


生物策略格式

KJC, 2019/10/21

類別	生物策略 (Strategy)	
生物策略 STRATEGY	對流裝置可保存熱量且維持體溫 (Counter-current arrangement can retain heat and maintain body temperature.)	
生物系統 LIVING SYSTEM	革龜 (棱皮龜) <i>Dermochelys coriacea</i> (Leatherback sea turtles)	
功能類別 FUNCTIONS	#維持體內平衡 #Maintain homeostasis	
作用機制標題	藉由對流交換，成年革龜氣管內的血管內壁可協助它們在冷水中覓食時保持體溫 (The vascular lining in the trachea of adult leatherback sea turtles helps them maintain body temperature while foraging in cold water via counter-current exchange.)	
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>「成年革龜為大型的動物 (300-500 kg)，大小範圍與海洋的鰭足類及鯨豚類重疊。與海洋哺乳類不同，約 40-50 g 重的幼龜 (hatchling) 時，牠們就開始水棲生活了，在獨立生存期間，會增加一萬倍的體重。幼龜僅能生存於熱帶和淺層海域。成年革龜是膠質浮游生物的專性捕食者，屬巨溫性動物 (gigantotherm)，在深海 (<1280 m) 或高緯度的冷水時，可維持並提高核心體溫。此研究顯示與潛水及暴露於寒冷中有關的氣管結構，在個體發生上有巨大的改變。幼年革龜具有一般爬蟲類的氣管結構與穿插著大面積結締組織的圓形軟骨環 (cartilaginous ring)。成年革龜的氣管則是幾乎連續的橢圓形 (ellipsoidal) 軟骨管 (cartilaginous tube)，由連鎖板 (interlocking plates) 所構成的；在潛水時，此結構在水層上部就容易塌陷，避免造成與壓力相關的結構和生理問題。其內壁為大片且密集的直立血管叢 (vascular plexus)，可溫暖且濕潤吸入的冷空氣，也可能在呼氣時仍保有熱能。氣管亦具有下腔淋巴叢 (sub-luminal lymphatic plexus)。哺乳類和鳥類各自有獨立演化的鼻甲 (nasal turbinate)，可達到這種呼吸熱控的功能 (respiratory thermocontrol function)。對他們</p>		

而言，一般認為鼻甲是內溫動物的判斷依據。這研究是活體爬蟲類 (reptile) 的鼻甲對等物之首次證明。」 (Davenport et al.2009: 3440)

「氣管內壁是由連續的血管叢所形成的，具有高比例縱向 (longitudinally) 排列的大直徑血管，主要位於黏膜 (mucosa) 深層的三分之二處，彼此間有明顯的交叉連接。這樣的排列與其作為對流裝置排列的功能是一致的，可保存熱量且維持體溫等...。我們相信老年革龜氣管的血管內壁與鼻甲有類似方式的功能。」 (Davenport et al. 2009: 3445-6)

“Adult leatherbacks are large animals (300–500 kg), overlapping in size with marine pinniped and cetacean species. Unlike marine mammals, they start their aquatic life as 40–50 g hatchlings, so undergo a 10,000-fold increase in body mass during independent existence. Hatchlings are limited to the tropics and near-surface water. Adults, obligate predators on gelatinous plankton, encounter cold water at depth (<1280 m) or high latitude and are gigantotherms that maintain elevated core body temperatures in cold water. This study shows that there are great ontogenetic changes in tracheal structure related to diving and exposure to cold. Hatchling leatherbacks have a conventional reptilian tracheal structure with circular cartilaginous rings interspersed with extensive connective tissue. The adult trachea is an almost continuous ellipsoidal cartilaginous tube composed of interlocking plates, and will collapse easily in the upper part of the water column during dives, thus avoiding pressure-related structural and physiological problems. It is lined with an extensive, dense erectile vascular plexus that will warm and humidify cold inspired air and possibly retain heat on expiration. A sub-luminal lymphatic plexus is also present. Mammals and birds have independently evolved nasal turbinates to fulfil such a respiratory thermocontrol function; for them, turbinates are regarded as diagnostic of endothermy. This is the first demonstration of a turbinate equivalent in a living reptile.” (Davenport et al. 2009: 3440)

“[T]he trachea is lined throughout by a continuous vascular plexus. This contains a high proportion of longitudinally arranged, large-diameter blood vessels lying mainly in the deeper two-thirds of the mucosa, with prominent cross-connections between them. The arrangement is consistent with their functioning as a counter-current arrangement, retaining heat and maintaining body temperature... We believe that the vascular lining of the long adult leatherback trachea functions in analogous fashion to nasal turbinates.” (Davenport et al. 2009: 3445-6)

參考文獻清單與連結 (REFERENCE LIST)

Davenport, J., J. Fraher, E. Fitzgerald, P. McLaughlin, T. Doyle, L. Harman, T. Cuffe, and P. Dockery. (2009). Ontogenetic changes in tracheal structure facilitate deep dives and cold water foraging in adult leatherback sea turtles. *Journal of Experimental Biology* 212: 3440-3447. (<https://jeb.biologists.org/content/212/21/3440>)

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/Dermochelys_coriacea

文章貢獻/編修者與日期:

陳芷凌翻譯 (2019/04/26)；朱天愛編修 (2019/12/19)；吳皓編修 (2020/01/04)；
譚國銜編修 (2020/05/26)；紀凱容編修 (2020/11/26)；施習德編修 (2020/12/15)

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