生物策略格式

KJC, 2019/10/21

類別	生物策略 (Strategy)
生物策略 STRATEGY	因應熱調節而最佳化鳥喙大小 (Beak size optimized for thermal regulation)
生物系統 LIVING SYSTEM	鳥類 Aves Class (Birds)
功能類別 FUNCTIONS	#形狀/材料最佳化 #保護免受溫度危害 #Optimize shape/materials #Protect from temperature
作用機制標題	相對於不同的緯度及環境溫度，鳥喙大小會有所變異，因此為了因應熱調節，鳥喙會有最佳化的大小，此概念稱為艾倫定律 (Allen's rule)。 (The beak size of birds is optimized for thermal regulation because they vary in size relative to latitude and environmental temperature, a concept called Allen's rule.)
生物系統/作用機制示意圖	 

作用機制摘要說明 (SUMMARY OF FUNCTIONING MECHANISMS)

「經過測量世界上大範圍鳥種的喙尺寸後，研究人員已發現在炎熱環境下的鳥類具有較大的鳥喙，而在較冷環境下的鳥類則演化出較小的鳥喙。」

「這項研究....證明鳥類在自然環境下體溫的維持，影響了鳥喙的演化。」

「此研究證實了艾倫定律，一個 133 年前的生態理論，預測在寒冷氣候中，動物的附屬器官，像是四肢、耳朵、還有尾巴，會變得較小以減少熱的散失。」(The University of Melbourne 2010)

“By examining bill sizes of a diverse range of bird species around the world, researchers have found that birds with larger bills tend to be found in hot environments, whilst birds in colder environments have evolved smaller bills.”

“The study...provides evidence that maintaining body temperature in a bird’s natural environment may have shaped the evolution of bird bills...”

"The research validates a 133-year-old ecological theory called Allen's rule, which predicts that animal appendages like limbs, ears, and tails are smaller in cold climates in order to minimize heat loss." (The University of Melbourne 2010)

文獻引用 (REFERENCES)

「艾倫定律推測在寒冷氣候中為了減少熱散失，內溫動物的附屬器官與身體大小相比會比較小。對艾倫定律的實證支持，主要來自一些不定期報告，探討個別物種極端大小之地理性漸變群。種間的證據則僅限於兩項研究，探討海鳥及岸鳥的腳部比例。我們對 214 種鳥類進行親緣比較分析，檢驗熱交換重要位置的鳥喙是否符合艾倫定律。探討的物種包含多樣的類群—巨嘴鳥、非洲擬啄木、澳洲鸚鵡、梅花雀、加拿大雞、企鵝、鷗及燕鷗。在所有物種中，喙長與緯度、環境溫度之間都具有強烈的顯著關聯性，而寒冷氣候的種類有明顯較短的喙。除了雀鳥之外，與緯度或海拔相關的分布上，所有類群所表現出的類型都支持艾倫定律。與溫度直接相關的證據，則出現在四個類群中 (鸚鵡、雞、企鵝、鷗)。由於支持艾倫定律的腳部因素較弱，一般會推論鳥喙可能更容易感受到體溫調節的壓迫。我們的成果提供了迄今對艾倫定律最強烈的比較支持，也證明了體溫調節在形塑鳥喙的演化上，確實是一個重要的因素。」(Symonds and Tattersall 2010: 188)

"Allen's rule proposes that the appendages of endotherms are smaller, relative to body size, in colder climates, in order to reduce heat loss. Empirical support for Allen's rule is mainly derived from occasional reports of geographical clines in extremity size of individual species. Interspecific evidence is restricted to two studies of leg proportions in seabirds and shorebirds. We used phylogenetic comparative analyses of 214 bird species to examine whether bird bills, significant sites of heat exchange, conform to Allen's rule. The species comprised eight diverse taxonomic groups—toucans, African barbets, Australian parrots, estrildid finches, Canadian galliforms, penguins, gulls, and terns. Across all species, there were strongly significant relationships between bill length and both latitude and environmental temperature, with species in colder climates having significantly shorter bills. Patterns supporting Allen's rule in relation to latitudinal or altitudinal distribution held within all groups except the finches. Evidence for a direct association with temperature was found within four groups (parrots, galliforms, penguins, and gulls). Support for Allen's rule in leg elements was weaker, suggesting that bird bills may be more susceptible to thermoregulatory constraints generally. Our results provide the strongest comparative support yet published for Allen's rule and demonstrate that thermoregulation has been an important factor in shaping the evolution of bird bills." (Symonds and Tattersall 2010: 188)

參考文獻清單與連結 (REFERENCE LIST)

Symonds, M. R. E. and J. Glenn. (2010). Geographical variation in bill size across bird species provides evidence for Allen's rule. *The American Naturalist* 176: 188-97. (https://www.journals.uchicago.edu/doi/10.1086/653666)

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/Aves
文章貢獻/編修者與日期:
黃信榮翻譯 (2019/05/14)；朱天愛編修 (2019/12/19)；吳晧編修 (2020/01/04)； 譚國鎏編修 (2020/05/26)；紀凱容編修 (2020/11/26)；施習德編修 (2020/12/16)
AskNature 原文連結
https://asknature.org/strategy/beak-size-optimized-for-thermal-regulation/