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Speciation observed in mid-stride: A multi-gene analysis of the California Tiger Salamander

The California tiger salamander (CTS: *Ambystoma californiense*) is a phylogenetically distinct, endangered member of the tiger salamander complex. A California endemic, its range spans from Santa Barbara County in the south to Sonoma County at its most northerly range limit. These two counties are also home to two geographically disjunct populations that are in severe decline due to urban sprawl and agriculture, resulting in emergency listing under the US ESA in 2000 (Santa Barbara) and 2003 (Sonoma). Previous work from our laboratory based on mitochondrial DNA variation, found six well supported population units within the CTS, with Santa Barbara and Sonoma populations each resolved as monophyletic and deeply differentiated. Because single gene trees may not represent population or species histories, we sequenced 10 unlinked nuclear loci with a size range of 350-1200 base pairs for up to 32 exemplar individuals from across the range. Based on neighbor-joining trees for each locus, we found consistent support for geographically-structured variation at two levels. Deep in the history of CTS, we found two distinct, reciprocally monophyletic clades from the western and eastern flanks of the Great Central valley. Within the eastern clade, the Santa Barbara population was clearly observed as a monophyletic group in a majority of the gene trees, although a few showed paraphyly with respect to one or two gene copies. When viewed as an Adams consensus tree of all loci, individuals from the Santa Barbara isolate were consistently nested within the eastern lineage. Sonoma, though not as strongly supported, was maintained in the western group with relative consistency. Our multigene analysis suggests that both the Santa Barbara and Sonoma populations are distinct lineages in the process of speciating. The Santa Barbara population is further along in the process of achieving complete lineage sorting, and is best considered as a new lineage-based species.

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A molecular dissection of the mating system in the bluntnose minnow,
Pimephales notatus

Pimephales notatus is a common cyprinid that is able to flourish in polluted waters and is found ubiquitously in many freshwater habitats in Eastern North America; yet the breeding behavior and genetic mating system of this species have not been documented in a natural stream setting. Male bluntnose minnows excavate and guard nest sites under slab rocks and contribute paternal care until the eggs hatch. From the large quantity of eggs observed in these nests, it appears that multiple females contribute to each nest. Here we perform a molecular dissection of the bluntnose minnow mating system using three highly polymorphic microsatellite markers to quantify the total number of females contributing to a nest and to reveal any alternative mating tactics (ie. cuckoldry,

nest takeover events, and nest-guard swapping) that could be employed by males to enhance their reproductive success. Approximately fifty embryos from each nest were genotyped at three different microsatellite loci and compared to the genotype of the guarding male captured with each nest. Preliminary results from several nests indicate a significant portion of the embryos are not sired by the guarding male. These results are compared to a recent molecular parentage study on a closely related species *P. promelas*.

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Defending the Alamo: Compensatory biotic and abiotic forces regulate species distributions in a salamander community

The Peaks of Otter Salamander (*Plethodon hubrichti*) has an extremely limited range, and is completely surrounded by the cosmopolitan red-backed salamander (*P. cinereus*). Based on this distributional pattern, and research on other geographically restricted *Plethodon*, it is widely believed that the range of *P. hubrichti* is restricted as a result of interspecific competition with *P. cinereus*. However, previous behavioral research demonstrated that aggression exists between the species, but *P. hubrichti* is the more aggressive of the two; an outcome that runs counter to expectations. We examined trophic morphology, food resource use, and climatic data from multiple allopatric and sympatric populations of both species to obtain a more comprehensive understanding of their ecological interactions. A total of 20 populations were examined. In contrast to predictions from a competitive model, there was no partitioning of food use between species, and sympatric populations were significantly more morphologically similar than expected from chance. Such sympatric morphological convergence suggests local adaptation, rather than interspecific competition. In addition, we identified a significant association of morphology and climatic variation across the entire region. Finally, using bioclimatic modeling, we found that the predicted ecologically-viable range of *P. hubrichti* was roughly concordant with its current distribution. In contrast, the predicted ecologically-viable range of *P. cinereus* engulfed nearly the entire distribution of *P. hubrichti*; a location not currently occupied by *P. cinereus*. Synthesis of current data and previous work strongly suggests that abiotic forces and local adaptation restrict *P. hubrichti* to its current distribution, while biotic interactions (aggressive interference of *P. hubrichti*) prevents *P. cinereus* from encroaching upon its range. If this system is at equilibrium, it represents a distinctive example of compensatory biotic and abiotic forces maintaining species distributions in an ecological community.

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Habitat and Prey Selection in two Species of *Imantodes*

Imantodes cenchoa and *Imantodes inornatus* are two sympatric species of vine snake found at La Selva, Costa Rica. Previous natural history observations suggest that the two species differ in their habitat and prey use. Field observations confirm that *I. cenchoa* selects forest habitats and *I. inornatus* selects swamp habitats. In an experiment in which tongue flicks directed at a prey-scented cotton swab were used to assess interest by snakes in a particular prey item, *I. cenchoa* responded positively to anoles but not frogs and frog eggs when compared to an inert control (water), and *I. inornatus* responded positively to scents from frog eggs but not anoles and frogs when compared to the same control. Finally, we document that the preferred prey items are more abundant in the habitats selected by each species.

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Status of conservation and population declines of amphibians of Bolivia

During the last years, the knowledge of the distribution and systematics of Bolivian amphibians has increased noticeably, but studies on ecology and conservation status remain scarce. Among the 230 species reported for the country, the list of threatened species varies from 3 to 21, depending on the authors. These species are threatened due to habitat loss (e. g. *Hyla charazani*), pollution, and trade for local consumption (e. g. *Telmatobius culeus*). Although declines of amphibian populations have been documented in neighbor countries due to the chytrid fungus *Batrachochytrium dendrobatidis*, in Bolivia its presence has not been reported yet. Nevertheless, there have been unpublished records of certain populations of *Telmatobius* and *Phrynopus* which have suffered drastic decreases in cloud forests of Cochabamba, and dead specimens have been found. These decreases might be due to the presence of chytrids but this topic needs further research. Here we present the basis of a project that will study the problem by: 1) monitoring Bolivian amphibian populations in sites of past surveys to reveal possible declines; 2) detecting the presence or absence of chytrids in certain populations; and 3) establishing, if chytrids are found, the date of introduction of this fungus in the country by tissue sampling in specimens of scientific collections.

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The evolutionary trajectory of a recently established Alaskan threespine stickleback population

Postglacial adaptive radiation of the threespine stickleback fish, *Gasterosteus aculeatus*, provides one of our most enlightening cases of evolutionary diversification. Little is known, however, on the actual rate at which resident freshwater stickleback populations evolve, or the evolutionary trajectories they take. A newly established population in Loberg Lake, located in the Cook Inlet region of Alaska, is providing a rare glimpse into the evolution of freshwater stickleback populations. The population was established by anadromous (ocean-run) stickleback within a decade of when sampling began. Annual samples collected since 1990 indicate that armor traits for this population are evolving rapidly in the direction of neighboring resident lake populations. I describe the pattern of divergence in body shape of the Loberg Lake population over time using geometric morphometric methods. The evolutionary time series for Loberg Lake is projected onto a morphospace created from variation of neighboring lake and stream populations sampled between 1990-1992 and 2003-2004. Early in the time series, the Loberg Lake population is similar to its anadromous ancestor in body shape, but other phenotypic traits indicate that the specimens sampled developed in the lake. The population then quickly becomes similar to extreme lake benthic populations from the region, with the rest of the time series changing much more gradually and generally approaching the phenotype of the extinct population originally inhabiting the lake. The influence of ancestral phenotypic covariation on the evolutionary trajectory of the Loberg Lake population is also assessed. **STOYE ECOLOGY & ETHOLOGY**

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Prey capture kinematics of the chain catshark *Scyliorhinus retifer*

Past studies of feeding kinematics in the elasmobranchs (sharks, skates and rays) have focused on easily accessible species inhabiting the epipelagic portion of the ocean. Thus, our knowledge of feeding behavior in deeper dwelling elasmobranch fishes is strictly limited. The chain catshark (*Scyliorhinus retifer*) is a member of one of the most well researched groups of elasmobranchs (order: Carcharhiniformes), but this particular species inhabits a deep-sea environment and its feeding strategies are therefore unknown. In an attempt to better understand the feeding biology of *S. retifer* we utilized high-speed videography to document the kinematic events during prey capture. Sharks were filmed feeding on pieces of Atlantic silversides (*Menidia menidia*) scaled to the mouth diameter (large prey) and one-half the mouth diameter (small prey). Frame-by-frame analysis of kinematic variables indicated that the chain catshark utilizes mild suction to capture benthic prey items. Univariate ANOVAs found that prey size did not significantly affect the majority of kinematic variables. Though kinematic displacement measurements differed significantly between individuals, the timing of most movements did not. Only two timing variables,

time to minimum lower jaw angle and time to maximum hyoid displacement, were found to vary significantly between large and small prey items. However, a MANOVA of principal components found no significant differences when simultaneously analyzing all derived kinematic variables for the effect of prey size. These results suggest that *S. retifer* exhibits stereotypical feeding behavior when capturing benthic prey. The feeding behavior of the chain catshark shows a strong connection to the basic pattern of kinematic events described in feeding studies of other carcharhiniform sharks. Nonetheless, stark differences in RSI values and the timing of upper jaw protrusion between this species and *Cephaloscyllium ventriosum* indicate that multiple prey capture strategies exist within the family Scyliorhinidae. **AES GRUBER**

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Accounting for incomplete detection when estimating site occupancy of *Pteronotropis welaka* in southwest Georgia

Accurate assessment of habitat requirements, range and overall conservation status requires sampling methods that have a high probability of detecting the target species. Seining is a commonly used method to sample cyprinids in coastal plain streams of the southeastern United States, but detection probabilities using this gear type are usually unknown. In conjunction with a status assessment for *Pteronotropis welaka*, we surveyed 38 sites in the Flint basin of southwest Georgia using seines. The probability of detecting *P. welaka* during a single seine haul was substantially lower (0.06) than for *Notemigonus crysoluecas* (0.19), *Notropis harperi* (0.23) and *Pteronotropis grandipinnis* (0.33). Because of the large number of seine hauls we carried out at most sites (12-30 hauls), the proportion of sites where species were actually detected differed little from estimates of site occupancy that accounted for incomplete detection. For example, we detected *P. welaka* at 8% of our sites, but Program presence estimated that this species occurred at 10% of our sites. However, the standard error of the estimated proportion of sites occupied was much higher for *P. welaka* (0.42) than for the other species (0.08 for all three), indicating great uncertainty in the true number of sites occupied in southwest Georgia. To get a better estimate of site occupancy, we plan to model detection probabilities as a function of habitat characteristics, examine data from other recent surveys in the range of *P. welaka*, and conduct additional sampling.

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Reproductive biology of the Massasauga (*Sistrurus catenatus*) from south-central Illinois

This study was conducted at Carlyle Lake, Clinton County, Illinois. Preserved specimens examined for this study are in the Illinois Natural History Survey collection. Based on preserved snakes females initiate vitellogenesis in the summer/fall. Vitellogenic follicles reach 20 mm in length by late September. Follicles overwinter at this size and resume growth in the spring. Ovulation occurs the later in the spring. Spermatogenesis begins June and peaks in August and September. The diameter of the seminiferous tubules is less than 200 μ m in May and reaches a diameter of 300 μ m in late July to early September. The sexual segment of the kidney parallels the diameter of the testis. Sexual segment tubules are lowest in the early part of the active season and peak in diameter and secretory activity in August through September. Mating and male-male combat occur primarily in the summer when the sexual segment of the kidney is hypertrophied. As in other species of snakes, the sexual segment of the kidney never regresses completely, indicating that testosterone levels are elevated throughout the year. Elevated plasma testosterone may be necessary for long term sperm storage in the vas deferens. This elevated testosterone may also account for the presence of reproductive behaviors sometimes observed in snakes.

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Thermal biology of *Python natalensis*: Does temperature limit distribution?

Python natalensis occurs in Africa, from the equator southwards to the northern and eastern parts of South Africa. The southern edge of the distribution correlates well with isotherms (e.g., Daily Mean, Mean Daily Max, ET), suggesting that low temperatures may be the proximal limiter to distribution. This hypothesis is especially plausible because *P. natalensis* is large and heavy-bodied, reaching a body mass in excess of 55 kg. Low rates of body temperature (T_b) increase could thus severely limit the amount of time spent at selected T_b, especially in cooler areas. I measured rates of heating and cooling of 16 free-ranging pythons in the Limpopo Province of northern South Africa, near to the southern range edge for the species. I predicted that if temperature was the proximal range limiter, pythons would be limited to achieving selected T_b for a relatively small portion of each day. Although small pythons are able to heat more quickly than large ones, rates of heating for large pythons are still sufficiently fast to ensure that only a small portion of the day is required for basking. Thus, temperature does not appear to limit distribution by limiting time spent at selected T_b. This is further supported by data recorded from snakes incubating eggs: Selected T_b for incubating females is 37 °C, significantly higher than the 30 °C selected by nonbrooding females or males. Since brooding females are usually large, select higher T_bs, do not display shivering thermogenesis, and

only bask for relatively short periods of time, this demonstrates that *P. natalensis* has the potential for rapidly raising Tb well above the usual selected Tb. However, the presence of Aardvark (antbear) burrows appears to be critically important to the occurrence of *P. natalensis* as they provide stable thermal environments for the pythons.

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Phylogeny of the Oriental-Australian rear-fanged water snakes (Colubridae: Homalopsinae) based on DNA sequences

The Homalopsinae (Oriental-Australian rear-fanged water snakes) is a colubrid subfamily containing 10 genera and 34 species known for its ecological and morphological diversity. Here we build on our past work to present the results of an expanded molecular phylogenetic study of the homalopsines. First, we test the monophyly of the homalopsines using parametric bootstrapping and Bayesian analyses. We sequenced 21 homalopsine species for a portion of the *c-mos* gene and added 186 outgroup species available on GenBank to create a matrix of 207 taxa. Our analysis included representatives of nearly every major snake lineage and found significant support for the hypothesis that homalopsines form a monophyletic assemblage. Second, we present a molecular phylogenetic analysis of the homalopsines based on sequences from portions of three mitochondrial genes (12S, 16S, and Cyt *b*) and one nuclear gene (*c-mos*) from 21 ingroup and seven outgroup species. Maximum likelihood, Bayesian, and parsimony analyses were largely concordant and revealed strong support for many nodes throughout the tree. The marine crustacean eaters, *Fordonia leucobalia* and *Gerarda prevostiana*, formed a well-supported clade with *Cantoria violacea*, another crustacean eater, being its closest sister species. *Enhydris*, the most species-rich genus in the subfamily, was polyphyletic in our analyses, although five morphologically and ecologically similar species formed a well-supported clade. We discuss the evolutionary and ecological implications of these findings.

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Effects of varanid top predators on skink mesopredators and their prey

Top predators tend to disappear from anthropogenically altered habitats. Understanding the effects of these disappearances is critical for conserving remaining trophic levels, because top-level predators influence assemblage structure at lower trophic levels via both direct and indirect effects. There is,

however, no consensus on the size, direction, or nature of these effects, especially in terrestrial ecosystems. We studied the influence of top predator (varanid lizard) removal on skink mesopredators and lower trophic levels in the Australian tropics using a large-scale manipulative experiment. We used an array of 14 x 14 m (200 m²) enclosures, plus unenclosed plots of the same size, to expose plots to three experimental treatments: 1) control plots with natural varanid and skink densities, 2) plots with varanids excluded, but skinks allowed access, 3) unenclosed plots to control for enclosure effects. There are four replicates of each treatment. Excluding varanids had small effects on the composition of the skink assemblage, but had little effect on skink abundance. Despite this, varanid exclusion strongly affected the abundance and composition of the assemblages of spiders and litter invertebrates that serve as prey for skinks. Many of these changes appeared to be trait-mediated indirect effects caused by changes in the behavior of skinks in response to changes in their exposure to the risk of predation from varanids. It thus appears that in our study system, the strongest effects of top-level varanid predators on the food web may arise through trait-mediated indirect effects on mesopredators, rather than more direct effects on their abundance.

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Reproductive biology of *Potamotrygon scobina* Garman, 1913
(Chondrichthyes: Potamotrygonidae) in the Marajó Bay region, Pará,
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Potamotrygonids present a reproductive mode described as matrotrophic viviparity with *trophonemata*. This study presents the results on the reproductive aspects of the freshwater stingray *Potamotrygon scobina* in the Marajó Bay region. The specimens (n = 244) were sampled in the Colares Island region in the years 2000 through 2002. Males (n = 120) and females (n = 124) had their main reproductive characteristics analyzed in the field and in laboratory. All reproductive organs and embryos were fixed in formaldehyde solution (10%) and preserved in ethanol (70%). The HSI and GSI were also calculated for juveniles, sub-adults and adult specimens of both sexes. HSI values varied from 2.75 - 4.86 for males and 3.48 - 7.34 for females. GSI values varied from 0.17 - 0.65 for males and 0.16 - 0.45 for females. The Pearson Correlation Coefficient (r) of the disc width and clasper length was of 0.80. Abundant semen and spermatophores were present in 20.83% of the males sampled and were only observed at a minimal disc width of 358 mm. Embryos (n = 162) were present in 41.33% (n = 31) of the adult females sampled and were only observed at a minimal disc width of 387 mm. Adult females presented an average ovarian and uterine fecundity of around 5. The Pearson Correlation Coefficient (r) of the disc

width and number of embryos was of 0.66. Slight salinity changes seem to play an important role as a trigger for reproduction in the *P. scobina* population of this region. The results obtained indicate that the reproductive cycle of *P. scobina* is closely related to the hydrologic cycle of the Amazon Estuary region. (Supported by CNPq, CAPES and WWF - Brazil grants).

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Osteological development of *Diapterus peruvianus* (Percoidei: Gerreidae)

Osteological studies of *Diapterus peruvianus* are scarce and based on adult specimens. Because of this, our objective was to describe its osteological development using a series of 12 cleared and stained specimens wild caught (2.7 - 20.8 mm). In the smallest specimen analyzed (preflexion larvae) at 2.7 mm NL (notochordal length), the jaws, suspensorium, and opercular series were ossified and the neurocranium remained cartilaginous. A premaxillary ascending process could be observed at 3.8 mm NL, and the caudal and dorsal fins supports were present. At 4.8 mm SL (standard length) in the postflexion larvae, the frontals were ossified and had 24 vertebrates, the number of caudal fin rays, and the first rays and spines of the dorsal and anal fins were completed. At 6.1 mm SL, the preopercle had three spines, the 3th and 4th hypurals were fused, and the dorsal and anal fins were fully formed. In juvenile specimens at 9.2 mm SL, a supraoccipital crest was visible, the 1st and 2nd hypurals were fused and the pectoral and pelvic fins were completely formed. By 20.8 mm SL, the caudal supports were fully ossified.

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Masking interference and the evolution of the acoustic communication system of the poison frog *Epipedobates femoralis*

The efficacy of communication relies on detection of species-specific signals against the background noise. Features affecting signal detection are thus expected to evolve under selective pressures represented by masking noise. Spectral partitioning between the auditory signals of co-occurring species has been interpreted as the outcome of the selective effects of masking interference. However, masking interference depends not only on signal's frequency but on receiver's range of frequency sensitivity; moreover, selection on signal frequency can be confounded by selection on body size, because these traits are often correlated. We used the widely distributed Amazonian frog species, *Epipedobates femoralis*, to test whether geographic variation in communication traits agrees with predictions about masking interference. We considered two scenarios: masking interference may increase with the number of acoustically coactive species or with the occurrence of a single species, *E. trivittatus*, calling within an overlapping frequency range. We analyzed the signal's spectral features of all coactive species at eight sites throughout the Amazon basin. Since territorial males of *E. femoralis* strongly react to the presence of vocally active intruders, we used playback experiments under natural conditions to derive frequency-recognition curves. Most geographic variation in studied traits was correlated with either call frequency or with response frequency range. The calls of *E. trivittatus* partially overlapped with the calls of *E. femoralis*. The occurrence of *E. trivittatus* significantly predicted narrower and asymmetric frequency-recognition curves in *E. femoralis*, without concomitant differences in the call or in body size. The number of species did not significantly predict variation in any of the studied traits. Our results strongly support that the receiver but not the sender component of the communication system changed due to masking interference by a single species.

