Sicyopterus stimpsoni (20–24 mm total length) with *Awaous guamensis* and *Lentipes concolor* (both 12–16 mm TL) on a Plexiglas waterfall. *Lentipes* and *Awaous* climb using bursts of axial-based swimming. Bursts last 0.07±0.02 sec at 10.3±4.2 TL/sec (190±80 mm/sec). The pectoral fins extend perpendicularly between bursts, but adduct as climbing resumes (contributing to thrust initiation). *Sicyopterus* climb by alternately attaching oral or pelvic sucking discs to surfaces and 'inching' upwards with little axial undulation. As the oral disc attaches its size doubles, then the posterior body is pulled upwards; once the pelvic disc attaches, the oral disc releases and the anterior body advances. Climbing bouts include multiple cycles and last several seconds at 0.25±0.04 TL/sec (6±1 mm/sec). Power-burst climbing may be impeded in *Sicyopterus* as this species loses 15% weight during the metamorphosis preceding climbing. While climbing, *Sicyopterus* always remain attached to substrate by suction. ONR N000149910184 (Westneat); Hawaii Fish Restoration F-14-R-18 (Fitzsimons).

Bringing Fossils Back to Life: The Locomotion of the Messel Horse, *Palaeotherium parvulum*

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Propalaeotherium parvulum was as small horse known from the Eocene deposits of the Grube Messel (Germany). One specimen is only 55 cm in head-trunk-length. The small size of the animals suggests that the kinematics of its locomotion were different from those of the large extant horses. The question arises how the locomotion of this fossil horse might have looked like. Based on available descriptions and photographs of original fossil material we reconstructed the skeleton of *P. parvulum* three-dimensionally using surface subdivision modelling procedures implemented in 3D Studio Max software. Previous results of our working group on the locomotion of mammals of various sizes, indicated that the descriptive parameters of the kinematics of a mammal are size related. Thus, the locomotion of *P. parvulum* can be approximated based on data from extant forms of comparable size and proportions (*Hyrax*, *Tragulus*). These parameters were applied to the virtual *P. parvulum* skeleton and it was animated accordingly.

What is Evolutionary Constraint?

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It is now widely acknowledged that organisms reflect the duality of adaptation to current environmental demands and the inherited tendency to remain the same, or historical contingency. Adaptation is the province of environmental selection whereas contingency is assumed to reflect intrinsic, organismal attributes that somehow resist or bias the effects of that selection. As such, contingency is viewed as a 'force' that somehow limits the efficacy of selection to create an adapted phenotype and is therefore termed "evolutionary constraint." However, uncritical usage of constraint terminology has led to its dilution as a critical concept in evolutionary theory. In particular, ambiguity and conflict in the relationship of constraint to selection has been problematic. This treatment attempts to delineate the factors necessary to operationalize a moribund constraint concept by making explicit the relationship between constraint and selection. Several factors are considered essential: 1) specification of a null model, usually adaptive evolution by environmental selection (different null models lead to different definitions of constraint); 2) application to characters, not organisms or lineages; 3) specification of a clade; 3) specification of a focal life-stage; 4) recognition of both internal and external components of natural selection; 5) recognition that selection operates on all life-stages, including early development. If these criteria are met, evolutionary constraints can be defined mechanistically and with explicit reference to selection, eliminating ambiguity. Greater precision in usage should lead to a more useful constraint concept.

Analysis of Metric and Kinematic Parameters of the Locomotion in African Elephants (*Loxodonta africana*)

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The limbs of elephants are characterized by a pillar-like arrangement and straightened joints. Little is known about metrics, kinematics, dynamics and energetics of the locomotion of Proboscidia. Obviously the largest extant terrestial animals are not able to gallop but move quite smoothly. As a first attempt to understand the locomotory principles of African elephants and its ontogenetic development we measured metrics and kinematics of two juvenile animals (0, 2) at Thüringer Zoopark Erfurt. The locomotion was analyzed by an infrared motion analysis system (Qualisys) at 240 Hz, which recorded the light reflexions of markers stuck on the skin above the joints and the vertebral column and calculated their locations in the space. The angle-time-courses of limb joints (shoulder-, elbow-, wrist-, hip-, knee- and talo-crural-joint) at different speeds were calculated. At all speeds the animals used a lateral sequence walk. The fore- and hindlimb kinematics will be compared to that of small- and medium-sized animals (which have more flexed limbs).

Homology and Evolution of Cephalic Vasculature in Archosauria

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Cephalic vasculature is an integral component of the vertebrate head, but very little is known about it in Archosauria, and its functional role in the biology of these organisms has never been assessed. We sought to address this deficit in anatomical knowledge by documenting the anatomy of the head vessels of extant Archosauria (birds and crocodilians), testing hypotheses on the homologies and evolutionary history of the head vascular system, and reconstructing vascular structures in extinct archosaurs using the extant phylogenetic bracket methodology. The task of assessing homology was made difficult by the highly apomorphic head morphologies found in both extant archosaurian clades. However, results of this research project have identified a surprising level of similarity in vascular structure and patterning between birds and crocodilians. A higher level of plasticity was found at more general branching patterns, but even these are highly phylogenetically conserved. Many vascular structures have been found to leave clear osteological correlates which has allowed us to discern and reconstruct vascular structures and patterns in extinct archosaurs such as dinosaurs, to test hypotheses of homology, and to add to a comparative understanding of cephalic vasculature in all amniotes. Some of the reconstructed vascular structures appear to be correlated with important physiological mechanisms and behaviors, such as selective brain temperature regulation.

Relation Between the Ultrastructural Changes of Myofilaments and Neuromuscular Junctions During Altered Functional Demands

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Skeletal muscle fibers exist as dynamic structures and are capable of adapting to altered functional demands. Altered functional demands like exercise cause destruction of thin and thick myofilaments mostly located in the peripheral myofibrils. This process is accompanied by destruction of neuromuscular junctions. The aim of the study was to determine the relation between the changes of the myofilaments renewal, their ultrastructure and ultrastructural response of neuromuscular junctions to the ultered functional demand of skeletal muscle. The signs of focal denervation were one of the ultrastructural features of the exercised rats myofibers. Simultaneously signs of intracellular regeneration processes appeared in the muscle fibers of the exercised rats. During the exercise myosin and actin had slower turnover rate than in the pre-exercise period, but 24 hrs after the last exercise, myosin and actin turned over faster than in the control rats. Exercise causes an about 3-fold increase in the number of satellite cells as well as intensification of protein synthesis in the muscle fibers. In conclusion, changes in the turnover rate of muscle contractile proteins in muscle fibers clearly reflect the physiological conditions of myofibrillar apparatus, have good correlations with the activation of satellite cells and reorganization of neuromuscular junctions and can be regarded as a manifestation of the functionally determined adaptive process caused by an increase in muscular activity.

Cronology of the Skeletal Ossification in *Capra pyrenaica* (Mammalia: Artiodactyla)

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