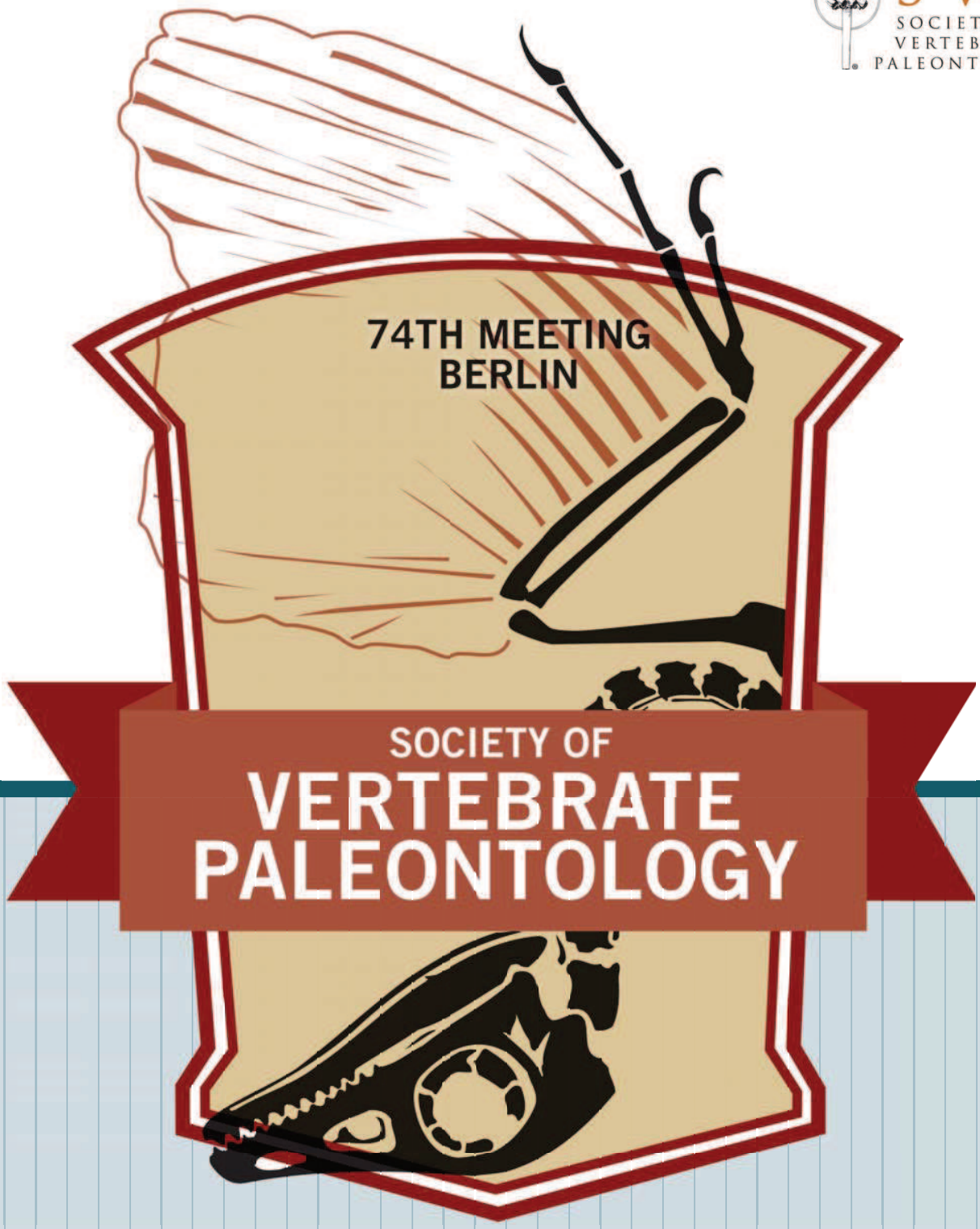
MEETING PROGRAM & ABSTRACTS

SVP
SOCIETY OF VERTEBRATE PALEONTOLOGY



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quantification of actual ontogenetic trajectories in the sample. We evaluated this by plotting principal components (shape data) against centroid size. As expected, when correlation between shape data and centroid size was present, it was often stronger in the unilateral dataset because taphonomic effects were minimized. Still, correlations within the unilateral dataset were relatively low and suggest that other factors apart from allometry are contributing to intraspecific shape variation in our sample. Based on these results, we caution workers to consider the impact of taphonomy on shape data when using 2D or 3D GM on fossils that have undergone taphonomic distortion.