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Plastic gonads: Do they exist?

There is considerable plasticity in size at metamorphosis in many species of amphibians. For example, tadpoles developing in low quality (i.e. low food) habitats grow slowly and are smaller at metamorphosis than conspecifics from high quality environments. Similarly, larval amphibians developing in temporary ponds will often quickly metamorphose in response to decreasing water levels resulting in small size at metamorphosis. It is believed that amphibians that metamorphose at larger sizes survive better and reproduce at

younger ages than animals that metamorphose at smaller sizes. One hypothesis for this relationship is that small metamorphs may simply not be in adequate condition (weight to length ratio) to reproduce in the first year. Alternatively, individuals in less hospitable environments may allocate more energy toward developing structures necessary for metamorphosis than toward growth, or gonad development. The ability to differentially allocate energy between somatic and reproductive development could be an important mechanism by which development of structures required for metamorphosis (i.e. limbs, or carnivore gut) can be maximized when environmental conditions are unfavorable at the expense of reproductive organs which could be developed in the next life history stage. Few studies have explicitly tested whether growth or developmental rates of gonads in amphibians are plastic. We designed two experiments to test the hypotheses that 1) Animals fed a restricted diet would have less developed gonads and lower condition at metamorphosis than those fed large quantities, and 2) Developmental rate of gonads is slower and not dependent on somatic development in food restricted animals. We discuss the conservation implications of this work.

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A survey of squamate biodiversity at Reserva Amazonica, Peru.

Reserva Amazonica, Peru is an ecotourist lodge constructed in 1974. In 1979, 10,000 ha of lowland rainforest neighboring the lodge were designated as a private reserve for biological investigation and tourism. Herpetofauna surveys of Reserva Amazonica, since BIOTROP (Neotropical Biological Diversity Program) in 1989 have chiefly focused on the 64 frog species inhabiting the area. In view of this, less data has been collected regarding the 81 reptile species on the site. Between 26 December 2004 and 16 January 2005, eleven researchers performing a survey of amphibians and reptiles logged 240 person days. Transects were walked nightly along the existing trail system by groups of two or more people. Additionally, funnel traps were placed along root buttresses and fallen trees proving successful in capturing fossorial snakes. A total of 39 reptile species were recorded from 109 observations. The previous survey in 2002-2003 compiled 50 observations of 21 reptile species over a total 114 person days logged. Of the 39 species recorded one *Typhlops reticulatus* had never been recorded at the site and at least one other *Platemys platycephala* had not been recorded since the original BIOTROP surveys.

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Genetic investigation into the origin of the Waccamaw Silverside *Menidia extensa*

Lake Waccamaw is one of the Carolina Bay Lakes which despite its relatively recent formation (25,000 -100,000 years ago) is home to three endemic freshwater fish species. Even more surprisingly, one of these endemics, the waccamaw silverside (*Menidia extensa*) is a member of a genus that is almost exclusively marine. Using both mitochondrial and nuclear loci, we examined the origins and population genetics of *Menidia extensa* as well as its relationships to its putative sister species, *Menidia beryllina*, and other members of the genus *Menidia*.

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Population genetic variation and gene flow among communal hibernacula of timber rattlesnakes (*Crotalus horridus*) in western St. Louis County, Missouri

We used nine polymorphic microsatellite loci to examine genetic relatedness within a local timber rattlesnake population. First we tested the hypothesis that den site fidelity creates system of mating inbreeding within dens by: 1) computing multilocus F_{IS} (f) values for groups of individuals of known den residence, and 2) estimating relatedness values within these same groupings. Next we tested the affect of female fidelity to nursery areas near dens on genetic relatedness among dens by: 1) comparing relatedness estimates among groups of proximal dens, and 2) comparing the relatedness values of males and females within these groups. The results of these analyses were compared to similar studies on this and other rattlesnake species and directions for future research are presented.

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Soniferous fishes in the Hudson River: Focusing on tidal freshwater Tivoli Bays

The purpose of this study was to catalogue types of underwater sounds recorded in the Tivoli Bays National Estuarine Research Reserve (NERR) located on the Hudson River. Although soniferous fishes have been studied in many different parts of the world, very few studies have been conducted in North American

freshwater systems. We recorded underwater sounds with an autonomous underwater listening system consisting of a hydrophone, digital sound recorder, and weatherproof housing. In the first year of the study 46 hours of unmonitored recordings were collected in mid-summer from two locations within the Tivoli Bays NERR. We identified 17 different sounds of interest. Although the specific identifications of these sounds were unknown, we categorized five sounds as most likely produced by fishes, seven as from an unknown biological source and two from a non-biological (man-made) source. Four sounds could not be identified to any of the categories and were classified as unknown. In the second year we attempted to identify the source of the observed sounds by conducting manned recording sessions and controlled sound auditing of fishes. We recorded sounds produced by two species of catfish: brown bullhead, *Ameiurus nebulosus*, and channel catfish, *Ictalurus punctatus*. This study reveals that unknown underwater sounds are diverse in the Tivoli Bay NERR and strongly suggests that passive acoustics can be an important new tool for the study of the bay's ecology. Future research focused on the identification of these unknown underwater sounds promise to provide scientists with new insights into the ecology of the Tivoli Bay NERR. **STOYE ECOLOGY & ETHOLOGY**

ANDREADIS, PAUL T.

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Snakes scentmark salient sites?

The selection of an ambush site is of paramount importance for sit-and-wait foragers. It has been suggested that predators revisit sites of prior success, but any means for recognizing sites with higher encounter probabilities would be advantageous. I have been studying the behavior of free ranging cottonmouths, *Agkistrodon piscivorus*, in wooded swamps of the southeastern USA. I use camcorders with near-infrared sensitivity to record the foraging movements of individuals over the course of an evening. Cottonmouths move more often than some better studied pit vipers; they occupied 1-5 sites (mean = 1.8) over 2-8 h intervals. Haphazard observations of prey encounters have provided insight into site selection. Though sample size is small, the cumulative impact of the observations is to clearly suggest that cottonmouths scentmark noteworthy locations. Within minutes of an encounter, cottonmouths rub their chin and sides of their head on relatively permanent, vertical structures like emergent wood. Such chemical signposting may not be limited to ambush sites, as one individual conspicuously marked at the "threshold" of its retreat. I discuss the implications of this behavior for foraging success. This behavior may provide insight into the chiseled facial angles of Agkistrodontini, and begs a histological/chemical analysis of the facial skin. It also suggests many possible behavioral tests with experimenter placed scentmarks.

***ANDRES, DIANA L.; MACKIE, RODERICK I.; SECOR, STEPHEN M.; ESPINOZA, ROBERT E.**

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The grass is greener: Costs of diet switching may inhibit insect eating by herbivorous lizards

Herbivory is rare in reptiles and speculation on why strict herbivory has evolved spans more than four decades. When fed insects or meat, captive herbivorous reptiles grow faster, reach a larger size, and produce more offspring. If eating insects is advantageous for captive herbivorous reptiles, then why don't herbivores seasonally switch to eating insects in nature? We tested the hypothesis that diet switching is costly for herbivorous lizards. Changes in diet were expected to alter gut physiology (e.g., nutrient transport) or the gut milieu (e.g., pH) making conditions less favorable for fiber-fermenting bacteria, thus altering the bacterial community and evoking a concomitant decline in the host's digestive efficiency. To test these predictions, herbivorous desert iguanas (*Dipsosaurus dorsalis*) were fed ground alfalfa (herbivore) or cricket (carnivore) diets for 5 weeks, switched to the alternative diet for 5 weeks, then switched back to the original diet for 5 weeks. Another treatment group received an omnivorous diet (50:50 alfalfa:crickets) for all 15 weeks. Fecal samples were used to determine whether diet switches were associated with changes in (1) apparent digestive efficiency, (2) nitrogen assimilation, or (3) the hindgut bacterial community (via numerical analysis of fecal banding profiles using PCR-DGGE). We also compared gross morphology and physiology (pH and rates of nutrient transport) of lizard guts across diet treatments. Bacterial communities inferred from fecal samples were individual specific, but varied with diet type and length of time lizards were fed a particular diet. Diet switches were associated with changes in gut morphology, pH, amino acid transporter activity, and digestive efficiency. These morphological and physiological changes tracked changes in the endosymbiont community. Because diet switching alters gut structure and function, as well as disturbs the endosymbiont community, then seasonally switching between insect and plant diets may be disadvantageous for herbivorous lizards in nature. **SSAR SEIBERT MORPHOLOGY & PHYSIOLOGY**

ANDREWS, KIMBERLY M.

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What is the half-life of a dead snake? Persistence of road-killed snake specimens as affected by scavengers, traffic density, and abiotic factors

Road counts of dead snakes are commonly used as estimates of overall road mortality levels on roads and relative abundances of species. However, counts are likely to be underestimates due to unobserved specimens that were removed by scavengers or simply destroyed by being run over repeatedly. We conducted a study in summer 2003 that was replicated in fall of the same year to determine

the persistence of snake carcasses on roads after being hit by a vehicle. Intact snake specimens that had been collected on roads were randomly assigned to one of three treatments: high traffic density, medium traffic density, and a closed road that served as a control. The rate of removal was highest at the lower traffic density, the primary scavengers being birds. Removal rate was lowest on the control road, the primary scavenger being ants, but birds arrived later in the experiment. The type of scavengers and the subsequent rate of removal were affected by abiotic parameters, particularly temperature and precipitation. Shorter and smaller snakes did not disappear more quickly as hypothesized. Whereas scavenging was reduced at the higher traffic density due to peak traffic flows coinciding with morning bird activity, smaller sizes were more often removed physically by vehicular traffic. A more thorough understanding of the variables influencing road kill persistence will allow a more accurate system in estimating true road mortality rates and relative abundances of snakes.

STORER - HERPETOLOGY

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Snakes on roads: Interspecific and intraspecific patterns of behavior as evidenced by a long-term database in the southeastern United States (1951-2005)

Researchers who use road cruising techniques are aware that some species of snakes are more characteristically observed on roads than others. However, the reasons that species are not observed at comparable frequencies need further investigation to determine why road crossing or avoidance varies among species. While many factors are involved in detection probabilities of species on roads, a first step in understanding the processes involves determining interspecific on-road frequencies and potential sources of detection biases. More than 16,000 individuals of 35 species of snakes were recorded from 1951-2005 on the Savannah River Site in South Carolina, permitting a comparison across species of capture frequencies as influenced by on-road and off-road techniques. Venomous or terrestrial species of snakes were significantly more likely to be found on roads than off roads when compared to non-venomous or aquatic species. A significant relationship was observed between the body size of species and their propensity to be captured on roads in that larger species are more likely to be detected. Males were more likely to be observed on the road than females for almost all species. The findings provide insights into how the ecology of a species relates to road-crossing tendencies and the efficacy of using road surveys for sampling snakes. Despite its many limitations, road cruising can be an effective technique for sampling snakes if these biases are understood and when used circumspectly with other methods.

SSAR SEIBERT ECOLOGY

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Issues of species identity and how these can bias population assessments

In order to address any biodiversity conservation issue and attempt the implementation of a conservation action plan, certain basic elements are necessary, such as the selection of the target species or ecosystem, some knowledge of its area of occurrence, geographic distribution, abundance or population density, and the problems affecting its survival or stability. However, in order to do this effectively, the conservation target has to be properly identified. If it is not, conservation action is bound to be flawed, ineffective or, in the best case scenario, hindered. Clear-cut definitions at the species level are nevertheless problematic. To this date, there is no consensus among taxonomists and systematists on a universally accepted species definition. There are over 22 species concepts in existence, and differences of opinion among experts as to what constitutes a species, so how can we ensure that we are talking about the same biological entities? The problem is compounded in certain taxa, such as amphibians, given the great number of morphologically cryptic species, and the potential for many new, unacknowledged species. Conservation attempts can thus be affected by biodiversity underestimates, and can result in inappropriate conservation action if the needs of cryptic species differ from those of their masking species. Herein we discuss how these issues of species identity can affect population assessments, and propose the use of certain tools to most accurately reflect the biological identities of selected amphibian taxa.

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Interactions between native and introduced guild members: responses of juvenile terrestrial salamanders to predatory invertebrates

When introduced species invade ecosystems, alterations in community structure can emerge from the competitive and predatory interactions that occur between introduced and native guild members. Because a number of recent studies have shown that large predatory invertebrates can both compete with, and prey on, small vertebrates, we examined the effects of introduced (*Lithobius forficatus*) and native (*Scolopocryptops sexspinosus*) centipedes on juveniles of the red-backed salamander (*Plethodon cinereus*). We addressed the following questions: 1) Do adult centipedes exclude juveniles of *P. cinereus* from cover objects in the field or in the lab? 2) Do juveniles of *P. cinereus* respond differently to the odors of, or to laboratory encounters with, either species of centipede? 3) Do adult centipedes of either species prey on juveniles of *P. cinereus*? In laboratory arenas, juvenile salamanders exhibited submissive behavior in response to the odors of both species of centipede, but the way in which they responded differed. Juveniles of *P. cinereus* spent significantly more time in escape behavior when presented with

native centipede odors and tended to remain immobile and flattened when exposed to odors of introduced centipedes. Despite significant size differences between centipedes and salamanders, no predation of juvenile salamanders by either species of centipede occurred in any pairings. Juvenile salamanders were more aggressive toward native centipedes and exhibited more chemosensory behavior toward native centipedes and their odors. Field and laboratory data suggest that juveniles of *P. cinereus* negatively associate with centipedes. In laboratory trials, the native centipede excluded juvenile salamanders from cover and we found fewer instances of co-occurrence of these two species in the field than expected. These studies are the first to examine the potential interactions between juveniles of a top predatory salamander and two intermediate predators, one introduced and one native, of eastern deciduous forest floor food webs.

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Behavioral time budgets of *Zebrasoma flavescens* in an artificial and natural ecosystem

Herbivorous fishes are considered a key element in the ecology of reef systems, as they are one of the most numerically abundant teleosts found on tropical coral reefs. Large schools of grazers have been observed to significantly reduce turf algae on areas of reefs that once supported dense patches. This study focuses on the behavioral time-budget of the yellow tang, *Zebrasoma flavescens* (Acanthuridae), with an emphasis on its feeding strategy. The importance of studying herbivory in an enclosed system is such that space and resources become limited, especially if nutrient and light levels are low. Fish must find a way in which to budget their time in order to achieve an optimal energy gain. I observed *Z. flavescens* in the Biosphere 2 Center (B2) Ocean Biome and on natural reefs in Hawaii. Fish in the B2 Ocean displayed four discrete behaviors (feeding, hovering, aggression, and fleeing), which were recorded and timed while snorkeling. Feeding accounted for 48% of their day, hovering 52%, aggression 0.55%, and fleeing from conspecifics 0.87%. On Hawaiian reefs, *Z. flavescens* were observed to spend 22% of their time feeding, and 62% swimming (not hovering), while aggression accounted for 0.13% and fleeing only 0.08%. Time allocated for feeding between the two sites was significantly different ($p < 0.001$). Results from this investigation suggest that variation in resource availability between the two sites affects the behavior and time budget of *Z. flavescens*. **STOYE GENERAL ICHTHYOLOGY**

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The morphology and uses of shark vertebrae

Known shark vertebrae may be divided into eight groups, a method that has to date been little used. One of these is called the lamnoid group, which will be

discussed here. Lamnoid vertebrae occur in two orders of sharks the Orectolobiformes and the Lamniformes. We here concern us with the 15 living species of Lamniform sharks. Externally the vertebral column can be divided into cervical, trunk, and caudal vertebrae. In general samples of vertebrae are taken just in advance of the dorsal fin. Posterior to this position vertebrae have little use in morphological studies. A pin can mark caudal vertebrae for x-rays or by simply cutting of the tail at the base. Cervical vertebrae show a slightly different morphology. Often the first is a hemi-vertebra attached to the endocranium. The configuration of the structures and in general number of vertebrae has value in separating the 15 Lamniform species. Vertebrae can be x-rayed or ground to their center to reveal their internal structure this may vary greatly depending in the position in the column. An understanding of the internal morphology is believed possible if taken from the correct part of the column to identify the 15 living species. The annular rings found in vertebrae are useful in age and growth studies. As with teeth , it is necessary to completely understand the vertebrae of living sharks before interpretations of the vertebrae in the fossil record will have true meaning.

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Elasmobranchs grow in length according to a two-phase growth model

Often, it is assumed that the von Bertalanffy growth model (VBGM) is appropriate to describe growth in length of elasmobranchs. However, a review of the literature suggests that a two-phase growth model could better describe growth in elasmobranchs. In this paper, we compare the two-phase growth model (TPGM) with the VBGM for 18 data sets of elasmobranch (16 species), by fitting the models to 36 age-length data pairs available (female, male and both sexes pooled). The Akaike Information Criteria (AIC) and the difference in AIC between both models revealed that in 23 cases (from 36) the probability that the TPGM was correct $\geq 50\%$. The VBGM tends to estimate larger L_{inf} values than the two-phase growth model, while the K parameter tends to be underestimated. We show growth rate in length tends to decrease near the age at first maturity in several species of elasmobranch. This growth pattern seems to be a characteristic of elasmobranchs. The importance of the TPGM lies in that it appropriately describes this aspect of the life history of the species. In this context, we conclude that the VBGM is not appropriate to describe the growth of elasmobranchs, and that the TPGM should not be overlooked, particularly in stock assessment models.

