographica*, in contrast, have a bony carapace and produce highly-permeable eggs. These factors may influence how chemicals, such as atrazine, impact the development of embryos. We harvested eggs from both species and randomly placed them into one of four treatment groups (control, 0.1ppb, 10.0ppb, 100.0ppb). The eggs were treated with atrazine once within the first 7 days after oviposition and allowed to develop and hatch. Incubation length, morphometric measurements of body size, and gonadal sex were determined for each individual to assess the impact that atrazine has on these two distinct turtle families.
experience, education, local outreach, and mentoring. The program utilized the extensive local diversity in reptiles (8 species of turtles, 7 species of snakes, 1 species of lizard) to allow students to receive hands-on experience with research. Reptiles present variety of model organisms for achieving these four goals given their abundance, ease of capture and handling, human familiarity with them, and generally passive dispositions. Students gained a meaningful experience in all four of our target areas by working with these organisms. Overall, TREE provides an excellent environment for advancing interest in, and knowledge of, science and for positively influencing career plans of the participants.

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239 Poster Session I, Exhibitor’s Hall, Friday 24 July 2009

Kirsten Nicholson

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Endemic and Esoteric Pacific Island Anole, Anolis medemi

Gorgona Island is home to five species of anoles, one of which is the endemic Anolis medemi, about which nearly nothing is known. The island is approximately 54 km off the coast of Colombia, comprises an area of 26 km² with a maximum elevation of 338 m near its center. It is nearly uninhabited except for a very small field station and crew present year round, and is well-protected by the government. Anolis medemi is very common on the island and occupies microhabitats low to the ground and is often found in the typical head-down perching posture on tree trunks. The relationship of this species to other anoles is unknown, although the original species description placed it within the Norops clade. Here we report on the phylogenetic placement of the species and discuss the implications of our results to its biogeography. It appears that A. medemi is a close relative of A. fuscoauratus, a wide-spread South American species, and common in Colombia. In addition, A. fuscoauratus and A. medemi seem to occupy similar microhabitats. The island is believed to have shared an aerial connection with the mainland so it is highly likely ancestral A. fuscoauratus individuals dispersed to the island before the land connection was lost and subsequently speciated.

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711 Herp Development & Morphology, Galleria North, Sunday 26 July 2009

Philip Nicodemo, Harvey Lillywhite

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Ontogenetic Shifts of Heart Position in Snakes

Heart position relative to body length varies among snakes, with anterior hearts in arboreal species and relatively more mid-body hearts in aquatic or strictly ground-dwelling species. Thus, heart position correlates with gravity stress on blood circulation, which increases with the absolute length of a vertical blood column above
the heart. Anterior hearts decrease the cardiac work associated with cranial blood flow during head-up climbing. Here we investigate the question of whether heart position shifts during ontogenic increases in body length. Insular cottonmouth snakes, *Agkistrodon piscivorus*, are entirely ground-dwelling, with adults ≥ 75 cm total length having a mean heart position that is 32.1 (± 0.13 SE) % of total body length from the head. In contrast, arboreal rat snakes, *Pantherophis obsoleta*, of similar lengths have a mean heart position that is 17.3 (± 0.12 SE) % of total body length from the head. In both species, heart position shifts cranially during ontogeny, but relatively moreso in *Elaphe* than in *Agkistrodon*. Using a large data set of morphometric measurements available for *Agkistrodon* (N = 188 individuals, 23-155 cm total length), we demonstrate there is an anterior ontogenetic shift of the heart (= 4.56% trunk length) when elongation is corrected for both head and tail allometry. Tail length exhibits near-isometry whereas head length exhibits negative allometry. These data suggest that ontogenetic changes of heart position are likely attributable to normal growth processes of the body cavity and organs, but with presumptive selection for greater displacement in the arboreal species.

541 Herp Biogeography, Galleria North, Saturday 25 July 2009

Stuart Nielsen¹, Aaron Bauer², Todd Jackman², Brice Noonan¹

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Something Old in New Zealand: Dating Suggests Possible Gondwanan Connections for New Zealand’s Endemic Geckos

The long-standing debate concerning the origin and age of diversification of New Zealand’s reptiles has recently experienced a renaissance with the advent of sophisticated dating algorithms. Geological evidence suggests that the largely submerged subcontinent Zealandia, which includes New Zealand (NZ), separated from Gondwana approximately 80 MYA. Although some of NZ’s biota represents remnants of a pan-Gondwanan fauna, most lineages appear to be the result of recent dispersal/colonization. Among NZ’s three reptile clades – sphenodontids, scincids and diplodactyloid geckos, dating analyses of only the two former taxa have been addressed in any detail. Sphenodontids have an extensive fossil record outside of NZ, suggesting diversification during the Cretaceous. Numerous recent analyses of NZ’s skink fauna suggest colonization from New Caledonia (NC) during the early Miocene, with diversification of the modern lineages between the late Miocene to early Pliocene. Using a combination of nuclear (RAG1 and Phosducin) and mitochondrial (ND2 and 16S) markers, we performed phylogenetic analyses to estimate relationships among diplodactyloid geckos of NZ, NC and Australia. Using the well-resolved phylogeny, we performed multiple BEAST runs, based on three independent calibrations (two fossil and one geological event), and found that divergences both between and within clades range widely in their relative ages. The earliest cladogenesis within NZ geckos appears to be mid-Tertiary in age and may post-date the Oligocene marine transgression, but relationships of the NZ clade as a whole to its closest relatives in Australia and NC may reflect Gondwanan connections.
Status and Relative Abundance of the West Virginia Spring Salamander (Gyrinophilus subterraneus) from General Davis Cave, Greenbrier Co., West Virginia

The West Virginia Spring Salamander (Gyrinophilus subterraneus) is one of four obligate, cave-dwelling species of plethodontid salamanders found east of the Mississippi River in the United States. Unlike the other three species, G. subterraneus is not neotenic and readily undergoes metamorphosis, albeit at an exceptionally large size (up to 95 mm SVL). Additionally, it is endemic to a single cave system, General Davis Cave, in the Appalachian Valley and Ridge karst region in Greenbrier Co., West Virginia, where it is syntopic with the closely-related Spring Salamander (G. porphyriticus). Although not in immediate danger of extinction, the West Virginia Spring Salamander is of critical conservation concern because of its restricted distribution and threats to the cave system it resides in. Accordingly, G. subterraneus is listed as “Critically Imperiled” by NatureServe and “Endangered” by IUCN. Because of its conservation status and lack of data regarding the ecology and life history, particularly about population size trends, we present data on relative abundance, habitat use, and diet over a 33-year period for G. subterraneus from 1975–2008. Specifically we address (1) stability of the population over the last 33 years, (2) variation in habitat use by life stage (larva and adult) and between species (G. subterraneus and G. porphyriticus), (3) plausibility of neoteny in G. subterraneus, and (4) characterization of diet.

754 Poster Session I, Exhibitor’s Hall, Friday 24 July 2009

An Analysis of Anuran Abundance in Relation to Water Proximity at Lago Sachavacayoc, Peru

Because anurans are highly dependent on water for respiration and reproduction, they may use microhabitats in proximity to standing water preferentially to other microhabitats. We examined the anuran assemblage of Sachavacayoc, Peru to test
whether lake proximity, distance to trees, temperature, and humidity influenced anuran abundance and diversity in a rainforest habitat. We conducted quadrat searches of paired-plots at the shore of a lake and 25 m distant from the lake's shore. Abundance of anurans and of *Leptodactylus andreae* were significantly higher in the lake shore quadrats. Temperatures at capture sites in the water quadrats were significantly higher; frogs were significantly closer to trees in the away from water quadrats. Humidities at points of capture did not differ significantly with quadrat position. Most of the anuran species found in the water quadrats depend on standing water for reproduction. However, *Leptodactylus andreae* is a terrestrial nester and had not previously been recorded as using a lakeshore microhabitat. We hypothesize that the extreme lack of rain experienced during the time period preceding and during the study caused *L. andreae* to shift its microhabitat to a more humid area to prevent dehydration. Additional studies that examine the fine scale spacing in relation to large water bodies will shed more light on this phenomenon.

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**843 Storm Symposium, Pavillion West, Friday 24 July 2009**

Ronald Nussbaum

*University of Michigan, Ann Arbor, United States*

**Post-hatching Maternal Care in Caecilians: Maternal Dermatophagy in *Boulengerula taitanus* of Eastern Equatorial Africa**

Although the growth and development of most multicellular animals depends on the provision of yolk, there are many varied contrivances by which animals provide additional or alternative investment in their offspring. Providing offspring with additional nutrition should be favoured by Natural Selection when the consequent increased fitness of the young offsets any compensatory reduction in fecundity. Alternative forms of nutrition may allow parents to delay and potentially redirect their investment. Here I summarize the results of studies of a remarkable form of parental care in a caecilian amphibian. *Boulengerula taitanus* from eastern Equatorial Africa is a direct developing, oviparous caecilian, the skin of which is transformed in brooding females to provide a rich supply of nutrients for the developing offspring. Young animals are equipped with a specialised dentition, which they use to peel and eat the outer layer of their mother's modified skin. This novel form of parental care provides a plausible intermediate stage in the evolution of viviparity in caecilians. The specialised dentition of skin-feeding (dermatophagous) caecilians constitutes a preadaptation to the foetal feeding on the oviduct lining of viviparous caecilians.
Objective Partition Choice and the Phylogenetic Systematics and Biogeography of the True Crocodiles

Crocodylian systematics has been dominated by investigations of higher-level relationships aimed at resolving the disparity between morphological and molecular data, especially regarding the phylogenetic placement of the true gharial (*Gavialis*). Consequently, no studies to date have provided adequate resolution of the interspecific relationships within the most broadly distributed and species-rich crocodylian genus, *Crocodylus*. The true crocodiles (*Crocodylus*) have traditionally been viewed as an ancient group of species derived from Africa whose circumtropical distribution was the result of vicariance during continental breakup, although newer data have suggested a more recent, dispersal-mediated history. In this study, partitioned phylogenetic analyses were performed on a DNA alignment of 10 loci (7,282 bases) from 79 individuals representing all 23 crocodylian species. The dataset was analyzed under a suite of objective and subjective partitioning strategies to investigate the modeling effects of a priori partition choice in phylogenetics. A robust phylogeny of all extant crocodylians was reconstructed and used to estimate ancestral distributions and divergence times, testing the hypotheses that the most recent common ancestor (MRCA) of *Crocodylus* predated continental breakup and was from Africa. The results reject both hypotheses and demonstrate that the true crocodiles originated from a MRCA in the tropics of the Serravallian Indo-Pacific and rapidly radiated and dispersed around the globe during a period marked by mass extinctions of fellow crocodylians. The results also reveal more diversity within the genus than recognized by current taxonomy, and demonstrate that a priori partitioned models perform poorly in comparison with partitions estimated from the data.
dominated by *Montastraea* spp. at four sites in Culebra, Puerto Rico. Digital photography was used to document changes in benthic community structure before (2005) and after (2007, 2008) this event. Because overfishing has been implicated in the decline of herbivorous reef fishes, another objective of our research was to learn if the living tissue-cover of *Montastraea* spp. on reefs located in areas where fishing is not prohibited has different percent tissue cover and fragment survival compared to corals located in a No-take Natural Reserve. We conducted visual censuses of herbivorous reef fishes. Mass coral mortality caused a 66 to 98% decline in the percentage of living tissue cover in *Montastraea* spp. No significant difference in % living tissue cover loss or in mean fragment size was documented among sites. Fragment density was higher (p<0.0001) at Carlos Rosario Beach (130/m²) in comparison to the other sites (25-40/m²). We found no significant difference (p=0.157) in the density of the herbivorous reef fishes among sites. The control site, outside the Natural Reserve, reflected lower scraper and higher non-denuder abundance. More fish censuses and long-term ecological monitoring are needed to address questions regarding future reef resilience.

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**284 AES Conservation & Management II, Parlor ABC, Saturday 25 July 2009**

Craig O’Connell¹, Daniel Abel¹, Eric Stroud¹, Patrick Rice¹

¹Coastal Carolina University, Myrtle Beach, SC, United States, ²SharkDefense Technologies, LLC, Oak Ridge, NJ, United States, ³Florida Keys Community College, Key West, FL, United States

**A Quantitative Analysis Examining the Effects of Permanent Magnets on Elasmobranchs in Recreational and Longlining Fisheries**

Elasmobranch fishes (sharks and rays) detect magnetic fields through the process of indirect-based magnetoreception via electromagnetic induction using their ampullae of Lorenzini. We evaluated the feeding responses of elasmobranchs in the presence of permanent magnets in hook-and-line and longline fishing experiments. In the hook-and-line study, we used control, sham magnet, and neodymium magnet hook treatments. Longlines, 150 m in length and containing 24 hooks, were deployed with an alternating sham magnet hook - magnetic hook design. Atlantic sharpnose sharks (*Rhizoprionodon terraenovae*) were significantly repelled from the magnetic hook-and-line treatments (X²=11.967, d.f.=1, p=0.0005), while spiny dogfish (*Squalus acanthias*) were not (X²=0.532, d.f.=1, p=0.4658). On longlines, ceramic magnets significantly altered shark capture (X²=4.455, d.f.=1, p=0.035). Blacktip sharks (*Carcharhinus limbatus*; X²=4.455, d.f.=1, p=0.035) and southern stingrays (*Dasyatis americana*; X²=1.286, d.f.=1, p=0.257) did not demonstrate a preference for hook type. Results suggest that magnetic-induced repellent behaviors may be a species-specific phenomenon. The effectiveness of these magnets may have large implications in elasmobranch population recovery in two areas where anthropogenic mortality is the leading contributor to elasmobranch declines, e.g. on commercial longlines.
Environmental conditions have well known immediate effects and less-studied long term phenotypic consequences for fish larvae. For instance, water temperature affects metabolism, developmental rate, growth and performance of general functions, but the permanent effects of environmental conditions on fish phenotype are less well known. Red drum (*Sciaenops ocellatus*) is an interesting model organism to test these ideas because females spawn during a period of sharp decline in water temperatures, between September and November (from 30 °C to 20 °C). Previous research on this species has shown a seasonal decrease in performance of wild larvae but no strong effects of recent thermal experience in laboratory produced individuals. The aim of this study was to investigate the effects of incubation temperature on behavioral performance of settlement-size larvae. Fertilized eggs were collected immediately after spawning and incubated at five constant temperatures (23, 25, 27, 29 and 31 °C). Ten days after hatching, all larvae were transferred to a common temperature (27 °C) until 20 days posthatching. Then, 24 fish from each incubation temperature were tested in two different assays: routine swimming and escape responses to a visual stimulus. The experiment was replicated to account for possible differences between egg batches. Our results contribute to a better understanding of the effects of early thermal experience on behavioral traits with potential consequences for recruitment of marine fish.

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**V1a Receptor Regulation of Pairbond Formation in a Monogamous Cichlid Fish**

Arginine vasotocin/vasopressin (AVT/AVP) regulates social behavior, including aggression and reproduction, across vertebrates. In monogamous prairie vole males, the vasopressin V1a receptor is crucially important for pair-bond formation, specifically by influencing affiliative behavior toward the mate and aggression toward non-mates. Monogamous social systems are found in numerous taxa, including teleost fishes. Cichlid fishes, in particular exhibit an astonishing diversity of mating systems. We hypothesized that the AVT/AVP-V1a pathway is associated with the evolution of monogamy across diverse taxa. We used the monogamous convict cichlid, *Amatitlania nigrofasciata* to test this idea. In the first experiment, we administered on three consecutive days a selective V1a receptor antagonist to males that were in an established pairbond. Control males were treated with vehicle. In established pairs, male affiliation
towards the mate and aggressive behavior towards territorial neighbors were not affected by the antagonist. However, there was a significant interaction between inhibiting AVT/V1a, treatment day, and presence of offspring affecting aggression toward neighbors. In the second experiment, we treated males with the V1a antagonist during pairbond formation. We observed a significant reduction in both affiliative behavior toward the (potential) mate and aggression toward neighbors. However, the antagonist did not prevent the pairbond from forming and the behavioral effects disappeared on subsequent treatment days. Our results suggest that the role of the AVT/AVP-V1a pathway in regulating social affiliation may be evolutionarily conserved across vertebrates despite the fact that monogamous mating systems have evolved independently many times.

415 Poster Session I, Exhibitor’s Hall, Friday 24 July 2009

M. Pilar Olivar¹, Mikhail Emelianov¹, Fernando Villate², Ibon Uriarte², Francesc Maynou¹, Elvira Morote¹, Ignacio Álvarez¹

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The Role of Water Dynamics and Plankton Availability in Larval Fish Assemblages off the Catalan Coast (NW Mediterranean)

In the northwestern Mediterranean most fish species reproduce in early summer, while the mixing autumn period is the spawning season for a lower number of species. This study analyses and compares larval fish assemblages (LFA) in both seasons, being the first attempt to characterize autumn LFA structure for the autumn period. We analyze horizontal and vertical distribution of fish larvae, and micro and mesozooplankton biomass and abundance of the main zooplankton groups. The oceanographic situation was analyzed through the study of data from CTD, Nu-Shuttle and ADCP. LFA were determined by similarity analyses based on larval abundance, and the relationships between larval assemblages and environmental variables were investigated through Canonical Correspondence Analysis. The importance of water masses, current fields (along-shelf and across-shelf transport) and abundance of zooplankton organisms are discussed as important factors shaping assemblages structure. In early summer LFA were mainly structured by a combination of bathymetry and trophic components, although sea surface temperature plays also a role in shaping the horizontal larval distributions. In autumn, trophic variables were the main factors influencing shelf-dwelling species assemblage. On the contrary, larvae of oceanic species were not related to them, but were more affected by current fields.
Severe Underestimation of Specific and Phylogenetic Diversity in the Australian Gecko Fauna

Australia has an exceptionally diverse squamate fauna and the number of species recognised is still increasing. We report the results of molecular systematic studies of several genera of gecko in the family Diplodactylidae. In spite of a long history of taxonomic work, our results suggest that actual species diversity of the Australian radiation of Diplodactylidae may be as high double the current total. Much of this unrecognised diversity is also phylogenetically divergent and is estimated to date back to at least the mid-Miocene. The high levels of cryptic diversity uncovered have important ramifications for biogeography, ecology and conservation management.

Larvae of Zeiform Fishes

Larval stages of four of the 16 known genera of zeiform fishes have been described. Here we report the discovery of larvae in three additional genera and comment on the potential use of ontogenetic data in phylogenetic analysis of the order. The larva of the thorny tinselfish Grammicolepis brachiusculus is distinctive in the possession of narrow, vertically elongate scales characteristic of the family Grammicolepididae. Larvae of Zenion (Zeniotidae) possess the adult compliment of fin elements by 9 mm SL. A larva of Allocyttus (Oreosomatidae) bears a conspicuous cranial cone-shaped spine that persists in juveniles. Phylogenetically informative ontogenetic traits include elongate dorsal, anal and pelvic elements, pterotic spines, serrated orbital; ridge, cranial sculpturing, spiny scales and patterns of metamorphosis.
Amphibian Chytrid Fungus: Global Patterns

The amphibian chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*), is recognized as both an infectious disease and invasive species with potentially profound effects on global amphibian biodiversity. Losses attributed to *Bd* are documented in single species, and in some areas assemblages of amphibian species appear to be affected. In 2008, *Bd* was listed as a notifiable disease by the World Organization of Animal Health (OIE) due to its biosecurity risk. Understanding the geographic and taxonomic scope of the disease is a first step in developing research directions and management guidance. Our Global *Bd* Mapping Project was initiated with this overarching goal in mind. Furthermore, our global *Bd* database has enabled distributional and taxonomic analyses of patterns, including habitat modeling at the world scale using available environmental metrics such as climate parameters. We have compiled over 2,000 sites worldwide where *Bd* has been sampled. We have found the occurrence of the disease is associated with locations known to have enigmatic amphibian declines, i.e., losses that have been previously unexplained. In our model of *Bd* global habitat associations, temperature metrics are the most significant predictors of *Bd* detection. This suggests that the distribution of *Bd* will respond to scenarios of climate change. The distribution of *Bd* is a moving target due to both its invasive tendencies and the hypothesized altered prevalence rates with climatic variability. Maintenance of global *Bd* mapping through the website spatialepidemiology.net/bd-maps/ will allow scientists and managers to understand its occurrence and address areas of potential risk to future infections.

