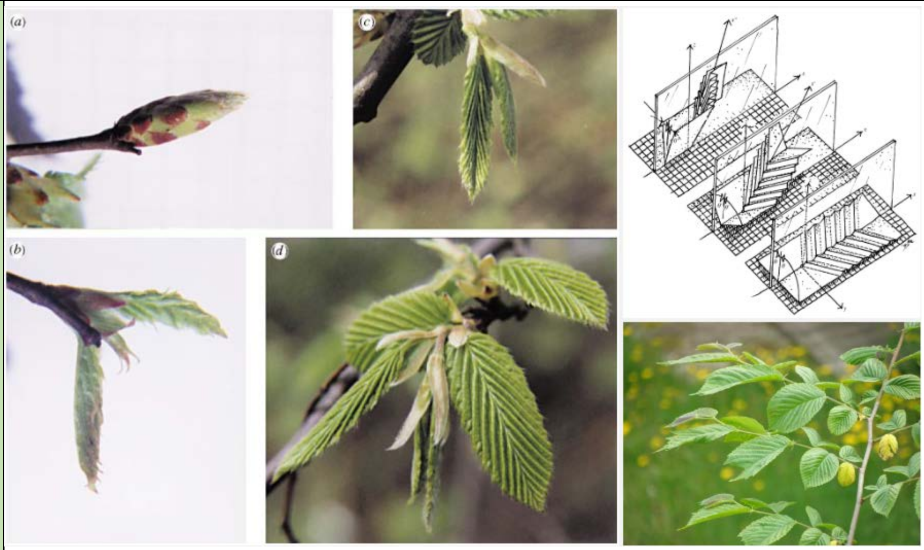
生物策略表

類別	生物策略 (Strategy)
生物策略 STRATEGY	折疊增加靈活性及堅固度 (Folding improves flexibility and rigidity)
生物系統 LIVING SYSTEM	歐洲鵝耳櫪 *Carpinus betulus* (European hornbeam)
功能類別 FUNCTIONS	#改變大小/形狀/質量/體積 #Modify size/shape/mass/volume
作用機制標題	鵝耳櫪的葉片皺褶方式可以在靈活性及堅固度之間取得平衡 (Leaves of the hornbeam tree have a corrugated fold pattern that allows for a balance between flexibility and rigidity.)
生物系統/作用機制示意圖	

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

作為光合作用的場所，葉片提供給植物關鍵的功能。然而，由於葉片位於枝條的末端，所以特別容易受到風的損害。一片葉子能夠以彎曲或折疊的方式減少曝露的表面積，以減輕風的損害。不過，葉片也必須能夠保持開展並維持堅固度，以吸收最多的陽光進行光合作用。因此，葉片必須在保護葉片免受風害的靈活性方面與容許葉片表面積曝露最大化的堅固度方面取得折衷。

一個能達成這種平衡的方法就是使用山峰與山谷交互折疊 (alternating crest and valley folds)（風琴式折疊）的簡單折疊樣式，如同鵝耳櫪樹葉的皺褶方式。山谷折疊處使葉片能夠適時彎曲，將曝露於風害的表面積降到最低。而山峰折疊處則容許葉片維持堅固的形狀以進行光合作用。這種結合山峰和山谷交互折疊的皺褶樣式容許葉片有自我支撐的能力 (self-supporting) 而不用在靈活性上作出讓步。

As the sites of photosynthesis, leaves serve a critical function of the plant. However, because of their location on the edges of branches, leaves are also particularly susceptible to damage from the wind. A leaf can mitigate wind damage by bending or folding, which minimizes surface area exposure. However, leaves must also be able to stay flat and rigid, to maximize sun absorption for photosynthesis. Thus, leaves must find a compromise between a flexible state that protects from wind damage, and a rigid state that allows the leaf to maximize surface area exposure.

One way to achieve this balance is to use a simple corrugation pattern of alternating crest and valley folds, as is found in the leaves of the hornbeam tree. These folds emanate from both sides of the center vein and repeat along the length of the leaf. The valley folds allow space for the leaf to bend in on itself when needed, so as to minimize surface area and exposure to wind damage. The crest folds allow the leaf to sustain a rigid shape when required for photosynthesis. Together, this corrugation pattern allows the leaf to be self-supporting without compromising flexibility.

文獻引用 (REFERENCES)

參考文獻清單與連結 (REFERENCE LIST)

Kobayashi, H., B. Kresling, and J. F. V. Vincent. (1998). The geometry of unfolding tree leaves. *Proc. Biol. Sci.* 265: 147-154. (https://doi.org/10.1098/rspb.1998.0276)

De Focatiis, D. S. A. and S. D. Guest. (2002). Deployable membranes designed from folding tree leaves. *Philosophical Transactions of The Royal Society A Mathematical Physical and Engineering Sciences* 360: 227-38. (https://doi.org/10.1098/rsta.2001.0928)

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/Carpinus_betulus
https://www.onezoom.org/life/@Ostrya_multinervis=3930033?img=best_any&anim=flight#x417,y310,w0.4169
https://eol.org/pages/1148643

撰寫/翻譯/編修者與日期

譚國鎏翻譯 (2021/03/22)；洪麗分編修 (2021/04/10)

AskNature 原文連結

https://asknature.org/strategy/folding-improves-flexibility-and-rigidity/