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Application of bomb radiocarbon chronologies to Shortfin Mako (*Isurus oxyrinchus*) age validation

Age estimation is an issue for the shortfin mako (*Isurus oxyrinchus*) because of ongoing disagreement on the periodic deposition of vertebral growth bands. A band pair is defined as a set of opaque and translucent bands in vertebral centra. Using four age determination techniques, Pratt and Casey (1983) concluded two band pairs formed annually; however, Cailliet et al. (1983) assumed one band pair per year. To evaluate the validity of both interpretations, a new technique was applied using radiocarbon measured in shark vertebrae. In the 1950-1960s, thermonuclear testing released large amounts of radiocarbon into the atmosphere, which reacted to form $^{14}\text{CO}_2$ and entered the ocean through gas exchange over the following years. This influx created a time-specific marker in the marine environment that can be used in age validation. In the first application to elasmobranchs, Campana et al. (2002) validated the vertebral ageing methodology for the porbeagle (*Lamna nasus*) and assayed four samples from one shortfin mako vertebra, suggesting annual deposition of one band pair for both species. In the present study, band-counting age estimates from 54 shortfin mako vertebrae collected in 1950-1984 ranged in age 1-31 years. Bands in early stages of life appeared broad and clear and became less defined with age. Ageing error between readers was consistent, with 76% of the estimates ranging within two years of each other. Twenty-one radiocarbon values from vertebrae of eight shortfin makos (collected in the Western North Atlantic in 1963-1984) ranged between -160.2‰ and 86.8‰. The resulting concordance with the porbeagle indicated shortfin mako has longevity of at least 31 years and supports annual deposition of a single pair of growth bands. This work was performed, in part, under the auspices of the U.S. Department of Energy by University of California, Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

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Trophic position and environmental correlates of the abundances of three turtle species in north Florida lakes

Lakes in the southeastern United States support a high diversity and abundance of reptiles and amphibians, including many species of turtles. However, the role of turtles in lake food webs has never been studied, as most food web research is based on north-temperate systems with low turtle abundance. The objective of

this study was to determine if trophic position influences the habitat distribution and abundance of three turtle species across a lake productivity gradient. I used stable isotope and diet analysis to demonstrate that trophic position (TP) of three focal species differed at Lake Jackson, Leon County, Florida. The Florida cooter, *Pseudemys floridana*, was a specialist algivore (TP = 2.3), the yellow-bellied slider, *Trachemys scripta*, was a generalist omnivore (TP = 3.3), and the Florida softshell, *Apalone ferox*, was an omnivore with some specialization on insects and snails (TP = 3.8). I then performed a survey of turtle abundance and 18 biotic and abiotic habitat characteristics at 17 lakes in Leon County, Florida. Mantel analysis revealed that one of the best predictors of turtle abundances was periphyton. Abundances of all three focal species were strongly correlated with a mud and muck substrate and both top-down (no alligator predation) and bottom-up (high periphyton productivity) factors. On a finer scale, abundances of the individual species were correlated with additional factors that may be related to their trophic position: *T. scripta*, high phosphorus and high chironomid abundance, *P. floridana*, low macrophyte cover and high chironomid abundance, and *A. ferox*, high macroinvertebrate abundance, high snail abundance, and high phosphorus. The results of this study suggest that patterns of abundance of sympatric freshwater turtle species can be strongly influenced by environmental variables that are correlated with their trophic position in the food web. **SSAR SEIBERT ECOLOGY**

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A study on the learning and sensory capabilities of a captive *Manta birostris* (Mobulidae)

A female *Manta birostris* (4 m wingspan) was observed in the Lisbon Aquarium over an 18 day period during September 2004. Her presence in her feeding square, the position of the cephalic fins and surfacing behavior were recorded by the EthoLog softver before and during regular feedings, as well as at random times between feedings. These behavioral elements were also recorded to test the effects of (1) the presence of a person on a bridge above the feeding square, as well as (2) the empty feeding bucket, (3) a bucket not usually used for feeding, (4) shrimp soup and (5) normal feeding bucket with shrimp soup , each in the water separately. The *Manta's* normal behavior and her responses to these stimuli were also observed in another square of the tank, different than her usual feeding square. The results showed the presence of a person on the bridge didn't change her usual swimming behavior. However, the presence of the empty feeding bucket and the other bucket or the shrimp soup, all attracted her to the feeding square, where she spent more time and showed surfacing behavior in an attempt to feed. The most significant response was recorded after the empty feeding bucket was placed into the water at her feeding square. These results suggest that this *Manta birostris* has learned to appear in order to get her food in response not only to olfactory but visual cues as well. **AES CARRIER**

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Revisions of *Lasiancistrus* and *Peckoltia* sensu stricto

Two of the more confusing genera in the Loricariidae are *Peckoltia* and *Lasiancistrus*. *Lasiancistrus* has about 15 species currently from much of South America. A revision of *Lasiancistrus* has found that four of those species are valid (*L. castelnaui*, *L. caucanus*, *L. guacharote*, and *L. heteracanthus*), two are *incertae sedis* (*Ancistrus multispinis* and *Chaetostomus trinitatus*), and one is an *Ancistrus* (*L. nationi*). In addition, two new species need to be described. *Lasiancistrus caquetae*, *L. guapore*, and *L. scolymus* are synonyms of *L. castelnaui*, *L. maracaiboensis* and *L. mystacinus* are synonyms of *L. guacharote*, and *L. mayoloi*, *L. planiceps*, and *L. vulcanensis* are synonyms of *L. caucanus*. A wide range of species have been placed in *Peckoltia*, but the genus is not diagnosable by synapomorphies. However, there is a core group of *Peckoltia* with at least six described species and two undescribed species referred to as the *P. vittata* species group. This group includes the type species *P. vittata*, *P. braueri*, *P. brevis*, *P. cavatica*, *P. kuhlmanni*, and *P. vermiculata*. In addition, *Peckoltia bachi* (with synonyms *P. arenaria*, *P. filicaudata*, and *P. ucayalensis*) may be recognized as a unique genus. This genus was recently described as *Sophiancistrus* (type *P. ucayalensis*); however, *Peckoltichthys* is an older name (type *P. filicaudatus*). An up-to-date phylogeny for the Ancistrini will be provided, but has little resolution in the species of *Peckoltia* and its relatives.

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Controversies around basal actinopterygian relationships

An analysis of the available hypotheses shows that there is great disagreement in the relationships of basal actinopterygians. This is caused by different selection of taxa and different assumptions over homologies. The disagreements are clearly illustrated by major changes in the relationships of living polypteriforms, acipenseriforms, amiiforms, and lepisosteiforms to fossil forms and also to teleosts. Several hypotheses of sister-group relationship to teleosts have been proposed based on morphological evidence (e.g., mobile maxilla, presence of supramaxilla, position of symplectic). For instance: (other actinopterygians + [lepisosteids + [amiids + Teleostei]]); (other actinopterygians + [amiids + [lepisosteids + Teleostei]]); and (polypteriforms + [acipenserids + [[amiids + lepisosteids + Teleostei]]]). Molecular studies have not clarified the sister group of teleosts, but rather given uncompromising solutions, e.g., (polypteriforms + [acipenserids + [[amiids + lepisosteids] + Teleostei]]) and (polypteriforms + [[acipenserids + amiids + lepisosteids + Teleostei]]). Traditionally, polypteriforms and chondrosteans are interpreted as having a basal position in the palaeonisciforms; however, new evidence suggests that they could be more advanced than previously considered.

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A phylogenetic analysis of Batoidea (Elasmobranchii) based on morphological data

Although monophyly of the batoids (electric rays, sawfishes, guitarfishes, skates, and stingrays) is widely accepted and well corroborated, the interrelationships within batoids remain controversial. The most contentious issues concern the phylogenetic position of the Torpediniformes (electric rays) and the Pristiformes (sawfishes), and the composition of the Rhinobatiformes (guitarfishes). A phylogenetic analysis based on 81 anatomical characters of representatives of 32 of the 72 genera of batoids and four outgroups revealed that batoids comprise three major clades: Torpediniformes, Rajiformes, and Myliobatiformes. Rajiformes include Pristidae, *Rhina*, *Rhynchobatus*, Rhinobatidae, and Rajidae. Myliobatiformes include Platyrrhinidae, *Zanobatus*, and Myliobatiformes (in a traditional sense). The derived myliobatiforms comprise two major clades: *Gymnura* and the pelagic rays, and the benthic rays. The terminal benthic rays form two clades: 1) Indo-Pacific *Himantura*, New World *Himantura*, and potamotrygonids, and 2) *Dasyatis kuhlii*, *Taeniura*, *Pteroplatytrygon*, and *Dasyatis*. Neither *Himantura* nor *Dasyatis*, as presently conceived, are monophyletic. Several West African species of *Dasyatis* are more closely related to Indo-Pacific *Himantura* than to *Dasyatis*.

***ATTUM, OMAR; BAHA EL DIN, SHERIF; SWEIRKI, SULIMAN H.; BRUCE KINGSBURY**

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Egyptian tortoise conservation: A field research program developed from a study on a semi-captive population

We devised an in-situ conservation and research program from a captive population of the globally endangered Egyptian tortoise *Testudo kleinmanni*. We examined the activity patterns and dietary preferences of 28 semi-captive Egyptian tortoises that were considered for possible reintroduction into Zaranik Protected Area (ZPA), North Sinai, Egypt. A goal of this study was to have someone from the local community be the research technician and collect all the data in order to utilize use their indigenous tracking skills and knowledge of the area. In order to overcome any problems with illiteracy, we created a data sheet based on symbols and numbers. The research on captive animals was part of a larger conservation program that included an educational outreach and craft program initiative, which eventually lead to the rediscovery of wild Egyptian tortoises in North Sinai, at which time was thought to be extinct. We have now shifted our focus to in-situ conservation, using the research and local capacity building template developed from this captive population study. We discuss how understanding the activity patterns and dietary preferences of the tortoises

assisted us in conserving wild tortoises. We believe our template can be used by zoos and conservation organizations with small budgets and native collections in natural habitats to create similar captive research programs that can be applied to in-situ conservation.

***AUSTIN, JAMES D.; LOUGHEED, STEPHEN C.; MONTGOMERIE, ROBERT D.; ZAMUDIO, KELLY R.**

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Phenotypic and genetic divergence among disparate mtDNA lineages of spring peepers (*Pseudacris crucifer*)

Ongoing research on the intraspecific evolutionary history of *Pseudacris crucifer* shows significant range-wide phylogeographic structure and displays multiple areas of secondary contact. This pattern makes *P. crucifer* an ideal non-model vertebrate species with which to address questions on the relationship between genetic divergence and levels of reproductive isolation. We are characterizing one such contact zone in SW Ontario in detail (neutral genetic, and phenotypic characters including call structure, sperm morphology, and body proportions) and preliminary work suggests that there are phylogenetic differences in phenotypic characters. Ongoing work across other contact zones representing greater lineage divergences will permit the determination of the extent to which gene flow is incomplete and, ultimately, the relative importance of pre- versus post-zygotic mechanisms underlying differentiation in *P. crucifer*.

***AVOLIO, CARLA**

Biological Sciences A08, University of Sydney, NSW 2006, Australia

Rough boys score better under the sea: Why it pays male snakes to be rugose in an aquatic environment

In several species of sea snakes (Family Hydrophiidae), males possess more rugose scales than do females. I quantified the nature and distribution of these rugosities in relation to sex, size, body condition, season and latitude in four species of sea snakes (genus *Astrotia*, *Emydocephalus*, *Hydrophis* and *Lapemis*) from museum collections. I also evaluated the functional significance of scale rugosities in the reproductive strategies (male-female interactions, male-male interactions and mate searching) of male turtle-headed sea snakes, *Emydocephalus annulatus*. Scale rugosities in this species may have multiple functions, including sensory feedback during courtship (tubercles were better innervated with myelinated nerves) and increased friction between the males and females at this time. Scale rugosity also affected boundary-layer characteristics in various flow regimes. Biomechanical analyses showed that shear stress was greater over models of male (rugose) skin than female (non-rugose) skin at water velocities typical of the speed of courting pairs, but this situation was reversed at higher flow rates (as seen in mate searching males). The greater turbulence over male skin at low flow may enhance gas exchange with the water at courting speeds, whereas the opposite situation at higher (mate searching) speeds may decrease drag force and hence, enhance swimming efficiency. Together, these results

suggest that rugose scales in male sea snakes initially evolved to enhance grip and tactile sensitivity of body parts used directly in copulation, but have been elaborated to cover the entire body surface for hydrodynamic benefits. **SSAR SEIBERT EVOLUTION/SYSTEMATICS**

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Movement patterns of the draughtboard shark *Cephaloscyllium laticeps* using acoustic telemetry and conventional tagging

The draughtboard shark *Cephaloscyllium laticeps* (Duméril, 1853) is the most common catshark in coastal areas of southern Australia. We have been using a combination of acoustic and conventional tagging technology to provide a greater insight into the behavior of this species. Between January 2000 and February 2004, 375 conventionally tagged sharks were released in an isolated reef study site in the Derwent Estuary, Tasmania, Australia. To date, 121 sharks have been recaptured with 36% recaptured on multiple occasions. The large amount of multiple recaptures within the reserve suggests a high degree of site fidelity. Larger longer-term movements of up to 200km have been recorded. The longest period between tagging and recapture was 39 months. Between January-July 2003, 25 sharks were fitted with acoustic tags. Acoustic receivers were deployed in the study site, along the Derwent Estuary and in an adjacent bay. Acoustic tag results also demonstrated the high affinity that draughtboard sharks have for the study site. The analysis of the acoustic data also provided information on residency periods and behavior that could not be obtained from conventional tagging studies. **AES CARRIER**

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Endocrine correlates of the reproductive biology of the oviparous catshark, *Cephaloscyllium laticeps* (Duméril, 1853)

The draughtboard shark *Cephaloscyllium laticeps* is an oviparous species that inhabits the coastal waters off Southern Australia where it is a common bycatch species in commercial trap, net and hook fisheries. We addressed the reproductive condition of this species based on the level of steroid hormones in the plasma. We tested four hormones, Estradiol (E2), Testosterone (T), 11-Ketotestosterone (11-KT) and Progesterone (P4). 11-KT was not detectable in any shark. T, E2 and P4 were present in females although P4 and E2 were only found in low concentrations in males. Correlations of reproductive development with the level of gonadal steroids were obtained and subsequently used to assess the

maturity of sharks caught and released in a scientific reserve. Results from this study demonstrate that assessment of reproductive biology in elasmobranchs can be achieved without harm to the shark. The development of a non-destructive sampling technique has benefits for sampling sharks that do not need to be killed, such as endangered species, species in marine protected areas, nursery areas or bycatch species. This study has significant implications for future elasmobranch research and also advances our knowledge on endocrinology of marine fish. **AES GRUBER**

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A survey of breeding salamanders in Cass County, Michigan:
Identification of two new hybrid genotypes of the *Ambystoma laterale* complex

In 2003 and 2004, 398 salamanders were trapped from ten suitable breeding sites using enlarged, unbaited minnow traps. Three species were captured during the early spring breeding season: Blue-Spotted Salamanders (including the *Ambystoma laterale* complex); Spotted Salamanders, *Ambystoma maculatum*; and Tiger Salamanders, *Ambystoma tigrinum*. No Eastern Newts, *Notophthalmus viridescens*, were captured. All salamanders were anesthetized using MS-222 and the snout-vent length, total length, and mass were measured. In the case of salamanders of the *A. laterale* complex the ploidy levels were determined using flow cytometry and the nuclear genomes of 81 hybrid *A. laterale* complex salamanders were determined by allozymes. In addition to several previously known genotypes that have involved genomes of *A. laterale*, *A. jeffersonianum*, *A. texanum* and *A. tigrinum*. identified in these populations, two new genotypes were discovered in this current survey. These new hybrids were a diploid *A. laterale-tigrinum* (LTi) and a triploid *A. (2) laterale-tigrinum*.

BANACH, EILEEN M.

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Using hemipenis characteristics to determine the correct classification of *Dipsadinae incertae sedis*

The hemipenes of the species comprising the group *Dipsadinae incertae sedis* are described and illustrated. Analysis of hemipenis characters (position of the origin of the retractor muscle, hemipenis length, number of spines, number of spine rows, and the position of the distal end of the spinose midsection of the hemipenis) was conducted to determine the variance within and among the species. Previous systematic study of the species in this group has not yielded reliable placement in a Colubrid subfamily. Therefore detailed investigation of hemipenial characters may enable such placement and should prove useful for future systematic work.

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Habitat use of juvenile slider turtles (*Trachemys scripta*)

Life history studies often detail ontogenetic changes such as differences in habitat use. Several freshwater turtle species exhibit marked differences in habitat use patterns across ages and sizes. However, little is known about the juvenile class of the widely studied red-eared slider (*Trachemys scripta*). Because *T. scripta* is ubiquitous in habitat occupancy as adults, survival pressures on juveniles may result in a marked comparative shift in habitat. We investigated differential habitat use in a population of *T. scripta* from a floodplain lake located in Gallatin County, Illinois. In our initial year of study, we used 25 baited hoop traps for 26 days and all *T. scripta* captured were aged, measured, and sexed. At each trap location we measured water depth, distance from shoreline, canopy cover, presence/absence of logs, presence/absence of bushes, and bank slope for comparison among age classes. Many of our results indicate that more sampling effort will be required to determine if there are trends present. We plan to augment sample sizes by trapping a wider span of habitats and with double the number of traps in the upcoming season.

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Ambush site selection in a generalist forager, the Western cottonmouth (*Agkistrodon piscivorus leucostoma*)

Ambush site selection plays a crucial role in the foraging success of ambush predators. We characterized the nocturnal ambush sites of a prey generalist, the Western cottonmouth (*Agkistrodon piscivorus leucostoma*), in a stream/pool system in Hardin Co., Tennessee. Ambushing snakes (n=30, immobile at site for >15 min) were located between 2100-0500 h. Habitat features were recorded at the ambush sites as well as at four distinct sites at a distance of 2 meters from the ambush sites. These random sites were determined using the four compass points and were used as potential sites that were not selected by the snakes. Recorded habitat features included aquatic versus terrestrial habitat, cover, water depth, grass density, distance to/from shore, water flow, distance from wood structure (with >2 cm diameter) and presence of aquatic support. Sex, mass, SVL and TL were recorded after capture, and snakes were paintmarked to avoid in recapture. The importance of prey availability in site selection was examined as well. Ranid frog density surveys were conducted while walking an 800 m transect of stream/pool shoreline at night, recording the number of frogs sighted, flushed or heard calling within 2 m of the stream. Ambush site selection by *A. p. leucostoma* was non-random. Ambush sites differed from random sites in water depth and degree of cover (snakes selected shallower water and greater cover), but not in distance from wood structure or aquatic versus terrestrial

habitat. Cover may aid in crypsis of snakes, both from predators and prey, while shallow water may increase the probability of successfully seizing prey. Frog density was shown to have a positive correlation with site selection. Thus, ambush site selection may be proximately cued by both abiotic and biotic factors, and the adaptive significance of this choice may be in its effect on nutrient intake.

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Differences in the ratios of fin to carcass weight among fourteen species of sharks

The practice of shark finning, or the harvest of a shark's fins without the carcass (meat), was prohibited by federal law in 1993. To regulate and minimize shark finning, federal rules were enacted that allowed fins to be landed if the total weight of the fins was no more than five percent of the total weight of the landed dressed carcasses. Although many different species are harvested for their fins, the "five percent rule" was established using data from only sandbar sharks, *Carcharhinus plumbeus*, due to a lack of data for other shark species. Fin weight ratios were calculated for several commercially valuable shark species from coastal waters of the U.S. Atlantic Ocean and Gulf of Mexico using standardized data collated from state and federal databases. Analysis of variance procedures, Scheffe's multiple comparison analysis, and student's t-tests were used to test for statistical differences in the fin weight ratios of 14 species of sharks. Comparisons were made among species for which comparable size data were available; therefore large coastal and pelagic sharks were analyzed separately from small coastal sharks and dogfishes. The fin weight ratio of the sandbar shark (5.33%) was the largest of the 14 species examined, while the silky shark, *Carcharhinus falciformis*, exhibited the lowest ratio at 2.53%. The fin ratio of the sandbar shark was significantly higher than most of the other large coastal species we examined, and the bonnethead shark, *Sphyrna tiburo*, had a fin weight ratio (4.91%) that was significantly higher than other small coastal species examined. Fin ratios were not different between juveniles and adults for most species, suggesting an isometric growth relationship. The variation in ratios among the species we examined suggests that species-specific management of shark finning in U.S. waters should be further explored. **AES GRUBER**

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Factors affecting Southern Leopard Frog, *Rana sphenoccephala*, distribution
and detection in five coastal plain refuges

The Department of Interior Amphibian Research and Monitoring Initiative (ARMI) began in 2000 with the goal of evaluating the status and trends of amphibian populations throughout the United States. The southeastern region includes Alabama, Florida, Georgia, North and South Carolina, and Tennessee. Much of the SEARMI effort has been focused on five Gulf and Atlantic Coastal Plain U. S. Fish and Wildlife Service National Wildlife Refuges: Harris Neck, Lower Suwannee, Okefenokee, St. Marks and Savannah. To date, we have recorded 6,500 individual observations of 36 species of amphibians on these refuges. The Southern Leopard Frog, *Rana sphenoccephala*, occurs on all five sites and accounts for approximately 10% of our records. Although many species of amphibians are restricted to certain aquatic habitat types for breeding based on abiotic or biotic characteristics, we have observed *R. sphenoccephala* larvae and adults in the presence and absence of vertebrate and invertebrate predators and in wetlands with ephemeral to permanent hydroperiods. The physical parameters of breeding sites ranged widely with pH (3.62-7.77), dissolved oxygen (0.56-13.1 mg/L), conductivity (0.014-0.808 ms/cm), and temperature (9.21-32.49°C). Although seemingly an obvious candidate for monitoring due to its ubiquitous distribution and apparent abundance, the Southern Leopard Frog is so much of a generalist that meaningful covariates that might help explain its presence or absence in a percent of area occupied analysis are challenging to define. Understanding the factors that influence the abundance and detection of this widespread amphibian may help us develop methods and protocols for other amphibian species that are in decline.