Skates of the Subgenus *Arctoraja* (Bathyraja: Rajidae): Morphological and Genetic Variation, New and Cryptic Species

We provide morphological and molecular evidence to recognize the North Pacific skate subgenus *Arctoraja* Ishiyama as monophyletic, confirming the validity of the subgenus. *Arctoraja* was previously recognized as a distinct genus of Rajidae and later synonymized with *Bathyraja*. Although the nominal species have all been considered synonyms of *Bathyraja parmifera* by various authors, on the basis of morphometric,
meristic, chondrological, and molecular data we recognize four species, including a new
species restricted to the western Aleutian Islands. Species of Arctoraja are distributed
across the North Pacific Ocean and adjacent seas from southern Japan to southeastern
Alaska. Bathyraja parmifera is abundant in the eastern Bering Sea, Aleutian Islands, and
northern Gulf of Alaska; B. smirnovi is a western Pacific species common in the Sea of
Okhotsk and Sea of Japan; B. simoterus is restricted to waters around the northeastern
coasts of Hokkaido; and the new species, the Leopard Skate, is restricted to the western
Aleutian Islands. The Leopard Skate is diagnosed by its color pattern of light yellow
blotches with black spotting on a greenish brown background, high thorn and vertebral
counts, chondrological characters of the neurocranium and claspers, and a unique base
sequence within the mitochondrial cytochrome oxidase gene. Furthermore, the species
we presently recognize as Bathyraja parmifera exhibits two haplotypes among specimens
from Alaska, suggesting the presence of an additional cryptic species. We also discuss
morphological variation evident among specimens of B. smirnovi and aspects of the
zoogeography of the North Pacific Ocean and its adjacent seas.

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785 Poster Session II, Exhibitor’s Hall, Saturday 25 July 2009

Guillermo Orti

University of Nebraska, Lincoln, NE, United States

DeepFin Research Coordination Network Update: News and Opportunities to
Build the Tree of Life of Fishes

DeepFin is a research coordination network (RCN) of systematic ichthyologists and
biologists with expertise in the analysis of fish biodiversity, seeking to integrate
knowledge of morphology, paleontology, molecular biology, and bioinformatics. The
ultimate goal of the RCN is to establish the phylogenetic tree of all fishes, to decipher
their evolutionary relationships. The RCN coordinates activities in three main fronts:
group meetings/workshops, website and database development, and student
recruitment, training, and exchange. We are funded by a grant from the National Science
Foundation (USA). The student exchange program continues in 2009 to provide funding
for undergraduate and graduate students with new research opportunities. These
students are be able to experience new research environments, not available to them at
their home institutions. The goal is to help lower existing barriers between traditionally
isolated disciplines by raising a new generation of scientists with broad academic
training experiences. DeepFin funds are used to cover travel and room & board
expenses for students visiting other labs for periods of up to three months. New website
developments include a wiki with commonly used genetic markers, methodological
information, and their phylogenetic utility, available from the Deepfin home page
(www.deepfin.org). Other resources and opportunities for collaboration will be
displayed on the poster.

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Multi-locus Major Histocompatibility Complex Class IIb and Parasite Diversity in the Rio Grande Silvery Minnow

Genetic variation at immune genes is especially important for aquatic species, whose chemical and microbial environment is impacted heavily by humans, which may increase their risk of exposure to pathogens. In this study we characterized and measured diversity at genes of the major histocompatibility complex (MHC) Class IIb. We also calculated diversity the mitochondrial ND4 gene and at 9 microsatellite loci in the endangered Rio Grande silvery minnow, *Hybognathus amarus*. These data were used to examine the relationship between MHC variation and pathogen diversity. Three divergent groups of MHC alleles were identified. There were high levels of diversity at these loci in Rio Grande silvery minnow. We also identified relationships between presence or absence of particular alleles and severity of infection with particular parasites. We did not detect associations between gill parasite diversity or abundance and MHC diversity nor did we detect any association between pathogen diversity or abundance and the number of MHC allelic groups expressed by individuals.

Effects of Land Use on Initial Juvenile Amphibian Dispersal

Movement of animals is imperative for population regulation, metapopulation dynamics, and long-term persistence of species. For amphibians with complex life cycles (aquatic larval phase and terrestrial juvenile-adult phase), movements to and from breeding sites are essential for viability of local populations. Following timber harvesting, dispersing juveniles likely experience increased risk of mortality through desiccation. For predicting the effects of land use on amphibian populations, a better understanding of juvenile dispersal is needed to aid in conservation planning efforts. In 2007 and 2008, we conducted a mark-recapture experiment with experimental forestry arrays, in a Missouri oak-hickory forest. We individually marked recently metamorphosed green frogs [*Rana (Lithobates) clamitans*] and spotted salamanders (*Ambystoma maculatum*) as they emerged from their natal pond. Drift fences encircling each pond provided initial captures and drift fences at 20 m and 50 m determined initial dispersal success. We found that significantly more green frog juveniles were recaptured in controls (32.8%) and partial cuts (14.9%) than in either the unburned clearcuts (2.2%) or burned clearcuts (4.0%). Of green frog juveniles initially released into controls, 93% of recaptures remained there. Less than 10% released into clearcuts were recaptured there and approximately one half moved into controls and a third moved into partial cuts.
Juvenile salamander recaptures declined significantly with distance from pond and in 2008 we recaptured a significantly greater proportion in the forested treatments compared to clearcuts. These results should inform policy makers and managers as they attempt to balance the need for forest products with preservation of biodiversity.

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952 Poster Session III, Exhibitor’s Hall, Sunday 26 July 2009

Nicholas Osman, Brad Hauch, Henry Mushinsky, Earl McCoy

University of South Florida, Tampa, FL, United States

Out of Harm’s Way: Translocation Success of the Florida Sand Skink (*Plestiodon reynoldsi*) in Differing Habitat Types

The fossorial Florida Sand Skink (*Plestiodon reynoldsi*) inhabits a highly restricted range of scrub and sandhill fragments on the ridges of central Florida. The high rate of urban and agricultural development in this area necessitates conservation strategies other than land acquisition and management because of the limited remaining sand skink habitat available. Our study tests the viability of translocation as a conservation strategy for this species and assesses which features of a recipient site may contribute to successful establishment of a population. In 2007, 300 individuals were collected from a single population, individually marked, and moved to a nearby site with no existing *P. reynoldsi* population. Fifteen 20m² enclosures were constructed at the recipient site, and 20 skinks were randomly assigned to each. These enclosures were divided among five treatments, which represented the range of habitat types at the donor site and differed in the presence or absence of a shade giving object and coarse woody debris. Translocated skinks were monitored for two years to measure survival, reproductive success, and growth rate of juveniles as indicators of success in each treatment. Despite the sand skink’s extreme habitat specificity in the wild, survival, reproduction, and growth were apparent in all treatments. These variables differed among treatments, however, and were differentially affected by the treatment type. Differences in sun intensity, ground cover, and root mass associated with varying degrees and types of canopy cover had the greatest effect on indicators of success.

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953 Fish Behavior, Parlor ABC, Monday 27 July 2009

Shyril O'Steen

Seattle University, Seattle, WA, United States

Does Guppy Courtship Locomotion Honestly Indicate Performance, and Do Females Care?

The indicator theory of sexual selection suggests that mating displays may honestly signal genetic quality or condition. Locomotor performance is a good candidate for such
an honest indicator, as many mating displays include rapid or extended locomotion whose physiological requirements may limit cheating. We previously found that mating display locomotion of male guppies, *Poecilia reticulata*, predicted survival time during subsequent encounters with a natural cichlid predator, supporting the possibility that courtship provides an honest signal. Here we will test two hypotheses, first, that the mechanism linking male courtship to survival is in fact locomotor performance. Using high-speed video, we quantified swimming kinematics of male guppies first while displaying to females, and second during later encounters with a predator. We will use these data to test the prediction that male courtship kinematics are positively correlated with those anti-predator kinematics known to increase male survival time. We will secondly address the hypothesis that female guppies respond to performance cues provided by courtship. We recorded behavioral responses of females during male mating display trials, and will use these data to determine if females are more attentive to males that display the kinematic traits linked to survival. If so, sexual and natural selection may act in concert in guppies to influence the evolution of swimming performance.

632 Poster Session II, Exhibitor’s Hall, Saturday 25 July 2009

Patrick Owen¹, Noah Gordon²

¹The Ohio State University at Lima, Lima, OH, United States, ²University of Missouri, Columbia, MO, United States

Do Testosterone Levels Predict Throat Patch Characteristics In Male Green Frogs?

Male green frogs, *Lithobates (= Rana) clamitans*, possess a brightly colored yellow throat patch during the breeding season that is variable in its physical extent and its chromatic characteristics. This patch is only visible in dominant resident males that call from a high floating position in the water. Steroid hormone levels have been linked to the expression of color patches in other animals, but this has not been investigated in frogs. During the summer of 2007 we took digital photographs of the ventral regions of male green frogs in a small pond near Ashland, MO, USA. We quantified the characteristics of these color patches using photo analysis software and determined plasma testosterone levels of these individuals. We found that testosterone level did not significantly predict any of the measured properties of the color patches (patch relative area or chromatic characteristics). Given that previous work indicates that some color patch characteristics are linked to body condition in male green frogs, nutritional state may play a more important role than hormonal state in color patch expression.
The All Catfish Species Inventory (ACSI): A Highly Successful Planetary Biodiversity Inventory

The All Catfish Species Inventory (ACSI) was one of the first projects funded by the National Science Foundation’s Planetary Biodiversity Inventories Program (PBI). The goal of PBIs is to accelerate discovery of the world’s biodiversity by supporting teams of investigators to conduct worldwide inventories of diverse groups of organisms. ACSI has supported 225 research projects around the world, sponsored workshops in Brazil, Singapore and South Africa, and funded 65 field projects in 22 countries, including major expeditions in Brazil, Cameroon, Central African Republic, Guyana, Indonesia, Papua New Guinea, Peru, Mongolia, Republic of Congo, Tanzania, Thailand, Venezuela, and Zambia. About 400 scientists and students in 53 countries are participating. Since ACSI began in 2003, 482 species of catfishes have been described, 393 papers on catfish systematics have been published, 320,000 specimens and 8,000 tissues of fishes have been collected (in 28 countries), 3 post-doctoral fellows, 10 graduate students, and 18 undergraduates have been trained in the U.S., and support has been provided for dozens of students in foreign countries. Many more descriptions and revisions are in progress; the final counts of new species and publications supported by ACSI are projected to increase by 50%. ACSI websites at ANSP (with 9,000 images of primary types at 55 museums), Auburn University and University of Florida provide an overview of ACSI, descriptions of projects, and taxonomic and distributional information on catfishes.

Morphology and Selective Particulate Filtration in Cartilaginous Fishes: Models, Mantas and Whale Sharks

There are 13 species of filter feeding elasmobranchs, which include: manta ray, devil rays, whale shark, basking shark, and mega mouth shark. Understanding the basic biology of these fishes including the movement patterns, mechanics of prey capture, and food preference is necessary for successfully predicting migratory patterns and for assessing and maintaining well-managed stocks. Our approach has been to consider the effect of swimming speed, morphology and water flow on capture efficiency and prey size selection. We found that with simple, cylindrical models of neonatal whale sharks, we could determine parameters that had a significant effect on filtration efficiency and prey selectivity (e.g. gill morphology, swimming speed, etc). We were able to induce
passive prey size selectivity by adjusting morphological parameters and swimming speed. This implies that fish with differing physical morphologies could feed in the same plankton bloom, but passively filter different sizes and species of prey. We have catalogued the anatomical differences between the gill raker structures of elasmobranch suspension feeders using computed tomography, physical examinations and permeability measurements. Although there are four main gill raker morphologies, 1) bristle-like gill rakers 2) fur-like, short gill rakers 3) widely spaced, flattened gill rakers and 4) rigid, leaf-like, folded raker structures, the permeability measurements indicate that the resistance through the their raker structures is minimal. The differences in each species' ecology and physiology indicate that these elasmobranchs may filter their prey using a variety of mechanisms (e.g. cross-flow filtration, hydrocyclone filtration, and dead end sieving).

749 AES Reproduction & Genetics, Galleria South, Saturday 25 July 2009

Brittany Palm, Dave Koester, James Sulikowski

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Fecundity, Viability, and Gestational Rates of Little Skate, Leucoraja erinacea, Egg Cases in the Gulf of Maine

The direct determination of fecundity, viability, and gestation rates of little skate, Leucoraja erinacea, egg cases in the Gulf of Maine are unknown. Determining these reproductive parameters, are essential to the effective management of this and other skate species. Thus, the goals of this study were to determine these parameters for little skate specimens collected from the Gulf of Maine and housed under ambient conditions. Sexually mature little skates were maintained in tanks equipped with ambient, free flowing seawater to monitor the effects of seasonal variation over a full year. Fecundity was calculated at 49 eggs per year and egg deposition peaked in June but was consistently high during the summer months (June, July, August). Out of the 346 eggs laid by seven sexually mature females, 75.1% were viable at the termination of the study and viability was statistically lower in the spring when compared to summer, fall, and winter. Gestation lengths ranged from 22 weeks to 54 weeks and eggs that were laid in the fall displayed the longest gestational period (average=44.3 weeks, S.E. ± 0.13 weeks) while those laid in the spring displayed the shortest gestational period (24.8 weeks, ± 0.24 weeks). Skates developed slower and were statistically smaller in colder seasons than skates that developed faster and larger in warmer seasons. To further investigate the variability in gestation and total lengths, metabolic rates of embryonic skates are currently being measured over a full annual cycle under ambient conditions.
Recognition of an Introduced Predator by Foothill Yellow-legged Frog Tadpoles

The consequences of species introductions into non-native habitats are a major cause of concern in the U.S. Of particular interest are the effects of introduced fishes on native amphibian communities. In Oregon, the Foothill Yellow-legged Frog (Rana boylii) has disappeared from more than half of its historical range and is now listed as a state and federal Sensitive Species. These declines may be partly attributed to the recent introduction of Smallmouth Bass (Micropterus dolomieu) to some of the rivers systems in which these frogs live. Although Smallmouth Bass have been implicated, very little is known about interactions between these two species. We sought to determine whether tadpoles could recognize bass as a predatory threat. Through a series of experiments, we examined the behavioral responses of tadpoles to a variety of stimuli including native predator (newts), introduced predator (bass), and non-predatory fish (dace). Each experiment examined a different potential mode of sensory detection: 1) chemical cues; 2) visual cues; or 3) a combination of chemical/visual/mechanical cues. Results suggested that individual tadpoles of this species require multiple cues to facilitate predator detection. Consequently, Foothill Yellow-legged Frogs appear to be especially vulnerable to predation by non-native Smallmouth Bass.

Can Bonnethead Sharks Digest and Assimilate Seagrass?

The increasing volume of shark diet studies show that sharks are carnivores, although plant material has been identified in the stomachs. Presently, it is assumed that plant material is accidentally consumed while sharks forage on benthic prey and that sharks with plant material found in their stomachs are unable to digest or assimilate this material. However, the digestive capabilities of sharks and their ability to assimilate plant material may have been previously underestimated. Sharks are capable of secreting even more acidic gastric fluids than herbivorous fish and may therefore be able to lyse plant cell walls in their digestive tracts. Diet studies conducted on bonnethead
sharks (*Sphyrna tiburo*) in three areas of the eastern US Gulf of Mexico revealed that blue crabs are the most important dietary item, but that significant amounts of seagrasses are also found in their stomachs. The contribution of seagrass varies with life stage and geographic location (between 8-60%). Although we cannot conclusively state that bonnetheads digest plant material, it appears likely based on their isotope signatures. Omnivory could have significant implications for trophic foodwebs in which these sharks are included.

101 AES Ecology I, Pavillion West, Saturday 25 July 2009

Yannis Papastamatiou¹, Carl Meyer¹, Katsufumi Sato², Yuuki Watanabe³, Kim Holland¹

¹University of Hawaii at Manoa, Kaneohe, HI, United States, ²University of Tokyo, Otsuchi, Japan, ³National Institute of Polar Research, Tokyo, Japan

New “Ecological” Tags and their Use in the Study of Shark Behavior

While a variety of acoustic, satellite and archival tags are being used to quantify shark movements, very little is known about the factors regulating these movements. We have been deploying and testing “ecological” tags which measure a variety of parameters, in both captive and free-ranging sharks. These include gastric motility data loggers and acoustic pH transmitters to record foraging and digestion; a bio-acoustic probe which documents the external acoustic environment; and an acceleration/speed data logger to record swimming mechanics and detailed diving behavior. Although limitations exist with each type of tag, these new sensors will provide a more detailed insight into the underlying behaviors behind the movement patterns and habitat selection of free-ranging sharks.

126 Darwin Symposium, Grand Ballroom I, Monday 27 July 2009

Lynne Parenti

National Museum of Natural History, Smithsonian Institution, Washington, DC, United States

Darwin, Wallace and Biogeographic Classification

Recognition, and mapping, of discrete global biogeographic regions was an early key to the development of a theory of biological evolution for Charles Darwin and Alfred Russel Wallace. At the start, for both, the history of species and the history of Earth were linked. In his early notebooks, Darwin used biological distributions to explore geological theories. Darwin later shifted his focus to process: explanations of the evolutionary significance of distribution patterns rather than of the patterns themselves. Dispersal from a center of origin was assumed a priori as the process of organic
distribution. And, he argued forcefully for the permanence of continents. Likewise, Wallace considered continental rearrangement as an evolutionary driver but abandoned that idea in favor of permanence. Wallace proposed a global, continent-based, terrestrial classification for both plants and animals, based on that of ornithologist Philip Sclater. Wallace’s area classification contradicted many known global biological distribution patterns; it was convenient, but unnatural. Further, the relationship between a global classification and the distributional history of a taxon was not explored. Thus, study of the history of species and the history of Earth became disjointed. Identification and classification of biogeographically meaningful areas can form a framework for interpreting and understanding organic evolution. It can link biology and geology at all scales. Our job is at a critical stage: accidental dispersal of organisms throughout global trade routes has ushered in what has been called ironically the "Homogocene" - an era being marked by the obliteration of natural biogeographic patterns.

610 ELHS/LFC Connectivity Symposium II, Galleria South, Friday 24 July 2009

Claire B Paris¹, Jean-Olivier Irisson¹, Jelle Atema², Michael Kingsford³, Gabriele Gerlach⁴, Cedric M Guigand¹

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In-situ Response of Pelagic Coral Reef Fish Larvae to Reef Odor Conference Workshop: Temperate-tropical Differences in Connectivity – Real and Perceived

Larval reef fishes are often habitat selective and finding a good place to settle is essential for survival. The probability of finding reef habitat could be improved by behavioral decisions guided by sensory cues. For example, larvae are able to discriminate between reef and ocean water in the lab. However, at the scale of the larva, odor cannot be perceived as a directional cue. So the realized impact of these abilities on dispersal will only be known after they are tested in situ, together with other sensory fields. We observed larval behavior in its natural settings using a Drifting In Situ Chamber (DISC) permeable to odors, light, and sound, deployed at various distances around One Tree Island, Great Barrier Reef. The instrument was equipped with a camera that recorded the larva responses, a compass that tracked the instrument’s rotation, a GPS which recorded drift, and a CTD that provided information on the water mass. The DISC was deployed at 3 m depth, for 20 minute trials, inside and outside the odor plume leading out of the lagoon, to test the effect of odor on the behavior of 100 pre-settlement stage larvae (Apogonidae and Pomacentridae). Statistical analyses focus on the effect of reef odor on larval activity, checking whether olfactory stimuli have an effect on behavior in situ, but also orientation, to test the hypothesis that, although reef odor is not directional, it could signal the proximity of a reef and trigger oriented swimming in response to other cues.
Midget Faded Rattlesnake Biology, Ecology, Population Genetics and Landscape Modeling

The Midget Faded Rattlesnake (*Crotalus oreganus concolor*) is a species of concern that receives state-level protection throughout its range in Wyoming, Utah, and Colorado. I conducted a field study throughout their range in Wyoming between 2000 and 2002 using 50 transmittered snakes to shed some light on their ecology. I also collected blood samples from 350 snakes for genetic analyses. The field data collected helped us to understand the biology, ecology, and population genetics of this secretive animal as well as provided assistance with their management. One particularly sensitive characteristic of this species is their communal denning habits that are complemented by the limited denning habitat in the region. The data made available to management agencies only identified 16 populations and den sites in southwestern Wyoming. With the impending threat of oil and gas development using seismic and strip mining tactics around the Flaming Gorge Reservoir (the extent of their range in Wyoming), management agencies need predictive tools to help evaluate future development sites to determine the level of threat to this species. This year, based on the data from this study, we will be developing landscape models that will predict the presence of populations and location of den sites. We will also be incorporating genetic data into these landscape models to understand how landscape variables influence population genetic structure in this region.

