Analyzing Correlations between Different Locomotor Types and Skeletal Structures of Various Mammals

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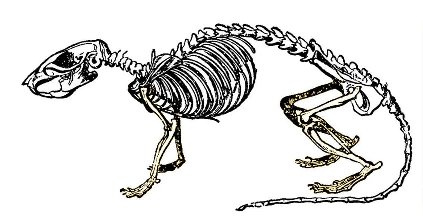
Abstract

The interactions between certain muscles and bones of the forelimb and hindlimb propel mammals forward through lever mechanics, with the most striking differences between mammals and their specific movement techniques stemming from the unique characteristics of each species, such as size, environment, and adaptability. The factors that affect how mammals are able to move vary between each individual species, differing through the animal's muscular differences, specific gait, movement techniques, or generally the skeleton itself. Through their species specific skeletal makeup, mammals have different methods of locomotion, opting to either run, jump, or dig within their habitat to better suit their needs. By directly viewing different species at the skeletal level, both through manuals and pictures, as well as real models, we were able to see that different bone and muscle modifications developed within different species of mammal in regards to their locomotor systems. We were able to observe that particular limb bones in some species had either fused, grown longer, or even been completely lost to accommodate different body sizes or lifestyles. With the information collected and specific instances shown through models, we are able to plan an informative exhibit at the Rutgers Geology Museum that would be able to teach a wide variety of visitors and patrons the core differences that exist at the skeletal level that allow mammals to move in their own unique ways.

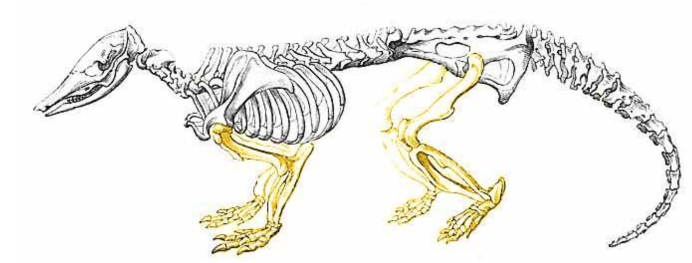
Skeletal Differences

- Through the usage of mammal skeletal diagrams like those shown below, a clear distinction of differing bone structure, bone placement, and bone size can be observed. With these differences in mind, we can see a direct correlation between those characteristics and how mammals move around.
- In the skeleton of a rat, minimal adaptations have been made to the bones in terms of the locomotor system. The hindlimb and forelimb bones are not more dense than usual, and no bones have fused for increased maneuverability. Rats move through ambulatory locomotion, operating through basic walking.

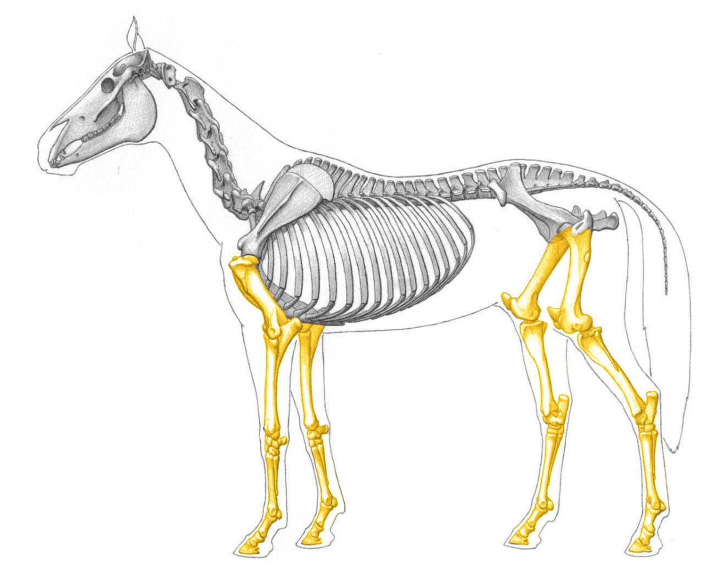


https://pestologyltd.co.uk/what-size-hole-can-a-rat-get-through/

- In fossorial, or digging mammals, parts of the skeleton are optimized for "swimming" through the earth. The olecranon process, the bony upper part of the ulna, is elongated allowing for increased power when digging through the dirt. In contrast, cursorial or hoofed mammals, have specifications for running rather than digging. Bone fusions at both the radius and ulna, as well as the tibia and fibula reduce weight and allow for more speed within cursorial mammals. The fusion and adoption of an unguligrade (or tip-toed) locomotion style also allows for more streamlined, quick movements.