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A minisatellite in the growth hormone gene of Esocidae is derived from a
single copy element in the salmonid genome

The growth hormone gene has been used to infer phylogenetic relationships in fishes, and in closely related species the intronic sequence has shown particular value in discriminating among taxa. To utilize this approach for the esocid family, we first cloned the genomic copy of the growth hormone gene from *Esox masquinongy* and subsequently the fourth intron from the four remaining esocid species. Our initial analysis identified a 33-nucleotide minisatellite in the fourth intron that is present in copy numbers ranging from 7 to 16 among the various species. Database searches indicate that this minisatellite is present only as a single copy element in all of the salmonids, indicating a recent expansion in the *Esox* species since their divergence from a common ancestor. The minisatellite was not detected in any other growth hormone sequences available at the time of this writing. Furthermore, point mutations and deletions in the esocid minisatellites indicate a model for the evolution of this genetic element and corroborate existing molecular phylogenies for the five members of this genus.

***BARRIBEAU, SETH; WALDMAN, BRUCE**

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Kinship association reduces the growth inhibitory effects of the pathogen *Aeromonas hydrophila* on *Xenopus laevis* tadpoles

We examined the effects of crowding, kinship composition, and habitat complexity on the growth and survival of *Xenopus laevis* tadpoles exposed to the bacterial pathogen *Aeromonas hydrophila*. Pathogens increasingly are contributing to amphibian population declines, so we need to understand the factors that predispose amphibians to infection. Crowding, kin composition, and habitat complexity ('psychological space') have been linked to tadpole growth. We examined how these factors influence tadpoles' disease resistance. Tadpoles were raised with just siblings or in mixed kin groups, in crowded or uncrowded conditions, and in simple or physically partitioned (complex) habitats. Under these regimens, tadpoles were exposed either to *A. hydrophila* or to a sham inoculum. We found that tadpoles' growth rates decreased and became more variable as a function of density, exposure to *A. hydrophila*, rearing with non-kin, and increased habitat complexity. Tadpoles in pure sibling groups grew larger than those reared in mixed groups, but this difference was most pronounced when tadpoles were exposed to *A. hydrophila*. Differences in growth rates between sibling and mixed groups decreased in crowded conditions. Size differences between exposed and control tadpoles were greater in low-density than in high-density treatments. Mixed kinship composition and high tadpole density may increase competition and thus reduce growth. Our results suggest that growth is inhibited by exposure to pathogens but that this effect may be ameliorated by reduced competition within sibling groups. Schooling with kin may reduce tadpoles' vulnerability to infection.

***BARRIBEAU, SETH; WALDMAN, BRUCE**

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MHC and disease resistance in *Xenopus laevis* tadpoles

Given recent cataclysmic amphibian declines, understanding the mechanisms involved in disease resistance is becoming increasingly urgent. The Major Histocompatibility Complex (MHC) is an integral part of the vertebrate adaptive immune system and has been well characterised in *Xenopus laevis*. To elucidate the importance of the MHC in conferring disease resistance, we challenged *X. laevis* tadpoles, with known combinations of MHC alleles, to lethal and sublethal doses of *Aeromonas hydrophila*. This ubiquitous bacterium, although commonly associated with 'red leg' in frogs, tends to affect already immunocompromised individuals. We exposed tadpoles of six MHC types, three homozygous and three heterozygous, to *A. hydrophila* that we had isolated from sick frogs, and measured the tadpoles' growth and developmental rates. Initial results indicate that MHC type significantly affected development and growth, although there was no interaction between MHC type and exposure dose. Homozygotes developed more rapidly than heterozygotes and certain MHC types consistently developed faster than others and were more susceptible to the pathogen. There was no difference in survival between heterozygotes and homozygotes. While

the absence of heterozygote advantage is expected when a single challenge pathogen is used, the presence of an *A. hydrophila* 'weak' MHC type illustrates the importance of maintaining population-level genetic diversity at the MHC among at-risk species.

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Utility of the growth hormone gene for estimating phylogenetic relationships among cypriniform fishes

Studies suggest that single-copy, protein-coding nuclear genes are effective for estimating deep divergences in organismal phylogenies and thus can help investigators avoid pitfalls associated with use of only mitochondrial genes for phylogeny reconstruction. The growth hormone gene (GH) is a single chain, pituitary specific hormone that is essential for promotion and maintenance of somatic growth in vertebrates. A number of GH coding sequences are available for fishes and studies have shown that GH is an excellent locus for deep phylogenetic inference. In fishes of Order Cypriniformes, GH comprises 5 exons, and 4 introns and codes for a protein of approximately 220 amino acid residues. In this paper, we use sequences from both exons and introns to demonstrate the utility of the GH gene for resolving relationships among select cypriniform taxa, representing all families and a number of the currently recognized subfamilies. The analysis resolves Order Cypriniformes as monophyletic with high bootstrap support. Catostomids are also monophyletic and sister to cyprinids. This group is sister in turn to Gyrinocheilids plus cobitoids. GH coding sequence divergence among cypriniform families ranges from 12-15% and shows little evidence of saturation or loss of phylogenetic signal, even at the third codon position. Introns are more variable and useful for resolving relationships at more superficial levels within the cypriniform phylogeny. We demonstrate the utility of intron data for examining relationships at and below the genus level in Family Catostomidae. We compare phylogenies based on GH to those based on morphology and mitochondrial DNA sequences.

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Patterns of sequence variation in introns of the growth hormone gene in species of *Ictiobus* (Cypriniformes: Catostomidae)

Genus *Ictiobus*, as currently recognized, comprises four or five species of suckers commonly referred to as buffalofishes. Species in the genus are morphologically

distinct, widespread geographically (Hudson Bay system of Canada to Rio Usumacinta in Guatemala), and have a fossil record dating to the lower Pliocene. Previous work indicates that, with the exception of *Ictiobus labiosus* of central Mexico, cyt b sequence divergences among *Ictiobus* species are very low and inconsistent with morphological variation. The pattern of cyt b sequence variation suggests either low rates of substitution, recent speciation, introgressive hybridization, or a combination of these factors. In order to gain a deeper understanding of the factors contributing to this pattern, we sequenced introns of one of two paralogous copies of the nuclear growth hormone (GH) for specimens from throughout the geographic ranges of currently recognized *Ictiobus* species. GH introns exhibit higher sequence divergences and patterns of variation generally more consistent with morphology than cyt b. However, the GH intron data also show evidence of past and present interspecific hybridization and recent establishment of current geographic distributions of species in the genus. The results suggest decoupling of morphological variation from patterns of variation in both mitochondrial and nuclear genes.

***BART, HENERY L.; RIOS, NELSON E.; JOHANSEN, JOHN W.**

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Computerization, recuration, and inventory of the Tulane University Museum of Natural History fish collection

The Tulane University Museum of Natural History (TUMNH) Fish Collection, one of the largest collections of post larval fishes in the world, has been undergoing curatorial improvements since 1994 with support from the Biological Research Collections program at the National Science Foundation (NSF). The project is currently in the third and final phase. The goals of the project were to completely computerize and georeference collection records, recurate the collection, and inventory the holdings against the collection database. All jar lots in the collection are being transferred from 50% isopropanol to 70% ethanol. In the process, experiments are being conducted to assess the long-term effects of preservation in the two types of alcohol on specimen quality. To date, approximately 90% of the collection has been recurated and inventoried. The collection records are completely computerized, georeferenced and accessible over the Internet. The georeferenced data were use as a test bed to develop an automated georeferencing tool (GEOLocate) which is enjoying wide use in the natural history collection community. The preservation experiments suggest that ethanol is superior to isopropanol for long-term specimen quality. Every summer since 1996, we have been employing minority high school students from the New Orleans Center for Science and Mathematics as curatorial interns with support from the Research Assistantships for Minority High School Students (RAMHSS) program at NSF. supplements since 1996, to involve minority high school students in the collection improvement tasks.

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Do gopher tortoises (*Gopherus polyphemus*) consume exotic cogongrass (*Imperata cylindrica*)? Results of a feeding experiment

The gopher tortoise (*Gopherus polyphemus*) is considered a keystone species because individuals dig burrows that provide shelter and refuge not only for themselves but for numerous commensal organisms, including several protected species. The gopher tortoise is federally listed as threatened in much of its range beyond Florida, and is a species of special concern within Florida. Habitat loss due to rapid development is the greatest threat to the gopher tortoise. A relatively new threat to the persistence of gopher tortoise populations may be the highly invasive cogongrass (*Imperata cylindrica*). This study documented the threat of an expanding monoculture of cogongrass to a population of relocated gopher tortoises in central Florida. The study site was located within the Teneroc Fish Management Area in Polk County, Florida. The first part of the study consisted of a series of feeding experiments conducted in the field. Tortoises were trapped using bucket traps placed outside burrow entrances. Captured tortoises were placed in a holding pen near their burrows for one hour to stabilize their behavior. Cogongrass previously transplanted to a pot was placed in front of the tortoise for an additional three hours to determine absolute preference. The experiment was repeated with two control groups, presenting either *Aristida*, a negatively selected native wiregrass, or green lettuce, a food highly favored by captive tortoises, in place of the cogongrass. The data gathered will be incorporated into a larger study including experiments investigating the effect of cogongrass on the homing and orientation abilities and habitat use of the tortoises. For a number of reasons the spread of the invasive grass effectively reduces the tortoises' habitat, compounding the threat of anthropogenic habitat destruction to this threatened keystone species.

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Seeking caeca: Loss of pyloric caeca - a siluriform gut synapomorphy associated with an animal diet

A survey feeding habits, gut morphology and some preliminary gut histology of siluriforms and related groups reveals synapomorphic conditions of coiling, a possibly pedomorphic lack of coiling and a synapomorphy of the catfish clade, the apparent complete lack of pyloric caecae. Pyloric caecae are wide spread among fishes, both animal and plant feeders, and greater numbers of them are generally considered to be associated with herbivory. The apparent loss of pyloric caecae in the hypothetical ancestral catfish is hypothesized to be a manifestation of a fundamental commitment to feeding on animal material, which when reversed in the very few siluriform plant feeding groups, namely the loricariids, is not accompanied by the reappearance of pyloric caecae. Rather, the Loricariidae is well known for having developed an extreme degree of intestinal coiling.

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Grinding the millstone: Evolutionary divergence within the ocean sunfish, Molidae (Tetraodontiformes)

Ocean sunfish, family Molidae, are enigmatic members of the epipelagic fauna of all tropical and temperate oceans. Although the species *Mola mola* holds the Guinness World Record for the most fecund of fishes, with an estimated 300,000,000 ova found in one female, even a basic understanding of their natural history is lacking. Some research has focused on the systematic relationships among the Tetraodontiformes, including Molidae, but little is known about the population genetics of many of the species in the family or their evolutionary history. We have been studying the population biology and genetics of the ocean sunfish, *Mola mola*, and present phylogeographic and systematic inferences gained from DNA sequences of the control region of the mitochondrial genome of this globally distributed species. Preliminary findings indicate strong population structure between, and to a lesser degree within, ocean basins. During our investigations we have also discovered a cluster of deeply divergent lineages and here we argue for the systematic distinctiveness of this group based on previous species descriptions and geographic distributional information. Additionally, we examine the systematic relationships between members of the family Molidae, including *Ranzania laevis* and *Masturus lanceolatus* using data from the cytochrome b gene. We have found strong support for the traditional hypothesis regarding the sister taxa relationship between *Masturus* and *Mola* and the basal position of *Ranzania* within the family.

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An Eocene gecko in Baltic amber: Implications for gekkotan evolution

A new genus and species of gekkonid lizard is described from the Lower Eocene of northwestern Russia based on a specimen preserved in Baltic amber. The digits of the manus exhibit a combination of characters not present in any living or fossil group of geckos, but the absence of osteological data from the specimen precludes even tentative phylogenetic placement at this time. The specimen represents the first and only record of a gecko from Baltic amber, the oldest amber-preserved gecko, and the first gecko in amber not assignable to a living genus. The foot of the amber gecko has well-developed subdigital lamellae that are indicative of a complex adhesive system comparable to that of living geckos. This places the minimum age of the evolution of scansorial toes in geckos at approximately 54 million years. Like all other amber-preserved geckos, the new

taxon is minute and was probably similar in ecology to *Lygodactylus* spp., the most commonly encountered gekkonid in copal, a more recent plant resin that has yielded many lizard inclusions.

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Experimental analysis of allocation patterns in ambystomatid salamanders

Ontogeny of *Ambystoma tigrinum* and *A. maculatum* were manipulated in order to test the hypothesis that metamorphic timing, metamorphic size, and expression of paedomorphosis are affected by light, growth rate, and temperature. Fat bodies and gonads were removed, scored, and weighed to detect allocation toward sexual development in order to assay paedomorphosis. Identical treatments were imposed for each species to contrast the treatment effects on metamorphic timing in both an obligate metamorph and a facultative paedomorph. Low temperatures resulted in increased metamorphic size and extended larval periods in both species. Increases in food led to increased gonad development. Reduced food led to increased larval periods in both species. Light did not play a significant role in any allocation variable. determining SVL or metamorphic mass. Analysis of allocation to storage, gonads, and metamorphic development supports that notion that facultative paedomorphosis is a feature that is contingent upon environment context. For example, tradeoffs predicted to lead to paedomorphosis are only exhibited in low temperature, low food condition and only in *A. tigrinum*. Thus, there are species-specific differences in allocation patterns that make one species more likely than another to express a paedomorphic life cycle.

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Highs and lows in salamander evolution: Phylogenetics of coastal plain dusky salamanders

The morphologically-conservative plethodontid genus *Desmognathus* has proved repeatedly problematic for herpetologists examining its species-level systematics. Although recent molecular phylogenies have helped resolve relationships among montane forms, species from the coastal plain have been largely ignored. *Desmognathus* is widespread in both Atlantic and Gulf coastal plains and three species *Desmognathus auriculatus*, *D. conanti*, and *D. apalachicola* are currently recognized. However, equivocal species assignments (e.g., *D. auriculatus* vs. *D. conanti*) persist for several populations over broad geographic areas. To clarify relationships among coastal plain *Desmognathus*, we sampled 40 populations from North Carolina to Louisiana and analyzed mitochondrial COI variation for 120 individuals. High levels of sequence divergence suggest more than three species occur in the coastal plain. For example, we documented within drainage sympatry along the Tar River for two undescribed forms historically considered to be *D. auriculatus*. Bayesian inference suggests that the coastal plain likely experienced multiple invasions of ancestral montane *Desmognathus* and that certain coastal lineages have reinvaded montane settings.

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Potential consequences of the coqui frog invasion in Hawaii

The introduced Puerto Rican frog, the coqui (*Eleutherodactylus coqui*), threatens Hawaii's multi-million dollar floriculture, nursery, and tourist industries as well as its unique ecological systems. Using data from Puerto Rico and preliminary data from Hawaii, we suggest likely consequences of the invasion and future areas of research. We expect the greatest impact will be reductions of Hawaii's native arthropods, even though the majority of their diet consists of non-native species. Because native birds are mostly restricted to high elevation forests, there is currently little overlap between coqui and native bird habitats or diets. Furthermore, preliminary data suggests that coquis will not bolster introduced mammal populations, well-known native bird predators. However, coquis may change lowland ecosystems, where the majority of their populations are found, in such a way that native bird re-invasion into these areas would be more difficult. For example, coquis appear to be controlling arthropod prey and increasing nutrient cycling rates, which can alter plant species composition. In summary, research from Puerto Rico and preliminary data from Hawaii suggests that coquis will change community and ecosystem properties where they invade. The ability for other invasive amphibians to have these effects should not be overlooked. Citric acid spraying has curtailed coqui invasion in Oahu and Kauai; however, repeat spraying is necessary to ensure complete eradication and should be complemented with the removal of habitat structure. We will present preliminary data from the first study to determine the impacts of citric acid spraying on coqui population dynamics. This research is relevant to other parts of the world because coqui invasion into other areas is mostly a matter of time.

BEAUMAN, RICHARD L.

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Factors affecting degree of burrow collapse and resulting tortoise self excavation and behavior

The Gopher Tortoise is a federally listed species in the western portion of its range, and a species of concern elsewhere. Their burrows are often collapsed and tortoises become entombed during human activity associated with logging activity and land use. Little is known to what extent burrows collapse, what factors contribute to the degree of collapse, how this impacts the tortoises' ability to self excavate after the collapse, and what effect this has on movement behavior. As part of a larger study to determine how physiologically detrimental this disturbance is to tortoises, we documented the physical factors that impact the degree of the collapse and monitored pre collapse and post excavation movement behavior. In the spring of 2004, we experimentally collapsed active burrows with tortoises in them using a piece of forestry equipment. The burrows were collapsed near their mouths with a JD 648 logging skidder (n = 22). We measured the collapse zone and monitored the number of days until each

tortoise self excavated. The collapsed zone ranged from 0.66 to 2.21m and the amount of time to self excavation ranged from hours to 85 days. The majority of tortoises excavated within 20 days. The distance from the original mouth to the point of exit on self excavation ranged from 0 to 3.05m. There was a significant positive correlation between the amount of burrow collapse and the exit distance from the original mouth. There was no significant difference between the number of burrows used, the number of times moved or the size of the home range pre and post collapse. Upon self excavation, tortoises stayed in the collapse burrow (50%), moved to a previously used burrow (4.5%), or moved to a new burrow (45.5%). This and other aspects of movement behavior will be discussed.

BEAUPRE, STEVEN J.

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Long-term responses of Timber Rattlesnakes (*Crotalus horridus*) to food augmentation.

Bioenergetic modeling and observational studies suggest the primary importance of food availability in determining growth and body condition of low-energy adapted pit vipers. Since 1998, I've conducted a long-term supplemental feeding experiment with Timber Rattlesnakes (*Crotalus horridus*) in the Ozark Mountains of northwest Arkansas. A large sample of radiotagged snakes has been divided into a control group (CON, which feeds naturally) and a supplemental group (SF, offered feeder rats). I've monitored several response variables, including growth rate, body condition, and reproductive behavior. In general, SF animals exhibit significantly greater growth rate, increased body condition (residuals of mass-SVL regression) and increased rates of reproductive behaviors. Significant differences among years in the magnitude of the effect of supplemental feeding result from annual variation in food availability to CON animals. An exceptionally poor food resource year (2004) resulted in the greatest differences between SF and CON treatments. CON snakes are subjected to increased mortality during food-poor years due to starvation and a willingness to adopt risky strategies (foraging late into Fall). Food-poor years result in increased mortality when snakes are caught by hard frosts in November or December. For a variety of reasons, it is unlikely that supplemental feeding will become a useful technique for the remediation of endangered populations. However, growth rates and body condition of Timber Rattlesnakes respond rapidly to changes in food resource availability, making these animals potentially useful for bioassessment.

