

生物策略表

類別	生物策略 (Strategy)
生物策略 STRATEGY	足墊應付體重增加 (Footpads manage increasing body mass)
生物系統 LIVING SYSTEM	哺乳類 (Mammals)
功能類別 FUNCTIONS	#應付擠壓 #應付撞擊 #Manage compression #Manage impact
作用機制標題	哺乳類的足墊透過改變幾何及材料特性，以在體重增加時維持功能的完整性 (The footpads of mammals maintain functional integrity as body mass increases through changes in geometry and material properties.)
生物系統/作用機制 示意圖	
作用機制摘要說明 (SUMMARY OF FUNCTIONING MECHANISMS)	
文獻引用 (REFERENCES)	
<p>「在多數的哺乳類之中，足墊是每次踏步時先撞擊地面的部分，所以它們的力學性質必然影響腿部的功能，然而，在過去的種間運動力學尺度分析研究中，卻忽略了足部及其軟組織。在這個研究裡，我們探究食肉目趾行動物的足墊接觸面及其硬度如何隨身體質量改變，以揭示足墊的力學特性及幾何大小如何相應改變，以維持功能的完整性。在跨數量級的體重增加時，我們發現：(1) 足部接觸面積增加的速度跟不上體重的增加，因此，足底壓力隨之增加，使體型較大動物的足墊組織處於更大的損壞風險；(2) 但足墊的硬度也隨之增加，因此較大動物的足墊組織必然承受較少的內在應變；(3)後腿足墊所儲存的總彈性能比前腿足墊的稍多，這額外的彈性能回饋能產生更大的推進效率。此外，隨體重變化的足墊硬度能使不同體型大小的動物得以維持相似的肢體負載特徵，以利長骨重塑。因此，在跨物種尺度上，足墊的結構特性並不像其他生物支撐結構般只單純地改變幾何大小，而是同時改變幾何大小及材料特性，這能幫助運動系統中其他部分的維持及運轉。」(Chi & Roth 2010)</p> <p>“In most mammals, footpads are what first strike ground with each stride. Their mechanical properties therefore inevitably affect functioning of the legs; yet interspecific studies of the scaling of locomotor mechanics have all but neglected the feet and their soft tissues. Here we</p>	

determine how contact area and stiffness of footpads in digitigrade carnivorans scale with body mass in order to show how footpads' mechanical properties and size covary to maintain their functional integrity. As body mass increases across several orders of magnitude, we find the following: (i) foot contact area does not keep pace with increasing body mass; therefore pressure increases, placing footpad tissue of larger animals potentially at greater risk of damage; (ii) but stiffness of the pads also increases, so the tissues of larger animals must experience less strain; and (iii) total energy stored in hindpads increases slightly more than that in the forepads, allowing additional elastic energy to be returned for greater propulsive efficiency. Moreover, pad stiffness appears to be tuned across the size range to maintain loading regimes in the limbs that are favourable for long-bone remodelling. Thus, the structural properties of footpads, unlike other biological support-structures, scale interspecifically through changes in both geometry and material properties, rather than geometric proportions alone, and do so with consequences for both maintenance and operation of other components of the locomotor system.” (Chi & Roth 2010)

參考文獻清單與連結 (REFERENCE LIST)

Chi, K. J. and V. L. Roth. (2010). Scaling and mechanics of carnivoran footpads reveal the principles of footpad design. *Journal of The Royal Society Interface*. 7: 1145-1155.
<https://doi.org/10.1098/rsif.2009.0556>

延伸閱讀

生物系統延伸資訊連結 (LEARN MORE ABOUT THE LIVING SYSTEM/S)

<https://en.wikipedia.org/wiki/Mammalia>

撰寫/翻譯/編修者與日期

譚國銓翻譯 (2020/04/22)；紀凱容編修 (2020/05/09)

AskNature 原文連結

<https://asknature.org/strategy/footpads-manage-increasing-body-mass/>