生物策略表

類別	生物策略 (Strategy)
生物策略 STRATEGY	果莢自動旋轉 (Seedpod autorotates)
生物系統 LIVING SYSTEM	岩槭 *Acer pseudoplatanus* (Sycamore maple)
功能類別 FUNCTIONS	#散佈種子 #分配氣體 #在氣體中移動 #Disperse seeds #Distribute gases #Move in/through gases
作用機制標題	岩槭的翅果由於彎曲的形狀而自轉 (Samara of the sycamore autorotates due to curved shape.)
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)

「有翼的 (winged) 種子或果實…可以分為兩類—平面翅 (plane-winged) 為其中的一型，它的種皮 (seed coat) 或果皮 (fruit wall) 多少與縱軸對稱地生長，並以線性滑翔飛行，在自動旋轉翼中，這種升力是由繁殖體上的翅膀在自由落體期間自轉所產生的…自動旋轉種子和果實的行為與直升機的行為非常相似，是由稍微彎曲的果實或種子翼狀結構產生的攻角和側滑 (angle of attack and sideslip) 所結合而產生的。翅膀頂部產生的局部速度相對較高，並且與相應的力矩一起產生很大的動態穩定性。從上方和下方觀察時，旋轉翼掃出一個淺錐形截面，其面積為 Ap（圖 9.10）。對應果實或種子縱軸和水平面的角度是錐角 β，作用在旋轉翼上的離心力 (centrifugal force) 之間的平衡條件（產生傾向於迫使機翼進入水平位置的轉動力矩）和空氣動力（往往會使機翼移動到垂直位置）。因此，錐角是由於離心力和空氣動力引起的力矩的結果。」(Niklas 1992: 461, 463)

「歐洲楓 (European maple) 和岩楓 (sycamore) 的設計更加經濟。 它們只配備一個翼，從一側發芽。種子重量和機翼長度之間的平衡是如此精確匹配，以至於這些種子也能旋轉…即使在微風中，它們的微型旋轉直升機也可以在郊野之中旅行一段很長距離。」(Attenborough 1995: 19)

"Winged seeds or fruits... can be placed into one of two categories—plane-winged, in which the seed coat or fruit wall grows more or less symmetrically with respect to its longitudinal axis and generates a linear gliding flight, and autogyroscopically winged, in which lift is created by wings on the propagule that permit autorotation during free-fall...The behavior of autogyroscopic seeds and fruits is remarkably similar to that of a helicopter and results from the combination of angle of attack and sideslip generated by the slightly curved blade of fruit wing or seed wing. The local speeds developed at the tip of the wing are relatively high and, together with the corresponding moments, produce great dynamic stability. When viewed from above and below, the rotating wing sweeps out a shallow conical section with an area Ap (Figure 9.10). The angle subtending the longitudinal axis of the fruit or seed and the horizontal plane is the coning angle ß, the equilibrium condition between the centrifugal forces acting on the rotating wing (which produce a turning moment tending to force the wing into a horizontal position) and aerodynamic forces (which tend to displace the wing into the vertical position). Thus the coning angle is the result of moments due to centrifugal and aerodynamic forces." (Niklas 1992: 461, 463)

"European maples and sycamores have an even more economical design. They are equipped with only a single wing, sprouting from one side. The balance between the weight of the seed and the length of the wing is so accurately matched that these seeds also spin... Even in a light breeze their tiny spinning helicopters can travel for very long distances across the... countryside." (Attenborough 1995: 19)

參考文獻清單與連結 (REFERENCE LIST)

Niklas, K. J. (1992). *Plant Biomechanics: An engineering approach to plant form and function*. University of Chicago Press.

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延伸閱讀

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

https://en.wikipedia.org/wiki/Acer_pseudoplatanus

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AskNature 原文連結
https://asknature.org/strategy/seedpod-autorotates/