***BELL, KRISTEN E.; DONNELLY, MAUREEN A.**

Department of Biology, Florida International University, Miami, FL 33199, USA

Influence of forest fragmentation on community structure of frogs and lizards in lowland Costa Rica

We examined community and population structure of frogs and lizards in the fragmented landscape surrounding La Selva Biological Station in the Sarapiquí region of Costa Rica. Frogs and lizards were sampled in nine forest fragments (1-7 ha each) and La Selva (1600 ha) using diurnal leaf-litter quadrats and nocturnal

transects; all sites were sampled monthly between October 2003 and August 2004. Species richness in all fragments (pooled) was 82% of that found in La Selva with comparable sampling effort. Richness varied from 10 to 24 species among forest fragments, compared to 36 species at La Selva. Frogs and lizards responded differently to fragmentation: lizard density was higher and frog density lower in fragmented patches than in continuous forest. Community composition varied among sites and by fragment size class. Species occurrence was nested with respect to fragment area. Between 18 and 25% of species we sampled in continuous forest were absent from forest patches. Such fragmentation-sensitive species may not survive outside continuous forest, while some lizards and other fragmentation-tolerant species remain abundant in forest fragments. Nevertheless, the high diversity observed in the entire set of fragments indicates that preserving a network of small forest patches may be of great conservation value to the herpetofauna of the Sarapiquí region. **SSAR SEIBERT CONSERVATION**

**BELL, KRISTEN E.; WHITFIELD, STEVEN M.; SASA, MAHMOOD;
*DONNELLY, MAUREEN A.**

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Population variability of a leaf-litter herpetofauna at La Selva, Costa Rica: Seasonal and long-term trends

We compared population densities of leaf-litter amphibians and reptiles across 35 years at La Selva Biological Station, a lowland wet forest site in Costa Rica. La Selva has received more attention from herpetologists than nearly any other Neotropical site, and because researchers use a standard sampling method, this site provides a unique opportunity to compare quantitative data on populations over time. Our objectives were to determine whether patterns of seasonal abundance at La Selva are consistent across years, to assess changes in density and relative abundance of amphibians and reptiles over the last four decades, and to compare these changes between amphibians and reptiles to see if they support the hypothesis of amphibian declines. Seasonal abundance patterns were examined for 1973-74 (13 months) and 2003-04 (6 months). In 1973-74 there was a large peak in abundance for most species in March and April, corresponding to the end of the dry season; this peak was absent in 2003-04, and overall densities were an order of magnitude lower than those in 1973-74. Mean monthly densities were calculated for at least two months from each of the following years: 1970, 1971, 1974, 1990, 2000, 2003, and 2004. Most common species of both frogs and lizards in this assemblage demonstrated significant decreases in density over the 35-year period. Members of this assemblage depend on a similar set of habitat and dietary resources, which may explain the similar response across taxa. Our data do not support the hypothesis of an amphibian-specific decline at this site, but may either indicate widespread faunal declines or add to our knowledge of natural population fluctuations of tropical herpetofaunas.

BELL, MICHAEL A.

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Development and evolution of lateral plate position in threespine stickleback: Developmental constraint or natural selection?

Lateral plates are bony armor structures of threespine stickleback, *Gasterosteus aculeatus*. The ancestral complete plate morph has 32-36 plates, with one per myomere, but plates are restricted to the first ten myomeres and number from zero to about ten in low morphs. We scored the myomeres on which plates occur in larval specimens from populations with high adult plate counts (complete and low morphs) but incomplete plate development, and in adult low morphs with a range of plate counts. During ontogeny, lateral plates usually develop first on myomere six, and the second plate is usually added on myomere five. Additional plates are added alternatively in front of or behind these first two plates, maintaining the median plate position of about six until the adult plate complement develops. Most adult low morphs have plates on the same myomeres as corresponding ontogenetic plate number phenotypes from populations with higher adult plate number phenotypes. There is a roughly inverse relationship between plate addition during plate development and plate loss during evolution. Thus, the pattern of plate loss during evolution of lower plate-number phenotypes represents paedomorphosis and might reflect developmental constraint. However, the last plates lost during evolution are the most important ones to stabilize the dorsal spines for defense against predatory vertebrates. Thus, it is possible that natural selection independently favors both early development and retention during evolutionary reduction of the most important plates for predator defense. Selection for a developmental pattern that increases defense function during plate ontogeny in larval stickleback may contribute to canalization of plate development.

BELTRÁN, JENNIE L; PORTER, MARIANNE E.; SUMMERS, ADAM P.
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What makes and breaks cartilaginous jaws: The biomechanics and biochemistry of shark jaw cartilage

All vertebrates begin with a cartilaginous skeleton in the embryonic stage. As they mature, most convert their cartilaginous skeletons into bone. However Chondrichthians (sharks, ratfish, and rays) maintain a cartilaginous skeleton and thrive in the same niches as bony fish. In most vertebrates cartilage is a soft connective tissue that serves two purposes; a low-friction bearing surface and contour filler. Fish with cartilaginous skeletons can function at extremes (growing big, swimming fast, and eating hard-prey) which suggest that the skeletons of these animals are stronger than originally assumed. We also believe that the biochemical properties (collagen, proteoglycan, and water contents) affect the mechanical properties of the cartilage. We examined the biomechanics and biochemistry of shark jaw cartilage from four shark species; *Carcharhinus falciformis*, *Carcharhinus plumbeus*, *Sphyrna zygaena*, and *Isurus oxyrinchus*. Multiple 8.0 mm or 10.0 mm cylindrical plugs were tested by compressing the plug three times to ten percent of its initial thickness ($=0.10$) at 2 mm/sec.

Properties differed between species ($p < 0.001$). Shark cartilage was also stiffer than mammalian cartilage (5.2×10^7 vs. 2.0×10^7 Pa). Shark and mammalian cartilage was similar in strength. The plugs were lyophilized and collagen and proteoglycan was measured with hydroxyproline and DMMB assays. The average value for water content was consistent with mammalian cartilage (85% vs. 75%). Collagen content was much lower than mammalian cartilage (13% vs. 50% DW). Further biochemical studies will investigate why shark jaw cartilage, which has very little collagen content, is as strong as mammalian cartilage.

BENARD, MICHAEL F.

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Survival trade-offs between two predator-induced phenotypes in Pacific treefrogs (*Pseudacris regilla*)

In many organisms, specific predator species induce defensive phenotypes in prey that are qualitatively different from the phenotypes induced by other predator species. This differential induction implies that there is no optimal phenotype that works best against all predators. However, few studies actually test if each predator-induced phenotype provides the highest survival rate in encounters with the predator that induced that phenotype. In this experiment, I reared pacific treefrog (*Pseudacris regilla*) larvae with chemical cues from two different predators (bluegill sunfish and predaceous diving beetle larvae), and without predator cues. The pacific treefrog larvae in the three treatments differed in their morphology and foraging behavior. I then exposed tadpoles from each treatment to free-foraging predaceous diving beetles and bluegill sunfish. Tadpoles survived best when exposed to the predator whose cues they were reared with, and worst when exposed to the other predator. In both predator environments, the tadpoles reared in the non-predator control treatment had intermediate survival between the two predator-induced groups. Thus, there is no generalized 'antipredator' response to these predators; rather, there was a clear trade-off in survival abilities between the predators. **SSAR SEIBERT ECOLOGY**

***BENDIK, NATHAN F.; CHIPPINDALE, PAUL T.; GLUESENKAMP, ANDREW G.**

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Rapid radiation in central Texas neotenic salamanders and the systematic status of the Comal blind salamander, *Eurycea tridentifera*

The neotenic plethodontid salamanders of Central Texas include groups that have undergone rapid diversification, and display remarkable morphological variability associated largely with cave versus surface habitats. These rapid radiations, coupled with evidence of morphological convergence on habitat-associated morphotypes, make fine-scale phylogenetic inference problematic. *Eurycea tridentifera* is a state-protected cavedweller whose systematic status

remains uncertain despite repeated efforts to resolve its relationships with other closely related Texas *Eurycea* ("southeastern", i.e., Blepsimolge clade). Previously, relationships among populations of *E. tridentifera* have been inferred largely based on limited molecular and morphological data. However, monophyly of this species was not well supported, and populations known as *E. tridentifera* could represent convergence to a cave-morphotype which formerly surface populations evolved when they became confined to subterranean habitats. Because the radiation within Blepsimolge is relatively recent, we used fast-evolving molecular markers to reconstruct the evolutionary history of this group. Here we present analyses of sequence data from the mitochondrial control region and other genes for putative populations of *E. tridentifera* plus other species, including numerous recently discovered populations. We test whether the populations identified as *E. tridentifera* (based primarily on morphology) form a monophyletic group, and resolve species boundaries and fine-scale relationships within the Blepsimolge clade of Texas *Eurycea*.

BERENDZEN, PETER B. Z.

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Phylogeography of the Bigeye Chub, *Hybopsis amblops* (Teleostei: Cypriniformes)

Periodic climatic fluctuations during the Pleistocene are thought to have played a major role in shaping the diversity and distribution of freshwater fishes in the Central Highlands of eastern North America. The bigeye chub, *Hybopsis amblops*, is one member of the Central Highlands fauna with a widespread, disjunct distribution in the Mississippi River Basin. This study presents a phylogenetic and demographic analysis of *H. amblops* using complete mitochondrial cytochrome *b* gene sequences for one-hundred and two individuals from twenty-four populations across the range of the species. The objective was to identify patterns of genetic variation across the range of *H. amblops* and use these patterns to assess the roles of dispersal and vicariance in shaping the present diversity and distribution within the group. The phylogeographic patterns exhibited by *H. amblops* are compared to patterns observed in other taxa. The results reveal deep divergence between populations east and west of the Mississippi River and patterns of demographic expansion consistent with glacial cycles. Populations in the Ozark Highlands are estimated to have expanded during the interglacial period following the pre-Illinoian glaciations and populations in upper Ohio River drainage are estimated to have expanded following the most recent Wisconsin glaciation. **STOYE GENERAL ICHTHYOLOGY**

***BERIAULT, KARINE; BOGART, JAMES P.**

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What is critical habitat? The case of the Jefferson Salamander

The purpose of this study was to test whether the presence of Jefferson Salamanders (*Ambystoma jeffersonianum*), Blue-Spotted Salamanders (*Ambystoma laterale*), and their associated polyploid unisexuals in Southern Ontario could be

predicted using habitat variables, and whether these putative predictor variables differ among species/genotypes. The Jefferson Salamander has been designated as Threatened in Canada, and determination of its critical habitat has been deemed an important part of its recovery plan. Radiotelemetry on 16 polyploid unisexuals was employed to determine the average post-breeding migration distance and terrestrial microhabitat use. A range of biologically significant habitat variables was measured at a variety of breeding and non-breeding pond sites and in the surrounding forest habitat. The presence or absence of the various species/genotypes was determined by collecting egg masses and tissue samples from larvae and breeding adults. Post-breeding migration distance was determined using GIS and the habitat variables were analyzed using AIC. These types of data are typically used in the description of critical habitat, but given the results of this study it seems crucial that the concept of critical habitat and the method of its determination be critically reevaluated.

BERRA, TIM M.

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Observation of egg carrying by male nurseryfish, *Kurtus gulliveri*: Natural history notes from northern Australia

Egg carrying by male nurseryfish, *Kurtus gulliveri* (Perciformes: Kurtidae) is often cited in literature reviews of parental care, but rarely witnessed in nature. During 20 field trips in October-November 2003, and eight trips in July-August 2004, 988 nurseryfish (70% male, 30% female) were collected by gill netting in Marrakai Creek, a tributary of the Adelaide River 65 km east of Darwin, Northern Territory. Seven egg masses (six unfertilized and one containing eyed embryos) were caught during 2003 in the nets, stripped from the male supraoccipital hook by the mesh. This demonstrates that eggs become attached to the male before fertilization. We observed males carrying eggs, and we witnessed the subsequent detachment of the egg mass. Two unfertilized and six fertilized egg masses were caught in gill nets in 2004. A table of 29 other species that were caught with *Kurtus* is provided. This includes 31 specimens of the undescribed speartooth shark, *Glyphus* sp. A. The polynemid, *Eleutheronema tetradactylum*, regurgitated a partially digested nurseryfish, and a barramundi, *Lates calcarifer*, had a nurseryfish in its stomach. These represent the first records of fish predation on *Kurtus gulliveri*. A nurseryfish specimen with a minute left pupil is illustrated for the first time—a teratological phenomenon known as a pin-hole camera eye. In July and August 2004 electrofishing in Marrakai Creek and Beatrice Creek was carried out in an attempt to collect males with intact egg masses. This technique was very effective for barramundi but not for nurseryfish as they prefer the deeper mid-channel rather than the more easily shocked bank. Water chemistry data are presented showing that this region of the Adelaide River is of low conductivity and high turbidity.

***BESENHOFER, LAUREN M.; CARR, JOHN L.**

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Assessment of parentage in clutches of Alligator Snapping Turtle (*Macrochelys temminckii*) eggs using microsatellite markers

The Alligator Snapping Turtle (*Macrochelys temminckii*) is the largest freshwater turtle in North America. It has been heavily exploited in the past and now receives some protection in every state within its range. *Macrochelys* exhibits strong sexual size dimorphism, suggesting that forced insemination may occur in the wild. Multiple paternity may result from forced insemination, multiple matings, or sperm storage. Determining whether or not *Macrochelys* exhibits this mode of reproduction is important because it may help slow the loss of genetic variability through drift in small populations. The genetic benefit of this reproductive tactic to the female include increasing the possibility of sperm competition and insuring that the sperm of at least one of her mates is genetically compatible with her own gametes. Increases in offspring quality and even overall population size are the ultimate consequences of these genetic benefits. The absence of evidence of multiple paternity may indicate that female mate choice, and not forced insemination may occur in the wild. Another possibility is that females do not encounter more than one male in the breeding season and therefore do not have the opportunity to mate with multiple sires. This study uses microsatellite regions in DNA to determine the parentage of nine clutches of *Macrochelys* collected from Black Bayou Lake National Wildlife Refuge in northeast Louisiana. Microsatellites mutate at such a high rate that they are good indicators of parentage. Microsatellites have been used to observe the occurrence of multiple paternity in nearly all turtle species studied including, 37.5% of *Podocnemis expansa* clutches, 66% of *Chelydra serpentina* clutches, 33% of *Caretta caretta* clutches, and 58% of *Lepidochelys kempii* clutches. Two microsatellite loci have already been identified for *Macrochelys*, and others will be adapted for *Macrochelys* from other closely related turtle species.

BESSERT, MICHAEL L.

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Conservation genetics in the genus *Cycleptus* (Catostomidae) based on mtDNA and microsatellite data

Cycleptus is a geographically widespread genus of suckers (Catostomidae) that occurs in large rivers throughout the Mississippi, Rio Grande, and Mobile basins as well as several disjunct coastal drainages in central North America. The genus was considered monotypic for over 175 years as *Cycleptus elongatus* until the recent morphological description of a sister species, the southeastern blue sucker (*C. meridionalis*). A subsequent allozyme study suggested an additional distinct type in the Rio Grande basin of western North America. In this study, I have assessed range-wide mtDNA diversity to determine whether previous morphological and allozyme distinctions are supported by molecular genetic data and to ascertain whether each disjunct coastal drainage harbors a unique genetic type. Results show that three geographically isolated clades exhibit reciprocal monophyly at the mtDNA control region. Two conform to the current species delineations while the third occurs in the Rio Grande basin. Phylogenetic

topology and genetic distance between clades indicate that populations in the Rio Grande basin may warrant description as a third species. Microsatellite and mtDNA genetic data are also being used to estimate local population parameters such as effective population size and gene flow between disjunct areas. These results have important implications for conservation given that populations in the Rio Grande basin are currently recognized as *C. elongatus* and that cycleptids are categorized as S3 (vulnerable) to S1 (critically imperiled) in all 21 states where they occur. **STOYE CONSERVATION**

***BETANCUR, RICARDO; ACERO, ARTURO; BERMINGHAM, ELDREDGE; COOKE, RICHARD**

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Systematics, evolution, and biogeography of New World Ariids as inferred from mitochondrial, nuclear and morphological evidence

Phylogenetic relationships for 37-41 New World and two Old World species of sea catfishes are hypothesized using maximum parsimony (MP) and Bayesian inference (BI) optimality-criteria on 2922 mitochondrial (cytochrome b, ATP synthase 8 and 6, ribosomal 12S and 16S) and 978 nuclear (RAG2) characters. Mitochondrial data yielded clades highly resolved at subfamilial, generic and specific levels. Nuclear RAG2 data showed poor resolution and BI responded with higher sensitivity than MP to the low phylogenetic signal. The molecular phylogeny was compared to a previously compiled morphological data set that was expanded herein to a total of 23 ariid species and 56 characters. The phylogeny derived from MP analysis of the morphological data was highly congruent with those derived from the molecular evidence. All topologies agree in the division of Ariidae into two subfamilies (ariines and the monogeneric galeichthyines). The monophyly of the genera *Ariopsis*, *Bagre*, *Cathorops*, *Galeichthys*, *Notarius*, and *Sciades* and the validity of *Potamarius* is supported. The genus *Arius* as commonly recognized is not monophyletic and should not be applied to New World species. '*Arius*' *dasycephalus* was recovered as a primitive *Cathorops* lineage. *Potamarius* and *Ariopsis* formed a clade sister to *Sciades*. '*Arius*' *platypogon* was often recovered as an independent lineage within ariines clade and should be placed in a new genus. Phylogenetic positions of four taxa confined to freshwaters imply three independent reversions from the derived condition of ariids (i.e., marine or estuarine inhabitants) to the primitive condition of Otophysi (i.e., freshwater inhabitants). Diversification of the predominantly tropical ariines likely occurred in the Tethys Sea whereas speciation events in the subtropical galeichthyines are probably tied to the southern coast of Gondwana.

***BETHEA, D.M.; HALE-WILLIAMS, L.; CARLSON, J.K.; CORTÉS, E.; MANIRE, C.A.; GEILSCHLETER, J.**

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Latitudinal variation in the diet and daily ration of the bonnethead shark *Sphyrna tiburo* from the eastern Gulf of Mexico

Bonnethead *Sphyrna tiburo* diet and daily ration were determined for three major areas in the eastern Gulf of Mexico: northwest Florida (latitude $\approx 30^{\circ}\text{N}$), Tampa Bay ($\approx 28^{\circ}\text{N}$), and Florida Bay ($\approx 25^{\circ}\text{N}$). In each area, diet was assessed size classes (40-60, 61-80, and 81-100+ cm TL) and quantified using six indices: percent by number, percent by weight, frequency of occurrence, the index of relative importance (IRI), IRI expressed on a percent basis (%IRI), and %IRI based on prey category (%IRIPC). In northwest Florida, a mix of decapod crabs, decapod shrimps, and crustaceans other than lobster were found in stomachs of sharks 40-60 cm TL (n=78). Stomachs of sharks 61-80 cm TL (n=60) and 81-100+ cm TL (n=51) contained mostly decapod crabs. The same trend was observed in Tampa Bay for the larger two size classes of sharks (n=103 and n=61, respectively). In Florida Bay, sharks 40-60 cm TL (n=27) fed on crustaceans and cephalopods, sharks 61-80 cm TL (n=90) took fewer decapod crabs and shrimps and more lobsters and cephalopods, while the diet of sharks 81-100+ cm TL (n=38) was dominated by cephalopods, lobsters, and decapod crabs. Correlation and simple correspondence analysis showed diets from northwest Florida and Tampa Bay to be similar; diets of sharks from Florida Bay were different. A bioenergetic model was constructed to estimate daily ration using diet data from this study and species-specific inputs from other studies. Daily ration was different among areas and life stages. Daily ration was highest for young-of-the-year sharks and lowest for adult sharks.

***BEVIER, CATHERINE R.; PARKER, JILLIAN E.; CONLON, J. MICHAEL**

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Antimicrobial peptides in skin secretions from frogs of the *Rana catesbeiana* species group

A remarkable variety of compounds are synthesized and secreted in anuran amphibian skin. These serve primarily to protect the animal from predators and pathogens. Ten peptides from secretions collected from the mink frog, *Rana septentrionalis*, and carpenter frog, *R. virgatipes*, members of the monophyletic *R. catesbeiana* species group, were purified and structurally characterized, and showed differential inhibition of microorganism growth. The distribution of these peptides in these two ranids, and in other North American ranid frogs that have been analyzed, can be studied in a phylogenetic context, and contributes to a better understanding of potential pathogenic sources of recent amphibian population declines, such as the chytrid fungus, *Batrachochytrium dendrobatidis*.

For example, ranalexin has only been detected in members of the *R. catesbeiana* species group, including *R. catesbeiana*, *R. gryllo*, *R. clamitans*, and *R. virgatipes*, but were not found in skin secretions from *R. septentrionalis*. On the other hand, four paralogs of brevinin-1, a family of peptides widely distributed in the skins of Eurasian ranids and North American ranids in the *R. pipiens* species group, and a highly potent brevinin-2-related peptide were isolated from secretions from *R. septentrionalis*. We are continuing investigations of interspecific and geographic variation in the peptides, and especially their effectiveness on local microbial fauna. These peptides could also contribute to the development of novel antimicrobial agents to treat the rising numbers of antibiotic-resistant pathogenic bacteria.

