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# Locomotory Muscles and their Elasticity in Vertebrates

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## Opinion Article

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## ABOUT THE STUDY

The movement of vertebrate species is primarily reliant on elastic processes in animals. The tendons that are located within the muscles and connective tissue are linked to the muscles that regulate vertebrate movement. A spring can be used as a mechanism for various motions such as hopping, running, and walking, as well as for a variety of additional purposes include conserving metabolic energy, amplifying muscle power production, and attenuating muscle power production.

A body employs springs to store energy when it is moving, such as whether it is running, walking, or hopping, which suggests that elastic processes have a significant impact on a body's dynamics. A spring bends and stores energy in the form of elastic strain energy. This energy is released when the spring recoils after the applied force has been removed. Elastic proteins give the spring its elasticity, enabling the spring to bend to great strains with little force and to bend reversibly without losing energy. Elastic proteins have low stiffness and great resilience, which aids the function of elastic strain energy.

Tendons can lower the metabolic rate of muscular activity when running by lowering the volume of the muscle that is actively producing force. Utilizing the mechanical and energy advantages of tendon flexibility requires careful consideration of the timing of muscle activation. Power attenuation through the usage of tendons may enable the muscle-tendon system to absorb energy at a rate that exceeds the muscle's maximal rate of energy absorption. Because the intrinsic power limits of the spring and muscles are different, power amplification methods can function. The greatest power that skeletal system muscles can produce may be constrained. The tendons' ability to amp up power enables the muscle to generate more force than it is capable of. Tendons' mechanical actions have a structural foundation and are not constrained by restrictions on power output.

It was discovered through earlier experimental investigations on large animals that mammals retain a substantial amount of energy during active movement by using elastic tissues in their legs as they would otherwise need for

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sprinting. Measurements of the oxygen consumption rates of different animals while they walked, ran, or hopped showed that animals appear to conserve more than half the metabolic energy they would normally need for movement while moving quickly. Kangaroo jumping is one prominent instance. Kangaroos can move as efficiently (from an energy perspective) at high speeds as they could if they were moving at lower speeds. When hopping at modest speeds, their energy requirements grow linearly.

The tendon or ligament is compressed strongly when the animal's foot makes contact with the ground during high-speed locomotion, storing elastic energy much like a compressed spring. When the foot lifts off the ground, the compressed tendons and ligaments are relieved of pressure, and the elastic recoil from these spring-like structures adds additional force to propel the animal, saving energy. Simple calculations based on the forces involved in kangaroo hopping demonstrate how the storage of elastic strain energy can reduce the metabolic energy needed for hopping by 20%-30%. At high speeds, measurements of oxygen consumption in conjunction with variations in kinetic and gravitational potential energy show elastic savings of at least 54%.

It is crucial to keep in mind that larger animals, not species like insects, likely benefit more from elastic materials' metabolic properties. This is due to the obvious fact that larger animals can move with far greater stresses on their tendons and ligaments than small animals.