


生物策略表

類別	生物策略 (Strategy)
生物策略 STRATEGY	葉脈系統對損傷有抵抗力 (Vein system resilient to damage)
生物系統 LIVING SYSTEM	雙子葉植物 (Dicotyledons)
功能類別 FUNCTIONS	#分配液體 #形狀/材料最佳化 # Distribute liquids #Optimize shape/materials
作用機制標題	一些植物葉片的葉脈系統因具有高密度封閉及互相連通的環路，使得葉脈系統有抗損傷的性質。 (The vein systems in some plant leaves are resilient to damage because they contain a high density of closed, interconnected loops.)
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>「葉脈是一個常見的複雜生物網絡例子，為葉子提供運輸系統和機械彈性。樹木中有著效率最佳的傳輸網絡，因為沒有任何環路 (loopless)。然而，雙子葉植物的葉脈有許多封閉環路 (closed loop)，它們是具有功能的，能夠在任何一條葉脈受損的情況下都能順利運輸液體，包括一級脈。受到葉片脈絡的啟發，我們研究了兩個在運輸網絡中存在高密度環路的兩個可能原因：傷害抵抗能力和負載變動。在第一個情況，透過對每個連接的損壞進行平均，我們尋求在隨機損壞發生的情況下最佳的運輸網絡。第二個情況，當負載的分佈稀疏分散時，我們尋求能使運輸效率最佳化的網絡：在任何時間下大部分積儲 (sink) 都是封閉的。我們發現這兩個條件使環路能發揮最佳狀態。」 (Katifori et al. 2010: 048704)</p>	

“Leaf venation is a pervasive example of a complex biological network, endowing leaves with a transport system and mechanical resilience. Transport networks optimized for efficiency have been shown to be trees, i.e., loopless. However, dicotyledon leaf venation has a large number of closed loops, which are functional and able to transport fluid in the event of damage to any vein, including the primary veins. Inspired by leaf venation, we study two possible reasons for the existence of a high density of loops in transport networks: resilience to damage and fluctuations in load. In the first case, we seek the optimal transport network in the presence of random damage by averaging over damage to each link. In the second case, we seek the network that optimizes transport when the load is sparsely distributed: at any given time most sinks are closed. We find that both criteria lead to the presence of loops in the optimum state.” (Katifori et al. 2010: 048704)

參考文獻清單與連結 (REFERENCE LIST)

Bernabé, Y., C. Bruderer-Weng, and A. Mainault. (2003). Permeability fluctuations in heterogeneous networks with different dimensionality and topology. *J. Geophys. Res.* 108: 10. (<https://doi.org/10.1029/2002JB002326>)

Corson, F. (2010). Fluctuations and redundancy in optimal transport networks. *Phys. Rev. Lett.* 104: 048703. (<https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.104.048703>)

Katifori, E., G. J. Szöllösi, and M. O. Magnasco. (2010). Damage and fluctuations induce loops in optimal transport networks. *Physical Review Letters*. 104: 048704.

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/Magnoliopsida>

撰寫/翻譯/編修者與日期

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AskNature 原文連結

<https://asknature.org/strategy/vein-system-resilient-to-damage/>