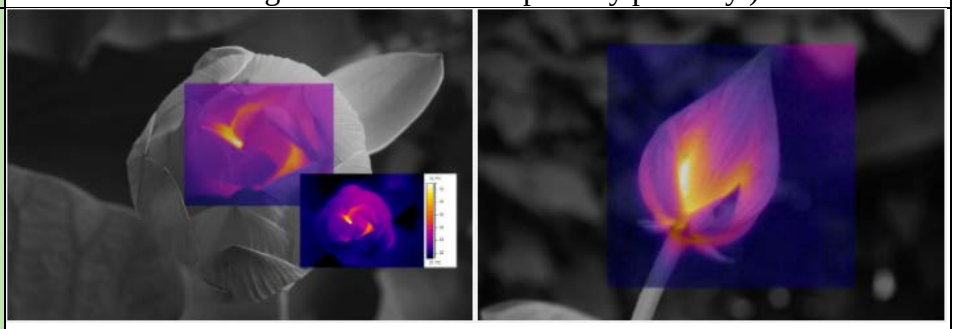
生物策略表

類別	生物策略 (Strategy)
生物策略 STRATEGY	電子流動產生熱力 (Electron flow generates heat)
生物系統 LIVING SYSTEM	荷花 *Nelumbo nucifera* (Sacred lotus)
功能類別 FUNCTIONS	#傳遞光訊號（非可見光譜） #熱能轉型 #Send light signals in the non-visible spectrum #Transform thermal energy
作用機制標題	荷花透過一種非磷酸化的電子傳遞途徑，以電子流動經替代性呼吸作用路徑釋放能量產生熱力而吸引傳粉者 (The sacred lotus attracts pollinators by producing heat through a nonphosphorylating electron transport pathway that releases energy by electron flow through an alternative respiratory pathway.)
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)

替代呼吸路徑 (alternative pathway of respiration) 是由交替氧化酶 (Alternative Oxidase, AOX) 所催化，在荷花 (*Nelumbo nucifera*) 中負責產生熱力。

「我們報導了從活體測試 (in vivo measurements) 中得到的結果，使用氧同位素鑑別技術 (oxygen isotope discrimination techniques)，測試在產熱植物 (thermogenic plant) 組織中，即荷花的花托部位 (floral receptacle)，替代呼吸作用路徑及細胞色素呼吸作用路徑的變動。溫度調節花朵 (thermoregulating flowers) 對於周圍環境溫度而反應出不同程度產熱作用中，兩種呼吸作用的變動都被測量記錄。在比周圍環境溫度高 16℃到 20℃的荷花花托中，替代呼吸作用有顯著的增加，但產熱溫度較低的則沒有。在最熱的花托中，替代路徑的變動是總呼吸作用變動的 75%。相反地，在產熱期間，細胞色素路徑的變動並沒有顯著變化。這些證據支持了替代路徑變動的增加負責荷花中發熱的假說，而從細胞色素路徑變動增加而產生的解偶聯蛋白 (uncoupling proteins)，則不太可能顯著地導致這些組織的發熱。比較根據發熱量而使用抑制劑的實際變動，推測出替代路徑是以接近荷花發熱組織的最大發熱量來運作。然而，在非發熱組織中，抑制劑數據顯著地高估了替代路徑的變動。這證實了同位素測量對於準確判斷這兩個路徑的變動是必要的。」(Watling et al. 2006: 1367)

The alternative pathway of respiration, catalysed by the Alternative Oxidase (AOX), is responsible for heat production in the sacred lotus (*Nelumbo nucifera*).

"We report results from in vivo measurements, using oxygen isotope discrimination techniques, of fluxes through the alternative and cytochrome respiratory pathways in thermogenic plant tissue, the floral receptacle of the sacred lotus (*Nelumbo nucifera*). Fluxes through both pathways were measured in thermoregulating flowers undergoing varying degrees of thermogenesis in response to ambient temperature. Significant increases in alternative pathway flux were found in lotus receptacles with temperatures 16°C to 20°C above ambient, but not in those with lesser amounts of heating. Alternative pathway flux in the hottest receptacles was 75% of the total respiratory flux. In contrast, fluxes through the cytochrome pathway did not change significantly during thermogenesis. These data support the hypothesis that increased flux through the alternative pathway is responsible for heating in the lotus and that it is unlikely that uncoupling proteins, which would have produced increased fluxes through the cytochrome pathway, contribute significantly to heating in this tissue. Comparisons of actual flux, with capacity determined using inhibitors, suggested that the alternative pathway was operating at close to maximum capacity in heating tissues of lotus. However, in nonheating tissues the inhibitor data significantly overestimated the alternative pathway flux. This confirms that isotopic measurements are necessary for accurate determination of fluxes through the two pathways." (Watling et al. 2006: 1367)

參考文獻清單與連結 (REFERENCE LIST)

Watling, J. R., S. A. Robinson, R. S. Seymour. (2006). Contribution of the alternative pathway to respiration during thermogenesis in flowers of the sacred lotus. *Plant physiology* 140: 1367-1373. (https://www.researchgate.net/deref/http%3A%2F%2Fdx.doi.org%2F10.1104%2Fpp.105.075523)

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/Nelumbo_nucifera

撰寫/翻譯/編修者與日期

譚國鎏翻譯 (2021/03/22)；黃盟元編修 (2021/03/22)

AskNature 原文連結

https://asknature.org/strategy/electron-flow-generates-heat/