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The Timeline for Male Emergence from a Well-studied Hibernaculum: Optimal Patterns for Emergence and an Experimental Test

The red-sided garter snake (*Thamnophis sirtalis parietalis*) is the most extreme case for studying explosive reproduction in reptiles. In the spring of every year, these snakes emerge in the tens of thousands from limestone hibernacula in the Interlake Region of Manitoba, Canada, following an eight month winter dormancy. The sex ratio at the den is male biased (~10:1), with males emerging before and staying after the females have emerged. We randomly caught groups of males (n=100 ea.) every week for 5 weeks at the den and recorded SVLs and masses. Males of "greatest" condition (largest body residual values) had emerged coincident with the peak of female abundance. Further, the longest males were in the den at the peak of female abundance, suggesting that there may be an ontogenetic shift in the timing of emergence. We conducted a simple
laboratory experiment during hibernation to determine if there was a sex difference in substrate choice that could enable different emergence patterns. We offered snakes a choice between full immersion in water vs. dry land, and there was a significant difference between the sexes. Males spent half of their time on land, whereas females remained partially or fully submerged in water. Given that air has a lower specific heat than water, males may be hibernating near the water/air boundary to quickly assess when air/ground temperatures are changing. By doing so, male garter snakes can ensure an early emergence to maximize their ability to find, court, and mate with females.

96 Poster Session II, Exhibitor’s Hall, Saturday 25 July 2009

M. Rockwell Parker, Chris Friesen, Robert Mason

Oregon State University, Corvallis, OR, United States

Associated Reproduction in a Model Dissociated Breeder, the Red-sided Garter Snake

Most vertebrates exhibit an associated reproduction pattern, where maximal sex steroid production, mating behavior, and gametogenesis occur simultaneously or at least in close proximity. The other reproductive pattern, dissociated reproduction, is typified by the uncoupling of one of the aforementioned components from the other two. The red-sided garter snake (Thamnophis sirtalis parietalis) has long been described as a model dissociated breeder. Maximal courtship and mating in this species occur in the spring of every year following winter dormancy while sex steroid levels are basal (or at least decreasing) and no gametogenesis is occurring. Following the spring mating season, all snakes disperse from the den to various lakes and ponds of the Interlake Region of Manitoba, Canada, where they will undergo gametogenesis and parturition with a concomitant increase in sex steroid synthesis. Over the past two summers, we have surveyed male snakes for courtship behavior at a specific summer site (Fish Lake) and found that ~50% of the males exhibit courtship behavior (chin rubbing and body alignment). We bled all of the males to measure their total androgen levels via radioimmunoassay. Males that exhibit courtship behavior in the summer have higher total androgen levels than non-courting males, suggesting that androgens may be directly activating courtship behavior during the summer feeding period concomitant with gametogenesis. Future work in the summer of 2009 will test whether this disparity between courting and non-courting males is due to the attractiveness of females at this time or the levels of circulating androgens present.
Sex Expression in Snakes: The Interplay between Hormones and Pheromone Production

Three pheromone phenotypes exist in the red-sided garter snake (Thamnophis sirtalis parietalis): females, males, and she-males. Mature females have pheromone profiles dominated by long-chain, unsaturated methyl ketones, while mature males produce low levels of short-chain, saturated methyl ketones. Lastly, she-male pheromones are a mix of short- and long-chain methyl ketones that are mostly saturated. We have shown that estrogen (17β-estradiol) implants induce female pheromone production in male garter snakes. The pheromone profiles produced by these E2 males were dominated by one long-chain, unsaturated methyl ketone, making these males extremely attractive, even compared to females. This past summer, we removed the E2 implants from a set of males (n=12) that had implants since the summer of 2007. At that time, we implanted new males (n=12) with E2 implants. Both groups were artificially hibernated in the lab and then taken back into the field in the spring of 2009 for bioassays. All of the males were bled to validate the success of the implants and removals via radioimmunoassay. If implant-removed males are still attractive, we will have demonstrated a permanent, organizational role for estrogen in adult snakes. If estrogen organizes the skin to become a pheromone producing apparatus, then she-male garter snakes may ultimately be the result of developmental effects of estrogen. Previous work has shown that she-males have higher circulating levels of testosterone, which may be converted to low levels of estrogen in the skin via aromatase. Whether these effects are permanent will be discussed in an activational/organizational context.

Uterine Angiogenesis in the Australian Skinks Ctenotus taeniolatus and Saiphos equalis

The evolution of viviparity involves modifications to multiple integrated physiological features to support growth of embryos in utero throughout gestation. Embryonic growth during pregnancy depends on oxygen supplied by the maternal uterine vascular system. The uterus must match the increasing embryonic oxygen demand as development proceeds. We tested the hypothesis that total surface area of blood vessels in the uterine epithelium increases in concert with embryonic growth and oxygen demand during gravidity/pregnancy in the skinks Ctenotus taeniolatus (oviparous) and Saiphos equalis (viviparous) by quantifying the uterine microvascular density and...
morbidity during gestation. We also tested the hypothesis that uterine angiogenesis is controlled by progesterone during pregnancy; we blocked progesterone using the drug mifepriston (RU-486). In both species, uterine vessel density (Nv) and vessel length-density (Lv) differ spatially between regions of the uterus with the highest vascular density associated with the area apposed to the embryonic chorioallantois. For C. taeniolatus, Nv and Lv in the embryonic hemisphere of the uterus are 23% and 17% less than those of S. equalis and vascular surface-area does not change through embryonic development. For S. equalis, overall Nv, Lv, and vessel diameter (Dv) increases by 36% (Nv), 44% (Lv), and 60% (Dv) late in gestation. The chorioallantoic membrane of S. equalis increases in absolute size but vascular density does not differ with embryonic stage. The increase in uterine vascular density and surface-area coincides with the phase of rapid growth in embryonic mass and metabolic rate.

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918 Fish Conservation II, Pavillion West, Sunday 26 July 2009

Daryl C. Parkyn, Debra J. Murie, Douglas E. Colle, Geoffrey Smith, James D. Austin

University of Florida, Gainesville, FL, United States

Capture and Patterns of Recapture to Assess Movements of Greater Amberjack in the Gulf of Mexico

Greater amberjack (Seriola dumerili) were captured and tagged as part of a study to assess the potential for mixing of Gulf of Mexico, Atlantic, and Caribbean stocks and its implications for harvest management of this species. We tagged 682 fish from four regions in the Gulf, removing 2-3 pectoral finrays for aging and a finclip for genetics from each fish. To date, tags from 51 fish have been returned, providing both information on distance moved, as well as rate of growth. In general the size distribution of recaptured fish was skewed to larger individuals compared to fish initially released, both because of minimum size limits for recreational and commercial fishers, as well as the fact that amberjack grew at an average rate of 1.5 mm per day. Movements of individual fish ranged from 0-1250 km, with an average of 40 km movement prior to recapture. Number of returned tags was not uniform across tagging areas. The higher rate of recapture in some regions appeared to be indicative of higher fishing pressure on this species in these regions, although a seasonal component was evident. In addition, the overall high rate of recapture (7.5%) may be a function of lower release mortality of these fish, which we attribute, in part, to features of the swimbladder of amberjack that we have not previously observed in other species.
Amphibian and Reptile Use of Mitigation Wetlands in a Predominately Agricultural Landscape

Amphibians, and to a lesser extent reptiles, have been the focus of much attention because of worldwide population declines. Wetlands in an agricultural state such as Iowa are exceedingly rare and amphibians must often rely on anthropogenic habitats such as farm ponds and constructed wetlands for their breeding and survival. We conducted a two year study on the ecological performance of 12 Iowa Department of Transportation mitigation wetlands and three reference wetlands in Iowa. Amphibians and reptiles were intensively sampled at each site over a year by a variety of methods including frog-call surveys, drift fences with pitfall traps, turtle trapping, and opportunistic searching. Species richness and abundance of amphibians and reptiles did not differ significantly between reference and mitigated wetlands, for example the most diverse site for amphibians was a mitigation wetland (9 species) and the lowest number of species was found at Doolittle Prairie, a natural wetland (2 species). Frogs, especially bullfrogs and cricket frogs, were found at high densities at many mitigation wetlands, and at more recently constructed wetlands. We also did not find any species unique to the reference wetlands to use for a rapid assessment of habitat quality. On average we recorded 5 amphibian species and 3 reptile species at our wetland sites and it appears that factors such size, habitat heterogeneity, and connectivity to other wetlands may be more important to amphibians and reptiles than whether the wetland is created or natural.

Genetic Characterization and Conservation Status of Pupfish in River Springs, California

Pupfish (Cyprinodon spp.) are a group of short-lived species found in discrete aquatic systems across the southwest desert of North America. These fishes possess extraordinary tolerance of environmental variables including pH, salinity, temperature, and parasite community. An unidentified pupfish population occurs at River Springs (north of Bishop), eastern California, presumably derived from pupfish in Salt Creek (C.
salinus salinus) and Amargosa River (C. nevadensis amargosae), Death Valley, California introduced by RR Miller in 1940. River Springs and each of the habitats occupied by the two putative ancestral species differ in elevation, temperature, salinity and biotic factors. We investigated the contribution of each ancestral population to the extant River Springs fish using DNA sequence variation in the mitochondrial Cytochrome b gene (1,095bp). Pupfish in River Springs share the identical haplotype with Amargosa River pupfish, and are distinguished from Salt Creek pupfish by 10 diagnostic single nucleotide polymorphisms. The taxonomic status and conservation significance of pupfish in River Springs are discussed.

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676 Poster Session II, Exhibitor’s Hall, Saturday 25 July 2009
Jennifer Parris Joice, David Etnier, Darrin Hulsey

University of Tennessee, Knoxville, TN, United States

Tennessee Fish Collection: Strengths and Development

The Tennessee Fish Collection housed in the Department of Ecology and Evolutionary Biology at the University of Tennessee is the largest fish collection in Tennessee. This collection represents over 40 years of work by Dr. David Etnier and continues to grow. In terms of total species it ranks in the top 20 among North American Fish collections. The collection houses 35,220 lots to date, which contain ~425,000 specimens from 206 families. The hyper-diverse fauna east of the Rocky Mountains is well represented in the collection, and it contains the best darter collection in North America based on numbers of species + specimens + lots of rare specimens. The collection and associated information is widely used by government, private, and academic institutions and we would like to encourage increased use of the collection’s holdings. Since 2006, the collection has been housed in the Hesler Biology building in the heart of the UT campus. It is outfitted with modern compactors and its holdings are currently being digitized. The entire collection is projected to be searchable on the web by Fall 2009.

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463 SSAR SEIBERT ECOLOGY AWARD, Galleria North, Thursday 23 July 2009
Susan Parsons, Charles Peterson, Marjorie Matocq

Idaho State University, Pocatello, ID, United States

Landscape Genetics of Great Basin Rattlesnakes, Crotalus oreganus lutosus, on the Idaho National Laboratory

The absence of baseline data in pristine environments hinders conservation efforts directed at threatened populations, making ecologically descriptive studies increasingly more important. Sagebrush-steppe ecosystems are among the most endangered
terrestrial ecosystems in North America, but the plants and animals living on the Idaho National Laboratory (INL), a federally protected research facility found in the sagebrush steppe of southeastern Idaho, do not suffer from many of the deleterious effects of habitat conversion and fragmentation characterizing more typical western landscapes. This research describes patterns of gene flow within a group of largely undisturbed Great Basin rattlesnake (Crotalus oreganus lutosus) hibernacula on the Idaho National Laboratory. Landscape genetics, made possible by high resolution molecular markers and Geographic Information Systems (GIS), combines landscape ecology and population genetics to explain how landscape characteristics affect gene flow and population structure. Six polymorphic microsatellite DNA loci are used to genotype 200 individuals from 10 hibernacula located at spatial distances of 3-45km from each other. Genetic connectivity, estimated using traditional Fst calculations, is correlated with Euclidean and least cost path distances, as well as the proportion of suitable denning habitat found between hibernacula. Genetic analyses show that only modest levels of population substructuring characterize INL rattlesnake hibernacula, and GIS-based landscape analyses produce significant correlations between Fst and the availability of intervening denning habitat, but not with Euclidean or least cost path distances. These findings provide strong evidence that the availability of high quality habitat corridors along movement paths maintain gene flow in a communally denning, temperate snake species.

358 Poster Session II, Exhibitor’s Hall, Saturday 25 July 2009
James Paterson
Laurentian University, Sudbury, ON, Canada

Microhabitat Selection by Eastern Ribbon Snakes (Thamnophis sauritus) in a Coastal Lake Huron Wetland

Habitat selection occurs when an organism uses habitat disproportionately when compared to the available resources. Eastern ribbon snakes (Thamnophis sauritus) are a small, at-risk North American species that occurs near bodies of water. A use-availability study was conducted to determine if ribbon snakes were selecting microhabitat sites in a coastal wetland in Ontario, Canada. To determine if habitat selection was occurring at this scale, microhabitats in which snakes were found were compared to random 1m² plots located in the available habitat. Comparisons were made using discriminant function analysis (DFA) and a classification and regression tree (CART). Snakes disproportionately used microhabitats in shallow water close to shore similar in temperature to their reported preferred body temperature. However, the results differed between the methods used, emphasizing the use of multiple analyses when using multivariate habitat data. The determination of important habitat characteristics is crucial for the development of management plans for this species-at-risk. This is one of the first descriptions of habitat use by this species in Ontario.
A Comparative Study of the Capacity for Aerobic and Anaerobic Metabolism in the Muscle Tissues of the Three Species of Thresher Shark (Family Alopiidae)

A recent study of the three species of thresher shark (Family Alopiidae) has revealed some striking interspecific differences in locomotor muscle morphology. The common thresher (Alopias vulpinus) differs significantly in the position of the red myotomal muscle (RM) when compared to the bigeye (A. superciliosis) and the pelagic thresher (A. pelagicus), and is the only thresher known to have regional muscle endothermy. The objectives of this study were to 1) determine if the pelagic and bigeye threshers have warm RM and 2) to quantify the activity of citrate synthase (CS; an index of aerobic capacity) and lactate dehydrogenase (LDH; an index of anaerobic capacity) in the RM in order to determine if the metabolic biochemical capacities are species-specific. Temperature readings were taken in six longitudinal positions along the body of the sharks and show that the RM temperatures of common thresher were above that of the ambient temperature at depth caught, while the pelagic and bigeye thresher RM temperatures were closer to ambient temperature at depth caught. The CS and LDH activity at 20°C in the RM of the common thresher was higher when compared to the other two species. In addition, thermal effects were determined over a wide temperature range (10-30°C) and showed that the mean Q₁₀ for CS and LDH did not differ significantly. These results indicate that although the thermal effect on enzyme activity is similar, the overall activity of these enzymes in the RM is higher for the common thresher shark.
Discordance between Mitochondrial and Nuclear Gene Phylogenies and its Impacts on the Systematics of the *Bufo boreas* Species Group

The *Bufo boreas* species group contains four species in western North America including the widespread Western Toad, *B. boreas*, and the Yosemite Toad, *Bufo canorus*, an endemic of the central Sierra Nevada of California. Results of previous mtDNA phylogenetic studies of these species conflict with current taxonomy and an earlier unpublished allozyme analysis. Mitochondrial DNA studies suggest that northern and southern populations of *B. canorus* are each more closely related to northern and southern populations of *B. boreas* than to each other. In contrast, allozyme studies recover *B. canorus* as a distinct clade and the sister taxon to the remaining species. Here, I conduct phylogenetic analyses of multiple mitochondrial and nuclear genes with sampling throughout the ranges of *B. boreas* and *B. canorus* to test for discordance between mitochondrial and nuclear loci. These new mitochondrial analyses continue to recover *B. canorus* as non-monophyletic while the nuclear data, including a re-analysis of the allozyme dataset, indicate *B. canorus* is monophyletic. Importantly, a combined analysis of available *B. canorus* mtDNA data (>400 individuals) indicates all *B. canorus* have mtDNA haplotypes from *B. boreas* (i.e., no *canorus* mtDNA haplotypes are found to be nested outside of *B. boreas* as in the nuclear datasets). These results suggest mitochondrial introgression from *B. boreas* into *B. canorus* followed by multiple mitochondrial selective sweeps. This discordance adds to the growing evidence that mtDNA results should not be used as the sole basis for systematic and management decisions.
transformation, as shown by the presence of presepermatids in one late transformation specimen. Mature females are very rare and a distinct difference in maximum egg diameter is noted in different genera. DNA analyses of 32 individual cetomimids including four larvae, one male, five female genera and nine species, plus three outgroup families, have provided confirmation that these three life stages belong to a single family. The analyses also have indicated linkages of different life stages and provided information about generic and familial relationships. Unique meristic counts link the larva *Parataeniophorus gulosus* with the male *Cetomimoides parri* and the female *Cetostoma regani*; also *Mirapinna esau* is the postlarva, and senior synonym, of the female *Procetichthys kreffti*. Other linkages are more challenging and fresh larvae for DNA are needed. Reconciliation of generic relationship trees from DNA and anatomy will be discussed. Barbourisiidae is the sister group of Cetomimidae. Videos of two individual whalefishes at 1400-1700 m indicate two distinct swimming modes.

