生物策略表

類別	生物策略 (Strategy)
生物策略 STRATEGY	捲繞的口器鬆開 (Proboscis unwinds)
生物系統 LIVING SYSTEM	蝴蝶和飛蛾 (Butterflies and moths)
功能類別 FUNCTIONS	#改變大小/形狀/質量/體積 #改變位置 #Modify size/shape/mass/volume #Modify position
作用機制標題	蝴蝶的口器通過肌肉收縮和一個液壓的、逐步的機制，從緊密收卷的狀態伸展開來 (The proboscis of the butterfly unwinds from a tightly coiled position via muscular contraction and a hydraulic, step-wise mechanism.)
生物系統/作用機制示意圖	

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

在休息期間，蝴蝶的管狀進食結構（即口器，相當於「舌頭」）保持緊緊收卷在頭上。但是當蝴蝶移動去以花朵的花蜜或類似的東西為食時，口器就會展開，向下延伸到花朵的中心。卷曲口器的展開始於最接近頭部的肌肉，即基部外顎葉肌肉 (the basal galeal muscle)，該構造將卷曲口器稍微抬起，以使其從收卷的姿態「解鎖」。卷曲口器通過整個口器中其他肌肉的收縮開始鬆弛，這被稱為「節片肌 (stipes muscle)」。這種收縮通過擠壓節片管，在進食管的各個區域上施加壓力。這會產生一種循序漸進的反應，透過對節片中的尖瓣狀結構加壓，進一步開展口器。

During rest, the tube-like feeding structure of the butterfly (i.e. the proboscis, equated to a “tongue”) remains coiled tightly against the head. However, when the butterfly moves to feed upon the nectar of a flower or something akin, the proboscis unfurls to extend downward into the flower's center. The uncoiling is initiated in the muscle closest to the head, the basal galeal muscle, which lifts the coils slightly to “unlock” it from its tightly held position. The coil begins to unwind via the contraction of other muscles throughout the proboscis, known as stipes muscles. This contraction places pressure on various areas throughout the feeding tube by compressing the stipial tube. This creates a step-wise reaction that further unfurls the tube through pressurized increases in the stipes’ valve-like structures.

文獻引用 (REFERENCES)

「展開卷曲口器的過程有賴於液壓機制…口器首先從其收合狀態被解開—它透過基底外顎葉肌肉升高。由於其彈性，卷曲的口器會變得鬆動。節片肌肉的收縮可進一步解開口器，從而使節片硬化部分的運動擠壓節片管。節片的反覆擠壓，迫使血淋巴進入連接的外顎葉。由於節片的結構形成一個閥門，所以當外顎葉內部的血淋巴壓力增加時，口器就逐步展開。內部壓力的增加導致展開口器的背壁向外拱起。展開的口器通常是彎曲的姿態，具有或多或少明顯的彎曲，稱為彎曲區域或膝蓋彎曲。彎曲區域可能是由於口器的彈性引起的，增加血淋巴壓力可使口器接近筆直的狀態；在某些情況下，口器遠端可略微向上彎曲。在訪花過程中，口器因基底關節肌肉的收縮而抬起，而彎曲區域遠端的向前或向後運動，則各是由於節片抽吸引起的壓力增加或內在的外顎葉肌肉組織活動所引起的。」 (Krenn 2010: 315)。

"The uncoiling process relies on a hydraulic mechanism...The proboscis is first unlocked from its resting position—it is elevated by the basal galeal muscle. Owing to its elasticity, the coil of the proboscis loosens somewhat. Further uncoiling is enabled by contraction of stipes muscles, whereby movements of the sclerotized part of the stipes compress the stipital tube. The repeated compressions of the stipes force hemolymph into the attached galea. Because the structures of the stipes form a valve, the proboscis is stepwise uncoiled when the hemolymph pressure inside the galeae increases. The increased internal pressure results in an outwardly arched dorsal wall in the uncoiled proboscis. The uncoiled proboscis normally assumes a bent position with a more or less distinct flexion, termed the bend region or knee-bend. The bend region is probably caused by the elasticity of the proboscis. Increased hemolymph pressure can lead to a nearly straight position of the proboscis; in some cases, the distal proboscis bends slightly upward. During flower handling, the proboscis is elevated by contraction of the basal joint muscles, while forward or backward movements of the region distal to the bend region are caused either by an increase in pressure due to stipital pumping or by action of the intrinsic galeal musculature of the proboscis, respectively." (Krenn 2010: 315)

參考文獻清單與連結 (REFERENCE LIST)

Krenn, H. W. (1990). Functional morphology and movements of the proboscis of Lepidoptera. (Insecta). *Zoomorphology* 110: 105-114.

Krenn, H. W. (2010). Feeding mechanisms of adult Lepidoptera: structure, function, and evolution of the mouthparts. *Annual Review of Entomology* 55: 307-327. (https://link.springer.com/article/10.1007/BF01632816)

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/Lepidoptera https://www.onezoom.org/life/@lepidoptera https://eol.org/pages/747
撰寫/翻譯/編修者與日期
溫翔喆翻譯 (2020/04/21)；譚國鎏編修 (2020/06/02)；許秋容編修 (2020/06/23)
AskNature 原文連結
https://asknature.org/strategy/proboscis-unwinds/