baboons. We studied tooth size variation in a pedigreed population of *Mus sp.* from the University of California Museum of Vertebrate Zoology (n = 222). All dental phenotypes returned significant heritability estimates. Through bivariate analyses we found that minor variation in mouse incisor size appears to be genetically independent of the minor variation in their molars. Given that mice have derived dentitions relative to many other mammals, we undertook a quantitative genetic analysis of homologous phenotypes in the baboon dentition. We collected data from captive pedigreed *Papio hamadryas* individuals from the Southwest Foundation for Biomedical Research and Southwest National Primate Research Center (n = 630). These analyses also return significant heritability estimates. And similar to the mice, bivariate analyses of the baboons suggest genetic independence between the minor variation in incisors and molars. These data suggest that the genetic architecture of these two species is similar in many respects despite the dramatic morphological differences between their dentitions and despite the 75 millions years since they last shared a common ancestor.

Apical Ectodermal Ridge (AER) Development in the Pectoral Fin of the Australian Lungfish (*Neoceratodus forsteri*)

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Thorogood (1991, in Hinchliffe, J.R. *et al*. (Eds) Developmental Patterning of the Vertebrate Limb. Plenum Press, New York) proposed a model based on a heterochronic two phase shift in skeletal patterning within developing appendages as vertebrates moved from the water onto the land. The first phase involves patterning of the endoskeletal elements. During the second phase dermal skeletal elements develop in, and are unique to, fish fins. The AER is a morphologically distinct entity, present in most vertebrate fin/limb buds, and is an integral component of the proximo-distal outgrowth of endochondral elements within the developing appendages. In the chick and other tetrapods the AER persists until the end of digit formation. However, in some amphibians there is no morphologically distinct AER and yet limbs develop with the full complement of endochondral elements, i.e., humerus, ulna, radius, wrist bones and digits. In ray-finned fishes, the AER or pseudo-apical ectodermal ridge is very short lived which is coincident with a reduction in endoskeletal elements and extensive development of dermally derived fin rays. The pectoral fin of the dipnoan, *Neoceratodus forsteri*, contains both well developed endochondral and dermal skeletal elements and, as such, represents a "half way point" between appendages of primarily dermal origin, as in the actinopterygians, and the wholly endoskeletally derived limbs of the tetrapods. Scanning electron microscopy and histological investigations together with the localization of the fgf8 gene product were used to describe the form and function of the AER in *N. forsteri*. The results of this study are discussed within an evolutionary context.

The Principles of Shoulder Biomechanics in Land-living Tetrapods: Cursorial Mammals, Recent Squamata, Archosaurs and Fossil Sauropods, Analyzed with the Aid of FES

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The indirect attachment of the forelimbs to the trunk in all land-living tetrapods seems inadvantageous, because permanently energy-consuming. It implies, however, solid biomechanical advantages, which will be presented. The remarkable variation of the shoulder girdles was investigated under biomechanical viewpoints. The force flow between the weight-containing trunk and the supporting forelimb is made visible with the aid of three-dimensional Finite Element Systems (FES) analysis. Biomechanical requirements diverge between forelimbs in sprawling and in extended positions on cross sections. In sprawling postures, the m. pectoralis keeps the shoulder joint in equilibrium. Its pull leads to compression between the shoulder joint and the muscle's origin, to which the coracoid offers resistance. The extended limb position in (cursorial) mammals implies a short load arm of the weight force at the shoulder joint. The m. pectoralis can be recruited for carrying a part of body weight, especially if the sternum is shifted to a position ventral to the shoulder joint. So the ribs carry weight, and the bony connection between shoulder joint and sternum is superfluous. In sauropods, our biomechanical analysis and the morphology of the compression-resisting skeletal elements leads to adaptations: the thorax was extremely narrow, a cartilaginous sternum was present and located much deeper than the shoulder joints, the forelimbs were extended in walking, but not in reclining to resting postures; the circle of forces was closed partly through the coracoid like in reptiles, and partly through the ribs like in mammals. The implications of these traits for locomotion will be discussed.