***BICKFORD, JOEL; LOWERRE-BARBIERI, SUSAN; WALTERS, SARAH**

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Determining the number of ultrasonic receivers needed to evaluate fish residence times.

Sonic tags and remote receivers can be used to determine the movement of fishes. In order to use remote receivers to determine residence times, tag range has to be determined. We tested the ranges of two Vemco VR2 receivers and Vemco V8sc-2L tags in Tampa Bay at Bunces Pass in March 2004. A single spotted seatrout, *Cynoscion nebulosus*, was captured and internally implanted with a sonic tag and held for an extended period in a netpen that was anchored on the bottom. One receiver was placed at a distance of 85m and the other at 170m from the netpen and both were moored approximately 1.5m off the bottom. A macro was written in Microsoft Excel to give quantitative measurements of reception. Tag reception of the 170m receiver was significantly lower than that of the 85m receiver over the test period. With respect to current, the 170m VR2 reception varied significantly between the ebb and flood tides, whereas the 85m VR2 did not. Based on the minimum range at which there was consistent reception, Arc View 3.3 was used to determine the GPS positioning of an array of 18 VR2 receivers. This array ensures that if a tagged fish occurs anywhere within our predetermined sampling area, it will be detected under all tidal regimes.

***BIZZARRO, JOSEPH J.; SMITH, WADE D.; MÁRQUEZ-FARIAS, J.F.; HUETER, R.E.**

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Reproductive biology and fishery aspects of the golden cownose ray, *Rhinoptera steindachneri* (Evermann and Jenkins, 1891) from the Gulf of California and Pacific coast of Baja California Sur, Mexico

The golden cownose ray, *Rhinoptera steindachneri* (Evermann and Jenkins, 1891),

is widespread in coastal waters of the tropical and subtropical eastern Pacific. It was among the most abundant species taken in artisanal elasmobranch fisheries of the Gulf of California and Bahía Almejas (Baja California Sur), Mexico, during 1998-2000. In the northern Gulf of California, *R. steindachneri* landings peaked during summer months and were negligible during winter. In Bahía Almejas, this species was frequently landed in August and uncommon in June, a trend also noted in CPUE (#individuals/vessel/trip; August =1.13, June=0.13). Size segregation and schooling behavior was evident from landings in both regions. Disc width (DW) of *R. steindachneri* harvested in the Gulf of California ranged from 39-98 cm and averaged 64.2 cm for males (n=585) and 64.4 cm for females (n=505). The largest male (96 cm DW) and female (104 cm DW) were recorded at Bahía Almejas. Size at first maturity and 50% median maturity were similar for males (64 cm, 69.9 cm DW) and females (65 cm, 70.0 cm DW). The largest immature male was 78 cm DW and the largest immature female was 72 cm DW. Fecundity was determined to be one offspring per female with larger females carrying larger embryos. Parturition was estimated to occur from late June to August at 39-45 cm DW after a gestation period of 10-12 months. Bahía Almejas served as a nursery ground for neonate *R. steindachneri* and a likely breeding location for adults. The conservative reproductive strategy of *R. steindachneri*, in which a single pup is produced annually after maturity is reached at a relatively large size, suggests that this species is of low productivity and highly susceptible to overexploitation.

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Osteology of *Arthroleptis* and *Schoutedenella* (Anura: Ranoidea: Arthroleptidae)

Few studies have addressed osteological diversity within African ranoid frogs. Exceptions include studies of the Hyperoliidae (Laurent 1941b, 1944; Drewes 1984; Wilson 2000), Ranidae (Clarke 1981) and taxa currently treated as the Petropedetidae (Laurent 1941a). In addition, Raymond Laurent (1940, 1941a,b) discussed the osteology of a diverse range of ranoids including taxa currently included in the Arthroleptidae, Astylosternidae, Hyperoliidae, Petropedetidae, and Ranidae (Frost 2004). Laurent (1973) proposed a specific phylogenetic hypothesis for the relationships within the Arthroleptidae based on a suite of skeletal morphologies. In the light of more recent work on the effects of small body size on skeletal morphology in amphibians (e.g., Hanken 1983, 1984; Hanken & Wake 1993; Wake 1986), it is apparent that many of the characters proposed to unite the genus *Schoutedenella* may be due to the evolution of small body size and thus not necessarily indicative of close phylogenetic relationship. My research addresses the effect of body size and growth on skeletal morphology within the Arthroleptidae and aims to resolve whether small body size, and thus similar skeletal morphologies, have evolved convergently within this group. Thus far, my research on osteology within the Arthroleptidae, particularly in *Arthroleptis* and *Schoutedenella*, indicates potentially greater osteological diversity than was recognized by Laurent. Two particularly interesting results include the ability to easily discriminate between species that are essentially cryptic based on external morphology (e.g., *Schoutedenella xenodactylus* and *S. xenodactyloides*) and that the osteology of species currently

placed in the genus *Schoutedenella*, characterized by small body size, exhibits marked heterogeneity. In addition, comments will be made on postembryonic skeletogenesis in *Arthroleptis* and *Schoutedenella*. **STORER HERPETOLOGY**

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The geographic distribution of genetic diversity in the *Etheostoma flabellare* species complex (Percidae, *Catnotus*) from the lower Atlantic Slope River drainages of North and South Carolina

Based on morphology, the fantail darter, *Etheostoma flabellare*, is highly variable geographically and has long been recognized as a species complex. To assess the magnitude of variation and unrecognized diversity in the *E. flabellare* species complex, I examined genetic variation among populations from across the geographic range of the complex using two molecular markers, the mitochondrial ND2 gene and intron 1 of the nuclear S7 gene. Phylogenetic analyses generated congruent trees for both S7 and ND2 data sets and recovered several distinct lineages, which have each undergone subsequent diversification. One of these lineages, a well-supported, monophyletic clade containing *E. flabellare* from the Pee Dee, Santee, Savannah and Cape Fear River drainages, and the New (Ohio R.) and upper Tennessee river systems, was further examined for population-level genetic structuring. The ND2 gene was sequenced for an additional 70 individuals from 30 localities within this clade to investigate the geographic distribution of genetic diversity and the level of population subdivision. Examination of ND2 haplotype networks generated for these individuals revealed high levels of population subdivision across drainage divides and at smaller spatial scales within river systems. Sampled haplotypes were not shared among populations from different drainages or among sub-populations within drainages. The genetic structuring of populations in the lower Atlantic Slope region is generally congruent with the observed geographic variation in morphology. However, many genetically distinct populations share similar morphologies, suggesting that populations are more subdivided than predicted by morphology alone. **STOYE GENERAL ICHTHYOLOGY**

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Body size and head size of island *Boa constrictor* in Belize: Environmental and genetic contributions

Marked differences in body size and head size have been documented between island and mainland populations of boas (*Boa constrictor*) in Belize. Island boas average one-half the length and one-fifth the mass of mainland boas and island boas have longer heads and larger eyes compared to mainland boas. However, the genetic and environmental contributions to these differences are unknown. Herein, we describe patterns of offspring size and reproductive investment in

island and mainland boas and present the results of two common-garden experiments; the first designed to elucidate genetic and environmental contributions to body size and the second designed to elucidate the effects of prey size on head size. The results demonstrate that island and mainland boas contribute similar proportions of their mass to litters but that island boas have smaller litters of smaller neonates compared to mainland boas. After rearing in the common-garden, island boas made up a difference in mass (in 50 days) and length (in 100 days) but then achieved growth rates that were less than that of mainland boas and ultimately island boas did not achieve a smaller size compared to mainland boas. However, in the lab island boas grew larger than most wild-caught snakes. Our results support the idea that body size differences between island and mainland boas are due to a mixture of genetic modification of growth rates and phenotypic plasticity. Results from the head size experiment showed that after adjusting for body size, island boas were born with cranial elements of different size compared to mainland boas. When reared on a diet of either one large or 2 small rodents, we found no effect of prey size or location (island versus mainland) suggesting that boa cranial elements are genetically fixed and differences in head size of free-ranging boas may be locally adapted.

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Mitochondrial genetic variation of the Mahi Mahi *Coryphaena hippurus* from the central and eastern Pacific

Pelagic species such as the circumtropical mahi mahi *Coryphaena hippurus* face few barriers to dispersal. In Mexico, this species is reserved to recreational fisheries and commercial exploitation is not permitted by law. The need to revise this management policy has prompted the issue of whether Mexican mahi mahi can be managed as a single stock or more. Here we present genetic data from specimens collected in Hawaii and the eastern Mexican Pacific, to provide some insight to the possible existence of genetically differentiated subpopulations in this region of the species range. PCR-RFLPs of the mitochondrial NADH1 gene revealed relatively high levels of haplotypic diversity and moderate levels of nucleotide diversity. Statistical analyses of genetic heterogeneity showed no evidence of genetic structure in the populations sampled suggesting that high levels of gene flow prevail in this region. Nevertheless, these results are preliminary in that they are constrained both geographically and genetically, future analyses of a larger data set including more localities and loci will provide more definitive answers on the levels of genetic differentiation of mahi mahi in the eastern Mexican Pacific.

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The *Conorhynchos conundrum*: Investigating the phylogenetic position of an enigmatic neotropical catfish (Siluriformes, incertae sedis)

Conorhynchos conirostris, the only valid species in the genus *Conorhynchos*, is thought to be endemic to the Rio São Francisco. For a long time, the taxon has been included in the large neotropical family Pimelodidae. However, that placement of *Conorhynchos* was based exclusively on the general aspect of the fish, since scarcity of study material discouraged detail investigation of its anatomy. Recent study based on new material reveals that *Conorhynchos* does not share the known synapomorphies for Pimelodidae or any of its major subgroups. In fact, *Conorhynchos* does not share known synapomorphies with any single current catfish family, neotropical or otherwise. In this study, we review all the morphological evidence for putative placements of *Conorhynchos*, with a comparative coverage encompassing practically all siluriform families. We survey with special emphasis the possible relationships of *Conorhynchos* with Pimelodidae, Bagridae, Auchenoglanididae, Doradoidei (Doradidae, Auchenipteridae and Mochokidae) and "arioids" (Ariidae, Claroteidae, Pangasiidae, Schilbidae). The morphological evidence points most strongly to the hypothesis that *Conorhynchos* is a member of the suborder Doradoidei (Mochokidae + Auchenipteridae + Doradidae). Further characters indicate that the genus is sister group either to Doradidae plus Auchenipteridae or to all other doradoids. Either phylogenetic position requires recognition of a separate family for *Conorhynchos*, and implies respectively a relatively simple or a complex biogeographical explanation. We look forward to testing these hypotheses with additional broadly comparative data. This research is supported by CNPq, FAPESP, and NSF.

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Identification of genomes in multigenomic unisexual salamanders (genus *Ambystoma*) using GISH

More than 20 nuclear genomic combinations are known to exist in natural populations of Eastern North American unisexual salamanders in the genus *Ambystoma*. These females are mostly triploid but diploid, tetraploid, and pentaploid individuals have also been found in the complex. Based on isozymes, individual unisexual females have chromosomes that are derived from two, three or four distinct, normally bisexual species (*A. jeffersonianum* (JJ), *A. laterale*

(LL), *A. texanum* (TT), *A. tigrinum* (TiTi)). Based on mitochondrial genes, the originating female for the unisexual complex is a fifth species (*A. barbouri*). The unisexuals live in sympatric association with at least one of the four bisexual species. Sperm from a sympatric male is required for development of the unisexual eggs but is usually not incorporated and the eggs can develop by gynogenesis. Occasionally, the genome of a male is incorporated to elevate the ploidy level or to replace a genome. Unisexuals are automictic. Meiosis involves a pre-meiotic doubling of the chromosomes followed by a reductional division. All of the four bisexual species that can contribute chromosomes to the unisexuals have very similar karyotypes and, using conventional cytogenetic techniques, the chromosomes can only be counted to confirm ploidy level. We applied genomic *in situ* hybridization (GISH) techniques to document the genomic contribution of *A. laterale* and *A. jeffersonianum* in LJJ and LJJJ unisexuals. Previous hypotheses of genetic stability and monophyletic unisexual clonal lineages are not supported. Observed inter- and intra-genomic chromosomal translocations demonstrate that unisexuals undergo considerable genetic restructuring. Genetic variation and genomic interaction within unisexual individuals explain both their evolutionary success in mixed unisexual-bisexual populations well as the high frequency of embryonic mortality that is observed in all unisexual populations.

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Evolution of post-zygotic isolation in Centrarchidae

It is well known that the more distantly related two species are, the less likely they are to hybridize. However, many questions remain about the speed at which reproductive isolation evolves, its genetic basis, and the role of divergent natural selection. We conducted a comparative analysis of hybridization success in centrarchids, to quantify the relationship between hybrid viability and the amount of time two species have been evolving in isolation. We took advantage of a well-resolved phylogeny of Centrarchidae based on 7 genes, and fossil calibrations from within the clade, to generate estimates of divergence time between all possible species pairs. We then collected published data on hybrid viability in centrarchids. Using a statistical correction for the phylogenetic non-independence between different pairs of species, we showed that hybrid viability declines at a constant rate after a lag time of about 6 million years during which hybrid viability remains equivalent to or even exceeds the viability of pure species controls. After this lag, viability is lost at a rate of 3% of hybrid embryos per million years of divergence. This is the slowest rate yet documented for the evolution of post-zygotic isolation. We argue that the absence of distinct sex chromosomes in centrarchids eliminates the capacity for this family to experience Haldanes Rule, and therefore centrarchids evolve genetic incompatibilities more slowly than in other vertebrate groups, suggesting that chromosomal architecture influences the rate of speciation. Evidence for cyto-nuclear incompatibilities is based on the observation that reciprocal crosses between species yield asymmetrically viable F1 hybrids, which requires interactions between haploid and diploid loci. Finally, we present evidence that body size divergence, indicative of ecological divergence, can promote speciation. This is

based on our finding that species pairs with greater body size divergence have lower hybrid viability than expected given their divergence time.

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Choice of spawning temperature by Neotropical cichlid fishes

Fishes are very particular about choosing when and where to spawn. Many factors may affect a parent's choice of where to spawn such as substrate availability and temperature of the water. Water temperature is very important because it likely affects oxygen concentration and developmental rates of the offspring. Warm water holds less oxygen than cool water, and larger eggs consume more oxygen than smaller eggs. We predicted that when given a choice, parents should choose a temperature based on the size of eggs that they will lay, i.e., fish that lay larger eggs should prefer to spawn in cooler water than fish that lay smaller eggs. To test this, we designed and built a temperature-based spawning-choice apparatus. The apparatus enables a pair of fish to have four different temperatures to choose from in which to spawn. Working with neotropical cichlids (e.g., *Archocentrus nigrofasciatus* and *Archocentrus spinosissimus*), we found that individuals of a species make precise and consistent choices of the temperature at which to spawn. **STOYE ECOLOGY & ETHOLOGY**

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Biogeography and evolution of body size and toe number in the salamanders of the family Amphiumidae

The enigmatic salamanders of the family Amphiumidae inhabit lowland aquatic ecosystems throughout the Coastal Plain of the southeastern United States. The only extant genus, *Amphiuma*, includes three elongate, permanently aquatic species with four highly reduced limbs that append one, two, or three toes. The large-bodied species *Amphiuma means* and *A. tridactylum* are more widespread, occurring across the Atlantic and the Mississippi Coastal Plains, respectively, whereas the diminutive *A. pholeter* has a relatively limited distribution across the panhandle of Florida and adjacent states. To date, the only molecular phylogenetic hypothesis for these species found *A. means* and *A. tridactylum* to be very close relatives (Nei's $D = 0.12$), and very divergent from *A. pholeter* (Nei's $D \geq 0.73$). However, even though this study was based on 24 allozyme loci, it only analyzed a very limited number of populations. Here we present the first phylogenetic analysis of the Amphiumidae based on DNA sequences. We sequenced Ն bp of mt-DNA (cyt b and 16S) for many individuals from

throughout the distribution of the three species. We found at least three very divergent mt-lineages in this family. These lineages roughly correspond to the three currently recognized taxa but, contrary to the former allozyme study, we found a group of *Amphiuma* with three toes to be most divergent. This discrepancy in our results appears to be due to discordance among allozymes, mt-DNA, and toe number across the species boundary between *A. means* and *A. tridactylum*. To further address this trichotomy we sequenced approximately half of the mt-genome (~8000 bp) and the nuclear gene Rag-1 (~1500 bp) for representative individuals. Using this new robust phylogeny for the family, we clarify species boundaries and taxonomic issues, and present hypotheses for biogeography, evolution of body size, and digit reduction in the Amphiumidae.

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Growth in spotted seatrout (*Sciaenidae*) as an indicator of estuarine conditions in the southeastern U.S.

The life history features of the spotted seatrout, *Cynoscion nebulosus*, have tremendous potential in being able to discern long-term trends in conditions within and among estuaries because the species is widely distributed (i.e., coastal areas from North Carolina to Mexico), is both commercially and recreationally important, and rarely leaves its home estuary. Thus the estuarine conditions to which it was subjected while growing could be reflected in changes in its life history features such as growth. About 400 spotted seatrout were collected from April to August 2003 from the lower Caloosahatchee River/Estuary in southwest Florida (USA). Otolith sections were examined with enhanced imagery to facilitate recording age and annulus increments from the otolith. Males and females were from 1-4 years of age and displayed a significant relationship between otolith radius and fish length that was different between sexes. A comparison of back-calculated size at Age 1 for four separate year classes (1999-2002) indicated that there were significant differences in growth among year classes. Time-series analysis indicated one-year lags in seagrass density and salinity were associated with fish growth. These environmental conditions are artificially manipulated in this estuary and may be responsible for the differences in growth rates observed for both males and females among year classes. Ongoing research will determine year-class specific growth parameters for other estuaries in the southeastern U.S. to allow comparisons between years and among estuaries.

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Molecular characterization of major histocompatibility complex class II alleles in wild tiger salamanders (*Ambystoma tigrinum*)

Major histocompatibility complex (MHC) class II genes are usually among the most polymorphic in vertebrate genomes because of their critical role (antigen

presentation) in immune response. Prior to this study, class II genes were poorly characterized in tiger salamanders (*Ambystoma tigrinum*), but the axolotl (*A. mexicanum*) class II gene is thought to lack allelic polymorphism. The monomorphism of the axolotl class II gene could be due to relaxed selection, phylogenetic constraints, or demographic history. Here, we use a comparative approach with tiger salamanders to differentiate among these alternate hypotheses. In this study of the evolution of MHC genes in urodele amphibians, we describe for the first time a polymorphic class II gene in wild tiger salamanders. We sequenced the peptide binding region of a class II gene from wild *A. tigrinum* (n = 33) and identified 9 distinct alleles. Observed heterozygosity was 73% and there were a total of 46 polymorphic sites, most of which correspond to amino acid positions that bind antigens. Patterns of nucleotide substitutions exhibit the signature of diversifying selection, but no recombination was detected. We have no direct data on the immunoefficiency of tiger salamanders, but the levels of polymorphism in our study population should suffice to bind a wide variety of foreign antigens (unlike axolotls). Our tiger salamander data suggest that the monomorphism associated with axolotl class II genes is a relict of their unique historical demography, not their phylogenetic legacy.

