生物策略表

類別	生物策略 (Strategy)
生物策略 STRATEGY	彈射昆蟲的觸毛 (Tentacles catapult insects)
生物系統 LIVING SYSTEM	毛氈苔 *Drosera glanduligera* (Sundew)
功能類別 FUNCTIONS	#獲得、吸收、或過濾生物 #Capture, absorb, or filter organisms
作用機制標題	澳洲南部毛氈苔葉片上的捕捉觸毛，能利用觸覺敏感的頭部以彈射到中央的方式捕捉地上的獵物 (Snap-tentacles on leaf of southern Australian sundew capture ground prey by catapulting them to their center via a touch-sensitive head.)
生物系統/作用機制示意圖	

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

澳洲南部的毛氈苔是一種利用獵物捕捉機制提供自身養分的食肉植物 (carnivorous plant)。它使用頭部具觸敏性的觸毛 (tentacles) 來捕捉獵物。當觸毛頭部被觸動時，會活化觸毛細胞的收縮機制（這尚未被完全了解，但有兩個假說機制）。此彈射機制 (catapult mechanism) 是這種食肉植物特有的，很多其它的植物只依靠其中心部位的黏性來困住獵物。當觸毛頭部被活化時，觸毛上接近植株端的數個細胞會延展，而遠離植株端的細胞會收縮，導致觸毛向上彎曲。透過 360 度的轉動，觸毛將獵物彈射到葉片的中央。這種捕捉觸毛 (snapping tentacles) 的運動是一次性的。基於觸毛細胞在延展/收縮過程中被折斷的假說，觸毛的使用無法超過一次。捕捉觸毛頂端頭部的觸發作用是高度精確的，不會因為陷阱中的獵物掙扎震動而啟動，必須透過和觸毛的直接互動才能啟動。

這種捕捉觸毛的用處是將獵物送到位於捕蟲葉 (trap leaf) 中央，更易捕捉獵物的黏性觸毛 (glue-tentacle) 區域中心。接著這些黏性觸毛會在兩分鐘內將獵物拉到更深處，並以活性酵素分解昆蟲，讓植株完全利用其養分。

The South Australian sundew is a carnivorous plant that utilizes a capturing mechanism to provide itself with sustenance and nourishment. It captures its prey using tentacles that have a touch-sensitive head. When the head encounters movement, it activates a contracting

mechanism (which is not yet fully understood but has two hypothesized mechanisms of its own) in the cells of the tentacle. The catapult mechanism is unique to this carnivorous plant; many other plants rely solely on the stickiness of their centers to trap prey. When the head becomes activated certain cells on the end closest to the plant body extend while cells farther out on the tentacle contract, causing the tentacle to bend upwards. In a 360-degree motion, the tentacle launches the prey to the center of the leaf. The movement of these snap-tentacles is a one-time motion. The tentacles cannot be utilized more than once due to hypothesized snapping of cells during the elongation/contraction process. The triggering of the head on the tip of the snap-tentacle is also highly precise; the head will not be triggered by vibrations from prey already trapped and must be activated via a ground-to-tentacle interaction.

The usefulness of these snap-tentacles is that they position the prey in a more vulnerable position in the center of the glue-tentacles, which reside in the middle of the trap leaf. These glue-tentacles then take two minutes to pull the prey in deeper and its active enzyme enables the plant to decompose the insect and utilize its nutrients to the fullest.

文獻引用 (REFERENCES)

「快速以陷阱捕捉與吸入獵物，是這些［食肉］植物主動捉住節肢動物作為主要營養補給的方法中最特別的兩個例子。我們證明了一種來自澳洲南部的毛氈苔 (*Drosera glanduligera*) 具有精密的彈射機制：當獵物接近毛氈苔邊緣時，會觸發具觸敏性的捕捉觸毛，這些觸毛會迅速將獵物彈射到鄰近具有黏性的黏性觸毛上；然後昆蟲會被黏性觸毛緩慢地拉進凹陷的捕蟲葉之中。」(Poppinga et al. 2012: 1)

「每片湯匙形狀的捕蟲葉向葉片中央處發育出數量龐大的黏性觸毛，並沿著葉緣發育出 12-18 根捕捉觸毛。兩種型態的觸毛皆具有觸敏性，它們朝向中央的彎曲運動是由觸毛頭部受到機械刺激而觸發。捕捉步行的獵物分為兩步驟：首先，動物因觸碰到捕捉觸毛而觸發快速的彈射動作，獵物先被舉起然後被拋擲到具黏性的葉片中央部分。隨後，黏性觸毛將獵物拉進內凹的葉片深處。第二步驟較緩慢，維持大約兩分鐘左右…

捕捉觸毛的長度約 6.3±2.2 mm (n = 11)，兩側對稱，末端盤狀物 (terminal disc) 上帶有凸起的腺體（並不會產生黏液）[11] (圖 2)。觸動頭部會導致沒有任何動作的初始刺激後階段 (post-stimulation) （大約 400 ms）。捕捉觸毛透過位於觸毛基部旁的樞紐區域 (hinge zones) 變形而運動 [7] (圖 2a 及 b)。觀察發現，被切下的觸毛到可以彎曲 360 度，但葉子上的觸毛會被葉片中央部分阻擋，而只有一半的彎曲動作。」 (Poppinga et al. 2012: 3)

“Fast snap-trapping and suction of prey are two of the most spectacular examples for how these [carnivorous] plants actively catch animals, mainly arthropods, for a substantial nutrient supply. We show that *Drosera glanduligera*, a sundew from southern Australia, features a sophisticated catapult mechanism: Prey animals walking near the edge of the sundew trigger a

touch-sensitive snap-tentacle, which swiftly catapults them onto adjacent sticky glue-tentacles; the insects are then slowly drawn within the concave trap leaf by sticky tentacles." (Poppinga et al. 2012: 1)

"Each spoon-shaped trap leaf develops numerous glue-tentacles towards the centre and about 12–18 marginal snap-tentacles extending from the lamina margin. Both tentacle types are touch-sensitive, and their bending motions towards the centre of the trap are triggered by mechanical stimuli on the respective tentacle heads. Capture of walking prey takes place in two steps: First, animals that touch a snap-tentacle trigger its fast catapult-action and the prey is first lifted and then thrown onto the sticky central part of the leaf. Subsequently, glue-tentacles draw the prey into the depression of the deeply concave leaf. This slower second step lasts about two minutes...

Snap-tentacles are 6.3±2.2 mm (n = 11) long, bilaterally symmetric and each carry a raised gland (that does not produce mucilage) on the terminal disc [11] (Fig. 2). Triggering the head entails an initial post-stimulation phase without movement (about 400 ms). Snap-tentacles move by deformation of their hinge-zones [7] (Fig. 2a and b) which are situated next to the broadened tentacle base. Excised tentacles were observed to bend by 360 degrees, but when attached the motion is blocked halfway by the central part of the leaf." (Poppinga et al. 2012: 3)

參考文獻清單與連結 (REFERENCE LIST)

Poppinga, S., S. R. H. Hartmeyer, R. Seidel, T. Masselter, I. Hartmeyer, and T. Speck. (2012). Catapulting tentacles in a sticky carnivorous plant. *PloS One* 7: e45735. (https://doi.org/10.1371/journal.pone.0045735)

延伸閱讀

https://www.youtube.com/watch?v=Wzp-9FPGYUQ
（譚國鎏提供）

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

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

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/tentacles-catapult-insects/