

Among Xenarthra the femur is noticeably expanded mediolaterally, more so than in other mammals of comparable size. Tardigrada (sloths) exhibit the most extreme condition, particularly among the largest forms, such as the giant ground sloth, with femoral expansion always associated with strong anteroposterior compression. Biomechanical indexes show that Tardigrada, among Xenarthra, plotted far from other mammals, except those adapted to peculiar environments and strategies (such as aquatic, semi-aquatic or bipedal habits). The lateromedial expansion of the femoral diaphysis, along with anteroposterior compression, might be due to many factors: the lack of a medullar cavity, the torsion of the hindlimb associated with a complex and relatively rigid pelvic girdle, the rearrangement of the pelvic musculature and the presence of some sacrofemoral ligaments, and an inclined attitude during a bipedal stance (as might occur during feeding or defense). Further, hindlimb torsion probably affected lateromedial expansion more than previously supposed. According to other studies, the expanded and somewhat twisted femoral diaphysis is a morphological response to torsion strains due to the nearly horizontal position of the bone during both locomotion and bipedal standing. On the other hand, the short femoral neck is invariably associated with a well developed greater trochanter, always far from the caput. A better lever arm for the gluteal muscles involved in posture is produced mainly by the displacement of their insertions.

Comparative and Experimental Analysis of Jaw Muscle Morphogenesis in Quail and Duck: A Basis for Understanding Developmental Mechanisms Underlying Evolutionary Change

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Vertebrate jaw morphology is highly diverse and closely linked to species-specific differences in feeding. However, developmental processes that generate such diversity are not well understood. To identify molecular and cellular mechanisms that may have played a role during the evolution of the jaw complex, we conducted a comparative developmental study of avian jaw musculature. We analyzed the pattern of jaw muscle morphogenesis in two species of birds, quail (*Coturnix coturnix japonica*) and duck (*Anas platyrhynchos*), which belong to phylogenetically distinct groups (Orders Galliformes and Anseriformes, respectively), and which show considerable differences in jaw anatomy. We employed histology, immunohistochemistry, and in situ hybridization to follow myogenesis. The spatiotemporal patterns of myogenic gene expression and muscle-specific protein localization during relatively early stages of myogenesis (specification and differentiation) appear equivalent in these two avian species. In contrast, species-specific anatomical differences were observed in later stages of myogenesis (pattern formation). To understand the origins of such species-specific differences in muscle morphology, we generated quail-duck chimeras. Previous data have suggested that patterning of cranial muscles might involve connective tissues derived from cranial neural crest cells. Thus, we exchanged premigratory neural crest cells between quail and duck embryos to test the extent to which donor neural crest cells pattern host jaw muscles. We also performed transplants of jaw muscle precursors between quail and duck. Our results reveal the role of neural crest-derived connective tissues during muscle patterning and suggest that developmental mechanisms have shaped the course of morphological evolution.

Dissociation Between the Axial Myology and Osteology in the Anterior Preloacal Region of Limb-reduced Squamates Including Snakes

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In limb-reduced squamates with an elongated body, various anatomical structures that are usually associated with the cervico-dorsal boundary in tetrapodal squamates tend to be displaced relative to one another. In the present study, characteristics of the adult axial myology and osteology in the anterior preloacal region were examined in limb-reduced squamates including snakes. In forms that still retain a vestigial pectoral gir-

dle such as amphisbaenians and *Dibamus*, features of the axial myology (e.g., appearances of muscles inserting on the skull) and osteology (e.g., emergence of vertebral hypapophyses) tend to be dissociated not only from the position of the pectoral girdle but also from one another, occurring at different vertebral levels. Most notably, cranio-vertebral muscles belonging to both the subvertebral and m. transversospinalis groups tend to extend much more posteriorly well beyond the level of the pectoral girdle. The posterior extents of these cranio-vertebral muscles vary similarly in snakes. In addition, unlike in tetrapodal squamates, the posterior extents of hypapophyses and the subvertebral m. rectus capitis anterior are dissociated from each other in many limb-reduced squamates, with the latter muscle extending much more posteriorly than the former structure in amphisbaenians, *Dibamus*, *Acontias*, and scolecophidian snakes (but vice versa in many alethinophidian snakes). These observations suggest that the regulation of axial patterning may be dissociated between different muscle groups or between the vertebral column and the associated musculature within the primaxial domain in limb-reduced squamates and snakes, thus further blurring the cervico-dorsal boundary in these animals.

The Evolution of the Middle Ear in Parareptilia

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Traditionally, the origin and evolution of the impedance-matching (tympanic) middle ear in amniotes was considered a key innovation of basal tetrapods, only later modified during amniote diversification. Recent investigations, however, have shown that the otic region of early amniotes lacks any indication of impedance matching; consequently, the tympanic middle ear seen in modern taxa must have evolved independently multiple times. When turtles are considered diapsid reptiles, only two of the three major amniote clades, Synapsida and Eumetalia, were known to possess a true tympanic ear, with convincing evidence lacking for the third, Parareptilia. For an unequivocal interpretation of impedance matching in fossil amniotes, several functional requirements must be reflected in the anatomy: a) a modified temporal region indicating the presence of a tympanum; b) firm contact between the skull roof and paroccipital process, freeing the stapes from its bracing function; c) a slender stapes, indicative of mediating airborne sounds via vibrations from the tympanum to the inner ear; d) differentiation of the posterolateral braincase wall into oval and pressure-relief windows, along with ossification of the medial wall to separate the inner ear from the remaining braincase. Basal parareptiles lack these features, suggesting that airborne sounds could not be perceived effectively. However, we present here evidence that within derived parareptiles, a poorly-known clade from the Middle Permian of Russia possesses all anatomical characteristics typical of an impedance-matching middle ear. This represents the first true evidence of a tympanic ear in parareptiles, and the oldest yet found in amniotes.

Current Knowledge of Tooth Development, A Model Mineralized Element System

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The tooth represents a great model of epithelial-mesenchymal interactions and organogenesis, and due to its accessibility it provides a great opportunity for tissue engineering. The signals involved in many of the stages of tooth development have started to be elucidated and provide a wealth of information regarding initiation of a tooth, shape of a tooth, size of a tooth and number of teeth. Using the mouse as a model organism, tooth development will be discussed, looking at each of these processes which together result in the formation of a particular pattern of dentition. How variation in dentition could be generated will be discussed using information learned from gene manipulation in vivo and explant culture. In such studies the basic shape of a tooth, the cusp pattern, the number of teeth, the size of teeth and the pattern of mineralization have all been altered. Our understanding of tooth development can then be utilized to address the question of what is necessary for formation of a tooth. Given this information we can then move onto investigate how to re-create a tooth, with the ultimate aim of providing replacement teeth by tissue engineering.