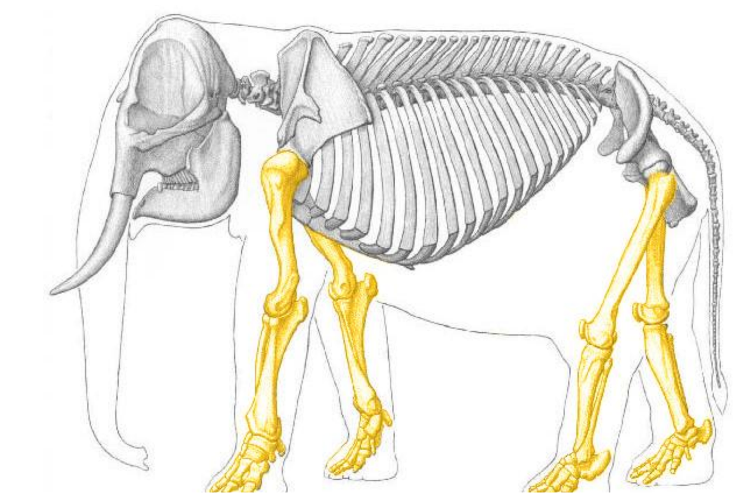


From Martin, 1841



From Goldfinger, 2004

- In mammals like elephants, bones increase in size and width to support the massive weight of the animal. The straight-legged walking pattern and gait for the creature, along with its straighter bones, accommodate the mammal's humongous size. An elephant's weight and posture are also supported by fleshy pads under its feet.
- Saltatorial locomotion, in species like the kangaroo, is a form of locomotion that correlates to an elongated tibia and fibula, along with the calcaneus in the heel. Their long tail doubles as a counterweight during hopping and a fifth limb when they walk.



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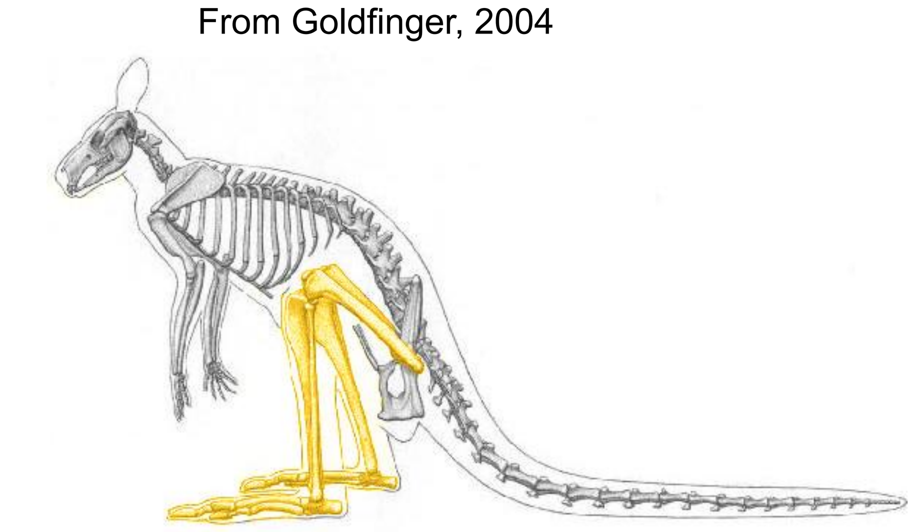
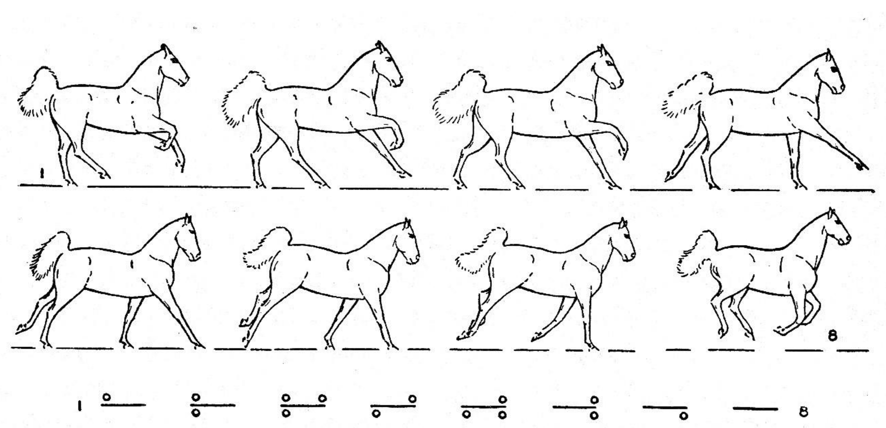