Technical Session III (Wednesday, November 5, 2014, 3:00 PM)

A BIOMECHANICAL EXPLANATION FOR THE AMPULLAE OF TYRANNOSAURID TEETH BASED UPON FRACTURE MECHANICS

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The teeth of tyrannosaurid dinosaurs possess ampullae, rounded or circular structures found in the dentin of serration interdenticle sulci. The function of these structures has been a mystery. Hypotheses include: 1) devices to stymie the propagation of carious infections and 2) serving to maintain the structural integrity of the tooth during feeding. In the latter, the ampullae are depicted as open semi-spherical voids at the end of serration channels. Presumably, they function to decrease the stress concentrations that cause cracking, thereby inhibiting fracture. We conducted a combined histological and FEM mechanical analysis of ampullae in North American tyrannosaurid teeth. The teeth were prepared in a variety of planes using standard petrographic techniques for osseous tissues. Finite element meshes were made for the regions of interest. These incorporated our findings on tissue distribution and their inferred material properties. Meshes with and without ampullae were loaded in uniaxial tension and the comparative stress distributions analyzed using modern fracture mechanics theory. Our histological results show that fractures do in fact originate between serrations, propagating through the enamel and terminating within individual ampullae. However, we found that the ampullae are solid structures and not voids, and are composed of mantle dentine. These observations necessitated a new explanation for how crack attenuation occurs in the teeth. The FEM analysis revealed that each interdenticle sulcus acts as a stress concentrator, predisposing the tooth to crack formation at these locations. After propagating through the enamel, fractures terminate within the dentin of the ampullae. We find that stress is "absorbed" by the area of low elastic modulus, inhibiting further crack growth and protecting the tooth from catastrophic failure. However, this is only one potential toughening mechanism and we propose material property testing will be needed to further evaluate the likelihood of any of these mechanisms.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

THE DISTRIBUTION OF DENTAL FEATURES IN NON-AVIAN THEROPODS AND A PROPOSED TERMINOLOGY OF THEROPOD TEETH

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Although theropod teeth are abundant vertebrate fossil remains often reported in the literature, they are not comprehensively described despite containing extensive anatomical and taxonomic information. Often, the paucity of original descriptions makes identification of isolated teeth difficult, and thus taxonomic assignments uncertain. We propose a standardization of the anatomical and morphometric terms for each tooth anatomical sub-unit, as well as a modus operandi to describe isolated teeth. Crown, carina, cervix, denticle, interdenticular sulcus, interdenticular diaphysis, flute, longitudinal undulation, marginal undulation, longitudinal ridge, basal striation, and enamel texture are anatomical terms among others proposed to describe theropod teeth. We also investigated the distribution of 30 dental characters related to tooth size, crown shape, curvature and cross-section outline, denticle size and recurvature, position and extension of carina, and enamel texture among 113 theropod taxa. Our research shows that isolated theropod teeth are more informative than previously thought. Most isolated teeth can be identified to family-level and often below that.

Functional clues for each dental feature were assessed to provide context on the degree of homoplasy relating to function. For instance, numerous transversal undulations and marginal undulations are present in non-coelurosaur averostrans and tyrannosauroids. Hypothetically, enamel undulations may have served to minimize suction when the tooth was pulled out of the flesh, to help strengthen the crown during feeding, or may be a byproduct of growth. Fluted crowns exist in mesialmost and lateral teeth of *Coelophysis*, Spinosauridae and some dromaeosaurids, being also common in piscivorous reptiles. Flutes most likely have some piercing and gripping function, allowing the sharp ridges to pierce the skin, and keeping slippery prey in the mouth. Interdenticular sulci are present in non-coelurosaur averostrans, tyrannosauroids, and dromaeosaurines. Interdenticular sulci may play several roles such as hosting septic bacteria for an infectious bite, helping the entry of venom, distributing stresses from the base of the denticle, or preventing suction when the crown was pulled out of the flesh. As a corollary, this study exposes the importance of detailing anatomical descriptions with the purpose of clarifying taxonomy and identifying isolated theropod teeth.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

THE EVOLUTIONARY HISTORY OF BURROWING IN NORTH AMERICAN ANURA

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Burrowing has been used by members of all vertebrate classes to avoid unfavorable climatic conditions, escape from predators, raise young and acquire food. With their extremely permeable skin, which allows for the absorption of water and oxygen from the environment, anurans are extremely susceptible to rapid dehydration when it is hot and dry. As such, many anurans use burrows either as daytime resting chambers or aestivation chambers to avoid desiccation. Anurans also use burrows as hibernation chambers in the winter to avoid freezing, lay eggs in, avoid predators, and for subterranean food acquisition.

At least two groups of anurans with a fairly decent fossil record, Pelobatidae (pelobatoids more closely related to *Pelobates*, *Scaphiopus* and *Spea* than to Pelodytidae and Megophryidae) and Rhinophrynidae, have a skeleton specialized for burrowing. Their limb bones are short and stout, especially the tibiale and fibulare, and the distal prehallux bone is modified into a distinctively shaped spade, which in life is covered by a keratinous sheath and used for digging. Rhinophrynids tend to have stouter limb bones than pelobatids, and carry a second spade on each hind foot that is derived from the distal phalanx of the first digit.

