生物策略表

類別	生物策略 (Strategy)
生物策略 STRATEGY	皮膚檢測熱訊號 (Skin Detects Thermal Signals)
生物系統 LIVING SYSTEM	黑鰭礁鯊 (Blacktip Reef Shark)
功能類別 FUNCTIONS	#感知環境中的溫度線索 #Sense Temperature Cues From the Environment
作用機制標題	細胞外凝膠的熱電特性…來自鯊魚的電感測器…會響應微小的溫度梯度而產生顯著的電壓。凝膠的這種體積特性表明，溫度可以轉化為電信息，而不需要離子通道，這種敏感性可能有助於鯊魚將熱鋒定位為進食區域。 (The thermoelectric properties of an extracellular gel… from the electrosensors of sharks… develops significant voltages in response to tiny temperature gradients. This bulk property of the gel indicates that temperature can be translated into electrical information without the need for ion channels, a sensitivity that may help sharks to locate thermal fronts as feeding areas.)
生物系統/作用機制示意圖 (確認版權、註明出處；畫質)	 https://www.flickr.com/photos/dfinney23/16352115103/

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

細胞外凝膠的熱電特性指出，鯊魚的電感測器可以對微小的溫度梯度產生顯著的電壓。這表明凝膠具有一種特殊的特性，使得溫度可以轉化為電信息，而不需要通過離子通道。這種敏感性可能有助於鯊魚將熱鋒定位為進食區域。在關於鯊魚凝膠熱電的簡短交流中，未考慮到表面電化學的系統效應。交流中提到了電極電位會隨著電解質溶液中的溫度而改變的現象。然而，進一步討論指出，海水中銀鉛等可能的電極反應所顯示的訊號與凝膠所觀察到的訊號相反，因此認為人為訊號不太可能是來源。隨後的工作討論了人工製品，並使用鉑電極重複了這一信號。另外，另一份報告發現了零訊號，但它忽略了凝膠填充引線中的熱電勢，這可能存在用兩種相似材料建構「零熱電偶」的風險。最後指出，電感測器的溫度函數尚不清楚，但熱電傳導假設仍然成立。

The thermoelectric properties of extracellular gel indicate that sharks' electroreceptors can generate significant voltage in response to small temperature gradients. This suggests that the gel possesses a unique characteristic whereby temperature can be converted into electrical information without the need for ion channels. Such sensitivity may assist sharks in locating

thermal gradients as feeding areas. In a brief discussion on the thermoelectric properties of shark gel, the systemic effects of surface electrochemistry were overlooked. The discussion mentioned the phenomenon of electrode potential changing with temperature in the electrolyte solution. However, further discussion revealed that signals from potential electrode reactions, such as silver-lead in seawater, contradicted those observed in the gel, suggesting that artificial signals were unlikely to be the source. Subsequent work examined artificial products and replicated the signal using platinum electrodes. Additionally, another report found a zero signal but overlooked the thermoelectric potential in gel-filled leads, posing a risk of constructing "zero thermocouples" using similar materials. It is noted that the temperature function of the electroreceptor remains unclear, but the assumption of thermoelectric conduction still holds.

文獻引用 (REFERENCES)

「我關於鯊魚凝膠熱電的簡短交流忽略了表面電化學的系統效應：電極電位隨電解質溶液中的溫度而改變。」(Brandon R. Brown. Nature 453, 469–474 (2008))
「然而，海水中的銀鉛和可能的電極反應的接受值顯與凝膠訊號相反的訊號，因此人為訊號不太可能是起源。」(Brandon R. Brown. Nature 453, 469–474 (2008))
「儘管另一份報告 4 使用鹽橋發現了零訊號，但它忽略了凝膠填充引線中的熱電勢，這存在用兩種相似材料建構「零熱電偶」的風險。」(Brandon R. Brown. Nature 453, 469–474 (2008))

參考文獻清單與連結 (REFERENCE LIST) **Harvard 或 APA 格式**

Brandon R. Brown. Neurophysiology: Sensing temperature without ion channels, Nature 421, 495 (2003).
(https://www.nature.com/articles/nature07133)

延伸閱讀: Harvard 或 APA 格式（取自 AskNature 原文；若為翻譯者補充，請註明）

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

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AskNature 原文連結

https://asknature.org/strategy/skin-detects-thermal-signals/