From Goldfinger, 2004

Background

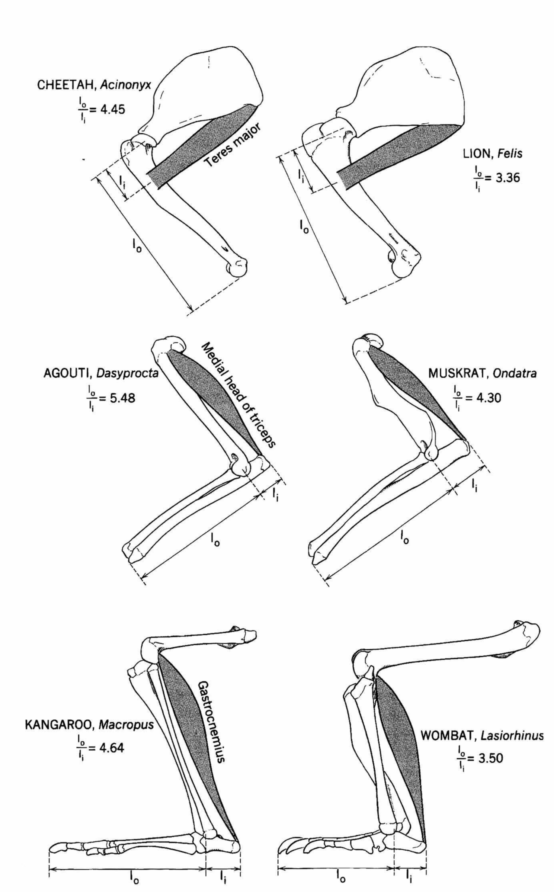
- The gait, or the specific ways and movements that an animal makes while moving, all stem from their skeletal locomotor system. Through adapting to the needs of their environment, mammal skeletons are able to create optimized modes of locomotion to better aid in their survival. The alterations made within the skeletal structure of the locomotor systems found within mammal species can be unique to those specific mammals, like the fusing of the hindlimb and forelimb bones within a horse, or the straightening and thickening of the leg bones within an elephant. These adaptations lead to a variety of locomotion styles in mammal species.