889 NIA STUDENT PAPER AWARD, Parlor ABC, Sunday 26 July 2009

Allison Pease¹, Rocio Rodiles-Hernandez², Alfonso Gonzalez-Diaz²

¹Texas A&M University, College Station, TX, United States, ²El Colegio de la Frontera Sur, San Cristobal de las Casas, Chiapas, Mexico

Structure and Morphological Diversity of Stream Fish Communities along a Longitudinal Fluvial Gradient in the Río Grijalva Basin, Mexico

The influence of environmental variables on fish assemblage structure and morphological diversity was examined along a longitudinal gradient in the Río Grijalva basin in Chiapas and Tabasco, Mexico. The ecomorphological diversity of fishes was measured along with a suite of environmental variables in communities across a range of environments, from high-elevation tributaries to lowland streams in the coastal plains. We measured morphological traits with known relationships to feeding ecology and habitat use and compared functional community structure among stream communities using multivariate ordination and ecological distance calculation techniques. Fish species richness and morphological diversity was highest in lowland communities, where habitats are more stable with high productivity and spatial heterogeneity that provide for a broad prey resource base. This diversity decreased in communities further upstream, where the flow regime is harsher and fewer favorable habitat types are available for fishes or their prey resources. In large tropical river basins, few studies have examined changes in fish assemblage structure at the watershed scale, and little is known about how functional community structure responds across environmental gradients in these systems.
Climate-driven Changes in the Survival and Growth of Marine Fish: Individual-based Model Estimates for Larval Herring (Clupea harengus) in the North Sea

North Sea herring (Clupea harengus) has experienced extremely poor recruitment in recent years despite having high spawning stock biomass. Field survey data suggest that poor year classes stem from processes acting during the first months of life, when cohorts of larvae passively drift eastward across the North Sea from western spawning grounds during the boreal winter. We investigated how intra- and inter-annual changes in climate-driven bottom-up processes might impact early larval growth and survival by developing a coupled 3-d individual-based, biophysical model for Atlantic herring larvae in this region. Physiologically-based foraging and growth subroutines allowed us to examine the impact of key abiotic (e.g., water currents, temperature, light, turbulence) and biotic (prey size and prey concentration) factors on the feeding, growth and survival of young larvae. Model foraging and growth estimates were validated using a variety of field and laboratory studies previously conducted on larval herring and a sensitivity analysis of model parameters was performed. Model simulations employed extensive (>35 yr) time series data on larval herring abundance and distribution and projected large inter-annual differences in prey concentrations required for the survival and growth of this species in this region. In many years, climate-driven changes in average winter water temperature and zooplankton phenology were predicted to markedly influence the survival of the youngest larvae originating from selected spawning grounds. Although projecting future trends remains challenging, climate-driven changes in bottom-up processes should be taken into account for the effective management of North Sea herring.
Larval Fish Assemblages: Seasonal Connectivity in the Gulf of California

Patchily distributed, marine species possessing pelagic larvae have the potential for considerable levels of connectivity among local populations. By larval dispersal, the connectivity is important for determining demography of local populations. The strong seasonal variability in the Gulf of California (GC) and the associated physical processes can play an important role on the larval fish dispersion. Fish larvae collected in the GC in December 2002 and August 2003 were used to describe larval fish assemblages (LFAs). In this work we have tracked particles in a current field coming from a 3D numerical model and we have constructed connectivity matrices for two periods with different circulation conditions (December 2002 and August 2003). The main connectivity path (20% of particles) was following the strongest seasonal current, but short time scale like tides must be consider in areas like the region of the Big Islands and the northern Gulf of California. This connectivity path was according to the gradients of species richness and larval abundance, northward during December and southward to during August. The Lagrangian analysis reveals that the circulation favors the permanency for time periods as long enough to allow fish larvae to remain in a favorable environment until they complete their development or until the climate drastically changes with the seasons. Also, the model shows that the main interchange of larval is between areas that belong to the same LFA.
elucidating patterns of lineage diversification and defining species limits using a multilocus approach (mtDNA and two unlinked nuclear genes). This study will help uncover the biogeographic history of northwest México where few studies have addressed questions regarding lineage diversification processes in the area. Bayesian phylogenetic inference analyses of mtDNA recover four major lineages: 1) a geographically restricted lineage located at the northern portion of the Sierra Madre Occidental; 2) a widespread lineage ranging throughout the southwestern U.S. and northern México; 3) a lowland coastal Sonora lineage; and 4) a Sinaloan lineage. The mtDNA structure found within *U. ornatus* populations indicates the presence of possible cryptic species. The reality of these lineages and the possibility of restricted gene flow is being tested with nuclear data and coalescent based methods. Further analysis on these uncovered lineages will contribute to the knowledge about historical biogeographic patterns and processes affecting species in southwest U.S. and northwestern México.

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428 ELHS/LFC Ecology II, Broadway 1&2, Sunday 26 July 2009; ELHS SALLY RICHARDSON AWARD

Kestrel Perez, Stephan Munch

*Stony Brook University, Stony Brook, NY, United States*

**Bigger is Better, but only for a Little While**

Both in marine and terrestrial taxa, fitness typically increases with body size and selection pressure on size is generally positive. We reviewed the literature for estimates of size-selective mortality in the early life history and calculated standardized selection differentials. We found that overwhelmingly selection favored larger size at age and the strength of this selection was 5 times that seen in terrestrial taxa. However, most of these studies focused on the first few weeks of life and it is unclear whether selection continues to favor larger size throughout fish life history. To address this question, we collected a common annual marine species, *Menidia menidia*, for the first third of their lifespan. We estimated size at previous ages and selection differentials using otoliths. We found that early in life selection tends to favor larger sizes, but that selection favors smaller sizes in juveniles.

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512 General Herpetology, Galleria South, Sunday 26 July 2009

Gad Perry, Mark Wallace, Howard Curzer, Peter Muhlberger

*Texas Tech University, Lubbock, TX, United States*

**“Filling the Gap”: Improving Education on the Ethics of Animal Use in Field Biological Research**
Animal research is critical to herpetology, but scientists have few ethics guidelines to direct them: most existing regulations are focused on captive animals and may not be appropriate to field research. The absence of clear and appropriate guiding principles results in both unnecessary restrictions on some research and permission for ethically questionable research in other cases. The latter, and statements by prominent but poorly informed colleagues to the effect that tools such as toe-clipping constitute ‘casual barbarity,’ can harm the public image of scientists in this field. We are conducting an interdisciplinary project to develop refined ethical criteria for field research and educate graduate students in how to apply these criteria. In addition to the benefits to field studies, this project is attempting to create a unique research and pedagogical context that promises to advance environmental ethics. Our approach combines classroom teaching of new materials as they are being developed and refining them with participation of graduate students alongside IACUC members in the making of real decisions regarding field research. Benefits come from both classroom and apprenticeship pedagogical models. We will also rigorously test this novel pedagogical approach for enhancing professionals’ ethical reasoning that could be applied in other scientific fields and may have important implications in the social sciences for how to enhance ethical reasoning on any complex issue. We are looking for appropriate herpetological case-studies that can be used in this program.

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946 Poster Session II, Exhibitor’s Hall, Saturday 25 July 2009

Sean Perry, Mitchell Mulks, Sora Kim, David Capser, Paul Koch, Barry Sinervo

University of California-Santa Cruz, Santa Cruz, CA, United States

The Influence of Hibernation on Diet-to-blood Fractionation Factors in the California Mountain Kingsnake (Lampropeltis zonata)

Stable isotope variations are progressively being used as tracers in animal ecology and physiology. Past experiments use stable isotope analysis to look at mammals, birds, and fish species; yet, few studies look at ectothermic animals. Ectotherms depend solely on their environment to regulate their metabolisms. Fluctuating metabolic rates and differences in physiology will change assimilation and allocation of dietary carbon and nitrogen. Captive experiments with endotherms demonstrate predictable fractionation and isotopic enrichment of carbon and nitrogen during times of stress or protein loss. However, no research explores carbon and nitrogen fractionation through hibernation in ectotherms. We used twenty California Mountain Kingsnakes (Lampropeltis zonata) to determine if diet-to-blood fractionation factors vary before, during, and after hibernation. The snakes were caught 2-4 years ago, fed mice after being brought into a controlled laboratory setting, allowing their tissues to equilibrate to the mice diet. From October 2008 to March 2009 subjects were hibernated at 13°C. Blood was repeatedly removed by cardiocentesis before, throughout, and after hibernation. Preliminary data suggest a correlation between mass loss/gain and fractionation factor. During hibernation, some individuals’ carbon and nitrogen isotope values changed with mass loss. This trend is likely due to protein catabolism and deamination because the animals rely on their body reserves throughout hibernation. If hibernation influences stable isotope fractionation factors, an ectotherm’s physiological condition will need to be accounted for in further studies using stable isotope analysis.
Dental Sexual Dimorphism in Bluntnose Stingrays, *Dasyatis say*: Implications for Male Feeding Ability

Sexually dimorphic dentition has evolved in several species of Dasyatid stingrays wherein males replace their molariform teeth with cuspidate teeth during the mating season. Previous research has revealed that cuspidate dentition may increase male reproductive success through enhanced grip strength and improved ability to grasp and hold females during copulation. The replacement of cuspidate teeth with molariform teeth following each mating season is intriguing as it suggests that cuspidate teeth may be inferior as feeding structures and may compromise a male's ability to crush hard-shelled prey during non-mating periods. We explored trade-offs in the evolution of dental sexual dimorphism in the bluntnose stingray (*Dasyatis say*) by testing for potential feeding-related costs of cuspidate dentition, including 1) comparing bite forces required by mating and non-mating teeth to crush shelled prey, 2) examining the susceptibility of mating teeth to damage during feeding, 3) testing whether tooth damage compromises male grip strength, and 4) investigating whether the diets of wild individuals vary with dentition type. Preliminary findings suggest there is no significant difference between forces required by either dentition to crush shelled prey; however, we found cuspidate teeth to be significantly more prone to damage when used to feed on shelled prey. Results and implications of cuspidate tooth damage on grip strength will be presented and discussed.

Distribution and Habitat Characterization of the Saltmarsh Topminnow, *Fundulus jenkinsi*, Along the North-Central Gulf of Mexico

*Fundulus jenkinsi* occurs sporadically along the Gulf Coast from Galveston, TX to Escambia Bay, FL, appears to prefer Spartina marsh, and is generally believed to occur in low salinity. It is on the Federal Species of Concern list because of its connection to coastal wetlands which are being impacted by development although little is known about its habitat characteristics. We sampled across its range for two years and obtained 661 *F. jenkinsi* with associated habitat characteristics that were delineated by Principal Components Analysis (PCA). PCA explained 51.24% of the variation with PC I interpreted as a geomorphic marsh axis (33.00%) whereas PC II interpreted as a seasonal/spatial axis (18.24%). Sampling over a wide range of conditions, higher CPUE values occurred in low to moderate stem density (<50 stems), shallow to moderate depth (<30cm), and less steep slope sites (<20°) coupled with spring and very early summer water temperatures (>15°C), lower turbidity (<60 NTU), and low to moderate salinity;
the majority (77.5%) of them were collected when salinity <16. We verified their
distribution Barataria-Terrebonne, LA through Escambia Bay, FL with the majority
being collected from Weeks Bay, AL. PCA showed a narrow distribution within these
basins as compared to other fundulids with more individuals during the spring and
summer (increased juveniles). Our data suggests seasonal cues such as water
temperature, salinity, and turbidity may be influencing reproduction and spawning
whereas water depth, bank slope and stem density (geomorphic characters) influenced
CPUE and distribution when nested within the seasonal/spatial axis.

850 Clark Hubbs Symposium, Galleria South, Saturday 25 July 2009

Frank Pezold, Yongjiu Chen

Texas A&M University - Corpus Christi, Corpus Christi, TX, United States

Genetic Variation in the Genus Kribia (Eleotridae) in Guinea, West Africa

African pygmy sleepers (Kribia) are a group of small morphologically conservative
freshwater fishes native to Nilo-Sudanian and west central Africa. In this study, we
characterize DNA sequence divergences among different geographically isolated
populations in Guinea, West Africa, using mitochondrial cytochrome-b (Cyt-b) and the
nuclear S7 ribosomal protein intron (S7-I) genes. We recovered 1,136 base pairs Cyt-b
DNA sequences from 106 specimens of Kribia sp., and identified a total of 44 distinct
mitochondrial haplotypes. A phylogeny based on Cyt-b sequence variation shows three
significantly distinct lineages, among which the overall sequence divergences are in the
range of 10-20%, and several distinct clades within those lineages. Primary sequence
data of S7-I (784 base pairs) present less variation than those of Cyt-b, but the two genes
share a concordant topology of phylogeny. All haplotypes, but one, were site specific.
Preliminary studies suggest some concordance between molecular divergence and
differences in pigmentation.

427 AES Reproduction & Genetics, Galleria South, Saturday 25 July 2009

Nicole Phillips¹, Jennifer Chaplin¹, David Morgan¹, Stirling Peverell²

¹Centre for Fish & Fisheries Research, Murdoch University, Murdoch, Western
Australia, Australia, ²Queensland Department of Primary Industries & Fisheries,
Sustainable Fisheries, Northern Fisheries Centre, Cairns, Queensland, Australia

Conservation Genetics of Pristis Species in Australian Waters

Information on the conservation genetics of the Critically Endangered (IUCN) sawfishes
Pristis microdon, P. zijsron and P. clavata in northern Australia, which is believed to be
their last stronghold, is vital to the development of management plans. Since these three
species have different habitat requirements, such information also provides the
opportunity to investigate whether their population structures vary with habitat usage. Nucleotide sequence variation in a portion of the control region of the mitochondrial DNA was used to investigate the extent to which the assemblages of each of these three species in the northwest and northeast of Australia are connected and also to compare the levels of genetic diversity in these assemblages. The results indicate that *P. microdon*, which utilizes freshwater rivers as juveniles and marine waters as adults, exhibits strong genetic subdivision between these two regions ($F_{ST}=0.314; P = 0.000; N = 92$). In contrast, *P. zijsron* and *P. clavata*, which spend their entire life in marine and/or estuarine waters, exhibited less genetic subdivision between the northeast and northwest. The overall level of genetic diversity for each species was moderate, however, the assemblages in the northeast appear to have lower genetic diversity than those in the northwest of Australia. The results suggest that populations of *Pristis* sawfishes tend to be spatially restricted and management plans should be developed accordingly.

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364 Herp Biogeography, Galleria North, Saturday 25 July 2009

Ivan Phillipsen¹, Anthony Metcalf²

¹Oregon State University, Corvallis, OR, United States, ²California State University, San Bernardino, CA, United States

Phylogeography of a Stream-dwelling Frog (*Pseudacris cadaverina*) in Southern California

Recent phylogeographic studies of animal taxa in southern California have revealed common geographic patterns of evolutionary divergence and genetic diversity that are generally attributable to landscape influences. However, few studies have focused on the evolution of freshwater taxa in this region. Here, we investigate phylogeographic patterns in a stream-dwelling frog (*Pseudacris cadaverina*). Using sequence data from 1100 bp of mitochondrial DNA, we conducted phylogenetic analyses, analysis of molecular variance, and nested clade phylogeographic analysis to gain insight into the factors contributing to the distribution of genetic diversity in *P. cadaverina*. We tested hypotheses that genetic diversity in this species is partitioned into 1) major watersheds, 2) mountain ranges, and 3) coastal and desert regions. There is strong support for two major phylogenetic clades and evidence for a "Transverse Range Break," found in several other taxa. Genetic diversity appears to have been influenced by barriers in the form of watershed boundaries and lowlands separating mountain ranges, whereas no strong division exists between coastal and desert populations. Our results suggest that the eastern Transverse Ranges are the center of origin for extant *P. cadaverina* lineages and that the overall phylogeographic pattern for this species is the result of restricted gene flow among largely disjunct populations, with connectivity among populations mediated by landscape barriers.
Home Ranges and Movement Patterns of Louisiana Pine Snakes (*Pituophis ruthveni*) in Texas and Louisiana

A limited number of studies on the ecology of the Louisiana Pine Snake (*Pituophis ruthveni*) have been published despite the thought that they have been extirpated from large portions of their historic range. Extant populations are currently known from a limited number of small and fragmented localities in eastern Texas and west-central Louisiana. Using radiotelemetry, we determined the home ranges and movement patterns of Louisiana Pine Snakes (8 males, 8 females) in 5 study areas (2 in Louisiana and 3 in Texas). Annual active season home ranges ranged from 4.0 - 117.4 ha using 95% Minimum Convex Polygons. Annual home ranges within and among individuals often overlapped. The mean annual active season (Mar. - Oct.) home range size of 41 ha is relatively large for the genus. This is, at least partially, due to fragmentation of suitable habitat. Individual snakes that crossed unsuitable habitat to access blocks of suitable habitat, had larger home ranges than those that did not. Movements during the colder months (Nov. - Feb.) were greatly curtailed compared to the remainder of the year, and we had no evidence that snakes fed during this period. However snakes still often undertook substantial movements. Snakes exhibited no winter dormancy site fidelity within or among individuals. The increased understanding of home range parameters provided should assist those involved in management of *P. ruthveni* as they make decisions concerning the size of landscapes necessary to maintain viable populations.

Developing a Rapid Molecular Assay with Internal Controls for Detecting the VHS Fish Virus

The emerging viral hemorrhagic septicemia (VHS) disease is caused by a unique new strain of rhabdovirus (IVb) that broke out Great Lakes regions during the springs 2006-8, causing massive fish die-offs that threaten fisheries, economic development, tourism, and public health perception. The virus is transmitted at spawning time and can live for days in the water; causing deaths in yellow perch (*Perca flavescens*), muskellunge (*Esox masquinongy*), and drum (*Aplodinotus grunniens*), among others. The danger of spread to aquaculture systems is potentially high, and the virus appears to spread in some baitfish. Our goal is to develop a key genetic tool for rapid and accurate detection of the virus in infected fish, and test our results against the current “gold standard” conventional cell culture (a month-long process). We are developing an accurate and reliable molecular genetic test based on standardized reverse transcriptase polymerase chain reaction (StaRT-PCR) technology, which has built-in internal controls, enabling
rapid and cost-effective detection of the virus. Our test is designed with intrinsic quality control, a low detection threshold, and detects and identifies among all variant VHS strains; eliminating problems with false negatives and positives inherent in most other PCR tests. This test will markedly improve rapid, reliable, and accurate verification of VHS outbreaks within hours, aiding fishery management and disease control efforts.

189 General Ichthyology I, Pavilion East, Saturday 25 July 2009

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Habitat Fragmentation and Genetic Population Structure of Three Etheosotomatine Darters in the Duck River, TN

The greenside (Etheostoma blennioides newmanii), fantail (Etheostoma flabellare), and rainbow darters (Etheostoma caeruleum) are three abundant species found throughout the Duck River, Tennessee. We assessed genetic variation and structure from multiple populations for these species throughout the river system. Due to their varied ecological niches and life histories, we expected differing levels of population structure. A total of eight different microsatellite loci were analyzed from six different locations along Duck River. Five loci from 3 to 4 populations were scored for each individual species and were analyzed using multiple population genetics tools. It was found that the highest level of genetic structure (F<sub>ST</sub>=0.0842) was present in E. flabellare with the lowest levels being found in E. blennioides newmanii (F<sub>ST</sub>=0.0338). Etheostoma caeruleum had an intermediate level of population structure (F<sub>ST</sub>=0.0454). Significant isolation by distance effects were shown for E. blennioides newmanii (r=0.5494) and E. flabellare (r=0.5027). The results of this study are consistent with the predictions based on previous life-history studies of these species.

776 Poster Session I, Exhibitor’s Hall, Friday 24 July 2009

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Genetic Identification of Rhizoprionodon Shark Species Employing Nuclear DNA Sequences

The sharpnose sharks Rhizoprionodon lalandii and R. porosus account for approximately 50 to 60% of all sharks caught by commercial and artisanal fisheries in Brazil. One problem concerning the Rhizoprionodon group is that they are difficult to distinguish based on
morphology alone which, in combination with the common finning practice, hinders the monitoring of catch and trade of meat, fins and derivatives in a species-specific manner. Here, a molecular approach based on nuclear 5S rDNA sequence variability was applied successfully to correctly identify samples from the two *Rhizoprionodon* species collected in the wild or sold in markets. The sequence of the non-transcribed spacer (NTS) of the 5S rDNA showed high interspecific variability and no intraspecific polymorphism, making it a useful marker for sharpnose shark identification. Polymorphisms in the NTS sequences of *Rhizoprionodon* sharks also created unique restriction patterns for each species after PCR-RFLP analysis. This approach represents an efficient way to differentiate the two closely related shark species and can be used to reinforce morphological identification, allowing effective traceability of *Rhizoprionodon* sharks in future management studies.

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**264 Poster Session III, Exhibitor’s Hall, Sunday 26 July 2009**

**Susanna Piovano**

*Dept. Animal Biology, Torino University, Torino, Italy*

**Hooks, Baits and Lights - Mitigation of Pelagic Stingrays Fishing Bycatch**

The reduction of incidental catch of unwanted species during fishing operations has been identified among top priorities in fisheries management. The pelagic stingray *Pteroplatytrygon violacea* is listed among the main unwanted captures in longlining. In 2005-2007, 97 experimental longline fishing sets were run in the Strait of Sicily, central Mediterranean Sea, to verify the importance of hooks size and shape, baits size, and light attractors presence and type on the stingray capture rate. 9 vessels targeting swordfish were involved. A total of 222 pelagic stingrays were captured. Results highlighted the importance of hooks size and, among wide hooks, of the circular shape, that obtained the lower stingrays bycatch rate. On the contrary, nor the size of the fish baits, neither the presence and type of light attractors had a significant effect. *P. violacea* is now listed among IUCN Near Threatened species in the Mediterranean Basin. Results suggest that the introduction of wide circle hooks into local management planes for swordfish longline fisheries can play an important role in the conservation of the pelagic stingray in the Mediterranean Sea.