New Fossil, *Tiktaalik roseae*, and the Biomechanical Conditions for the Evolution of the Tetrapod Bauplan

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Newly found fossils from the Late Devonian are here considered not as "primitive" limb-possessing tetrapods, retaining traits of fish-like ancestors, but as animals adapted to the special conditions in their environmaent. The external forces acting on them and the stresses inside the body are analyzed, partly by means of FESA. Our results fit with the conclusions drawn by the authors of the first description, but reach farther: The selective advantages for characteristic morphological traits and relevant movements of animals living partly submerged in shallow water and partly on firm ground are defined semi-quantitatively. The flat skull and the mobility of the neck seem to be adaptations to lateral snapping movements for catching prey. The marked development of the shoulder girdle and free forelimbs are advantageous for performing this behavior on land as well as in water. The development of strong ribs is a mechanical requirement for land-living vertebrates which shift their body weight between the forelimbs on both sides. The results of these calculations can be interpreted as explanations of morphology, or as a well-founded hypothesis about the behavior and mode of life in the fossil animal. The behavioral and environmental conditions are determined under which the energy expenditure can be calculated.

Geometric Morphometric Analysis of Intraspecific Skull Variation in *Egernia depressa* (Squamata: Scincidae)

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Landmark-based geometric morphometric techniques were used to examine intraspecific skull shape variation among three populations of the pygmy spiny-tailed lizard (*Egernia depressa*) in Western Australia. In the northern part of their range (Pilbara; 22°S), these lizards inhabit rock crevices in disjunct outcrops. Two populations were sampled in the Pilbara; one population west of the Hamersley Range (n = 10) and one east of the range (n = 9). Preliminary results indicate that the shape of the ventral aspect of the skull differs significantly between these two populations. The shape change occurs primarily around the inferior orbital foramen, and, although no shape difference exists between males and females, juveniles and adults are significantly different. The Hamersley Range that separates these two populations likely creates a reproductive barrier that may account for the divergent morphology. In the southern part of their range (Gascoyne; 25°S), where these lizards occupy tree hollows instead of rock crevices, a third population was sampled (n = 4). Preliminary results indicate that the Gascoyne population does not differ significantly from the western Pilbara population, even though the lizards utilize different habitats.

Cranial Kinesis in Dinosaurs: Significance for Functional Inferences and Evolution

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Cranial kinesis has been postulated to have been present in many nonavian dinosaurs (e.g., theropods and ornithopods). The presence of intracranial synovial joints—structures shared with extant lepidosaurs and birds—has typically been the sole indicator of kinesis, whereas the protractor musculature, which supposedly powers these joints, has received little attention. In fact, whether these hypotheses envision a powered or passive system is unclear. We reviewed the cranial musculoskeletal systems of extant and fossil diapsids to assess inferences of cranial kinesis in non-avian dinosaurs. Intracranial synovial joints and protractor muscle are ubiquitous among dinosaurs including clearly akinetic taxa (e.g., ankylosaurs, ceratopsids). However, non-avian dinosaur taxa do not exhibit the breakdown of linkage systems of skeletal units (e.g., palatal and facial units) considered necessary for intracranial movement that kinetic birds and lizards possess. Additionally, most of the non-synovial contacts postulated to slide in dinosaurs are without extant analogs. Thus, most non-avian dinosaurs do not possess the morphology necessary and sufficient for positive inferences of cranial kinesis. Moreover, although many extant lizards bear all of the morphological features suggestive of cranial kinesis, they do not necessarily express it, which thus represents an important caveat for any fossil inferences. The widespread presence of synovial joints in non-avian dinosaurs, and diapsids in general, suggests these joints may be primarily responsible for mediating cranial growth and are only secondarily associated with cranial kinesis. This bears significance for understanding avian evolution as well as general reptilian cranial form and function.

The Microarchitecture of the Cornified Epidermal Sheath of the Cat Claw

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The microanatomy of hard cornified structures, such as claws and beaks, is notoriously difficult to analyze because of the complexity and the extreme range of hardness of the component tissues. A correlative approach using light microscopy, SEM, synchrotron x-ray micro-computed tomography (μCT with a resolution of 9 μm), and virtual 3D-reconstructions of the tomography data revealed a highly complex microarchitecture of the cornified sheath of the cat claw, which reflects the uniquely complex shape of the underlying dermal tissue and bony core. The cornified sheath is generated by the living epidermis that is supported by the dermis and its papillary body whose configuration varies depending on its location. The dermis is densely supplied with blood vessels, most of which emerge from the bony core. A single large dorsal dermal papilla points distally, and the overlying living epidermis forms cone-shaped layers of cornified epidermis, which are separated from one another by distinct breaks that appear to be formed periodically. The terminal cone forms the tip of the claw and is shed by cats through a mechanism that has been all but overlooked by science so far. The sides of the cornified sheath appear also to be formed in periodic layers and create sharp blades that frame the soft, friable sole horn of the claw and are responsible for the effectiveness of feline claws in cutting into flesh. (Supported by a Faculty Research Grant from Louisiana State University).