From Howell, 1965

Bone Muscle Comparisons

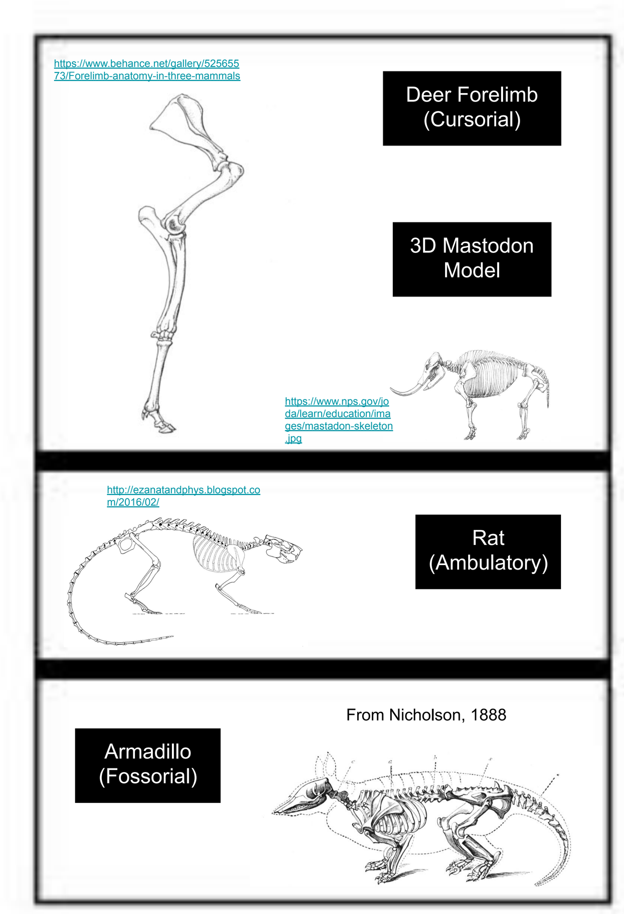
- Direct interactions between the muscular system and the skeletal systems occur to help propel all mammals forward. Individual muscles are able to attach to specific bones at their points of origin and insertion, stretching across joints to create movement. An example of this would be the teres major attaching to the scapula and humerus, which acts with the triceps, latissimus dorsi, and the deltoid to swing the whole forelimb back (retraction).



From Hildebrand, 2001

Results

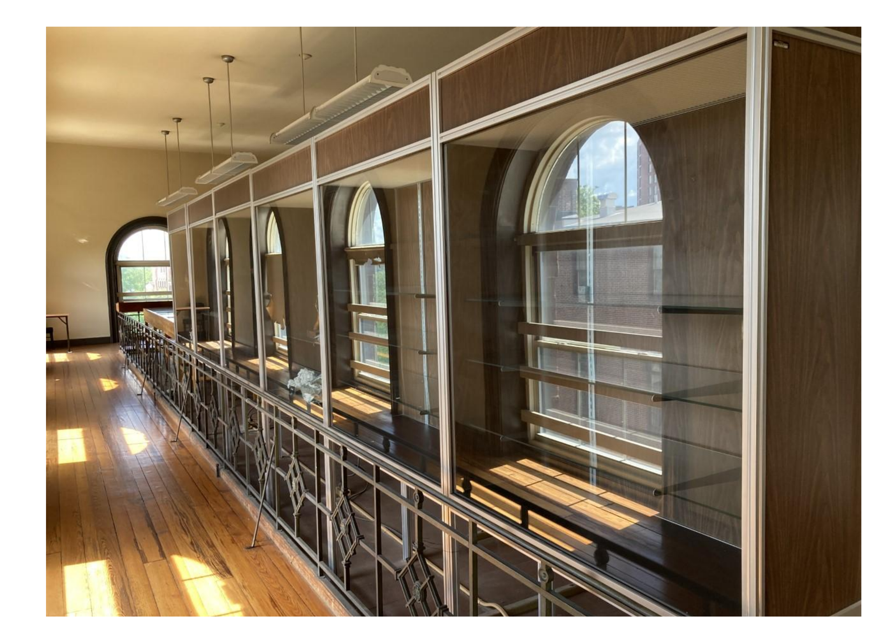
- With the information gathered through our research, along with the inability to be in the Geology Museum, our results are pointed towards the future with a proposed mockup of a display case for our Mammal Locomotion exhibit. This first display case will contrast the differences between fossorial, cursorial, and graviportal locomotion, while including an ambulatory mammal like a rat for comparison.



*Label boxes are in the place of text descriptions

Future Direction

- During the upcoming academic year, our research will focus on more unique forms of locomotion found in mammals, such as swimming and climbing. This will allow us to extend our research to mammal species like the dolphin and various primates. Our plan is to expand the exhibit to six cases, showcasing more unique and different mammal skeletons along with explanations comparing their movement methods and skeletal differences.



Acknowledgements

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