生物策略表

類別	生物策略 (Strategy)
生物策略 STRATEGY	果實化學將種子掠食者轉變為傳播者 (Fruit chemistry converts a seed predator to a disperser)
生物系統 LIVING SYSTEM	木樨草科 Resedaceae (Mignonette family)
功能類別 FUNCTIONS	#分配固體 #Distribute solids
作用機制標題	長尾草果實透過釋放化學物質使動物吐出種子，導致齧齒類動物從種子掠食者轉變為種子傳播者 (Fruits of *Ochradenus baccatus* cause rodents to convert from seed predators to seed dispersers by releasing chemicals that cause the animal to spit the seed out.)
生物系統/作用機制示意圖	

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

硫代葡萄醣苷 (Glucosinolates, GLSs) 是在很多植物物種中發現的次級代謝物 (secondary metabolites, SMs)。GLSs 一般是無害的，然而，當被芥子酶 (myrosinases) 水解 (hydrolysis) 後，將會形成全新的有毒化合物。通常這種水解作用會在含有 GLSs 的組織受損時發生，即是當齧齒類動物 (rodents) 咀嚼種子時。在長尾草 (taily weed, *Ochradenus baccatus*) 的植株中，GLSs 只在果肉中找到，它們與芥子酶（只在種子中找到）完全分隔開。當齧齒類動物，例如非洲刺毛鼠 (common spiny mouse, *Acomys cahirinus*)，咀嚼果實並破壞種子時，酵素會被釋放並與 GLSs 反應而形成毒素，其機制被稱為「芥子油炸彈」(mustard oil bomb)。這種刺激性的辣味使齧齒類動物將種子以準備好發芽的形式被吐出。齧齒類動物傾向將收集到的食物帶到岩縫中，在那裡比較涼爽及濕潤。這種類型的環境非常適合長尾草的生長，因此這類老鼠從種子掠食者轉變為種子傳播者。透過了解這些類型的化學關係，可能提供洞見給更安全的農藥開發，以及物種之間的互利關係。

Glucosinolates (GLSs) are secondary metabolites (SMs) that are found in many plant species. GLSs are generally harmless, however, when hydrolyzed by myrosinases, new, toxic compounds are formed. Usually this hydrolysis occurs when the tissue containing the GLSs becomes damaged, i.e., when a rodent chews on the seed. In the *Ochradenus baccatus* plant, GLSs are found only in the pulp of the fruit, which is neatly separated from the myrosinases

(which are found only in the seeds). When a rodent, such as the common spiny mouse (*Acomys cahirinus*), chews on the fruit and damages the seed, the enzyme is released and reacts with the GLSs to form harmful toxins in a mechanism known as the "mustard oil bomb." This pungent taste causes the rodent to spit the seed out in a form ready for germination. Rodents tend to take the food they gather to rock crevices, which are cooler and more humid. This type of environment is ideal for *O. baccatus* growth, thus the mouse is converted from a seed predator to a seed disperser. Understanding these types of chemical relationships may provide insight to developing safer pesticides as well as benefit relationships between species.

文獻引用 (REFERENCES)

「在這裡，我們提供了實驗性及行為性的數據來證明長尾草果實利用廣效性、非專一性的「芥子油炸彈」機制來迫使在生態學時間尺度 (ecological timescale) 上的行為改變，將種子掠食者的齧齒類動物轉變成種子傳播者。這是由芥子油炸彈進行獨特的分隔 (compartmentalization)所達成的，只有在共同攝取 (coconsumption) 種子和果肉時才會造成系統的活化，從而透過齧齒類動物吐出種子而促進種子傳播。我們的發現證明了次級代謝物具有改變動植物之間關係的能力，從掠食轉變成互利共生 (mutualism)，以及在跨物種層面之外，提供支持給物種內層面的定向威懾 (directed-deterrence) 假說。」(Samuni-Blank et al. 2012: 1).

"Here we present experimental and behavioral data demonstrating the use of the broad-range, class-independent 'mustard oil bomb' mechanism in *Ochradenus baccatus* fruits to force a behavioral change at an ecological timescale, converting rodents from seed predators to seed dispersers. This is achieved by a unique compartmentalization of the mustard oil bomb, causing activation of the system only upon seed and pulp coconsumption, encouraging seed dispersal via seed spitting by rodents. Our findings demonstrate the power of SMs [secondary metabolites] to shift the animal-plant relationship from predation to mutualism and provide support for the directed-deterrence hypothesis at the intraspecific level, in addition to the interspecific level" (Samuni-Blank et al. 2012: 1).

參考文獻清單與連結 (REFERENCE LIST)

Samuni-Blank, M., I. Izhaki, M. D. Dearing, Y. Gerchman, B. Trabelcy, A. Lotan, W. H. Karasov, and Z. Arad. (2012). Intraspecific directed deterrence by the mustard oil bomb in a desert plant. *Current Biology* 22: 1218-1220. (https://doi.org/10.1016/j.cub.2012.04.051)

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/resedaceae
https://www.onezoom.org/life/@resedaceae
https://eol.org/pages/4222

撰寫/翻譯/編修者與日期
譚國鎏翻譯 (2021/03/22)；林振祥編修 (2021/04/19)
AskNature 原文連結
https://asknature.org/strategy/fruit-chemistry-converts-a-seed-predator-to-a-disperser/