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Identification of steroid hormones in the allantoic fluid and plasma of loggerhead hatchlings

Assessing sex ratios for populations of sea turtles is an important aspect of species conservation. Laboratory studies of temperature and sex ratios have provided the community with good estimates of sea turtle pivotal temperatures, but may not be predictive in natural environments where temperatures are consistently changing. This project has developed a novel procedure for detecting the estrogens and testosterone in allantoic fluid and blood plasma of hatchling loggerhead sea turtles. Collection of egg fluids is non-invasive to the turtles, while blood collection is relatively easy for conservationists and scientists. Eggs were incubated in individual cups approximately 1 week prior to the estimated hatch date. Upon hatching, 2 mls of allantoic fluid were collected, and 200 μ l of blood was collected from the 2-3 day old hatchlings. These samples were frozen, extracted twice with ethyl acetate, dried under nitrogen and finally resuspended in an acetonitrile and distilled water mixture. High performance liquid chromatography was performed in the laboratory to determine hormone profiles. These profiles were compared to known standards to determine concentrations within the initial sample and percent recovery. Steroid hormones are readily detectable in both the allantoic fluid and plasma, with estrone concentrations highest in the egg fluids. Estrone and estradiol levels are both high in the plasma. Fluid estradiol levels were below equipment detection limits, but this hormone was detectable in plasma. This method could provide a means to assess sea turtle sex ratios in large populations at different ages and life stages.

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Shallow mtDNA coalescence in Atlantic pygmy angelfishes (genus *Centropyge*) indicates a recent invasion from the Indian Ocean

Pygmy angelfishes (genus *Centropyge*) are widespread and species-rich in the Indo-Pacific, but only three species (distinguished by color patterns) are recognized in the Atlantic: *C. resplendens* on the mid-Atlantic ridge, *C. argi* in the Caribbean, and *C. aurantonotus* in Brazil and the southern Caribbean. Atlantic species are very similar to *C. acanthops* in the western Indian Ocean, raising the possibility that pygmy angelfish recently invaded the Atlantic Ocean via southern Africa. To test this zoogeographic hypothesis, we compared a 454 bp segment of the mtDNA control region among pygmy angelfishes of the subgenus *Xiphypops*, which includes the three Atlantic species, the Indian Ocean species, and a Hawaiian endemic (*C. fisheri*). The Indian Ocean *C. acanthops* is closest to the Atlantic species ($d = 0.059$) relative to the Hawaiian *C. fisheri* ($d = 0.077$). The mtDNA genealogy indicates a dispersal pathway from the Indian Ocean to the West Atlantic, rather than to the Gulf of Guinea or the mid-Atlantic ridge. Mismatch and coalescence analyses indicate Atlantic colonization by a few tens of individuals, about 250,000-500,000 years ago. The three Atlantic species are polyphyletic, raising doubts about taxonomic assignments based primarily on color pattern.

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Evaluation of juvenile Brown Treesnake (*Boiga irregularis*) trappability in response to abundance of an introduced skink (*Carlia aylanpalai*)

Operational snake trapping is an effective tool for capturing medium to large (>900 mm SVL) Brown Treesnakes (*Boiga irregularis*, BTS) on Guam, although it seems to be relatively ineffective for small snakes (<800 mm SVL). Current trapping methods, using live domestic mice for bait, may not be attractive to small BTS, which forage primarily for lizards. This is problematic because small snakes constitute about half of the snakes on Guam and comprise the majority of snakes removed from outbound cargo. Small BTS also cause most of the snake-induced power outages on Guam. In 2003 small snake trappability was estimated with reference to trap attractant and abundance of a common introduced skink (*Carlia aylanpalai*) at two sites on northern Guam. Body condition was the most

important predictor of capture probability, with BTS of poorer body condition being more trappable. As expected, traps tended to capture few small BTS. There was slight evidence of increased trappability on the site with low skink abundance. A strong bait x site interaction was observed, with more BTS caught in mouse-baited traps at one site. Trap-capture rate indicated a strong decrease in snake activity shortly after dawn and activity did not increase again until early evening. In 2004, no difference in small BTS trappability was observed during a prey manipulation experiment conducted in two outdoor 20 m x 20 m enclosures. As in 2003, snakes ceased entering traps shortly after dawn. Improvements to trap design, attractants targeting small snakes, and further research into small BTS foraging strategies and movement are recommended.

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Reproductive parameters for population assessment of *Squalus megalops*

Population assessments of chondrichthyan species require several key parameters of their reproductive biology, which were estimated for *Squalus megalops*. For both sexes, length-at-maturity differed depending on the criterion adopted for defining maturity. For males, length-at-maturity is smallest when condition of seminal vesicles is adopted as a maturity criterion. For females, length-at-maturity is smallest when the largest follicle diameter >3 mm is adopted as the criterion for maturity; this is appropriate only as an indicator of the onset of maturity. Mature males are capable of mating throughout the year. Females have a continuous asynchronous reproductive cycle. The sex ratio of embryos is 1:1 and litter size and near-term embryo length increase with maternal length. Females have an ovarian cycle and gestation period of two years. This is reflected in the differences found between the maturity and maternity ogives. Although all females are mature at 600 mm, only 50% of them contribute to annual recruitment each year. Hence, for chondrichthyan species with reproductive cycles of two, three or more years, if maturity ogives are used in population assessments instead of maternity ogives, the models would over-estimate recruitment rates. **AES GRUBER**

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School and shoal distributions in a freshwater catfish species, *Corydoras paleatus* (Callichthyidae)

The South American armored catfish *Corydoras paleatus* has been observed to occur in nature in large schools, in smaller shoals, and individually or in pairs. These catfishes are advantageous for laboratory study because they are easily bred and raised, they spend large amounts of time resting between bouts of swimming and foraging, and their resting behavior in particular is easily

quantified. In these experiments, we explore (1) how individuals allocate their time among foraging/shoaling, schooling, aeration, and resting; (2) how much time individuals spend in available aggregations; (3) distributions of nearest-neighbor distance; (4) numbers of groups as a function of density; (5) activity patterns; and (6) how these factors change with density. We examine the implications of this research.

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Rattlesnake exclusion fences: Do they really work?

The conflict between humans and timber rattlesnakes (*Crotalus horridus*) has increased as residential and commercial developments have extended into more remote areas. The construction of exclusion fences has been proposed as a solution to minimize human/rattlesnake interactions. We report on a three-year study in New York that illuminates many of the problems with this approach. Based on the recommendations of an extensive three-year pilot study, an exclusion fence was completed in 2000. The fence was positioned to minimize the possibility that rattlesnakes would move down slope into the subdivision area after emerging from their den. The 1.2 m high fence, constructed with 1.3 cm hardware cloth buried in the ground and supported by metal rods, extended along the slope for approximately 2400 m. Between 2001-2003, six timber rattlesnakes were tracked using implanted radio transmitters. In spite of the fence blocking direct access, by the end of 2002 all six rattlesnakes had entered the subdivision. Five of the radio-tagged snakes returned to the subdivision in 2003. Each was relocated to a pre-selected area up slope from the fence. Sixteen translocations were performed on five snakes, four of which returned to the subdivision on one or more occasions. Although difficult to confirm, based on movement patterns, snakes appeared to move through the fence on many occasions, as well as around both ends of the fence. Breaches in the integrity of the fence appeared to be a function of inadequate design, poor installation and lack of sufficient maintenance. In addition, fourteen other rattlesnakes were also found within the subdivision and two rattlesnakes were found dead in the subdivision area during this study, possibly killed by humans. We conclude that the fence did not achieve the objective of minimizing human/snake conflicts and that exclusion fences have limited value for rattlesnake conservation.

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Differences in infection by *Batrachochytrium dendrobatidis* among sites, elevation, and habitats in central Panama

Central Panama is currently an active area of *Batrachochytrium dendrobatidis* (Bd) induced amphibian declines, where a front of new declines are consistently progressing westward. We conducted the first intensive field sampling of

amphibian communities for Bd presence at two environmentally and faunally similar sites, Santa Fe (SF) and El Cope (EC), separated by 40km. We sampled stream, pool/puddle, and terrestrial habitats at high and low elevations along two parallel elevational transects. Historically, SF and EC both showed high species richness (49, 63), abundance, and species overlap (60%). Prior to 2002-2003, Bd was not detected at SF in limited collections (0.0, CI 0.0-0.049, n=74), and first appeared in animals collected between July-August 2003 (0.464, CI 0.475-0.661, n=28). In May-July 2004, Bd prevalence was high at SF (0.30, CI 0.24-0.37, n=201), but still not detected at EC (0.0, CI 0.0-0.006, n=610) suggesting the front of infection was then between SF and EC. Logistic regression of site, elevation, and aquatic index by infection indicate the highest probability of infection occurs in species at SF occupying high elevation aquatic habitats ($\chi^2=54.91$, d.f.=1, $p<0.0001$). Post-decline prevalence at SF was high (>10%) in all habitats and species, and at high and low elevations, but only pool/puddle habitats showed corresponding high frog abundance. All persisting species are potential carriers of infection, but the remaining species occupying pool/puddle habitats at SF have broad elevational ranges, high dispersal capability, and low mortality due to infection and can thus be considered pathogen reservoirs. These reservoirs enable Bd persistence at SF, therefore, greatly limiting recovery potential. Our data support: widespread Bd infection as the mechanism of decline at SF, infection in the field is non-random, and that the post-decline community consists of reservoir species with high prevalence and abundance in pool/puddle habitats, thus potentially promoting continued infection and persistent declines.

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Patterns of decline in a tropical montane tadpole community

Adult amphibian populations have declined around the globe, although descriptions of larval population declines are lacking. We quantified changes in species composition and community structure of larval populations in four streams in a tropical montane watershed in central Panama for a year prior to declines, and for a year during and following adult mortality and population declines. We surveyed populations of seven species of tadpoles in which the adults were monitored concurrently by sampling specific habitats used by selected species (i.e., riffles for hylids; leaf packs in deep pools for centrolenids; and shallow isolated pools for *Colostethus spp*). For best results, different sampling techniques were used in each of these habitats. Prior to adult population declines, tadpoles were abundant during both dry (17.42 tadpoles/m² \pm 15.63) and wet seasons (4.13 m² \pm 5.62). Following the decline of adult populations, larval densities were reduced from previous wet (1.49 m² \pm 1.33) and dry season levels (1.78 m² \pm 1.78), with significantly fewer individuals than the previous year ($t=3.87$, 6 d.f., $p=0.008$). This decline affected all species ($\chi^2=83.37$, 6 d.f., $p<0.001$), transects ($\chi^2=82.64$, 3 d.f., $p<0.001$) and habitats ($\chi^2=13.28$, 2 d.f., $p<0.001$) and occurred \approx 1 mo. prior to finding the first dead frog. As adults continued to die, larval abundance continued to decline into the dry season of 2005 when larval abundance was significantly reduced from 5.88 m² \pm 5.98 to 0.96 m² \pm 1.34 ($\chi^2=93.82$, 6 d.f., $p<0.001$). As of March of 2005, 4 of the 7 species are missing. The 50% reduction in clutches between May-July 2003 and the same period in 2004 likely resulted from fewer breeding adults, as we

found no dead or dying tadpoles. Tadpoles are important grazers in these tropical mountain streams and their loss is expected to affect predator and prey populations.

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Atlantic shark species-specific management: Is it possible?

In 2002, the stock assessment for Atlantic large coastal sharks determined that the two primary species in the fishery, sandbar and blacktips, were rebuilding and rebuilt, respectively, and that the complex as a whole was still overfished. In the 2003 Amendment 1 to the Atlantic Tunas, Swordfish, and Shark Fishery Management Plan, the National Marine Fisheries Service (NMFS) established quotas for the large coastal shark complex as a whole rather than for the individual species. This decision was made in part due to the inability of some fishermen and dealers to identify sharks correctly and in part due to the paucity of data regarding the ability of fishermen to target one or two species while avoiding other species. NMFS is currently analyzing alternatives to improve the ability of fishermen to identify sharks. However, little or no research is being done regarding the ability of fishermen to target specific sharks. Gear research in the Atlantic pelagic longline fishery has indicated that sea turtle takes can be significantly reduced by modifying hook types and using certain types of bait. Similar research is needed in the commercial shark fishery, primarily for bottom longline and gillnet gears, to determine if the bycatch of unwanted sharks, finfish, and sea turtles can be avoided or reduced. Such research could protect the more vulnerable species while still allowing for a sustainable fishery on other species and could allow quotas to be established on a more species-specific basis.

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Behavior, census and distribution of freshwater turtles in Golden Gate Park lakes

We studied the activity, distribution, population size and inter-species behavior of freshwater turtle species in Golden Gate Park lakes beginning in October 2004. The study specifically surveyed the western pond turtle *Clemmys marmorata* (a California Special Concern species) that is declining throughout its range. We used capture, mark (notching and supercool branding techniques) and release methods to estimate population sizes in each lake. Preliminary data indicated that former pets, including *Trachemys scripta* and *Trionyx* exotic species, introduced to lakes by humans have negatively affected the fitness of *C. marmorata* and the native species must compete for feeding and basking sites.

STOYE PHYSIOLOGY & PHYSIOLOGICAL ECOLOGY

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Molecular phylogeny of cyprinid fishes in the genus *Cyprinella* from southwestern North America

The arid southwest of North America has a remarkably diverse fish fauna with the Cyprinidae being particularly important both in terms of diversity and abundance. At least nine species in the genus *Cyprinella* are restricted to the Southwest, and another, *C. lutrensis*, is broadly distributed in central North America as well as the Southwest. The southwestern fish fauna is fairly well studied in terms of species diversity, however, phylogenetic relationships for many groups remain poorly understood. We conducted a molecular phylogenetic analysis of southwestern *Cyprinella* using complete coding sequences of the mitochondrial Cyt-b, ND2, and ND4L genes. We used maximum parsimony and maximum likelihood to generate phylogenetic hypotheses for the 2485 base data set. Results suggest three major lineages of southwestern *Cyprinella*: a) an older, distinct group containing *C. proserpina* and *C. rutila*; b) a group containing *C. lutrensis*, *C. garmani*, *C. panarcys*, and *C. xanthicara*; and c) a group containing different lineages of *C. lutrensis* as well as *C. lepida*, *C. formosa*, and *C. bocagrande*. The southwestern species were not monophyletic as the proserpina-rutila clade was placed as the sister-group to *C. camura* and *C. galactura* which are native to the Mississippi basin. The remaining southwestern *Cyprinella* did form a monophyletic group, however, the presence of *C. lutrensis* in both of the major clades suggests that this widespread species may have given rise independently to several of the other species.

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Population genetic structure of the Eurasian round goby invasion in the Great Lakes

Eurasian round gobies (*Neogobius melanostomus*, family Gobiidae) are aggressive invaders in the Laurentian Great Lakes system, where they appeared in 1990. They spread rapidly throughout the lakes, but more slowly in river systems. Their invasive success may be linked to the sympatric presence of introduced dreissenid mussels, a native freshwater prey. Also in 1990, round gobies invaded the Gulf of Gdansk, Poland, located in the eastern Baltic Sea. Using two mitochondrial DNA regions, cytochrome b and the control region, we examined the population structure of North American and Eurasian round gobies from across their invasive and native ranges. We found evidence that the gobies likely arrived in North America in several, independent invasions that totaled a large fraction of the native Eurasian genetic diversity. In addition, the invasive populations show significant genetic differences between lakes. In contrast, the

invasion in Poland was much smaller and contained less genetic diversity. We discerned genotypes from native, saline populations present in the freshwater Great Lakes, suggesting a potential pre-adaptation to Atlantic coastal salt marshes. In those areas, they will find a ready food source, *Mytilus* mussels, a saltwater prey item in their native range. With their high genetic diversity and potential pre-adaptations, it is likely that round gobies will further extend their North American range, and continue a steady spread.

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Reproduction, age and growth of sheepshead, *Archosargus probatocephalus*, in Mississippi waters

Sheepshead, *Archosargus probatocephalus*, commonly occur in estuarine and offshore waters of Mississippi and are regularly targeted by fishermen. Sheepshead (N=150) were collected monthly using hook and line from December 2003 to November 2004 in Mississippi waters to assess their reproduction, age and growth. Sheepshead ranged from 110-386 mm SL (52-2,253 g) and 0 to 6 years, with age 4 fish most common in our samples. There was a highly variable but significantly positive distribution of lengths at age ($p=0.01$, $r^2=0.57$). Males are longer at a given age than females, and the von Bertalanffy growth equation (based on size and age of fish sampled) predicts a larger maximum size for male sheepshead. All females <232 mm SL were immature, although 22% of age 1 females were sexually mature. The smallest males examined histologically (222 mm SL, age 1) had spermatozoa in the testis. Ovarian maturation began in December, and GSI values of females increased in February, peaked in March and returned to low levels by May. Females are capable of multiple, but not daily, spawns, and most females captured during March and April were undergoing final oocyte maturation. Mean batch fecundity estimates are $219,100 \pm 36,700$ eggs/female (N=7), and there was no significant relationship between batch fecundity and SL or weight ($p>0.05$). Our preliminary data suggest the Mississippi sheepshead population appears to be younger, more fecund, and reaches sexual maturity sooner than sheepshead sampled during 1987-1988 in Louisiana.

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Did desmognathine salamanders reinvent the larval stage?

Recent phylogenetic studies of plethodontid salamanders using molecular data suggest (1) that desmognathine salamanders are nested within a clade comprising several direct-developing lineages, (2) that recognition of a subfamily Desmognathinae is no longer valid, and (3) that the biphasic species of the genus *Desmognathus* are derived from direct-developing ancestors. I examine the last

hypothesis from the following perspectives: (1) the plethodontid sister family question, (2) morphology and morphogenesis, (3) the biology of the extant direct-developing species of desmognathines, (4) the ecological scenario, and (5) problems in evolutionary reversals of life-history modes in plethodontids. I conclude that the new molecular data are concordant with morphological and life-history data supporting a phylogeny of plethodontids in which the biphasic life cycle is ancestral at the family level as well as in *Desmognathus*. This requires a minimum of five independent transitions from a biphasic life cycle to direct development, but no reversals.

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Insight into migration patterns of bull sharks in the South Pacific

Data on habitat use and seasonal movements are essential for designing conservation strategies, yet such data are rarely available for large marine animals such as sharks. In this study we equipped eleven bull sharks, *Carcharhinus leucas*, from a Fijian population with pop-up satellite tags to test the hypothesis that bull sharks migrate into nursery grounds. Individual tags remained attached for two to seven months. The pop-up locations give insight into movement patterns and distribution of bull sharks in the South Pacific. They further underscore the need for international cooperation in devising conservation plans.

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Phallic size variation in yearling alligators exposed to naturally occurring environmental contaminants

We collected alligator eggs from two north-central Florida lakes, one contaminated (Lake Apopka) and the other relatively pristine (Lake Woodruff). We incubated one set of eggs from each lake without treatment. Additional eggs were treated with two concentrations of a mixture of 9 contaminants found at elevated levels in eggs from lake Apopka. Eggs were incubated until hatching and the animals were reared for 1 year. We measured the phalli and clitero-phalli of all yearlings and compared measurements among treatment groups. Historically, male alligators from Lake Apopka have smaller phalli when compared with alligators from Lake Woodruff. Therefore, we hypothesized that introducing compounds previously characterized as estrogenic or anti-androgenic would lead to smaller phalli in exposed animals. Conversely, treated animals and animals from Lake Apopka all had larger phalli and clitero-phalli than control groups. These data suggest that the previously identified environmental estrogens or anti-androgens act as estrogens or anti-androgens in juvenile/adult animals but may be androgenic in developing embryos.