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**532 Snake Conservation, Pavillion West, Monday 27 July 2009**

**Renata Platenberg, Daniel Harvey**

*Division of Fish and Wildlife, St. Thomas, Virgin Islands, U.S.*

**Endangered Species and Land Use Conflicts: Identifying habitat for the Virgin Islands Tree Boa (*Epicrates monensis granti*)**
Wildlife conservation often takes a back seat to economic development, particularly on islands where land is limited. This is especially so in the US Virgin Islands (USVI), where coastal areas are being converted into upscale developments. Intense and unmitigated development pressures in recent decades has presumably resulted in significant loss of habitat for the endangered Virgin Islands Tree Boa (*Epicrates monensis granti*). This species is cryptic, nocturnal, and difficult to locate, and as such baseline information on its status and distribution is incomplete. In the face of ongoing development, it has become urgent to identify areas where this species is likely to occur in order to initiate conservation measures. Using geographic information systems and ad hoc observations collected over 25 years, we created a habitat suitability model for *E. m. granti* that allowed for the prediction of presence in any particular area within its known range. Microhabitat assessments were conducted to better understand habitat associations at a fine scale. Using this information, we developed a habitat delineation protocol for identifying habitat patches within a specific location. We use the habitat suitability model to prioritize areas for conservation, and require developers to conduct habitat delineation to identify areas requiring protective measures. Although this process is still in its infancy, there has been some success in scaling back development and directing restoration efforts.

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**669 Lizard Ecology, Pavillion East, Friday 24 July 2009**

Steven Poe, J. Tomasz Giermakowski, Eric Schaad, Ian Latella, Erik Hulebak, Mason Ryan

*University of New Mexico, Albuquerque, NM, United States*

**Ancient Colonization Predicts Recent Naturalization in Anolis Lizards**

Invasive species are a global concern due to resulting economic losses and extinction of indigenous wildlife. Three general hypotheses may explain the distributions and characteristics of invaders. First, invasive patterns may be due to novel anthropogenous processes of world biogeography such as transport of propagules on ships. Conversely, the unprecedented connectivity of humans may cause a simple acceleration of omnipresent ecological and evolutionary forces. Finally, as a null hypothesis, there may be no human effect. The first hypothesis predicts that invaders will possess unusual characteristics specific to interactions with humans. The latter two hypotheses predict similarity between ancient colonizers and recent invaders. Here we present the first tests of the latter hypotheses and show how they may be reconciled with the former. We show that species of Anolis lizard that are ancient colonizers share characteristics of anatomy, geography, phylogeny, and ecology with recently naturalized species of *Anolis*. Remarkably, characteristics of ancient colonizers are better predictors of naturalized invaders than are characteristics of naturalized species themselves. These results indicate that contemporary patterns of invasion are at least partially explained by omnipresent natural processes. However, some of the unusual traits of ancient colonizers are known to be associated with species that inhabit human-altered environments. Thus although modern invaders appear analogous to ancient colonizers—a basic assumption of invasion biology since Darwin—the unusual traits of ancient colonizers seem also to favor modern coexistence with humans.
Lentic-breeding Amphibians of the Mountains of Northern California: Status and Threats

The Klamath-Siskiyou Mountains and southern Cascades support a high diversity of native lentic-breeding amphibians including the Cascades frog (*Rana cascadae*), long-toed salamander (*Ambystoma macrodactylum*), rough-skinned newt (*Taricha granulosa*), western toad (*Bufo boreas*) and Pacific treefrog (*Pseudacris regilla*). Since 1999, we have studied their distributions, status and threats throughout these ranges in California using both large-scale surveys and whole-lake experiments. Primary known threats include introduced species, disease, and altered hydrologic regimes. Based on extensive surveys, we found a negative correlation between introduced trout and three species, *R. cascadae*, *A. macrodactylum*, and *P. regilla*. We followed with a replicated experiment in which we removed fish from four lakes and quantified the impact of fish and the recovery of *R. cascadae* following fish removal. We found dramatically increased survival and recruitment of frogs at the trout removal lakes. Currently we are studying the distribution and virulence of the deadly amphibian disease chytridiomycosis caused by the fungus *Batrachochytrium dendrobatidis* (*Bd*). In the summer of 2008 we performed a 140-lake survey of amphibians at sites that were inhabited by *R. cascadae* 6 - 9 years ago. We collected over 2000 swabs from seven species of amphibians; 1030 swabs have thus far been tested for *Bd* using qPCR. Approximately 14% of these swabs tested positive for the pathogen. Positive sites occur throughout the Trinity Alps Wilderness and southern Cascades, as well as in the Marble Mountains Wilderness and the Shasta-Trinity National Forest. The implications for populations of *R. cascadae* and other native amphibians will be discussed.
body curvature. As a first step in testing this prediction, we sought to determine the dynamic mechanical properties of cartilaginous vertebral columns and their response to varying frequencies, amplitudes, and length of the moment arm to reflect the loading of a shark swimming at varying speeds. We designed a rig that allowed us to measure the mechanical properties using a MTS Tytron 250 one-axis testing machine. In these tests, we used ten–centra-long segments of vertebral columns from three *Squalus acanthurus*. Stiffness, a structure’s ability to resist loading, measured by the elastic modulus (E, in MPa), increases with frequency and is almost 2X greater at bending frequencies of 2.0 Hz than at 0.5 Hz. Additionally, stiffness increases with testing amplitude by more than an order of magnitude, and stiffness is greatest at the shortest moment arms. These data contribute to the growing understanding of how cartilaginous skeletons respond to loads, and how those responses are correlated with morphology and swimming performance. This work was supported by NSF DBI-0442269.

690 Herp Biogeography, Galleria North, Saturday 25 July 2009; ASIH STOYE AWARD GENERAL HERPETOLOGY

Daniel Portik

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**Phylogeography of a Skink Species from Southwestern Africa**

*Trachylepis sulcata* is a species of lygosomine skink that is broadly distributed in the western portion of southern Africa. It exhibits chromatic variation across its range from southwestern Angola to the Eastern Cape of South Africa, and a melanistic subspecies, *T. s. nigra*, has been described from Lüderitz Bay, Namibia. To examine population structuring in *T. sulcata* and the validity of the subspecies *T. s. nigra*, three nuclear genes (totaling 2644 bp) and two mtDNA genes (totaling 2075 bp) have been analyzed for 86 individuals sampled across 64 unique localities. Results indicate nearly all genetic diversity in *T. sulcata* is contained in northern Namibia, and remarkable genetic homogeneity is maintained across populations from southern Namibia to the Eastern Cape (a distance of 1175 km). This is most appropriately explained by a southward range expansion of this species during a period of rapid warming (5-10°C) and increased humidity following the last glacial maximum (17,000-18,000 yr BP). *T. s. nigra* is not genetically distinct from *T. sulcata*, and the melanism in this population represents an adaptation to the high number of fog days present in this geographic area. Melanistic forms have been recorded from at least five localities in southern coastal Namibia, all within 60 km of the coast with 75-125 fog days per year. *T. sulcata* is excluded from Walvis Bay, a more northern area with greater than 125 fog days per year. This result is consistent with similar studies of melanistic forms of cordylid lizards also found in southern Africa.
Linkage Mapping in the Red Drum, *Sciaenops ocellatus*

In protecting biota modern conservation and management efforts should strive to preserve genetic resources and evolutionary potential within individual species. For widely distributed, exploited marine species, this means identifying geographic assemblages that possess localized adaptive variation. This poses a problem for traditional population-genetic approaches because high gene flow tends to homogenize neutral genetic variation, even in the face of localized selection. A population genomics approach that surveys large portions of the genome to distinguish between areas under selection and those that are neutral is required. Linkage mapping is a vital first step in this process. Red drum, *Sciaenops ocellatus*, are heavily exploited in recreational fisheries along both the Gulf of Mexico and southeast Atlantic coasts of the United States. The intense overfishing has precipitated stock-enhancement programs in Texas, Florida, Georgia, and South Carolina, where hatchery-raised fingerlings are released into coastal waters. The current status of the species, its wide distribution, and access to progeny from known mating pairs make this an ideal species for genomic mapping. Here we present results of sex-specific genetic linkage mapping. The present map is constructed with more than 200 microsatellite loci and will provide a new 'tool' for stock identification and more effective conservation and management of red drum resources. Implications and future directions of red drum genomics are also discussed.
HERPETOLOGISTS’ LEAGUE GRADUATE RESEARCH AWARD I,
Galleria North, Sunday 26 July 2009

Sean Powers, Roger Anderson

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How Does Spatial Variation in Climate Cause Spatiotemporal Patterns in Lizard Energetics?

A lizard’s ability to be active and to acquire food for growth, storage, and reproduction is expected to be seasonally constrained by the complex, dynamic set of phenomena that comprise climate. Hence variation in climate among locales should vary in how they constrain lizard activity and production. The western fence lizard (Sceloporus occidentalis) occupies a diversity of ecosystems from southern California to central Washington. Two locales that contrasted markedly in climate in Washington state, in the northern end of the species’ geographic range, are coastal temperate forest and the warm, dry pine-oak woodland of the state’s interior. How S. occidentalis is affected by this geographic “climate change” was examined by correlating daily and seasonal patterns of temperature, precipitation, and cloud cover with the patterns of lizard daily activity and energy expenditure, feeding rates and food availability along with related aspects of lizard population structure. Despite the greater food availability in summer for coastal lizards, the lizards in the warm, sunny woodland were larger, perhaps because of greater annual growth, associated with longer daily activity periods and longer activity seasons. Currently, the optimum climates for this species are not known, but future investigations of elevational and mesic-xeric gradients may enable predictions of population structure and population density patterns in the face of climate change.

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Improved Anesthesia Protocol Using Brevital Sodium in Snakes

Variability in the depth and duration of anesthesia in individuals within a species is frequently observed, yet few studies have investigated its causes in reptiles. To evaluate potential causes of variability in reptile anesthesia, we conducted experiments to test for effects of body temperature, body condition, gravidity and time post-feeding on the duration of brevital sodium anesthesia in Red-sided Garter Snakes (Thamnophis sirtalis parietalis). Mean times to righting ability of snakes anesthetized at 21°C were twice as long as snakes at 31°C. Lean snakes (those with lower mass/SVL ratios) regained righting ability 60% more slowly than heavy snakes. Gravid snakes anesthetized within 5 weeks of parturition had a mean time to righting ability that was twice as long as nongravid snakes of a similar mass. Time post-feeding did not have a statistically
significant effect on the time to righting ability in snakes that were anesthetized one, three and ten days after consuming 30% of their body mass in food. Recommendations for producing more predictable results when using brevital sodium in reptiles are given and an equation to predict the effective dosage based on body temperature and body condition in T. s. parietalis is proposed.

318 Live-Bearing Fish Symposium, Grand Ballroom I, Sunday 26 July 2009

Margaret Ptacek

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Using Mollies as a Model for the Evolution of Mating Signal Divergence

Sailfin mollies provide a model of how divergence in mating behaviors has led to speciation. Using a comparative approach to understand signal divergence, I quantified mating behaviors and associated morphology among the sailfin mollies, P. latipunctata, P. velifera and P. petenensis. Males of all sailfin species perform three mating behaviors: courtship displays, gonopodial thrusts and gonoporal nibbles, despite males of P. latipunctata having secondarily lost the exaggerated dorsal sailfin. The two species of sailfin mollies from the Yucatán peninsula, P. velifera and P. petenensis, differ primarily in individual variation in mating behavior profiles. Males of P. velifera show evidence of an alternative male mating strategy where small males perform few to no courtship displays, but high rates of gonopodial thrusts. Males of all size classes of P. petenensis perform courtship displays and gonopodial thrusts at similar rates. The range of variation in male size is greatest for P. velifera (22 – 89 mm SL) and this species shows the strongest allometry between male SL and dorsal fin size (slope = 4.5). Greater divergence in morphology among males of different sizes may promote the expression of the alternative male mating behaviors (courtiers versus sneakers) that appears to be lacking in other species of sailfin mollies. Sailfin molly species share characteristic courtship displays that are associated with divergence of the sailfin lineage from shortfin molly ancestors. Yet, variation within species in relative reliance on different mating strategies likely promoted the species differences observed in mating behavior profiles among sailfin species.

445 Amphibian Ecology I, Pavillion West, Saturday 25 July 2009

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Canopy Cover Impacts American Toads (Bufo americanus) in Multiple Life Stages
Individual performance and species richness of pond-breeding amphibians have been shown to transition across environmental gradients, including canopy cover. However, very few studies have followed individuals beyond metamorphosis to determine the influence of canopy cover on both aquatic and terrestrial life stages. We conducted complementary aquatic and terrestrial field experiments to evaluate the impacts of open-canopy and closed-canopy aquatic and terrestrial habitats on larval and juvenile American toads (*Bufo americanus*). Toads from closed-canopy pond mesocosms exhibited greater survival to metamorphosis and were on average larger at metamorphosis than toads from open-canopy ponds. However, although toads from open-canopy ponds were smaller at metamorphosis, they exhibited compensatory growth as terrestrial juveniles in forested habitats. Toads from both open- and closed-canopy ponds had very low survival as juveniles in unforested (i.e., open field) relative to forested terrestrial habitats. Both aquatic and terrestrial canopy cover had strong impacts on growth and survival of larval and juvenile toads; taken together, our findings suggest that the availability of suitable terrestrial habitat may ultimately determine juvenile recruitment, and thus the likelihood of population persistence, for this species.

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205  Fish Ecology I, Pavillion East, Friday 24 July 2009

Brad Pusey, Mark Kennard, Angela Arthington, Ben Stewart-Koster

*Australian Rivers Institute, Queensland, Australia*

**Sources of Variation in Trophic Structure of Fish Assemblages in Rivers with Variable Flow Regimes**

Variability is a key feature of the flow regimes of many Australian rivers. In this study we examine the trophic structure of fish assemblages in the Burdekin River, a large subtropical basin with a variable flow regime. Dietary information was collected from 12 locations throughout the river over a three year period encompassing a 1/20 year flood and entry into severe drought. When data were pooled across locations, sampling occasions and size classes, fish diets were found to be highly similar and chiefly centred on benthic micro-algae and small invertebrates such chironomid larvae and Trichopteran and Ephemeropteran nymphs. Subsequent examination of spatial, temporal and ontogenetic variation revealed that spatial and temporal variation in trophic structure were inconsequential (1.8 and 2.2% of total variation, respectively). Species identity accounted for 37.6% of the perceived variation whereas fish size and the interaction between species and size accounted for an additional 4.3% and 2.1%, respectively. Clearly, generalism in food use was widespread. We postulate that in a highly variable river such as the Burdekin River, generalism may be the most profitable trophic strategy. We use two recently developed tools, the Australian Hydrological Classification and the Northern Australian Freshwater Fish database to show that many rivers of northern Australia have a similarly variable flow regime as the Burdekin River and share a fauna similar to that studied in the Burdekin River. Consequently, we are confident that the trophic pattern observed in the Burdekin River is likely to occur across much of northern Australia.

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Comparative Home Range Sizes of a Population of the Northern Pacific Rattlesnake (*Crotalus o. oreganus*) in Central California

The Northern Pacific Rattlesnake (*Crotalus o. oreganus*) is a relatively poorly studied species of rattlesnake. Different populations and species of rattlesnakes exhibit varying behaviors, movement patterns, and spatial ecology. This study on *C. o. oreganus* allows us to compare its natural history to that of other species. Twenty snakes were tracked using radiotelemetry in the Carrizo Plain of Central California. Home range estimates of male and female snakes were constructed using a set of global positioning system (GPS) location points collected over a 3 year period. The GPS points in conjunction with geographic information system (GIS) software were used to construct minimum convex polygon and kernel density estimates to determine the approximate home range sizes of the snakes. Males have significantly larger home ranges than females using all estimates (about 8 times larger). However, males also have longer snout to vent lengths (SVL) and are higher in mass than females, meaning that larger snakes have larger home ranges. Most long movements of the snakes occurred during the spring when males are seeking mates, and females rarely made long movements. Therefore home range size and spatial ecology of *C. o. oreganus* is affected by many variables including sex, size, and season.

Detection of Stream Fish Assemblage Structure with Functional Groups and Taxonomy

The predominant approach to examining fish assemblage variation for streams is taxonomy-based. These analyses are useful in examination of spatial and temporal variation in and among watersheds. However, Hoeinghaus et al. (2006) showed that functional guilds in analyses at the scale of watersheds of Texas provided additional correspondence with local habitat or ecosystem variation. We examined two datasets of stream fish assemblages to compare the use of taxonomic and functional guilds in identification of spatial and temporal trends using multivariate analyses. Our Wabash River dataset includes 25 years of boat electrofishing collections over a 230-km river distance. The Indiana Department of Environmental Management dataset includes 1220 stream sites in the state of Indiana that were collected from 1996-2007. We compared several functional group approaches: reproductive guilds of Balon (1975), life history axes of Winemiller and Rose (1992), index of biotic integrity metrics as scored by Hitt
and Angermeier (2008), functional guilds of Poff and Allan (1995), and the ecosystem effects guilds from Matthews (1998). The taxonomic analysis of the Wabash River dataset was proficient at identification of the river distance assemblage variation. The reproductive, functional groups, and IBI functional categories provided the best explanation of temporal variation for the Wabash River data. The taxonomic analysis of the IDEM data provided reasonable explanation of geographic variation. The strongest explanation of habitat variation was using Balon’s reproductive guilds, followed by Matthews ecosystem guilds, and the other approaches.

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365 Fish Ecology II, Pavillion East, Sunday 26 July 2009

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Fish-Habitat Relationships at a Deepwater Coral Mound off North Carolina, USA

Deep-sea corals provide important habitat for many species; however, the extent of species-specific associations with corals or other physical variables is uncertain. Deep coral reefs on the southeastern U.S. slope were surveyed (2000-2007) using multibeam sonar and the Johnson-Sea-Link (JSL) submersible, allowing examination of faunal-habitat relationships. The Cape Fear mound, an isolated, topographic high off North Carolina (368-449 m depth), appears to be formed by successive growth, collapse, and sediment entrapment of Lophelia pertusa. A digital terrain model (from the multibeam data) of the Cape Fear mound allowed calculation of altitude, slope, aspect, curvature, and rugosity (Landserf, ArcGIS). Four general substrata types were classified using video from nine JSL dives: sand, sand-rubble, rubble, and hard coral. Hard coral habitat was further differentiated by vertical profile, percent bottom coverage, and percent live coral coverage. Fish abundances from video transect data were linked to habitat characteristics along each corrected, navigational dive track. Canonical correspondence analysis indicated that habitat characteristics, particularly profile, aspect, altimetry, and coral coverage, influenced observed faunal spatial patterns. Dominant fishes, Beryx decadactylus and Conger oceanicus, were most abundant on the southwest facing (upcurrent) slope near the top of the mound in high profile, high coverage, hard coral areas. Laemonema barbatulum and Helicolenus dactylopterus were most abundant in low profile habitats, while Polyprion americanus was most abundant in moderate profile, high coverage hard coral. Applying these methods to additional deep reef data collected off the southeastern U.S. coast would incorporate more diverse habitat types and elucidate regional-scale, faunal-habitat relationships.
Fin Reduction and Loss in Ostariophysan Fishes

Highly elongate body forms are found in most major groups of vertebrates. Limb reduction and loss has often been linked to body elongation in tetrapods. Fewer studies have focused on whether there is a correlation between body elongation and reduction or loss of the paired fins in fishes. In this study, we examined the relationship between body shape and fin size and morphology in ostariophysan fishes. We collected morphometrics of the body and fins from 22 species including members of Cypriniformes, Gymnotiformes, and Siluriformes. To determine whether reduction of the fins is correlated with a simplification of the musculoskeletal anatomy, we also described fin anatomy from two species: the stout-bodied Carassius auratus and the highly elongate Apteronotus albifrons. All of the species we examined had pectoral fins. Six species did not have pelvic fins and those species without pelvic fins were significantly more elongate than species with pelvic fins. In addressing the question of reduction of the paired fins, we found that body elongation was negatively correlated with length and width of the pectoral fins. Surprisingly, we found that the musculoskeletal anatomy of the pectoral fin was more complex in the elongate knifefish. It is likely that the increase in number of fin muscles is associated with fin use during locomotion. This work will provide an understanding of how fin size and anatomy differs among related species that range in body elongation. We are extending this work to include other lineages of actinopterygian fishes that have elongate members.

