


生物策略表

類別	生物策略 (Strategy)	
生物策略 STRATEGY	羽毛保護防止水分滲透 (Feathers protect from water)	
生物系統 LIVING SYSTEM	巴布亞企鵝 <i>Pygoscelis papua</i> (Gentoo penguin)	
功能類別 FUNCTIONS	#保護免受過多液體危害 #Protect from excess liquids	
作用機制標題	企鵝因其堅韌、緊密的羽毛結構而能防止水分滲透到皮膚 (The feathers of penguins prevent water from penetrating to the skin due to their stiff, tightly packed structure.)	
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>「大約在 1 億年前，企鵝失去了飛行的能力，而且其翅膀缺乏飛羽 (flight feather)。牠們堅韌緊密的羽毛形成不透水的厚層絕緣墊，且為游泳提供良好的流線型 (streamlined) 表面。」 (Foy and Oxford Scientific Films 1982: 111)</p> <p>「一些研究調查了企鵝『外套』(羽毛和皮膚的組合)的耐熱性，發現它低得驚人—平均為 $0.74 \text{ m}^2\text{KW}^{-1}$ 或 7.4 Tog。企鵝羽毛經過大幅度改造後，已變得短(長度約 30-40 mm 毫米)而堅韌，且為矛狀的 (lance shaped)。透過長形(長度約 20-30 mm)的副羽 (afterfeather) 提供絕緣的特性。企鵝的獨特之處，在於其羽毛是均勻地覆蓋在體表(每平方公分 30-40 根)，而非呈束狀排列。在絕緣方面，企鵝需要厚的充氣防風外套(類似於覆蓋有防風層的開孔型發泡材料)，才能消除對流，並將輻射熱和對流熱 (convective heat) 的損失降至最低。然而，在潛水時，企鵝需要薄而平滑的防水外套，且不能有夾帶的空氣(對活躍的游泳捕食者來說，正浮力是一個很大的缺點)。為了實現這點，它使用連結在羽毛軸上的肌肉來「鎖住」羽毛，以形成水密的屏障。此外，羽軸是背腹面 (dorso-ventrally) 扁平的，使其能夠隨著水壓的增加而彎曲並與身體形狀保持一致。」 (Dawson et al.1999: 199)</p>		

“The penguins (below) lost the power of flight some 100 million years ago, and have no flight feathers on their wings. Their stiff close-packed feathers form a thick insulating mat that is impervious to water and provides a good streamlined surface for swimming.” (Foy and Oxford Scientific Films 1982: 111)

“Several studies have investigated the thermal resistance of penguin ‘coats’ (feather and skin assembly) and found it to be surprisingly low—an average of $0.74 \text{ m}^2\text{KW}^{-1}$ or 7.4 Tog. Penguin feathers are heavily modified, being short (30-40 mm), stiff and lance shaped. Insulation is provided by a long (20-30 mm) afterfeather. Penguins are unique in that the feathers are evenly packed over the surface of the body (30-40 per cm^2) rather than arranged in tracts. For insulation the penguin requires a thick, air-filled, windproof coat (similar to an open-cell foam covered with a windproof layer) that eliminates convection and reduces radiative and convective heat losses to a minimum. However, when diving, the penguin requires a thin, smooth and waterproof coat with no trapped air (positive buoyancy would be a big disadvantage to an active swimming hunter). It achieves this by using muscles attached to the shaft of the feather to ‘lock down’ the feathers to create a water-tight barrier. In addition, the feather rachis is flattened dorso-ventrally allowing it to bend and conform to the body shape readily with increasing water pressure.” (Dawson et al. 1999: 199)

參考文獻清單與連結 (REFERENCE LIST)

Foy, S. (1983). *The grand design: Form and colour in animals*. Prentice-Hall.

Dawson, C., J. F.V Vincent, G. Jeronimidis, G. Rice, and P. Forshaw. (2002). Heat transfer through penguin feathers. *Journal of Theoretical Biology* 3: 291-295.

<https://doi.org/10.1006/jtbi.1999.0959>

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/Gentoo_penguin

撰寫/翻譯/編修者與日期

郭昱琪翻譯 (2019/04/21)；譚國鏊編修 (2020/04/16)；紀凱容編修 (2020/11/25)；
施習德編修 (2020/12/26)

AskNature 原文連結

<https://asknature.org/strategy/feathers-protect-from-water/>