The Ridge Pattern of the Cornified Oral Surface of the Upper Beak of Parrots: Individual and Genus-level Character

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Parrots and cockatoos (Family Psittaciformes) are seed predators with a specialized seed-shelling mechanism using distinct beak structures, which include the patterns of ridges on the cornified oral surface of the upper beak. Transverse or chevron-shaped filing ridges cover the oral surface of the overhanging upper bill tip. A curved transverse step separates this surface from the corneous palate with its own pattern of palatal ridges, which is indicative of generic relationships within the psittaciform families. The ridges are surface structures that are initiated at the level of the underlying connective tissue with its own papillary and ridge formations and are the result of alternating juxtapositions of horn of different hardness. Whereas the filing ridges and transverse step are directly involved in the seed-shelling mechanism, the palatal ridges are not. The ridge pattern of the cornified oral surface of the upper beak of 28 live individuals of the Hispaniolan Amazon (*Amazona ventralis*) was documented through photographs with an otoscope and through casts using dental impression material at 6-month intervals over the course of one year to establish that the ridge patterns are individually unique and that they do not change with time. The complex pattern of the ridges, like that of the human fingerprint ridges, is likely the result of epigenetically determined individual patterns within a genetically determined basic ridge pattern. The ridge patterns may potentially be used as a tamper-proof identification tag to distinguish captive-bred parrots and cockatoos from illegally captured one.

Odontogenetics of Tribosphenic Molars: Developmental Background of a Major Mammalian Apomorphy

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Prismatic enamel and monophyodont multicuspidate molars represent the major dental apomorphies of mammals and one of the key factors of the ecological prospect of that group. Molar development and enamel formation were extensively studied in several model species (mouse, vole, human etc.) only little information is available on these topics in tribosphenic molars (TM) though—as it was many times demonstrated—it presents a phylotypic stage to all mammalian molar types. We analyzed architecture of TM enamel coat in several model taxa, particularly bats, and studied early stages of amelogenesis on embryonal series of *Monodelphis domestica* and *Myotis nattereri* with aid of histological and SEM techniques. The results demonstrated that: (i) the crests, which are essential characters of TM, are preformed at the early stage of IEE histodifferentiation, (ii) the later stage of TM development is characterized by considerable emancipation of particular structural modules of the tooth, and by (iii) early beginning of the formation of prismatic enamel, while (iv) the final adult shape and size of the tooth and enamel maturation are established as late as the time of tooth eruption. The delayed enamel maturation, that is an essential precondition for expansion of tooth size and fine tuning of the crest interlocking pattern at the perieruptional stage, is related to a switch of the secretory actvity of ameloblasts from a slow production of large-crystallite prismatic enamel to a rapid production of small-crystallite interprismatic matrix and aprismatic enamel, supposedly under the mechanical stress of tooth eruption.

Fossorial Locomotion in a Fossorial Specialist: The Kinematics and Kinetics of the Ferret (*Mustela putorius furo*)

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Small mammals commonly utilize burrows for sanctuary as well as predation. While the biodynamics of digging has received considerable attention, how mammals move through the constrained environment of tunnels is largely unexplored. In the present study, we used a mammal morphologically adapted for fossioriality, *Mustela putorius furo* (domestic ferret), to evaluate the effect of constrained environments on locomotor biodynamics. We simulated burrow-like conditions in the laboratory using plexiglass tunnels overlying a trackway into which a force platform was integrated. Locomotor trials simulated both epigean (overground) and subterranean (tunnel) conditions. Simultaneous high-speed videography captured limb and spinal kinematic data. Previous gait analyses have reported just two gaits in *Mustela*: walking and half-bounding. Movement through tunnels constrains *Mustela* to non-bounding gaits and reveals a greater locomotor repertoire than has been previously recorded. In addition to providing baseline data on