Assessing Risks of Amphibian Declines Using Multiple Stressors in Field Surveys and Lab Experiments

We used an integrative approach to investigate the impact of Batrachochytrium dendrobatidis infection and atrazine contamination on amphibian populations in Southeastern Ohio. We conducted a survey of amphibian communities by testing water samples from breeding pools for atrazine, and testing tissue samples from over 200 adults of 8 amphibian species for B. dendrobatidis DNA. In addition, Rana pipiens tadpoles were reared in aquaria and exposed to B. dendrobatidis or atrazine or both in a factorial design. Several breeding ponds near cultivated land in SE Ohio were contaminated with atrazine. None of our tissue samples tested positive for B. dendrobatidis. The absence of B. dendrobatidis from this area, when it has been found in many adjacent localities, raises questions about local resistance to the pathogen, as well as the transmission patterns in North America since the first known infections of five decades ago. Tadpoles in the combined atrazine and B. dendrobatidis treatment did not experience increased mortality,
but there were significant sublethal effects. These tadpoles weighed less than tadpoles of
the same developmental stage and length in other treatments. Tadpoles in poor
condition may have less energy to put toward survival, so this cross-factor effect may
have a notable impact on population recruitment. The independent effects of
chytridiomycosis and atrazine exposure are already serious threats to amphibian
populations. Both factors can influence amphibian species over broad geographic
regions. We suggest that amphibian populations in areas subject to both of these factors
should be more closely monitored for decline.

757 Herp Ecology, Galleria North, Monday 27 July 2009

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Overwintering Ecology of Gopher Tortoises in Southern Mississippi

During cool fall and winter months, Gopher Tortoises (Gopherus polyphemus) inhabiting
middle to northern regions of the species’ range may remain in their burrows for long
periods and limit surface activity to particularly warm days. However, many aspects of
this period of greatly reduced activity remain undocumented, including energetics,
thermal ecology, and emergence cues. Using video cameras, activity monitoring
systems, and temperature data loggers, we conducted a 6-month (October 2006-March
2007) study of the overwintering ecology of adult Gopher Tortoises in southern
Mississippi. From mid-November until early March, tortoises only emerged on
unseasonably warm days. However, even on days when they were not active above
ground, they occasionally made movements within their burrows, which may play some
role in their ability to detect favorable surface conditions. Potential cues for winter
emergence may include reduced burrow thermal heterogeneity and thermal inversions
near the burrow entrance. We did not observe tortoises to forage between mid-
December and late February. However, some tortoises foraged in the fall until the final
day(s) before they were no longer observed above ground for weeks or months,
suggesting that they may have continued to digest consumed vegetation from within
their warm burrows. A better understanding of the digestive physiology of Gopher
Tortoises may be necessary to fully understand their overwintering strategy and how
this species may benefit from occasional activity during the coolest months of the year.
Cypriniformes Tree of Life: Morphology of the Dorsal and Anal Fins of Cypriniforms and Their Potential Phylogenetic Importance

One of the distinctive characters of the actinopterygians, or ray-finned fishes, is the relationship between the lepidotrichia and their supports. However, fin rays, their supports and their relationships to other bony structures have received little attention in actinopterygians, especially teleosts, with a few exceptions, such as characters related to the position of the dorsal and anal fin or the presence of spiny rays. Among ostariophysans, three dorsal and anal fin characters support the monophyly of gymnotoids, one supports the siluriforms, and one supports the siluriphysans. In the past, phylogenetic analyses of Cypriniformes based on morphology have suggested numerous characters as potential synapomorphies of certain families, especially the Catostomidae and Cyprinidae. However, a comprehensive survey of patterns of variation of the cypriniform dorsal and anal fins is still needed. Our survey of many species representing all cypriniform families demonstrates that the variation is of such a magnitude that no character is synapomorphous for the order, but there are numerous characters that can be recognized for characterizing certain subfamilies (for example, several subfamilies in the Cyprinidae show distinct characteristics, as does the tribe Plagopterini), and also certain particular genera. This variation likely represents a potentially rich source of phylogenetic characters, which may contribute significantly to the understanding of cypriniform interrelationships. We will present our findings on the morphology of dorsal and anal fins and their variation in Cypriniformes.

Hyoid Anatomy and Hypobranchial Muscle Function During Feeding in White-Spotted Bamboo Sharks

White-spotted bamboo sharks exhibit many characters associated with suction feeding such as labial cartilages to occlude the lateral portions of the gape and hypertrophied hypobranchial musculature to power hyoid depression against high negative pressures generated in the buccal cavity. The hyoidomandibular ligament (LHMM) may assist in lower jaw depression by harnessing and amplifying force generated by the in-series coracoarcualis (CA) and coracoarcualis (CA) and transferring it to the lower jaw to assist the coracomandibularis (CM) in depressing the jaw. Hyoid, upper and lower jaw kinematics and fascicle shortening in the CM, CH and CA were quantified using...
sonomicrometry, while muscle activity and buccal pressure were recorded simultaneously. Active shortening of the CM occurs prior to the onset of jaw opening and buccal pressure decrease, while jaw depression to peak gape occurs during CM lengthening. The CH actively lengthens and the CA actively shortens by 13% prior to onset of jaw and hyoid depression. Peak active CM shortening, onset of active CH shortening, depression of the hyoid and buccal pressure decrease occur simultaneously. A catch mechanism involving the LHMM and CM that would allow the CH to be lengthened by the CA and released, resulting in high powered expansion during suction feeding is proposed. Consequently, the CM initiates lower jaw depression while the CH and CA drive the jaw and hyoid to peak depression. The LHMM in bamboo sharks appears to be a biomechanical link coupling lower jaw and hyoid depression that is convergent with the mandibulohyoid ligament in bony fishes.

245  ELHS/LFC General Ichthyology II, Broadway 1&2, Saturday 25 July 2009; ELHS SALLY RICHARDSON AWARD

Tauna Rankin, Su Sponaugle

RSMAS/University of Miami, Miami, FL, United States

Behavioral Basis for Selective Mortality in a Coral Reef Fish

Fast growth and large size are thought to increase survivorship during the early life stages of marine fishes (growth-mortality hypothesis, GMH). Further, growth-related early life history traits (ELHTs) can carry over to juvenile survival. Recently we analyzed the otoliths of 13 monthly cohorts of settling larvae and early juveniles of the bicolor damselfish Stegastes partitus and found that mortality was selective for several ELHTs. Controlling for temperature, comparison of overall mean traits among cohorts indicated that survivors generally grew faster during the larval period and were larger at settlement. However, in contrast to the GMH, juveniles that survived to 2-3 wks exhibited slower juvenile growth during the first week. To test the underlying behavioral mechanism, we paired behavioral observations and otolith analysis with manipulated and naturally settled juvenile S. partitus. We collected and tagged 52 settlement stage larvae and placed them on the reef in pairs with one large and one small settler. Daily 5 min observations of total sheltering time, number times shelter was sought, and maximum vertical and horizontal distances traveled were made over approximately one week and survivors were collected at the end for their otoliths. Daily observations and collections of 236 naturally settled juveniles were taken over the same interval. The survivors of the experimental manipulations did not reveal significant trends among risk-taking behaviors and juvenile growth, however, larger settlers spent less time sheltered and traveled higher in the water column.
Body Shape Variation of a Neotropical Liverbearer in Relation to Predation Environment and Selected Intrinsic Factors

Morphological shape is an important phenotypic trait that may be correlated with ecological or evolutionary factors. Variation within this trait potentially reflects differences in selective pressures or patterns and therefore can provide information on such processes. We examined the morphological shape variation of a species of Neotropical livebearer (*Brachyrhaphis rhabdophora*: Poeciliidae) in relation to predator environment and selected intrinsic factors (i.e. sex, size, and behavioral movement phenotype) using morphometric techniques and multivariate linear mixed model analysis for each sex separately. Predator environment and size are significantly (p < 0.05) related to shape variation for both males and females. Behavioral movement phenotype, as assessed using a portable swim chamber, is significantly related to shape variation in females, but not in males; however, the factor was retained as it significantly interacts with size in males. This interaction is due to a difference in the direction of shape change. In males, predator environment and size also significantly interact due to a difference in the magnitude of shape change. Our results indicate that shape is indeed correlated with several factors, including intrinsic behavioral traits (e.g. movement behavior), which have important implications in further understanding the complex dynamics of livebearers.

Habitat Selection by Spotted Turtles (*Clemmys guttata*): Effects of Season and Scale of Analysis

Determining which habitats are important for life processes is a crucial step in the conservation of species. Selection of these habitats occurs when they are used disproportionately to their availability; however, the determination of ‘available’ habitat depends on the biology of the species under investigation. The habitat selection of a population of Spotted Turtles (*Clemmys guttata*) in Ontario, Canada, was studied over two consecutive years using radiotelemetry. Selection was assessed at two scales using compositional analysis. Spotted turtles are documented to have different habitat use and behaviours throughout the annual cycle, thus seasonal habitat selection was also analyzed. Selection occurred at both scales tested (2nd order, home range from population range and 3rd order, locations from home range), and the ranking of preferred habitats differed based on the scale of analysis. Meadow marshes were most preferred when considering the selection of home range from population range, whereas open wetlands were most preferred within home ranges. The largest discrepancy was in
the ranking of open uplands which were preferred at the 2nd order, but were ranked lowest at the 3rd order. Males and females selected similar habitats, but selection differed for both sexes based on the season. The variability in habitat selection based on seasons supports the need for surveys at multiple points within the year to fully understand the critical habitat requirements of this species.

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465 Turtle & Tortoise Symposium, Grand Ballroom II, Sunday 26 July 2009

Megan Rasmussen, Jacqueline Litzgus

Laurentian University, Sudbury, Ontario, Canada

Patterns of Maternal Investment in Spotted Turtles (Clemmys guttata): Implications of Trade-offs, Scale of Analyses, and Incubation Substrates

To maximize potential fitness, reproductive females should invest excess resources into either larger propagules (increase hatchling size), or more propagules (increase clutch size). Nest site selection can also affect hatchling phenotypes, such that females should choose areas that create ideal thermal and hydric conditions for developing eggs. This study examined maternal investment in a population of Spotted Turtles (Clemmys guttata) in Ontario, Canada over two years using radio telemetry, x-ray photography, and indirect assessments of hatchling fitness. Analyses were conducted at two scales (clutch and female), utilizing two measures of excess resources (body size and body condition). Larger females produced wider eggs, and similarity in the slopes of egg width and maternal pelvic aperture on body size may reflect a physical constraint on egg size. However, body size did not explain variation in egg morphometrics when considering the reproductive output of each female for the entire study. Instead, females in better body condition produced more eggs. With respect to nest site selection, no selection for thermal properties was observed; however, females exhibited fidelity to nest substrates but not locations. Hatchling locomotor performance was not related to hatchling body size or condition, but was related to incubation substrate. Thus, females in good condition maximize clutch size at coarse temporal scales, and incubation conditions may be more important in determining hatchling success than hatchling morphometrics.

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Genetic Variation of the Eastern Massasauga Rattlesnake: Implications for Conservation and Captive Breeding

The eastern Massasauga rattlesnake (Sistrurus catenatus catenatus) is declining throughout its range and is a candidate for federal listing under the Endangered Species Act. In addition, it is a species for which the Association of Zoos and Aquariums has initiated a Species Survival Plan which will include a captive breeding program. To aid in the conservation of wild populations and help structure a captive breeding program, mitochondrial DNA sequences from the NADH dehydrogenase subunit-II (ND2) gene were generated for 126 eastern Massasages. These sequences represent 33 different wild populations and 26 captive animals in AZA institutions. From these sequences, 16 different ND2 haplotypes were identified, representing three reciprocally monophyletic geographic subunits. The western subunit consists of the populations in Iowa, Illinois, and Wisconsin; the central subunit consists of populations in Indiana, Ohio, southern and central Michigan, and southwestern Ontario; and the eastern subunit consists of populations from northern Michigan, Pennsylvania, New York, and other parts of Ontario. Based on this information, the AZA has proposed a breeding plan that seeks to maintain these subunits as distinct and hopes to augment the captive population with wild-caught animals belonging to underrepresented subunits. These subunits appear to represent distinct geographic and genetic entities and wild populations should be managed to maintain existing genetic variation and ongoing evolutionary processes.

Panmixia across the Indo-Pacific in Two Species of Moray Eels

Phylogeographic studies of coral reef fishes have revealed patterns ranging from ocean-wide gene flow among populations to oceanic-island endemism. Coral reef fishes typically disperse only as larvae in pelagic currents, and their dispersal capability is limited by their larval duration. Moray eels maintain the longest larval durations among all coral reef fishes, and are thus likely to disperse further and maintain population genetic connectivity over greater distances than other species of coral reef fish. We tested this prediction by surveying two species of moray eels (Gymnothorax undulatus and Gymnothorax flavimarginatus) for phylogeographic structure in two mitochondrial (COI,
Cytb) and two nuclear genes (RAG1, RAG2). Tests for geographic genetic structuring among populations (Mantel tests, AMOVA, permutation tests on haplotype networks) reveal that both species are panmictic across the Indo-Pacific, a distance of approximately 22,000 kilometers. The distribution of pairwise distances among mitochondrial haplotypes indicates that genetic variation in G. undulatus and G. flavimarginatus coalesces to 2.3 and 5.7mya, respectively, more recent than comparable estimates for reef fish of the genus Naso. These results are consistent with predictions from their extended larval durations and identify G. undulatus and G. flavimarginatus as the most broadly-distributed panmictic species of coral reef fishes in the Indo-Pacific.

802 Snake Conservation, Pavilion West, Monday 27 July 2009

Robert N Reed¹, Julie A Savidge², James W Stanford¹, Ginger Haddock¹, Amy A Yackel Adams¹

¹USGS Brown Treesnake Project, Ft. Collins, CO, United States, ²Colorado State University, Ft. Collins, CO, United States

Canine Detection of Free-Ranging Brown Treesnakes on Guam: Field Validation and Lessons Learned

Detector dogs are used in various contexts to locate substances ranging from explosives to mold, and are increasingly used to detect animals for conservation purposes (whether to control unwanted species or to find threatened species). Dogs have been infrequently used to detect herpetofauna, and validation of detection ability often stops once dogs can successfully discriminate between target and non-target scent cues under artificial conditions. However, such tests offer little information on the actual efficacy (rate of finding the target organism) under realistic field condition. We trained dogs to detect, locate, and alert their handlers to the presence of the Brown Treesnake (Boiga irregularis), an invasive predator responsible for the loss of many of Guam's birds. Dogs were selected after preliminary screening of hundreds of candidates, and received initial training with professionals before arriving on Guam. After extensive validation in both controlled conditions and in the field, we conducted field trials to determine the rate at which canine teams could locate free-ranging radiotelemetered Brown Treesnakes in pre-defined search blocks. Dog handlers were blind to the location of the snake, and dogs were successful in >35% of 85 trials. Such intensive validation is necessary to examine the relative efficacy (in cost and/or capture rate) of canine teams as compared to other available tools (visual searching by humans, traps, etc.). For many herpetofaunal species and for most research programs, there are significant challenges to successful implementation of a detector dog program, and we discuss how such challenges have affected our program.
Tadpole Growth and Development in Invaded Pools

Invasive species are second only to habitat loss in the list of threats posed to native flora and fauna, and the ways in which invasive species can affect native species are numerous. At the same time, amphibians are facing declines across the globe. Understanding the mechanisms by which invasive species may affect native amphibians is critical to the work of conserving amphibian biodiversity. This study followed enclosed *Rana clamitans* and *Rana catesbeiana* tadpoles in non-invaded wetlands, and wetlands invaded by either *Typha angustifolia* or *Phragmites australis* over the course of the summer of 2008. The tadpoles consisted of three clutches each of early-lain green frogs, late-laid green frogs and bull frogs. All individuals came from a non-invaded pond that was not one of the study sites. Tadpoles were monitored weekly, and measurements of abiotic factors in the ponds were also taken each week. Abiotic measures included nitrate, ammonium, dissolved oxygen, pH, and temperature, and biotic measures included survival and total length. Wetlands varied in dissolved oxygen, nitrate, and ammonium based on wetland type, and temperature and pH varied both among wetland types and within wetland types. Temperature, wetland type, and frog group all influenced growth and survival, but in different ways. There were also numerous interaction effects across the study. The host of interactions and confounding variables makes interpretation difficult, but affects are there, even if the mechanisms are not clear at this point. This work is part of an ongoing dissertation research project.
Conservation Assessment and Prioritization of the Tropical Forest Habitats of Bangladesh: A Look on Amphibians and Reptiles

Between 1990 and 2005, Bangladesh lost more than 1.3% of its forest cover which sums up to 11,000 hectares of tropical forests. On the other hand, roughly 85% of the amphibians and reptiles of the country are facing conservation threats of various kinds which includes the 46 data deficient species. Majority of this herpetofaunal diversity is restricted to the already identified 19 protected areas of the country. But however, many of these forested areas are losing cover at a rate that we might have to sacrifice some of these protected habitats in the next few decades, mostly to respond the ever increasing human demands. My research aims to study the geographical distribution patterns of amphibians and reptiles in different forest types of the protected area system and to prioritize the habitats for immediate conservation measures. Using ArcGIS and ecological niche modeling, I am working to produce species distribution and habitat prioritization maps for Bangladesh which would ultimately help to re-assess the protected area network system of the country. Result, to date indentified an evergreen forest in the northeast part of the country, Lawachara National Park as the most diverse habitat in terms of herpetofaunal diversity, whereas a deciduous forest in central Bangladesh, Madhupur National Park supports the highest number of critically important species. Once done, the study results will be shared with the management authority of the country to produce a national conservation management plan for the amphibians and reptiles of Bangladesh.

Diversity and Biogeography of the Herpetofauna in Bangladesh

Roughly 85% of the amphibians and reptiles of Bangladesh are facing conservation threats of various kinds. This is obviously an under-estimate since it includes 46 ‘data deficient’ species and is based on survey efforts that have mostly been conducted over a century ago. Our study aims to prepare an updated species list with their geographical distribution patterns in different habitat types to prioritize the habitats in Bangladesh for immediate conservation measures. We have selected eleven sampling sites covering all major habitat types of the country. Visual encounter surveys (VES) were used for studying the herpetofauna of all these habitats. We also collected tissue samples of selected species for studying DNA sequence, mostly using cytochrome b gene (cyt b)
with known primers. Using ArcGIS and Maxent niche modeling, we are working to produce a species distribution and habitat prioritization map for Bangladesh. Result, to date includes 15 additional species for the country and one undescribed species of microhylid frog. At least 15 more specimens are being examined for their proper taxonomic identity. An evergreen forest in the northeast part of the country, Lawachara National Park, has been initially identified as the most diverse habitat, whereas a deciduous forest in central Bangladesh, Madhupur National Park supports the highest number of critically important herpetofaunal species. Conservation activities have been initiated by training local students, forming conservation groups in and around the forested areas and providing local media coverage for conservation.

