

# 生物策略表

類別	生物策略 (Strategy)
生物策略 STRATEGY	黏膠在濕潤時保持黏性 (Glue Stays Sticky When Wet)
生物系統 LIVING SYSTEM	圓網蜘蛛 Araneidae (Orb-weaver spiders)
功能類別 FUNCTIONS	#獲取、吸收、或過濾生物 #Capture, Absorb, or Filter Organisms
作用機制標題	圓網蜘蛛的蛛網黏膠因為吸濕性鹽分而在濕潤時保持彈性和黏性 (Web glue of orb-weaver spiders is elastic and sticky when wet because of moisture-absorbing salts.)
生物系統/作用機制 示意圖	
作用機制摘要說明 (SUMMARY OF FUNCTIONING MECHANISMS)	
<p>圓網蜘蛛 (orb-weaver spiders) 會建造螺旋形蜘蛛網以捕捉獵物。這些網具有非凡的物理性質，能夠承受相對較大的昆蟲獵物以高速飛行造成的撞擊。當昆蟲撞到蜘蛛網時，股線 (strand) 會拉伸並變形 (deform)，以吸收能量而不會被撕裂，然後反彈到其原始位置，為下一次撞擊做好準備。為了使獵物保持被困，蜘蛛網上的線 (thread) 也塗有性質絕佳的黏膠。</p> <p>圓網蜘蛛網的黏膠包含醣蛋白 (glycoprotein)，即是連接著碳水化合物（或醣類）的蛋白質。這些碳水化合物基 (carbohydrate group) 意味著黏膠可以形成大量的氫鍵 (hydrogen bond)。氫鍵是非常弱的鍵結，但非常大量的弱力 (weak force) 可以倍增形成非</p>	

常強的相互作用。以圓網蜘蛛網的黏膠來說，單一醣蛋白上有很多形成氫鍵的機會，單一黏膠液滴中有很多醣蛋白，蜘蛛網股線上有很多液滴，蜘蛛網中有很多股線。在每個層級 (hierarchical level) 中許多弱鍵的組合，使得獵物與網之間的整體相互作用非常強烈，確保了在蜘蛛網反彈時不會彈走潛在的食物。

除醣蛋白外，黏膠液滴還含有高濃度的鹽類。這些鹽類具有吸濕性 (hygroscopic) (它們會吸收大氣中的水分)，使黏膠蛋白保持濕潤。這使醣蛋白能夠在黏膠液滴內移動，形成並重新形成鍵結。因此，當與飛蟲的撞擊發生時，黏膠也具有彈性，拉伸並吸收撞擊能量，反彈回到液滴構型 (configuration) 而不會脫離蜘蛛網，覆蓋不幸的昆蟲並有效地將其捕獲。

不同種類的蜘蛛在其網黏膠液滴中具有不同的鹽類和鹽份濃度，這會根據其原生棲息地的濕度進行調整。人造黏膠在高濕度下的效果會減弱，但是圓網蜘蛛網的黏膠利用鹽類來調節從大氣中吸收多少水分，使它們在濕氣的存在下變得更加黏稠。

Orb-weaver spiders construct spiral webs for capturing prey. These webs have remarkable physical properties and are capable of withstanding impacts from comparatively large prey insects travelling at high speeds. When an insect hits a web, the strands stretch and deform to absorb the energy without tearing and then rebound to their original position ready for the next impact. In order for prey to remain trapped, the web threads are also coated in a sticky glue with remarkable properties.

Orb-weaver web glue contains glycoproteins, that is, proteins that have carbohydrate (or sugar) attached to them. These carbohydrate groups mean the glue can form large numbers of hydrogen bonds. Hydrogen bonds are very weak bonds, however, very large numbers of such weak forces can multiply up to form very strong interactions. In the case of orb-weaver web glue, there are lots of hydrogen bonding opportunities on a single glycoprotein, lots of glycoproteins in a single glue droplet, lots of droplets on a web strand, and lots of strands in a web. The combination of so many weak bonds at every hierarchical level results in very strong total interaction between prey and web and ensures potential food is not bounced off as the web rebounds.

As well as glycoproteins, glue droplets also contain high concentrations of salts. These salts are hygroscopic (they absorb moisture from the atmosphere), keeping the glue proteins wet. This enables the glycoproteins to move around inside the droplet, forming and reforming bonds. As a result, when an impact with a flying insect occurs, the glue also behaves elastically, stretching out and absorbing the impact energy without becoming detached from the web, before rebounding back to the droplet configuration, coating the hapless insect and effectively trapping it.

Different species of spider have different salts and salt concentrations in their glue droplets that are tuned to the humidity of their native habitats. Man-made glues become less effective under high humidity, but orb-weaver glues use the salts to tune how much water they absorb from the atmosphere, enabling them to become even more sticky in the presence of moisture.

## 文獻引用 (REFERENCES)

## 參考文獻清單與連結 (REFERENCE LIST)

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**撰寫/翻譯/編修者與日期**

李婕吟翻譯 (2021/03/28); 譚國銜編修 (2021/06/30); 張勝凱 (2021/12/27); 陳柏宇編修 (2022/01/02)

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