生物策略表

類別	生物策略 (Strategy)
生物策略 STRATEGY	黏性漿果附著 (Sticky berries adhere)
生物系統 LIVING SYSTEM	槲寄生 *Viscum album* (Mistletoe)
功能類別 FUNCTIONS	#永久性附著 #應付機械磨損 #Attach permanently #Mange mechanical wear
作用機制標題	歐洲槲寄生的種子，能在安全地通過取食鳥類的腸胃後，以種皮外易沾黏的纖維細絲力學特性，黏附在寄主植物枝條上發芽 (The seeds of European mistletoe pass safely through a bird's gut yet stick to branches where they germinate due to mechanical properties of the cellulosic filaments in their sticky coating.)
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)

「只有歐洲槲寄生 (European mistletoe) 這種怪異的對葉寄生植物在人類祈求人丁興旺的儀式 (human fertility rites) 中佔有過重要地位，或許是因為它的葉子在冬季仍保持著翠綠，而當它所寄生的樹木已經完全落葉時，它還是顯著地充滿著生命力…槲寄生的白色漿果有著非常黏稠的果肉，當一隻鳥例如是畫眉 (thrush) 或是烏鶇 (blackbird) 嘗試吃下果實時，種子甚至常常會黏在鳥喙上。鳥類因此覺得非常煩躁而嘗試把它擦拭掉，當牠們把種子抹在另一根枝條時，會將其塞到裂縫之中。然後種子會長出胚根並鑽入寄主樹枝中，最終與樹木枝條中的導管連接而獲得樹液。槲寄生以樹木的營養作為食物而得以蓬勃成長。」(Attenborough 1995: 229-230)

「這項研究的結果描述了在歐洲槲寄生 (*Viscum album*) 中，位於槲寄生素組織 (viscin tissue) 中厚重的細胞壁所含纖維素的驚人特性。起初，這些纖維素中的微纖絲 (microfilbrils) 確實緊密地與槲寄生素細胞以垂直方向纏繞。由於半纖維素 (hemicellulose) 亦同時存在，當水分充足的時候，這些纖維素微纖絲可以自由地交叉移動，在這種方式下槲寄生素組織的細胞壁因此可被拉扯而變形。這種變形有著能被拉扯幾百次而不會破裂的非凡特性，每個槲寄生素細胞上的微纖絲可從原本直徑為數十微米粗，被拉長成一根根不

超過幾微米寬的細絲。與繞射實驗 (diffraction experiments) （圖 9a）中的推論一致，這些拉長後的細絲纖維素有著異常的高度方向性。從這種高度方向性及纖維素有相當大分子量的特性，顯示這些細絲可能有高度的力學特性。它們的張力強度顯然與槲寄生素組織細胞的功能特性有關，使得槲寄生的種子能緊緊黏在鳥類的腸胃中。直到被鳥類排出並掉落到樹枝上時，種子因為其半纖維素含水而呈黏膠狀能黏附在樹枝上。部分種子甚至會懸掛在枝條上，只由槲寄生素組織細胞的纖維細絲所拉著。當風吹動下，這些懸垂種子會被晃回與枝條接觸，並黏附在枝條上進一步地發芽。這種現象解釋了為何有時槲寄生種子甚至會在枝條的下側發芽。」(Azuma et al. 2000: 16)

「同為槲寄生的澳洲種群則發展出比其歐洲姊妹群更加特化的運送系統。一種特定的鳥類，澳洲啄花鳥 (mistletoe bird, *Dicaeum hirundinaceum*)，幾乎只以槲寄生的漿果為食。在澳洲有很多槲寄生物種，每種都有其結果的季節，所以這種鳥在一整年中都可以找到槲寄生漿果，而且在每年都會沿著規律的遷徙路徑飛行。啄花鳥的消化系統因此還特化出適應這種飲食習慣的方式，其消化系統能以驚人的速度處理漿果，一顆種子從吞入到排出只花不到半個小時。當種子被排出時仍然殘留著明顯的黏性，因此會黏附在啄花鳥的尾部。然而排泄中的鳥並不會橫跨在細枝上等待槲寄生種子掉落。相反地，牠們會轉向使身體與細枝排成直線，將尾部在樹皮上擦拭。這雖能使種子附著在樹上，但種子黏膠的細絲仍藕斷絲連地黏在鳥的尾部，所以牠們需要側身在小枝上三次跳躍，才能使沾黏種子完全斷開連接。」(Attenborough 1995: 230-231)

