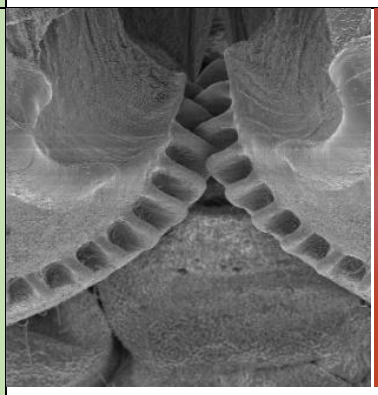
生物策略表

類別	生物策略 (Strategy)
生物策略 STRATEGY	腳在跳躍過程中同步化 (Legs Synchronize During Jumps)
生物系統 LIVING SYSTEM	伊蘇斯葉蟬 *Issus coleoptratus* (Planthoppers)
功能類別 FUNCTIONS	#在氣體中移動 #分配能量 #Move in/Through Gases #Distribute Energy
作用機制標題	葉蟬後腳的機械聯動裝置提供強而有力的同步跳躍 (Hind legs of planthoppers produce powerful synchronized jumps thanks to a mechanical linkage.)
生物系統/作用機制示意圖	 

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

「伊蘇斯葉蟬 (*Issus*)（半翅目 Hemiptera，瓢蠟蟬科 Issidae）的後腳 (hind leg) 在身體下方的同一平面內移動，這樣的排列表示牠們必須同步移動才能提供跳躍的力量。而且，他們移動迅速，所以必須在跳躍前儲存能量，然後瞬間釋放。高速成像 (high speed imaging) 和後腳近端關節 (proximal joint) 的力學分析顯示，機械機制可確保運動和能量儲存的同步性 (synchrony)；同步性 是透過每個轉節 (trochantera) 上小凸起 (small protrusion) 之間的機械性相互作用所達成的。當雙腳在跳躍之前翹起時，這些凸起會在中線互相觸碰。在死掉的葉蟬中，一股下沉的力會施加在翹起的腳，或在其轉節下降肌 (trochanteral depressor muscle) 的肌腱 (tendon)，導致兩隻後腳同時地降低。首先移動的後腳上的凸起會推動另一後腳，從而使兩者同步運動。轉節下降肌在跳躍之前的收縮使內骨骼 (internal skeleton) 的後胸肋膜弓 (metathoracic pleural arch) 彎曲。這些弓形結構的大部分區域在紫外光下發出明亮的藍色螢光 (fluoresce)，而這種螢光的強度取決於浸泡鹽水 (bathing saline) 的 pH 值。這些是橡膠狀蛋白質 (rubber-like protein) 的節肢彈性蛋白 (resilin) 之關鍵特徵。肋膜弓的其餘部分由堅硬的角質層所組成。彎曲這些複合結構可儲存能量，其反作用力 (recoil) 為跳躍提供力量。」

The hind legs of *Issus* (Hemiptera, Issidae) move in the same plane underneath the body, an arrangement that means they must also move synchronously to power jumping. Moreover, they move so quickly that energy must be stored before a jump and then released suddenly.

High speed imaging and analysis of the mechanics of the proximal joints of the hind legs show that mechanical mechanisms ensure both synchrony of movements and energy storage…Synchrony is achieved by mechanical interactions between small protrusions from each trochantera…which touch at the midline when the legs are cocked before a jump. In dead *Issus*, a depression force applied to a cocked hind leg, or to the tendon of its trochanteral depressor muscle causes a simultaneous depression of both hind legs. The protrusion of the hind leg that moves first nudges the other hind leg so that both move synchronously. Contractions of the trochanteral depressor muscles that precede a jump bend the metathoracic pleural arches of the internal skeleton. Large areas of these bow-shaped structures fluoresce bright blue in ultraviolet light, and the intensity of this fluorescence depends on the pH of the bathing saline. These are key signatures of the rubber-like protein resilin. The remainder of a pleural arch consists of stiff cuticle. Bending these composite structures stores energy and their recoil powers jumping."

文獻引用 (REFERENCES)

參考文獻清單與連結 (REFERENCE LIST)

Burrows, M. (2010). Energy storage and synchronisation of hind leg movements during jumping in planthopper insects (Hemiptera, Issidae). *Journal of Experimental Biology* 213: 469-478. (https://doi.org/10.1242/jeb.037861)

延伸閱讀:

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https://asknature.org/system/insects?post-type=Biological%20Strategies

撰寫/翻譯/編修者與日期

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https://asknature.org/strategy/legs-synchronize-during-jumps/