


生物策略格式

KJC, 2019/10/21

類別	生物策略 (Strategy)
生物策略 STRATEGY	舌頭的血管網預冷血液 (Lingual rete precools blood)
生物系統 LIVING SYSTEM	灰鯨 <i>Eschrichtius robustus</i> (Gray whale)
功能類別 FUNCTIONS	#維持體內平衡 #保護免受溫度危害 #Maintain homeostasis #Protect from temperature
作用機制標題	藉由對流熱交換方式，灰鯨的舌血管網可預先冷卻舌頭血液以避免熱散失 (Lingual retes of gray whales precool blood in the tongue to avoid heat loss via counter-current heat exchange.)
生物系統/作用機制示意圖	
作用機制摘要說明 (SUMMARY OF FUNCTIONING MECHANISMS)	
<p>像是灰鯨的鬚鯨類，會用他們巨大的嘴吞入大量的寒冷海水，並通過其鯨鬚的過濾面。鯨魚的舌頭最多佔其體表總面積的 5%，卻沒有像身體有鯨脂一樣能很好地隔熱。因此為了避免過多的體熱經由口腔損失到冷水中，灰鯨的舌頭擁有已知最大的對流熱交換器。此舌頭血管網 (lingual rete, 血管網狀結構，在舌頭的每一側內) 是由超過 50 組極長和極小直徑的動脈所組成，每個動脈由許多小靜脈包圍。這種結構可確保血液能緩慢的流動，並使得離開舌頭的靜脈冷血和進入舌頭的動脈溫血能夠進行大面積的熱交換。這樣的方式，使得血液在接近舌頭表面之前，能有效地預先冷卻，不會損失太多熱量到口腔的冷水中。在年幼灰鯨舌頭所測得的表面溫度僅比水溫高 0.5°C。</p> <p>極長的小直徑動脈和靜脈血管位於近距離的位置，加上低流速，是低溫舌頭表面重新獲得熱量並加以維持的有效關鍵。</p> <p>Baleen whales such as the gray whale move huge quantities of cold, ocean water through their very large mouths and across the filtering surface of the baleen. The tongue of a whale can represent as much as 5% of its total body surface area. The whale's body is well insulated with blubber but not the tongue. Thus, to avoid losing too much of its body heat to the cold water passing through its mouth, the gray whale's tongue has the largest counter-current heat exchanger yet described. This lingual rete (blood vessel network, inside each side of the tongue) is comprised of more than 50 sets of very long and small diameter arteries each surrounded by</p>	

many small veins. This structure insures a slowed blood flow and a large surface area for exchange of heat between the cool blood in the veins leaving the tongue and the warm blood in the arteries coming into the tongue. This way blood is pre-cooled very effectively before approaching the surface of the tongue and thus does not lose much heat to the cold water in the mouth. The surface temperature of the tongue of a young gray whale has been measured to be only 0.5 °C higher than the water.

The presence of very long, small diameter arterial and venous vessels in close proximity with low flow is key to the efficient recapture of heat and maintenance of a cool tongue surface.

文獻引用 (REFERENCES)

「這裡報導了灰鯨 (*Eschrichtius robustus*) 舌頭保存熱量的血管結構。在巨大的舌頭上布滿許多個別的對流熱交換器，且會聚在舌根處形成一對雙邊的網狀結構。由活體灰鯨口腔所測得的溫度，顯示儘管舌頭實際上有較多的血管化和較低的隔熱性，但是經由身體的鯨脂層所散失的熱量可能還是較多。當這些鯨魚在冷水中覓食時，這些熱交換器可以大幅度減少熱量的損失。」 (Heyning and Mead 1997: 1138)

“Vascular structures for heat conservation in the tongue of the gray whale (*Eschrichtius robustus*) are reported here. Numerous individual countercurrent heat exchangers are found throughout the massive tongue. These converge at the base of the tongue to form a bilateral pair of retia. Temperature measurements from the oral cavity of a live gray whale indicate that more heat may be lost through the blubber layer over the body than through the tongue, despite the fact that the tongue is far more vascularized and has much less insulation. These heat exchangers substantially reduce heat loss when these whales feed in cold waters.” (Heyning and Mead 1997: 1138)

參考文獻清單與連結 (REFERENCE LIST)

Heyning, J. E., J. G. Mead. (1997). Thermoregulation in the mouths of feeding gray whales. *Science* 278: 1138-1140. (<https://dx.doi.org/10.1126/science.278.5340.1138>)

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/Eschrichtius_robustus

文章貢獻/編修者與日期：

羅予宣翻譯 (2019/05/21)；朱天愛編修 (2019/12/28)；吳皓編修 (2020/01/04)；譚國銓編修 (2020/05/26)；紀凱容編修 (2020/11/26)；施習德編修 (2020/12/15)

AskNature 原文連結

<https://asknature.org/strategy/lingual-rete-precools-blood/>