443 Poster Session III, Exhibitor’s Hall, Sunday 26 July 2009

Justin Rheubert

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Preliminary Report of Reproductive Morphology of Iguanian Lizards as Displayed by Phrynosomatidae and Polychrotidae

Tissues from Sceloporus undulatus and Anolis carolinensis are continuously being examined histologically to determine the reproductive morphology of iguanian lizards in comparison with other squamates. Sceloporus undulatus and Anolis carolinensis have been collected in southern Louisiana from September 2008-current dates, the reproductive tracts were removed, fixed in formaldehyde, and processed histologically. Gross and cellular morphologies appear similar in both species. Grossly the testes lie anterior to the kidneys and the efferent ducts run laterally off the testes and ventrally over the kidneys. The kidneys appear to have a junction posteriorly beneath the pubic symphysis; however, histological analysis has not been performed on this junction. Both species display inactive testes during the month of September with residual amounts of sperm located in the efferent ducts. Recrudescence begins in October with mitotic activity increasing in germ cells and the efferent ducts become devoid of sperm. During these months the renal sexual segment of the kidney appears to be inactive although minor secretory activity is occurring. A single ductus efferentes leads from the testis and divides posteriorly into 3-4 ductuli epididymides. Sperm pass sequentially from the ductuli epididymides through the ductus epididymis, ductus deferens, and ampulla ductus deferens. The data collected thus far are consistent with some previous descriptions of squamate reproductive morphology. We have found no evidence, however, of an extratesticular rete testis or regionalization of the ductus epididymis, as reported for the Agamidae and Lacertidae.
Illustrating Ontologies with Morphbank and Phenoscape

This talk will discuss some ways that image management and annotation, ontology development, and studies of physical features of organisms are integrated to facilitate research in evolution and development. The management of metadata and annotations of images is a primary capability of the Morphbank system, an online image repository system that has over 250,000 images of a variety of organisms. The metadata in Morphbank for an image includes information about the content of the image—that is, characteristics of the objects shown in the image. This includes information about the specimen with Darwin Core fields and information about the anatomy and views that are presented. Morphbank and Phenoscape have combined to integrate anatomical and phenotype annotations on images. An image of a portion of a fish skeleton in Morphbank includes references to the Teleost ontology terms that describe that bone (c.f., http://www.morphbank.net?id=459110). 1500 skeletal images from CToL are currently in Morphbank. A search of Morphbank for the term will produce a collection of relevant images. An annotations of an image in Morphbank attaches one or more ontology terms to a specific part of the image. The integration of Morphbank with the Morphster ontology browser [ref] provides an illustration of ontology terms. A user may select a term in Morphster and see annotated Morphbank images that are relevant to that term. The inference capabilities of Morphster allow a user to find all images of "bone" or just those of "ceratobranchial" or those that exhibit a specific phenotype.

Does Haddock Egg Predation Decouple the Abundance of Atlantic Herring Larvae from Spawning Stock Biomass on Georges Bank?

We sought to explore the hypothesis that the mortality rate of benthic Atlantic herring (Clupea harengus) eggs on Georges Bank from 1971-2005 was a function of the intensity of haddock (Melanogrammus aeglefinus) predation. An index of Georges Bank haddock predation intensity was developed using stock assessment abundance-at-age data, adult trawl survey length-at-age and length-weight data, and a function describing daily ration versus weight. The equation linking predation intensity to egg mortality assumed a Type III functional response: at low egg densities, haddock switch to other prey and at high egg densities haddock were satiated. The parameters of the model were determined by fitting the predicted abundance of newly hatched Atlantic herring larvae (a function of spawning stock biomass and egg survival) to an Atlantic herring larval abundance index for Georges Bank. Estimated herring egg mortality from haddock
predation ranged from a low of 30% in the early 1990's to a high of 99% in recent years. Both the observed and predicted larval index had two instances (1975-1976 and 2003-2004) of large declines (over an order of magnitude), which followed the two strongest year classes of George Bank haddock in the time series. Overall this retrospective analysis provides a conceptual basis for how egg predation can drive the alternation between extended periods of high and low abundance in a population of Atlantic herring. Further support for this hypothesis will require field work focused directly on Atlantic herring eggs, a life stage that has received relatively little attention in the northwest Atlantic.

61 General Herpetology, Galleria South, Sunday 26 July 2009

Corinne Richards-Zawacki¹, Ian Wang², Molly Cummings³, Kyle Summers⁴

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Coloration as a Pre-mating Barrier to Reproduction in the Strawberry Poison Dart Frog (Oophaga pumilio): Have Differences in Female Preference Lead to Assortative Mating?

Strawberry poison-dart frogs (Oophaga pumilio) exhibit an amazing array of color and pattern variation on and around the islands of the Bocas del Toro Archipelago of Panama. This variation has apparently arisen rapidly since the Archipelago took on its present form about 6,000 to 9,000 years ago. Due to their recent divergence, geographic proximity, and unusual mating and parental care behaviors, O. pumilio populations provide a unique opportunity to study the process of speciation in action and elucidate the relative roles of various selective agents in that process. These frogs’ bright colors are thought to be aposematic, suggesting that natural selection may have shaped the pattern of variation across the archipelago. However, sexual selection could also have played a role in the diversification process as well, as color appears to also be important in mate choice. Using a combination of mate choice experiments and molecular techniques, we investigated the extent to which differences in coloration act as a pre-mating barrier to reproduction among individuals from a polymorphic population. Our results provide important insight into the mechanisms driving the rapid evolution of morphological diversity among O. pumilio populations.
Patterns of Evolutionary Diversification in South Pacific Scincid Lizards of the Genus *Emoia* based on Multilocus DNA Sequence Data

Skinks of genus *Emoia* are a major component of the diurnal lizard community on many South Pacific islands, ranging from Southeast Asia to Hawaii and Clipperton Island. Previous studies suggest that the 75 species of *Emoia* form a natural group within the Lygosominae, the largest subfamily within the Scincidae. Most species have restricted ranges and occur within isolated archipelagos, while a few are apparently wide ranging. The center of origin for *Emoia* is presumed to be in New Guinea; however, strict tests of this hypothesis have not been performed, nor has the monophyly of the group or its evolutionary affinities with other Lygosomine skinks been validated. It is also unknown whether *Emoia* species assemblages occurring on different archipelagos evolved in situ, or if speciation preceded major oceanic dispersal events. We used DNA sequences from one mitochondrial and three nuclear genes to build gene genealogies for reconstructing the historical biogeography and evolutionary history of the major lineages within *Emoia*, and to reconstruct their ancestral morphology and ecology. We also estimate a joint posterior distribution for the species tree using a method that accounts for differences in the coalescence times among individual genes. Phylogenetic results across all genetic markers indicate *Emoia* as a whole are not monophyletic, yet clusters of lineages within the genus form well-supported clades that are largely consistent with taxonomic groupings based on osteology and scutellation. Our findings also provide critical data for developing conservation priorities for several insular and cryptic *Emoia* species on the verge of extinction.

Conservation Genetics of the Critically Endangered Dusky Gopher Frog, *Rana sevosa*

Habitat loss, alteration, and fragmentation are major causes of population declines and extinction. Dusky gopher frogs, *Rana sevosa*, represent an extreme case in which the geographic distribution has been reduced to two geographically isolated populations. As a result, the species is listed as critically endangered by the IUCN and federally endangered by the USFWS. Isolated populations tend to become inbred and genetically differentiated from each other, and if local extinction occurs, recolonization is impossible. Therefore the probability of persistence for *R. sevosa* is low without human intervention. Along with other conservation efforts, captive populations have been
established in zoos to allow the possibility of future reintroductions. Our research objectives were to compare contemporary genetic variation and affinities between the two natural populations and to assess to what degree natural variation has been captured in captive populations. Genetic analyses were performed using genotypic data of seven nuclear microsatellite DNA loci and sequence data of the mtDNA control region. Analyses revealed that natural populations have severely reduced genetic variation due to consequences of population bottleneck events, geographic isolation, enhanced effects of genetic drift, and inbreeding. Additionally, we found differentiation of populations due to small population sizes and lack of gene flow between them. As landscape alterations continue, our ability to rescue imperiled taxa is dependent on an understanding of historical, demographic, and genetic parameters of diminishing populations. Results of this research will be discussed in the context of known demography, management, and long-term viability of this federally endangered species.

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313 Poster Session I, Exhibitor’s Hall, Friday 24 July 2009; AES CARRIER AWARD

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Biodôme de Montréal: Captive Breeding of the Barndoor Skate (Dipturus laevis) and Work on Early-Life Stages

The Biodôme de Montréal (Quebec, Canada) is an institution with conservation, educational and research purposes. Five different American ecosystems are represented as large open exhibits; one of these is the aquatic representation of the Gulf of the St-Lawrence, housing species found within its boundaries. In 1997, the Biodôme obtained five barndoor skates (Dipturus laevis; IUCN status: endangered) from the Massachusetts coast. The barndoor skates started reproducing six years later, with the first eggcases collected in 2003. Production of eggcases was observed throughout the year and annual fecundity was calculated for the first time for one female in 2006 (85 eggcases), and then in 2007 (115 eggcases). The incubation period ranged from 342 to 494 days, and the average size of juveniles at birth was 193mm in total length for a disk width of 128mm. An eggcase identification system was developed, along with a photo identification system to keep track of the growing juveniles. Microchips were inserted into one year old individuals. Morphological measurements taken at birth and at 2 years of age indicate similar growth trajectories for the captive-bred specimens in comparison to their wild conspecifics. Breeding in captivity of the winter skate (Leucoraja ocellata) has also been achieved. Current and future work on skate propagation efforts and research on early life stages at the Biodôme de Montréal are outlined and discussed.

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Two-Year Population Survey and Microhabitat Ecology of the Georgetown Salamander *Eurycea naufragia*

The Georgetown salamander, *Eurycea naufragia*, is a paedomorphic spring and cave-dwelling salamander known from only 13 sites in the San Gabriel River drainage of central Texas. Rapid urbanization places all known populations at risk and conservation strategies are hindered by a lack of information on the ecology of the species. We conducted salamander surface counts at one site over a two-year period and examined microhabitat preferences of salamanders at two sites. Numbers of salamanders and percent of cover objects occupied by salamanders varied from month to month, with a general trend of higher abundance in spring and summer. Within the spring flow, salamander abundance decreased with distance from the spring origin. Salamanders were more likely to be found under rocks than other types of cover objects and preferred larger rocks. Larger salamanders occupied larger cover objects; rocks covering multiple salamanders were larger than those covering single salamanders. Analysis of research literature suggests that salamander abundance will be negatively impacted by increasing urbanization, small substrate particles, water velocity, and variation in water temperature; salamander abundance will positively affected by increases in cover objects, factors that maintain substrate interstitial spaces, and by increasing aquatic invertebrates.

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Species Composition and Diel Vertical Distribution of *Cyclothone*, Bristlemouths, (Stomiiformes: Gonostomatidae) in the North-central Gulf of Mexico

We document depth patterns of size, abundance, and time of capture for six species of the genus *Cyclothone* (*Cyclothone acclinidens*, *C. alba*, *C. braueri*, *C. obscura*, *C. pallida*, and *C. pseudopallida*) collected in the Gulf of Mexico. As part of a larger study on the mesopelagic fauna, discrete depth Tucker trawling was conducted during the day and night (9–29 Aug 2007) over three cold seep sites (AC601, GC852, AT340) and one deep-coral site (VK826) in the north-central Gulf of Mexico (surface to 1377 m). *Cyclothone* was the dominant fish genus (5,353 total specimens), and 3,366 individuals were resolved to six species. Two different morphotypes did not match described species and may represent new taxa. Diel vertical migration (DVM) was analyzed for the most abundant species (*C. alba*, *C. braueri*, *C. pallida*, and *C. pseudopallida*) at GC852, AT340, and VK826. *Cyclothone* spp. generally did not undertake DVM, being concentrated between 400 and
700 m with peak abundance at about 400-550 m both day and night. Although, these species did not exhibit a DVM, some fishes were captured at night as shallow as 150 m and there was a general tendency to expand the range upward at night. They occurred in overlapping depth ranges in the water column with the exception of C. obscura which was only collected at night at 1149 m. In general, species captured at night in the mesopelagic were nearly identical in size to those captured in the epipelagic.

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598 ELHS/LFC General Ichthyology II, Broadway 1&2, Saturday 25 July 2009

Dominique Robert¹, Stéphane Plourde², Martin Castonguay², Jeffrey A. Runge³

¹Kyoto University, Fisheries Research Station, Maizuru, Kyoto-fu, Japan, ²Institut Maurice-Lamontagne, Department of Fisheries and Oceans, Mont-Joli, Québec, Canada, ³School of Marine Sciences, University of Maine, Portland, Maine, United States

**Importance of Prey Field Definition for the Assessment of the Relationship Linking Year-Class Strength to Prey Availability During the Early Larval Stage of Marine Fish**

Since Johan Hjort proposed the “Critical Period” hypothesis nearly 100 ago, the availability of adequate prey during early larval life has generally been considered the main factor accounting for year-class fluctuations in marine fish populations. This idea still remains the central tenet of most contemporary marine fish recruitment hypotheses. Despite the importance of this assumption, reports of a link between recruitment strength and prey production remain few. In a previous study, we showed a strong positive relationship between Atlantic mackerel year-class strength and the production of preferred prey during the first-feeding stage (nauplii stages of the calanoid copepods *Pseudocalanus* spp., *Calanus finmarchicus* and *Temora longicornis*). In this study, we explore the effects of modifying prey field definition on the strength of our recruitment-prey availability relationship. The proportion of variance explained by the relationship largely decreased when prey field definition was based on species selection only (i.e. all developmental stages considered) or on total zooplankton density. In the latter case, the relationship was mainly obscured by the abundant small cyclopoid *Oithona similis* and large calanoid *Calanus hyperboreus* when density was defined in number or organisms per litre and in µgC per litre, respectively. These results point to the importance of relying on prey selectivity data when linking prey abundance to recruitment. We argue that the absence of a positive link between these two parameters reported in several studies is principally attributable to imprecise prey field definition.

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Molecular Phylogenetics of the Reef Fish Genus Stegastes (Teleostei: Pomacentridae)

*S*tegastes* is a diverse genus of damselfishes associated to coral and rocky reefs in tropical oceans. Most species are solitary territorial herbivores that aggressively defend their feeding grounds, but a few are gregarious and feed on plankton. Juveniles are usually brightly colored and common in the aquarium trade. We sampled all 38 nominal species while scuba diving or snorkelling and preserved tissue samples in ethanol. Standard laboratory procedures were used to obtain sequences of one ribosomal RNA gene (16s) and one mitochondrial DNA gene (ATPase). As part of the phylogenetic analysis, we performed maximum parsimony, maximum likelihood and Bayesian analyses. The monophyly of the genus was rejected in all analyses. The genus appears to be split into two main groups, one clade (clade I) containing all Atlantic and eastern Pacific (indicating that this radiation originated from a single invasion of the Atlantic before the closure of the Isthmus of Panama) as well as some Indo-Pacific species, and a second clade (clade II) containing only Indo-Pacific species. Species of the genus *Microspathodon* form the base of clade II, whereas species of *Plectroglyphidodon* are present in both clade I and II. Additional taxon sampling is necessary to revise the current nomenclature. Cryptic speciation was also detected within many widely distributed species, the most notable case being *Stegastes fasciolatus*, which seems to be comprised of four different species.

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Two Putative New Syntopic Species of *Phreatobius* Goeldi (1905) From Aripuanã Basin, Amazonas, Brazil (Siluriformes: Heptapteridae)

The Neotropical catfish genus *Phreatobius* is one of the most peculiar Siluriformes in South America. This small catfish is known to occur in subterranean waters accessed by artificial wells. Few specimens, however, have been recently sampled in pools and marginal habitats of forests streams in the Amazon basin. The genus has three valid species, its type *P. cisternarum* and two additional species recently described, *Phreatobius dracunculus* from rio Madeira basin in Brazil, and *Phreatobius sanguijuela* from Iténêz Basin, in Bolivia. Despite the inclusion of *Phreatobius* in Heptapteridae, the position of the genus within Siluriformes has been reported as uncertain. Recently an expedition to rio Aripuanã basin, supported by the “All Catfish Species Inventory”, produced two new species inhabiting roots of riparian vegetation in a bank of a small stream. These
two putative new species can be distinguished from their congeners by the position of dorsal fin located well anterior to the pelvic-fin base, morphometric characteristics and number of dorsal-fin rays. These new species herein were found together in the rio Aripuanã basin, Central Brazilian Amazon, and are located approximately in the middle of the large geographic range area comprising the current localities of *Phreatobius*, suggesting that there might be more species still to be discovered.

268  Live-Bearing Fish Symposium, Grand Ballroom I, Sunday 26 July 2009

Helen Rodd¹, Anna Price¹, James Burns², Rosemary Gibson¹

¹University of Toronto, Toronto, ON, Canada, ²Centre Nationale de la Reserche ScientifiqueG, Gif sur Yvette, France

Various Roles of Pigment-based Coloration in Guppies

The role of carotenoid-based coloration in mate choice in guppies is well established. There is also evidence that females from some populations base their mate choice decisions on males’ melanin-based, black spots, with some females showing a preference for black spots and others showing distaste for them. I will discuss evidence from my lab that suggests that the black coloration of male guppies is also involved in signalling to rivals in male-male competition and to conspecifics of both sexes in stressful situations (e.g. simulated predator attacks). In addition, we have found that the coloration of the brain covering (meninx) can change rapidly from being nearly translucent to black and may be a useful indicator of stress in this species.

21  General Ichthyology, Parlor ABC, Sunday 26 July 2009

Cara Rodgveller, Chris Lunsford, Jeffrey Fujioka

NOAA, Juneau, AK, United States

Effects of Maternal Age on Larval Viability of Quillback Rockfish in Alaska

Studies have shown that older females may produce more fit larvae which can survive in environments that progeny from younger fish can not. Most fisheries select for larger and older fish, which can reduce the larval quality of the population and therefore the population recruitment. Rockfishes’ (*Sebastes*) slow growth and longevity are thought to be adaptations for successful reproduction, even when optimal environmental conditions are periodic. Studies of west coast rockfish show that larvae of older females have larger oil globules at parturition than larvae from younger mothers, and higher rates of survival in the laboratory; however, little work has been done in Alaska. The environment in Alaska differs from the west coast, and the age structures of many rockfish populations in Alaska still contain older fish. Additionally, the rockfish studied so far have been relatively shallow-water species with different life histories than many
of the deep-water species in Alaska. Our objectives were to collect pregnant quillback rockfish (*S. maliger*) in southeast Alaska and measure the oil globules of their developing embryos. From 2006-2008 we collected 90 pregnant quillback rockfish. Some samples were analyzed for protein, lipid, and fatty acid concentrations to examine body composition during embryogenesis. Measurements of oil globules from photographs of developing embryos will be analyzed to determine the relationship between maternal age and larval quality. From samples already analyzed for composition, it appears that oil globule size is highly related to total body lipid and protein content and is a good indicator of energetic status.

536 Herp Conservation II, Grand Ballroom II, Monday 27 July 2009

Carlos A. Rodríguez¹, Alberto L. López², Héctor J. Claudio¹, Rafael L. Joglar¹

¹University of Puerto Rico, Río Piedras Campus, San Juan, Puerto Rico, ²Puerto Rico Conservation Trust, San Juan, Puerto Rico

**Iguana iguana** in Puerto Rico: Is It Time for Management?

*Iguana iguana* is native to Central and South America, and was introduced in Puerto Rico in the 70’s. Since 1985, the species has been established and appears to be abundant. Because its ecology and natural history has not been studied, its effects on local biodiversity are still unknown. Our objectives were to: (1) estimate population densities; and (2) study its reproductive biology. Population surveys were performed on 1 ha quadrants at Canal Blasina (CB) in Carolina and Parque Lineal (PL) in San Juan. Reproductive biology was studied at Las Cabezas de San Juan (CSJ), in Fajardo. Population survey results revealed that iguanas at CB are three times more abundant than those at PL (223/ha and 85/ha, respectively). Population densities increased during the colder and dryer months of the year. Analyses testing for relationships between population densities, mean daily temperature, and mean daily precipitation, revealed that temperature was the only variable that significantly explained changes in population densities at CB and PL (*P* = 0.0210 and *P* = 0.004, respectively). Iguana densities in Puerto Rico are four times higher than in some localities of Central America where they encounter native predators. Our study of iguana reproductive biology revealed that it is similar to that reported for its native range. Average egg clutch size was 23.136 ± 11.613 eggs (*n* = 44), with a clutch success rate of 88% (*n* = 19). Given their high population densities and successful reproductive biology a management plan to control the species should be considered.
Serena Rogers

University of Nevada Reno, Reno, NV, United States

Genetic Variation in Three Remnant Populations of Northern Leopard Frog in Western Nevada

The Northern Leopard frog (*Rana pipiens*) was once the most widely distributed and commonly encountered amphibian in Nevada. In a recent resurvey of 97 historical sampling locations this frog was relocated in only eight sites. In the watersheds of the Truckee and Carson rivers of western Nevada extant leopard frog populations are only known from three locations. The statewide decline has been attributed to loss of habitat, nonnative amphibians and disease. Here we report on preliminary genetic analyses for the three wild and one captive population(s) of leopard frogs from these drainages. Tissue samples were collected from 121 adult and subadult individuals. We used five polymorphic nuclear microsatellite loci developed for *R. pipiens* and *R. sevosa* to explore within and among populations levels of genetic diversity and population differentiation. Levels of observed and expected heterozygosities per locus per population ranged from 0.03-0.80 and 0.1-0.66 respectively. The number of alleles across populations ranged from four to nine per locus which is similar to that reported for other *R. pipiens* populations while levels of heterozygosity tended to be lower. The two wild populations for which we had a sufficient sample size show evidence of genetic bottlenecks under both the IAM and TPM mutation models. The wild Truckee populations are highly differentiated from the Carson River populations (pairwise $F_{ST} = 0.3588, 0.3969$). Bayesian genotype clustering analysis revealed two distinct genotype clusters with little overlap in membership between river drainages.

