Tiny fossil horses put their back into it

April 27 2016

Modern horses are expert runners. They reach top speeds using a special running gait in which they hold their back stiff as they move. A new study published today reveals that tiny fossil ancestors of modern horses may have moved quite differently to their living counterparts.

"Horses provide a perfect case-study on the evolution of running because they have such an amazing fossil record", explains author Dr. Katrina Jones, a post-doctoral researcher in Harvard's Museum of Comparative Zoology. Dating back over 50 million years, the oldest horse ancestors were no bigger than a house cat. From those ancient horse ancestors, some lineages evolved larger sizes, grazing habit and limbs that were specialized for running. This new study suggests that the stiff-backed gait of modern horses likely evolved to save energy while running as horses got bigger through their evolution.

"For over a century, researchers studied the feet of fossil horses to explain how they evolved features specialized for running," explains Jones, "but very little is known about how the backbone might be involved in this famous transition." Four-legged mammals tend to move their lower back during running to help increase speed and regulate breathing. But horses are unusual because they restrict the motion of their lumbar spine to a single joint near their rump. Jones wanted to find out if this unusual pattern was shared by extinct horses, and how increasing size in horse evolution may have affected their back mobility and running style.

To understand the evolution of the back in fossil horses, Jones first

examined the anatomy and mobility of the spine in modern domestic horses. The shape of the vertebral joints—bony connections between the vertebrae—help determine how much motion occurs at each joint. Armed with this information, Jones then measured the shape of vertebral joints in 16 species of fossil horses spanning their full size and age range.

She found that small fossil horses, such as *Hyracotherium* (the 'dawn horse'), had quite different anatomy of the vertebral joints than their modern equivalents. This anatomy suggests more mobility was possible in the middle and lower portions of their back. Anatomy of these joints was also linked to body size—evolutionary branches which evolved greater size tended to display more restrictive joints. Jones hypothesizes that stability of the backbone evolved as a response to the mechanical challenge of large size in horses. Says Jones,"the energy required for a large animal to move at high speed can be extreme, so increasing running efficiency by minimizing motions of the trunk makes sense."

Jones speculates that these tiny ancient horses may not have been running in the same way as modern horses. Some living mammals can switch between stiff-backed and flex-backed running as they increase in speed. This could be one potential model for the evolution of specialized stiff-backed running in horses. This study reveals a new insight into a famous case-study of locomotor adaptation. Jones explains: "the findings are significant because they show how the backbone—a relatively understudied part of the anatomy—can provide new perspectives on locomotor transitions."

Provided by Harvard University