Anurans adapted to burrowing appear in the North American fossil record well before they occur in other regions of the world. Burrowing rhinophrynids first appear in the Late Paleocene of Wyoming and occur sporadically in western North America through the late Eocene. They appear at a time when the climate was becoming steadily warmer before the Paleocene-Eocene Thermal Maximum and inhabited Calf Creek, Saskatchewan, Canada, in the Late Eocene while the climate was still warm-temperate. It appears that as the climate became cooler, rhinophrynids were unable to adapt to freezing temperatures and withdrew to their current, more southerly range in seasonally dry, tropical forests in coastal lowlands from southern Texas through Central America.

When the first burrowing pelobatid appears in the middle Eocene of Nevada, the climate there was warm-temperate. This anuran most likely used a burrow as a daytime resting chamber and/or for aestivation, as their extant counterparts do. Burrowing-adapted pelobatids next occur in the early Oligocene and their record extends through the Holocene, a period in which the climate in the North American west became drier and cooler. At some point during this interval, in which extant taxa appear, pelobatids apparently developed the ability to hibernate in burrows to avoid freezing during the winter.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

FAUNAL EVIDENCE FOR HOMININ PALEOENVIRONMENT AND BEHAVIOR IN EARLY PLEISTOCENE CHINA

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The expansion of hominins into northeastern Asia has important implications regarding their abilities to adapt to and survive in new geographic and environmental settings. Evidence of this environment and the behavior of early hominins in Asia is found at the Paleolithic archaeological site of Feiliang in the Nihewan Basin of China. This is an ancient, down-faulted lake basin located approximately 120 km west of Beijing in northwestern Hebei Province. Feiliang is situated on the eastern margin of the Nihewan Basin in the Nihewan Formation and is dated to approximately 1.2 million years ago. At this time, no hominin fossils have been found at this locality, but their presence is known based on the discovery of stone tools in association with faunal remains. *Homo erectus* is suggested to be the manufacturer of these tools, as no other hominin species are known from Asia during this time period. An analysis of the faunal collection from Feiliang includes 361 mammal specimens, of which 138 are identifiable to element and 36 are identified to family level. The ungulate families Equidae, Bovidae, and Cervidae dominate the collection, although carnivore, fish, bird, and bivalve specimens are also present. The presence of *Equus sanmeniensis,* in contrast to the earlier *Hipparion,* indicates a shift to a more open, grassland environment for hominins at Feiliang. Surface damage on the fauna, in the form of cutmarks, hammerstone percussion marks, and toothmarks, indicates both hominin and carnivore involvement in the accumulation at this site. However, cutmarks are the most common form of damage observed, occurring on over 10% of specimens (n = 22) that display low to moderate weathering and retain the original bone surface layer. This proportion of cutmarks is higher than that seen at the well-preserved site FLK-22 at Olduvai Gorge, Tanzania and indicates that early hominins at Feiliang frequently supplemented their diet with meat, possibly in higher quantities or frequencies than has been observed at some African hominin sites.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

HISTOLOGICAL ANALYSIS OF AN ENIGMATIC MICROSTRUCTURAL PALEOPATHOLOGY ON LIMB BONES OF THE THEROPOD DINOSAUR *FALCARIUS UTAHENSIS*

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Over the past decade, thousands of bones of the theropod dinosaur *Falcarius utahensis* have been recovered from the Crystal Geyser Quarry (CGQ), a mass death assemblage in the Yellow Cat Member of the Cedar Mountain Formation in east central Utah. Several appendicular elements recovered from the CGQ, including a tibia, humerus, and metatarsal, display a prominent pathology, present externally in the form of a smooth-surfaced raised bone callus. The bony calluses range in size from approximately 50 to 90 mm and remain undistorted despite widespread crushing of the medullary cavity in several *F. utahensis* specimens.

Here we comparatively examine the paleohistology of an *F. utahensis* tibia exhibiting a bony callus and a non-pathological tibia of approximately the same dimensions. The non-pathological juvenile bone in *F. utahensis* is characterized by uniform fibrolamellar cortical bone tissue. The pathological bone is characterized by a distinctive microscale, reactive bone structure at the site of the morphology. This includes a cryptogenic mass/nidus that is embedded within the primary fibrolamellar bone and deep to a narrow band of secondarily deposited lamellar bone. Capping this central nidus and extending to the periosteal surface is a domed mass of reactive, rapidly deposited, secondary bone exhibiting radial vascularization. The opposing endosteal surface exhibits a highly localized region of reactionary bone.

Literature on diagnosing paleopathologies via histological analysis is sparse. However, this technique provides an independent methodology for examining bone abnormalities that can be correlated to visualizations produced by computed tomography. Additionally, paleohistological analysis of pathologies reveals the stepwise sequence of bone remodeling that may provide new insight into disease progression. No comparative