“The only European mistletoe is the strange twin-leaved parasite that once played an important part in human fertility rites, perhaps because in winter its leaves remain green and visibly alive when those of the tree on which it grows have all fallen…Its white berries have flesh that is so extraordinarily sticky that when a bird such as a thrush or a blackbird tries to eat them, they often become stuck to its beak. The bird finds this so irritating that it tries to wipe the berry off by scraping it on to another branch and in doing so, rams it into a crevice. The seed then puts out a root which worms its way into the tree and eventually connects with the vessels within the branch that carry the tree’s sap. And with that as food, it flourishes.” (Attenborough 1995: 229-230)

“The results presented in this study illustrate the remarkable characteristics of the cellulose located in the thick cell walls of the viscin tissue from *V. album*. Initially, the microfibrils of this cellulose are indeed tightly coiled perpendicularly to the viscin cell axes. Due to the hemicelluloses that are also present and when the hydration is sufficient, these cellulose microfibrils are free to move past each other in such a way that the wall of the viscin tissue is able to get deformed upon the slightest stretching action. This deformation can reach extraordinary values of several hundred folds without breakage, each viscin cell giving one tiny cellulose filament having no more than a few microns in width, as opposed to the initial viscin cells that had diameters of several tens of micron. As deduced from diffraction experiments (Figure 9(a)), the orientation of the cellulose in these stretched filaments is unusually high. The combination of this high orientation with the fairly large molecular weight of the corresponding cellulose indicates that these filaments should have high mechanical properties. Their strength must in fact be correlated to the biological function of the viscin tissue, which is to hold firmly the mistletoe seed through the bird guts. When expelled from the bird and dropped on the branch of a tree, the seeds will normally stick to the branch thanks to their hemicellulosic glue. Some of the seeds will even dangle down from the branch, held by the viscin cellulosic filaments. Under the action of the wind, these seeds will be brought back in contact with the branch to which they will adhere for further germination. This phenomenon explains why mistletoe sometimes germinates even at the underlying part of branches." (Azuma et al. 2000: 16)

"As a group, the Australian mistletoes have developed a rather more specialised system of transport than that employed by their European relative. One particular bird, the mistletoe bird, eats little other than mistletoe berries. There are so many species, each with its own fruiting season, that the bird is able to find berries throughout the year and it flies along regular migration routes in order to do so. Its digestive system is specially modified to cope with this diet. For some reason, it processes the berries with remarkable speed so that one will take less than half an hour to travel from entry to exit. When it emerges the seed still has considerable residual stickiness and so remains fastened to the bird's rear. The defecating bird does not, however, sit transversely across a twig waiting for the mistletoe seed to drop off. Instead, it turns so that its body is aligned along the twig and carefully wipes its bottom on the bark beneath. This fixes the seed to the tree but threads of the seed's glue still remain attached to the bird's rear and it has to make three separate sideways jumps along the twig before the connection is finally broken." (Attenborough 1995: 230-231)

參考文獻清單與連結 (REFERENCE LIST)

Attenborough, D. (1995). *The private life of plants.* Princeton University Press.

Azuma, J., N. Kim, L. Heux, R. Vuong, and H. Chanzy. (2000). The cellulose system in viscin from mistletoe berries. *Cellulose* 7: 3-19. (https://www.researchgate.net/deref/http%3A%2F%2Fdx.doi.org%2F10.1023%2FA%3A1009223730317)

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/viscum_album
https://www.onezoom.org/life/@viscum_album
https://eol.org/pages/582687

撰寫/翻譯/編修者與日期

譚國鋈翻譯 (2021/03/22)；王俊能編修 (2021/04/19)
AskNature 原文連結
https://asknature.org/strategy/sticky-berries-adhere-2/