Dawn Roje

University of Washington, Seattle, WA, United States

Mitigating the Effects of Substitution Saturation on Phylogeny Estimation: A Case Study from the Molecular Phylogenetics of the Flatfish Family Pleuronectidae

Substitution saturation occurs when enough mutation has taken place between DNA sequences such that the phylogenetic signal is overwritten by multiple changes at the same sites. This problem is usually dealt with in two ways: it's either ignored or the data are excluded from phylogenetic analysis. To evaluate the effect of the saturated data on tree topologies and clade support, two data sets (one with the saturated data and one without) were analyzed for the flatfish family Pleuronectidae. Of 2391 sites, 780 were variable, with the saturated sites providing an enormous 40.8% of the variability.
The exclusion of these data from further phylogenetic analysis would almost certainly result in poor phylogeny estimation, but their inclusion could do the same. To address this, it’s necessary to implement some criterion to evaluate the effect of the saturated data. By determining the point where the saturation curve plateaus, a threshold pairwise genetic distance that corresponds to unsaturated substitutions was determined. Topology of and statistical support for clades in which all members had pairwise distances less than this value can be thought of as inferred from unsaturated data. Surprisingly, the effect of saturation on clades corresponding to the deeper nodes was minimal. It follows that the phylogeny inferred from the entire data set can be considered the best possible, regardless of the inclusion of saturated substitutions. This implies that saturated data can and probably should be used, given a threshold pairwise distance can be implemented to evaluate the effects on topology and clade support.

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450 Poster Session I, Exhibitor’s Hall, Friday 24 July 2009

Jorge A. Rojo-Vázquez, Carmen Franco-Gordo, Enrique Godínez-Domínguez, Gabriela Lucano-Ramírez, Salvador Ruiz-ramírez, Víctor H. Galván-Piña, Salvador Hernández-Vázquez

Universidad de Guadalajara, San Patricio-Melaque, Jalisco, Mexico

Influence of the El Niño Southern Oscillation on the Recruitment of Lutjanidae Species from the Central Mexican Pacific

In order to explain the interannual variability of the abundance of fish larvae of the family Lutjanidae there was analyzed the abundance of breeding, the reproductive seasonality and environmental variability from December, 1995 to December, 1998. The fish larvae come from 316 samples collected during 27 months in the central Mexican Pacific. The variation of the reproductive season considered for the group is based on the reproductive pattern of Lutjanus guttatus. For the adults’ abundances were considered a series of catches from the artisanal fishery. The environmental variables that better define the variability are the sea surface temperature, the index of El Niño and the rate of upwelling. There was a coincidence in the seasonal variation of the abundance of the Lutjanidae fish larvae with the reproductive seasonality, with a lack of peak of one month. According with the abundances of both fish larvae and adults and hydrological conditions of the study area, two periods were identified: the first defined as Pre-ENSO (December, 1995 to March, 1997), characterized by lower abundances of fish larvae, and the second named ENSO (July, 1997 to September, 1998), characterized by the increase in the abundances of fish larvae. The abundance of adults presents an opposite trend that might be an effect to the fishing pressure. The high abundances of the Lutjanidae fish larvae during El Niño event might be due to the ability to perform in impoverished conditions, as during El Niño, more than to the size of the population of parents.
Growth of Juvenile Blacknose Dace (Rhinichthys atratulus) Along an Urban to Rural Gradient

Blacknose dace (Rhinichthys atratulus) stream minnows are a persistent species capable of withstanding the rapid environmental changes associated with urbanization. Previous research revealed increased somatic growth rates among dace from urban streams. To explain differential growth rates in urban vs. rural populations of dace, we measured instantaneous (using RNA concentration per mg of tissue) and recent (using otolith band width) growth rates, with collections from two urban and two rural sites spanning the first year of life. Urban fish sustained significantly higher instantaneous and recent growth rates compared to rural conspecifics. Geometric mean instantaneous and recent growth for an average-sized fish were 1.106 µg/mL RNA*mg tissue$^{-1}$ and 2.537 µm*seven bands$^{-1}$ at urban sites and 0.814 µg/mL RNA*mg tissue$^{-1}$ and 2.474 µm*seven bands$^{-1}$ at rural sites, respectively. Models comparing growth measures to standard length, mean temperature over one to ten days prior to collection, and site nested within urban vs. rural categories were analyzed with AIC. Only site differences (urban vs. rural) and standard length affected RNA concentration in the most supported model for instantaneous growth. The most supported model for recent growth included mean temperature over four days prior to collection, standard length, and site differences as independent variables. Increased recent growth may be due to higher temperatures in urban environments, while fish size and differences in unknown variables along an urbanization gradient explained differences in instantaneous growth. Future research will determine whether faster growth among urban dace relate to adaptive changes or phenotypic plasticity resulting from urbanization pressures.

Movement Patterns of Two Species of Rays in Mosquito Lagoon, Florida, USA

Several species of batoids utilize coastal lagoonal habitats of eastern Florida, USA. In general, behavioral ecology of batoids within this region has been overlooked despite their significance to the ecosystem. We utilized passive acoustic tracking methods to elucidate movement patterns, habitat use and home range of two common ray species, Dasyatis say (Bluntnose Stingray) and Gymnura micrura (Smooth Butterfly Ray), within Mosquito Lagoon. Smooth butterfly rays exhibited larger mean home range than bluntnose stingrays within this region. Both species exhibited similar diel activity.
patterns, with greatest activity occurring during early morning hours and least activity during afternoon hours. Seasonal movement patterns were also similar with both rays utilizing larger areas and displaying greater activity during the summer months. Sites near grass-bed margins were most commonly frequented by both species. Ray emigration and immigration patterns suggest the Mosquito Lagoon may serve as a nursery area for these two species.

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429 Herp Physiology, Galleria North, Monday 27 July 2009

Adam Rosenblatt¹, Michael Heithaus¹, Frank Mazzotti²

¹Florida International University, North Miami, FL, United States, ²University of Florida, Gainesville, FL, United States

Seasonal Salinity Variability and its Impacts on Alligator Behavior in the Florida Coastal Everglades

American alligators (Alligator mississippiensis) are some of the largest predators in the Florida Coastal Everglades (FCE), but little is known about their movements, trophic position, and ecological role in this ecosystem. Proposed restoration of the Everglades is likely to influence alligator movements, residence times, and the spatiotemporal patterns of their ecological effects making studies of alligator behavior important at this time. In October 2007, we initiated a study of alligators in the Shark River Slough of Everglades National Park using passive acoustic telemetry to quantify their movements and stable isotopes to elucidate their trophic position. In general alligators move away from high salinity waters near the Gulf of Mexico during the dry season, but are found more often in waters near the Gulf of Mexico during the wet season. There was a surprising degree of individual specialization in movement patterns and possible substructuring of the resident alligator population into two relatively distinct subpopulations. Stable carbon isotopes suggest that alligators primarily use freshwater and estuarine-based resources, but movements of some individuals suggest reliance on marine-derived food webs. Stable nitrogen isotopes suggest that, surprisingly, alligators feed at a relatively low trophic level (below large teleosts and juvenile sharks). Our preliminary studies suggest that alligator movements likely are influenced by a complex of physical and biological factors that may vary in importance across different spatiotemporal scales and that alligators may feed from diverse food webs but at a relatively low trophic level.

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325 Live-Bearing Fish Symposium, Grand Ballroom I, Sunday 26 July 2009

Gil Rosenthal

Texas A&M University, College Station, TX, United States

Mate Choice and Evolutionary Eenetics in Xiphophorus Hybrid Zones
Mate-choice behavior is an important determinant of reproductive isolation, and therefore of speciation and hybridization. I review the use of genetic and behavioral techniques to understand the impact of female mate choice on the evolution of hybrid zones between the poeciliid fishes *Xiphophorus birchmanni* and *X. malinche*. Hybridization itself arises from a breakdown in chemical communication mechanisms in mate choice. Using computer-animated playback techniques showed that hybrid fitness may be elevated due to the reorganization of phenotypic correlations among sexually selected traits in a way that addresses female preferences. Sexual selection acting on abundant natural variation has caused rapid trait evolution in the wild. Reproductive behavior has thus been a critical component in the evolution of novel communication systems.

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**296 Fish Ecology II, Pavillion East, Sunday 26 July 2009**

Steve W. Ross¹, A.M. Quattrini², A.Y. Roa-Varón¹, J.P. McClain¹

¹Univ. of NC-Wilmington, Center for Marine Science, Wilmington, NC, United States, ²Temple Univ., Biology Dept., Philadelphia, PA, United States

**Species Composition and Distributions of Mesopelagic Fishes Over the Slope of the North-central Gulf of Mexico**

Research on the midwater fauna of the Gulf of Mexico (GOM) has been relatively restricted and often has not included diel or vertical distribution data. We sampled midwater fauna over three cold seep habitats (1300-2500 m) and over a cold-water coral bank (450-650 m) in the north-central GOM. Day and night discrete depth sampling (9-29 Aug 2007, 159 Tucker trawls) yielded 126 species (9,802 individuals, 30 families) of juvenile and adult fishes. Collections were dominated by Myctophidae (38 species), Stomiidae (17 species), Gonostomatidae (12 species) and Sternoptychidae (10 species). Gonostomatidae dominated overall relative abundance (56% of total catch), followed by Myctophidae (28%), Phosichthyidae (6%) and Sternoptychidae (6%). Despite the wide separation of study sites, geographic and temporal patterns in fish assemblages were not evident in multivariate analyses. Station groupings were more related to similarities in sampled depths. Upper water column stations (< 400 m) comprised four groups typified by *Lepidophanes guentheri*, *Diaphus dumerilii*, *Vinciguerria nimbaria*, *V. poweriae*, *Valenciennellus tripunctulatus*, *Argyroplecus aculeatus*, *Notolychnus valdiviae*, *Benthosema suborbitale*, *Gonostoma elongatum* and *Hygophum taaningi*. Deeper stations (> 300 m) clustered into three groups typified by *Cyclothone alba*, *C. acclinidens*, *C. braueri*, *C. obscura*, *C. pallida*, *C. pseudopallida*, *V. tripunctulatus* and *H. benoiti*. A variety of depth, size and temporal distribution patterns were revealed for the dominant species. The mesopelagic ichthyofauna seems to be similar throughout the GOM. However, this fauna varies by depth: some species remaining deeper at all times (*Cyclothone* spp.), while others occur at mid-depths and exhibit various diel migrations (many myctophids).
Disease Dynamics of Pond-breeding Amphibians at a Blue Ridge Mountains Site in Georgia, USA

Reports of amphibian disease outbreaks and occurrences of the pathogenic fungus, *Batrachochytrium dendrobatidis* (Bd), have recently increased in the southeastern U.S. However, there is little information regarding population-level effects of emerging diseases on this region’s diverse amphibian fauna. We sampled amphibians in a single pond in the Blue Ridge Mountains at 3- to 6-week intervals for one year. We used PCR assays to detect *Bd* in skin swabs (postmetamorphic amphibians), mouth swabs (large ranid larvae), and tissue samples (oral discs of small anuran larvae). *Bd* prevalence in adult red-spotted newts (*Notophthalmus v. viridescens*) was higher in February-June (mean 63.6%) than in July-November (mean 12.2%). Prevalence of *Bd* infection in larval ranids also varied seasonally, declining to near-zero (95% CI: 0.0-7.0%) in October. *Ranavirus* (but not *Bd*) was detected in early-stage wood frog (*Lithobates sylvaticus*) larvae collected in late March. The subsequent absence of wood frog larvae in April suggests we may have missed a ranaviral outbreak. We found 7 dead or sick green frog (*L. clamitans*) larvae in October. According to realtime PCR and histopathology, all were infected with *Ranavirus* but not *Bd*. Finally, several adult newts and larval green frogs collected in May were subclinically infected with both *Bd* and *Ranavirus*. Despite the high prevalence of *Bd* infection and, in some cases, co-infection with *Bd* and *Ranavirus*, no species have been extirpated from this site. The interactions between *Ranavirus* and *Bd* deserve further investigation. Our observations also highlight the need for intensive surveillance to detect disease outbreaks.

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Body Temperature Variation During Nesting Forays in Midland Painted Turtles (*Chrysemys picta marginata*) on Beaver Island, Michigan

During terrestrial nesting forays, north-temperate freshwater turtles may experience a range of environmental temperatures that could cause over-heating or that could constrain movement if temperatures are too low. We studied *T_b* variation in *Chrysemys
*picta marginata* from a small marsh in northern Michigan, 2003–2004. Turtles emerged, nested, and returned to the marsh in a single day, or nesting forays lasted for up to three days. While terrestrial, $T_b$ and air temperature ($T_a$) showed parallel, diel oscillations. Mean $T_b$ of mobile turtles exceeded prevailing $T_a$ values but was similar to $T_b$ recorded for those same individuals while they were aquatically active (one week before and after the nesting foray). Therefore, active turtles on nesting forays may have maintained suitable $T_b$ values by use of sun or shade. Data indicated that low light levels, that could limit navigation, and $T_b$ values that could impede movements, did not directly cause turtles to seek terrestrial refugia after nesting. Rather, we suggest that impending low environmental temperatures, waning light levels that would eventually impair navigation abilities, and ultimately the risk of predation while returning to the marsh, caused turtles to seek terrestrial refugia.

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361 Fish Morphology & Physiology, Galleria South, Monday 27 July 2009

Zane Ruddy

*Texas A&M University-Corpus Christi, Corpus Christi, TX, United States*

**The Role of Handling Stress in the Survival of Hatchery-Reared Spotted Seatrout (*Cynoscion nebulosus*) when Subjected to a Predator**

The spotted seatrout (*Cynoscion nebulosus*) is one of the most sought after sport fish along the Gulf and Atlantic Coasts. Due to increasing recreational fishing pressure, the rearing of juvenile fish in hatcheries for release in bays and estuaries has been utilized. However, there is concern that these fish may not be behaviorally and physiologically prepared to survive in the wild after being subjected to stressors in the hatchery environment and during transport. This study aimed to determine whether handling stress increases the vulnerability of these fish to predation. Each group of 16 hatchery spotted seatrout (n=240) were chased and handled with a mesh dip-net until one mortality in each group was observed, resulting in 15 experimental fish presumed to be approaching critically high stress levels. The fish were placed in a 30-l tank containing an artificial seagrass bottom and two adult pinfish (*Lagodon rhomboides*)-an abundant natural predator of juvenile spotted seatrout. Control groups of unstressed fish (n=240) were permitted a 24 hr acclimation period within the experimental tanks before exposure to predators. Mortality was calculated each hour until all fish were eaten. Results indicate that stressed hatchery spotted seatrout experience significantly higher (p<0.05) levels of predation than unstressed fish, most notably within the first hour. The ability of a fish to evade predators until it reaches reproductive size is essential to the success of the fishery. This study shows that the ability of hatchery spotted seatrout to survive post-release may be influenced by handling stress.

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Multiple Road Effects on Amphibian Community Structure in Roadside Wetlands

The negative effects of roads are a major concern in amphibian conservation. Habitat loss, isolation, direct mortality, edge effects, disturbance, and toxic runoff are considered to be important factors affecting amphibians inhabiting roadside wetlands. We describe a series of field surveys and laboratory experiments conducted in Nova Scotia examining the effects of direct mortality, chronic disturbance, and toxic road runoff of deicing chemicals on amphibians. We surveyed 42 km of paved roads of varying traffic density through forested habitat for amphibian mortalities. Mortalities ranged from 0 to over 80% and were positively related to vehicle frequency and amphibian incidence; however species with low vagility were under-represented in road mortality. Wood frog chorus sizes were reduced in wetlands adjacent to high traffic roads while green frog and spring peeper choruses showed no similar reductions with traffic disturbance. A series of laboratory toxicity experiments indicated that spotted salamander and wood frog larvae were the most sensitive to NaCl contamination from runoff in acute exposures. Amphibian species showed different responses to environmentally significant chronic salt exposures at different life stages. The differential in effects of direct mortality, chronic disturbance, and particularly salt contamination to amphibians are important structuring factors in amphibian communities occupying roadside wetlands. Increasing urbanization and road construction are serious threats to amphibians.

Hibernation in Small-bodied Snakes in South-western Manitoba

Mounds abandoned by ants of the Formica genus are known to be used as hibernacula for small-bodied snakes. In Manitoba, these mounds are used by hibernating red-bellied (Storeria occipitomaculata), smooth green (Ophepdrys vernalis), juvenile plains garter (Thamnophis radix), and juvenile red-sided garter (Thamnophis sirtalis parietalis) snakes (Criddle 1937). The objective of this study is to examine the species' composition of these mounds, and their related thermal profiles. Five mounds were selected in the Souris River Bend Wildlife Management Area (SRBWMA), Manitoba. Drift fences and traps were monitored at each mound in the fall and spring, and thermal probes were installed from September to May of 2008 and 2009. Smooth green snakes and the two garter snake species arrived first at the hibernacula. Red-bellied snakes were the most common species, and arrived last. Temperatures in the mound remained steadier and warmer than temperatures at or near the surface. The average temperature of the ant mounds
was 2.5°C with a minimum and maximum of -6.5°C and 15.5°C. Snakes that were caught in the traps, as well as in the vicinity, indicate that the species using the ant mounds are consistent with previous work done by Criddle (1937) in Manitoba. The thermal profiles of each mound are similar to previous hibernacula studies (Brown et al. 1974; Jacob and Painter 1980) which provides an understanding of the thermal requirements for successful hibernation of small-bodied snakes in Manitoba.

320 SSAR SEIBERT ECOLOGY AWARD, Galleria North, Thursday 23 July 2009

Maureen Ryan¹, Jarrett Johnson¹, Benjamin Fitzpatrick²

¹University of California Davis, Davis, CA, United States, ²University of Tennessee, Knoxville, TN, United States

Ecological Impacts of Tiger Salamander Hybridization: Invasive Genotypes Impact Native Amphibians

We examined the ecological effects of tiger salamander hybridization (Ambystoma californiense x Ambystoma tigrinum mavortium) on three native amphibian species in central California: Ambystoma californiense (native, threatened California Tiger Salamander), Pseudacris regilla (Pacific Chorus Frog) and Taricha torosa (California Newt). In a series of mesocosm experiments, we examined the impacts of early generation hybrid cross types (first two generations of parental crosses) and contemporary hybrids (from the center of the hybrid zone) and found that most classes of hybrid tiger salamander larvae dramatically reduced the survival of Pacific Chorus Frog tadpoles and California Newt larvae. Most classes of hybrid larvae also negatively impacted native California Tiger Salamanders by reducing survival and size at metamorphosis and increasing time to metamorphosis. We also observed a large influence of Mendelian dominance on size, metamorphic timing and predation rate of hybrid tiger salamanders. Results from a field enclosure experiment support our mesocosm findings and highlight additional selective factors influencing the relative fitness of native and hybrid tiger salamanders (e.g., pond water quality). Our results suggest that both genetic and ecological factors are important in the dynamics of admixture and that hybrid tiger salamanders may pose a threat to pond-breeding species within the hybrid zone.