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The role of the accessory structure in a simultaneously hermaphroditic fish, sand perch (*Diplectrum formosum*)

Sand perch, *Diplectrum formosum*, is a serranid found along the Atlantic waters of the southeastern United States. Sand perch are simultaneous hermaphrodites in which the gonad (ovotestis) contains both active ovarian and testicular tissue. The ovotestis also contains an accessory structure located at the posterior-most portion, in which hydrated oocytes have been observed. The importance and function of the accessory structure in reproduction is unknown. Testicular and ovarian tissue within each ovotestis are slightly asynchronous from each other preventing self-fertilization, but partially negating the advantage of producing both sperm and egg. This study focuses on the presence or absence of hydrated oocytes in the accessory structure relative to the reproductive stages of the ovarian and testicular tissue present in the ovotestis. The role of the accessory structure in relation to advantages of being a simultaneous hermaphrodite is examined. **STORER ICHTHYOLOGY**

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Dietary patterns of predatory fishes at drifting fish aggregating devices (FADs) in the Indian Ocean

Predatory fishes aggregated around drifting fish aggregating devices (FADs) in the Indian Ocean were collected to investigate their trophic ecology, and determine whether they feed on fauna associated with the drifting FADs. Stomach content analysis of yellowfin tuna (*Thunnus albacares*), dolphinfish (*Coryphaena hippurus*), and wahoo (*Acanthocybium solandri*) collected in fall and spring reveal various interesting patterns. A clear seasonal dietary shift is observed for all three species, with diets dominated by pelagic crustaceans in the fall and epipelagic fish in the spring. A high amount of diet overlap between all three predatory species occurred in the fall. Stomach fullness was not correlated with time of collection, indicating no lack of rigid diel feeding patterns. None of the three predatory species fed on fish species (i.e. *Canthidermis maculatus*, *Kyphosus spp.*, *Decapterus spp.* and *Seriola rivoliana*) also aggregated in large numbers around drifting floating objects planted by tuna purse-seiners.

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Phylogenetic relationships of North American phoxinins (Actinopterygii: Cyprinidae) as evidenced by the S7 and Rag1 nuclear sequences

Previous phylogenetic hypotheses of North American phoxinins have been derived from both morphological characters and sequence variation of mitochondrial genes. While various relationships have been proposed based on morphological traits, mitochondrial genes have strongly supported a subset of these relationships. In this study nuclear DNA sequence data from intron 1 of S7 and exon 3 of RAG1 are used to evaluate the evolutionary relationships of North American phoxinin cyprinids. Results of parsimony and bayesian analyses of the individual and combined data sets recovers three monophyletic clades consistent with the open-posterior myodome (OPM), creek chub - plagopterin, and western clades reported in previous studies. Within the shiner clade of the OPM clade *Erimonax monachus* is the basal sister group to a clade inclusive of *Cyprinella*, *Codoma*, *Opsopoeodus*, and *Pimephales*. *Hybognathus* is part of a clade inclusive of *Notropis* and *Notropis harperi* is sister to *Pteronotropis*. Also within the OPM clade, *Erimystax* and *Phenacobius* form a sister group relationship as does *Clinostomus* and *Richardsonius*. Within the creek chub - plagopterin clade *Hemitremia* and *Semotilus* form a sister group relationship. *Orthodon* and *Phoxinus* are basal to the remainder of the taxa that form the western clade.

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Life history of chicken turtles (*Deirochelys reticularia*)

Over the last decade and a half, a life history and demographic paradigm for turtles has emerged. Turtle life histories are characterized by high annual adult survivorship, extended longevities, long reproductive lifetimes, delayed sexual maturity, low annual fecundity, variable and low nest survivorship, and high average juvenile survivorship. Examination of mark-recapture data collected on the Savannah River Site over 31 years (1967-1998), indicated that chicken turtles (*Deirochelys reticularia*) are shorter-lived than any other turtle species studied. We combined data from an intensive four-year study of a chicken turtle population with the long-term survivorship and reproductive data to compare the life history of chicken turtles to the general patterns observed and reported for other turtles. The observations of small females producing small eggs rather than delaying reproduction until they attain a larger body size, a winter nesting period, a carnivorous diet maintained throughout life, rapid growth rates of juveniles, and early maturity of males collectively suggest a life history strategy aimed at optimizing fitness in a seasonal and unpredictable environment.

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Trophic ecology of the common map turtle (*Graptemys geographica*): an isotopic investigation

In common map turtles (*Graptemys geographica*), females are mollusc specialists, whereas males have a broader diet. The invasion of zebra mussels (*Dreissena polymorpha*) has disrupted the trophic structure and mollusc fauna of freshwater ecosystems and may have altered the trophic ecology of common map turtles. We used stable carbon isotopes to investigate the trophic ecology of common map turtles in an Ontario lake severely infested by zebra mussels. The mean $\delta^{13}\text{C}$ of pelagic primary consumers (zebra mussels) was -29.43‰ . Littoral primary consumers had $\delta^{13}\text{C}$ values of -19.87‰ for snails (*Viviparus georgianus*), -19.77‰ for trichoptera (*Nectopsyche* sp.) and -20.40‰ for Ephemeroptera (Heptageniidae). Mean $\delta^{13}\text{C}$ values of adult males, juvenile females (overlapping in size with males), and adult females were -20.33‰ , -22.26‰ and -24.86‰ respectively. A two-source mixing model showed that the diet of males, juvenile females and adult females was composed of pelagic prey at 5%, 24%, and 52% respectively. Zebra mussels having almost extirpated native mussels in our study lake, the pelagic contribution to the diet of females is coming from zebra mussels. Diet analyses conducted before the invasion of zebra mussels have found snails to be the most important food item consumed by female map turtles. Our results suggest that the availability of zebra mussel has partly shifted the diet of female map turtles from the littoral to the pelagic foodweb.

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Ancestral area and divergence date estimation for lampropeltine snakes

The fossil record of ancestors of extant colubroid snake families and subfamilies prior to the Miocene is almost non-existent. Combining techniques of ancestral area and divergence date inference using phylogenetic estimates from extant taxa and calibration references from the Miocene fossil record permits greater confidence in assessing areas and dates of origin for ancestors of modern taxa. In North America, one of the most conspicuous and ecologically, behaviorally, and morphologically diverse group of snakes are the Lampropeltini (*Arizona*, *Bogertophis*, *Cemophora*, *Lampropeltis*, *Pantherophis*, *Pituophis*, *Pseudelaphe*, *Rhinocheilus*, *Senticolis*, and *Stilosoma*). This monophyletic tribe of 29 species is well-represented in the fossil record throughout the middle and late Miocene, and is known to be closely related to Old World (OW) ratsnakes (*Coelognathus*, *Coronella*, *Elaphe*, *Euprepriophis*, *Gonyosoma*, *Oocatochus*, *Oreophis*, *Orthiophis*, *Rhinechis*, and *Zamenis*). Using scnDNA and mtDNA sequences and maximum

likelihood (ML) and Bayesian inference (BI) methods of phylogenetic inference, we (i) determined the most probable OW sister taxon of the Lampropeltini, (ii) inferred ancestral areas of origin for lampropeltinines and OW ratsnakes by applying divergence-vicariance analysis and ML methods of area reconstruction, (iii) estimated divergence dates with penalized likelihood rate smoothing, and (iv) examined rates of color pattern evolution using ML and BI methods of character state mapping. We also relied on these ancestral area and divergence date estimates to assess whether the ancestors of modern-day lampropeltinines crossed from the OW to North America using the the trans-Atlantic or the trans-Beringian dipersal route.

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Courtship, mating, and alternative reproductive tactics in the Middle American Dwarf Boa, *Ungaliophis continentalis*

Reproductive behavior has not been documented in detail for either species of the cryptic Central American snakes of the genus *Ungaliophis*. Here we report on courtship of *Ungaliophis continentalis*, a species ranging from Chiapas, Mexico to northern Nicaragua. In February and March 2004, we observed a total of nine courtship encounters involving three males and two females. Males performed two distinct courtship patterns: a passive courtship pattern that was similar to that reported in other snake species and an assertive courtship pattern that featured a tail bite. Eleven behavioral acts performed by males were defined, of which four were unlike those reported for other snake species. This study revealed several interesting aspects of reproductive behavior in *U. continentalis* that appear to be related to individual males being capable of adjusting courtship tactics to bring about successful copulation. These include coercive reproductive behaviors such as the tail bite, the only courtship behavior reported in snakes to occur in a continuous, non-interrupted fashion from the first phase of courtship until dismount.

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Status of a relocated Gopher Tortoise population: One generation later

Relocations are sometimes used in the conservation of reptiles. However, success of most relocations have not been evaluated adequately due to the lack of long-term monitoring post-relocation. Here we report on a population of gopher tortoises (*Gopherus polyphemus*) 16 to 17 years after relocation. Eighty-three tortoises were relocated to Okeehetee County Park (OCP), Palm Beach Co., Florida, U. S. A. in 1985 and 1986. The initial follow-up in 1986 and 1987 found preliminary evidence of success. During 2002 we exhaustively surveyed OCP for all gopher tortoises and their burrows. We found 95 individuals and 290 burrows. Thirty-eight of these were relocatees from 1985 and 1986, indicating both that many individuals continued to persist at OCP, and that new

individuals were present. It appears many relocated tortoises left OCP in the first year after relocation, but that those that remained during the first year also stayed long term, and grew at rates normal for the region. Reproduction is occurring, but egg survivorship is so low that there appears to be very little recruitment. We conclude that this relocation has been successful by some standards, but the low numbers of juveniles suggests that management is needed to promote recruitment.

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**A model of reproductive behavior in the North American cyprinid genus
*Cyprinella***

A model of spawning behavior is proposed for the genus *Cyprinella*, the second largest genus of North American minnows (30 species). Insofar as known, all members of the genus lay eggs in narrow crevices or fissures in rocks and wood. The red shiner *C. lutrensis* is the only species known to exhibit behavioral plasticity, but it readily spawns in crevices. Crevice spawning is reported in three other North American genera: *Erimonax monacha*, *Hesperoleucus symmetricus*, and *Dionda dichroma*. Crevice spawning is a complex social interaction. The salient feature of crevice spawning is social organization that is dependent on an alpha male defending a crevice. In-depth study of digital videotapes of spawning in small aggregations (4 males: 12 females) of *C. caerulea* and *C. lutrensis* fostered recognition of common behavioral organization and formulation of a model for crevice spawning. The model (or ethogram) accommodates existing observations of *Cyprinella* spawning. The 40+ spawning behaviors are organized into functional classes: non-spawning, social-sorting, aggression, courtship, and spawning. The behavioral classes are organized in a natural hierarchy representing a daily spawning cycle. Within the two intensely studied species, shared and unique (possibly species specific) behaviors were identified. The crevice functions like a lek, an intense behavioral arena in which the tumult of aggression and retreat occasionally results in a spawn. To date, complex spawning behaviors are considered to have evolved independently in North American cyprinids, based on convergence of spawning modes. Social organization may be a more informative way to compare behaviors. However, there is no free lunch; such studies necessitate repeated observations of small assemblages to determine social structure.

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Revision of the American Fisheries Society list of imperiled freshwater and diadromous fishes of North America.

The American Fisheries Society Endangered Species Committee is compiling the third list of imperiled freshwater and diadromous fishes of North America (Mexico, Canada, and the United States). The first AFS list, using standardized definitions and listing criteria developed by the committee, was published in 1979 and assigned 251 species, subspecies, and undescribed taxa among three conservation categories. A decade later, the 1989 list reached 364 species, subspecies, and undescribed taxa, by adding 139 new taxa and removing 26 from the previous list. The forthcoming list may exceed 800 species, subspecies, populations, and undescribed taxa divided among five conservation categories: endangered, threatened, vulnerable, extirpated, and extinct. What are the reasons for such a large increase in the number of imperiled taxa? The 15-year hiatus since the last list corresponds to significant advances in phylogenetic analysis, population genetics, modifications of species concepts, new investigative methods, nomenclatural revisions, increased knowledge of the composition and status of faunas (especially for Mexico), and exponential increases of threats. Discovery of new taxa and diversity has increased; about 19% of imperiled taxa are undescribed species and evolutionarily distinct populations (ESU). Overall, imperilment of the North American freshwater and diadromous fish fauna is escalating, primarily among three general assemblages: large-river fishes, anadromous salmonids, and small fishes with limited ranges.

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First report of an intromittent organ in an inseminating characiform genus

We herein document, for the first time, true intromittent organs in four populations of inseminating fishes of the family Characidae, genus *Monotocheirodon*, which appear to comprise at least two new species. All females histologically analyzed from these populations, as well as a female of the described species, *Monotocheirodon pearsoni*, had spermatozoa within the ovary, confirming insemination. Male *M. pearsoni* produced aquasperm with spherical nuclei (diameter 1.6 μ m), with no intromittent organ being evident. On the other hand, males from the new populations of *Monotocheirodon* produced spermatozoa with slightly ovoid to elongate nuclei (lengths 1.8-4.1 μ m) and possessed distinct intromittent organs. Those with more elongate sperm nuclei had longer intromittent organs. Each intromittent organ consisted of an elongate extension of the body wall encompassing an extension of the sperm duct, which opened to the outside at the pointed tip of the organ. Skeletal muscle cells are present throughout the organ. At the base, the skeletal muscle is oriented around the organ (circular) possibly forming a sphincter. The skeletal muscle along the organ is mainly oriented longitudinally, although some circular bundles are present. These males are apparently able to manipulate the organs by means of this muscle. The wall of the sperm duct within the organ is thrown into folds and is lined with a low cuboidal epithelium. Degenerate sperm cells were found within the sperm duct along the intromittent organ. The posterior portion of the testes of these males lacks spermatogenic tissue and serves as an open storage region for mature spermatozoa.

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Second edition of Peterson Field Guide to Freshwater Fishes, Part I: What it tells us about fish diversity.

The 1st edition of the *Peterson Field Guide to Freshwater Fishes of North America North of Mexico* was published in 1991 and contained accounts for 790 species. The 2nd edition, to be published 15 years later, will contain accounts for about 890 species and allows us to examine how our fish diversity has changed. About sixty-five of the additional 100 species are newly described or recognized native populations, and 35 are newly established exotics. These dramatic increases reveal much about our biota, our view of species-level diversity, and changes in our environment. An analysis of data in the guide provides information on where these additional species are geographically and ecologically located, and

which higher-level taxa are changing in species-level diversity. We also will examine trends related to subspecies, nomenclature, higher-level taxa, endangered species, and extinctions.

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Control and eradication of exotic ticks introduced into the United States on imported reptiles

Since 1962, at least 29 species of exotic ticks have been introduced into the United States on imported reptiles. Some of these exotic tick species have developed breeding colonies in Florida and have infested other reptilian species in captivity, indicating that some species could become established in Florida and elsewhere in the United States with unknown risks for native reptilian populations. While a few are known to be vectors of important diseases of veterinary or public health significance, nothing is known about the pathogenic effects or vector potential of most of these exotic tick species. However, one species (*Amblyomma sparsum*), infesting a shipment of leopard tortoises (*Geochelone pardalis*) imported into Florida from Zambia in 1999, was found to be infected with the rickettsial bacterium *Ehrlichia (Cowdria) ruminantium* that causes heartwater, an acute disease of domestic and wild ruminants such as deer. In order to minimize risks associated with the introduction of these exotic ticks, practical protocols were developed for the control of ticks on infested reptiles and for the eradication of ticks from infested premises. Protocols for control of ticks utilized a formulation of permethrin (Provent-a-mite™) specifically developed for use on reptiles; tortoises were treated directly while snakes and lizards were treated indirectly by spraying of the substrate in their containers. Protocols for eradication of ticks involved treatment of reptiles with permethrin and concurrent treatment of the premises with cyfluthrin for tortoise facilities or permethrin for snake or lizard facilities. Using these protocols, an *A. sparsum* tick infestation was successfully eradicated from a tortoise facility and an *Amblyomma (Aponomma) komodoense* tick infestation was safely eradicated from a Komodo dragon (*Varanus komodoensis*) exhibit at a zoo.

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Morphology and phylogenetic implications of Recent and fossil carcharhiniform shark vertebral centra

The cross-sectional anatomy of secondary calcifications of shark vertebral centra has featured in phylogenetic hypotheses, although never in a rigorous cladistic framework. In this study, the internal calcification patterns, along with the external morphology, of fossil and Recent shark centra of the Order Carcharhiniformes have been coded and subjected to a cladistic analysis to address the utility of centrum features for revealing relationships. Carcharhiniform sharks were selected as a study group because they are a monophyletic clade with reasonably well understood intraordinal relationships,

a rich fossil record, and readily available Recent comparative skeletal material. The external characters evaluated include centrum proportions, the presence and distribution of cartilage canals, and the size, shape, and spacing of the foramina for the basidorsal and basiventral arch components. The internal calcification features evaluated include the morphology and spacing of the four intermedialia, the four noncalcified areas, and the four diagonal calcifications. Centrum characters were analyzed both separately and combined with additional morphological characters from previous analyses. Results of the cladistic analysis show that shark centrum characters are useful for elucidating phylogeny. Tree topology was very similar for both analyses, and similar to recent molecular databased phylogenies. The addition of centrum data to shark phylogenetic analyses will allow for a more objective means of determining the interrelationships of fossil and extant carcharhiniform sharks than studies based on teeth alone, with their well-documented difficulties. The data gathered will also be important for future studies to interpret the relationship between centrum morphology and swimming characteristics in extant, and ultimately, extinct taxa.

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Revision of the Ponyfish Genus *Gazza* (Teleostei: Leiognathidae)

Gazza is a member of Leiognathidae, a clade of bioluminescent fishes that exhibits a symbiotic relationship with the bacterium *Photobacterium leiognathi*, which they house in a circumesophageal light organ. It is hypothesized that bacterial luminescence functions to deter predators, locate prey, coordinate schools, and presumably also to signal potential mates. Five species currently comprise the genus, although intrageneric relationships remain unresolved and the taxonomic status of most nominal species remain uncertain, given that species diagnoses were not based on apomorphic features. Species identifications have primarily relied on squamation patterns on the anterior flank and the shape of the subocular silvery region, both of which are traits that exhibit little interspecific variation. Using these features, as well as several novel traits revealed in a previous study, three undescribed species are identified and briefly described. Diagnoses are presented for all species of *Gazza*, as well as a key to species. A phylogeny for *Gazza* is presented, in which the three new species are placed and interspecific relationships are resolved.

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Natural fragmentation of salamander populations due to moisture gradients

The fragmentation of salamander populations can occur as a result of land use. Forest fragments surrounded by developed land often lack salamanders. Natural fragmentation of salamander populations may occur in eastern hardwood forests

as a result of moisture gradients because salamanders are moisture dependent. Streams and their associated mesic valleys may act as corridors for migration of salamanders. We examined this natural fragmentation by comparing salamander species diversity and abundance under twenty-four plots within Mammoth Cave National Park. Each plot contained 20 coverboards. We placed eight plots in each of three distinct habitats; ridgetops, streamsides, and sinkholes. Increased species presence and frequency correlated with damper landscapes. The moist valleys surrounding streams may act as functional passageways between fragmented salamander populations. **STORER HERPETOLOGY**

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Effectiveness of bycatch reduction devices on crab pots at reducing Diamondback Terrapin capture and mortality

Diamondback terrapins (*Malaclemys terrapin*) drown in blue crab (*Callinectes sapidus*) pots throughout their range. The objectives of this study were to: 1) test if bycatch mortality of diamondback terrapins in commercial crab pots is reduced by using bycatch reduction devices (BRDs); 2) determine if BRDs enhance crab catch in Florida by comparing sex, size, and number of blue crabs captured in standard crab pots with those captured in pots equipped with BRDs; 3) formulate recommendations to Florida Fish and Wildlife Conservation Commission for regulations that reduce terrapin bycatch mortality in Florida waters. We fished 15 control pots and 15 pots with BRDs (experimentals) for 10-day periods in each of six Florida counties from 2002 through 2004. Pots were baited and checked daily. We determined sex of all captured terrapins and blue crabs and took measurements of each that would allow us to evaluate if BRDs affected the size of either species. Thirty-seven terrapins were caught in control pots and four in experimentals. Several were small enough that they would not have been prevented from entering either pot treatment, but we found that 73.2% of the terrapins in this study could have been prevented from entering crab pots with functional BRDs. There were no significant differences between the sex, number, or measurements of legal-sized crabs captured in control and experimental pots at any of the study sites. We will present this data combined with data from two additional counties we will study in May 2005. We recommend that Florida Fish and Wildlife Conservation Commission devise and adopt regulations that require the use of 45.0 x 120.0 mm BRDs on all commercial and recreational crab pots in Florida as soon as possible.
