# 生物策略表

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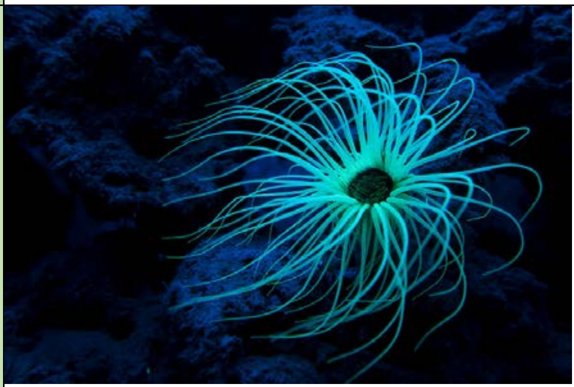
| **類別** | 生物策略 (Strategy) |
| **生物策略**<br>STRATEGY | 改變身體形狀<br>(Body changes shape) |
| **生物系統**<br>LIVING SYSTEM | 海葵<br>(Sea anemones) |
| **功能類別**<br>FUNCTIONS | #分配液體 #改變大小/形狀/質量/體積<br>#Distribute liquids #Modify size/shape/mass/volume |
| **作用機制標題** | 海葵的纖毛幫浦以低壓泵水使中心腔室再膨脹<br>(The central cavity of sea anemones is reinflated by water pumping in at low pressures thanks to ciliary pumps.) |
| **生物系統/作用機制示意圖** |  |

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

**文獻引用** (REFERENCES)

「想想一個與骨骼不一樣但有著支撐特性及功用、又能抵抗擠壓的固體材質會是什麼？海葵的體壁 (body wall)—這可是很堅實的，由厚實的中膠層 (mesoglea) 分隔為內外兩層表面，不難看出來整個構造就像一個長型的海水罐子，而外壁是由果凍狀物質組成…典型的海葵都有一種罕見的能力去改變身體的形狀，可以在數秒鐘到數小時內從大木桶變成高腰杯子，裡面還裝著揮舞的觸手…很明顯地，這一定牽涉到海葵的中膠層部分。肌肉能使部分形狀改變，尤其是從頂端開口的中空內腔瞬間噴出海水，但大片的纖毛 (cilia) 能造成其他改變，例如透過將海水泵回體內造成再膨脹 (reinflation)。你可以稱之為…纖毛幫浦 (ciliary pump)，能創造一個非常低的壓力環境，而在這我們研究這些生長在流動海水中卻可以達到半公尺高度的幫浦狀生物。」

「Alexander (1962) 證實了海葵中膠層黏彈性的重要功用，在樣本的蠕變測試 (creeptest) 中，拉力 (strain) 從初始數值大約 0.2，在大約 10 個小時後最終可達到十倍，這顯示中膠層有非常高的黏力 (viscosity) 以及彈力 (elasticity)—快速的施力很難改變它的形狀，但緩慢的加壓卻很容易改變形狀，還會有接近一小時的延遲時間（由 Biggs 計算，見 Vincent[1990]），這有多美妙！海浪的波動並不會把海葵沖刷得太厲害，一但平靜下來時，低壓纖毛幫浦就能適當的把海葵身體重新膨脹起來，雖然過程有點緩慢，海葵可以在單次的海浪中支撐下來，但在潮流的拖拉之下則很容易傾倒。此外，海葵的體壁能抵抗自

身肌肉短時間內收縮所造成的壓力，所以牠能夠伸展及拉直，而不會在肌肉活性不足時出現像動脈瘤 (aneurysm) 的體壁變薄或破裂現象。」(Vogel 2003: 360-361)

"Consider a solid material with properties and role about as distant from bone as a supportive, compression-resisting material can be. The body wall of a sea anemone–which can be quite substantial in size–consists of inner and outer surface layers separated by the thick mesoglea. One doesn't go far wrong viewing the system as a tall can of seawater whose walls are mostly made of jelly…A typical anemone has a rare facility for changing shape, ranging from a low barrel to a tall cylinder with a few flourishes in between, over times ranging from seconds to hours…Obviously its mesogleal stuffing must participate in the process. Muscle drives some of the shape changes, in particular the sudden expulsion of water in the central cavity from its single apical opening. But tracts of cilia drive other changes, such as reinflation by pumping water back in. You may recall that…ciliary pumps produce exceedingly low pressures, and here we're asking that they pump up creatures that may reach half a meter in height and live in moving water."

"Alexander (1962) showed the crucial role of mesogleal viscoelasticity for anemones. In creep tests on samples, strain increased from an initial value of about 0.2 to a final level ten times that, achieved after around 10 hours. That means the mesoglea has a lot of viscosity relative to its elasticity–it's hard to make it do anything fast but fairly easy to make it change shape slowly. It has a retardation time (calculated by Biggs; see Vincent [1990]) of a little under an hour. How nice! The pulsating or reversing flows of waves passing above won't sweep it about very much, but after it has hunkered down, the low-pressure ciliary pump will be adequate to pump it back up again, albeit slowly. It can stand up to a single wave but deflect in a tidal current that imposes the same drag. Furthermore, the anemone's body wall can resist the stresses of its own short-term muscle contractions, so it can bend or straighten without getting an aneurysm whenever its muscles aren't active." (Vogel 2003: 360-361)

**參考文獻清單與連結** (REFERENCE LIST)

Vogel S. (2013). *Comparative biomechanics: life's physical world, second edition.* Princeton University Press.

**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/Sea_anemone

**撰寫/翻譯/編修者與日期**

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**AskNature 原文連結**

https://asknature.org/strategy/body-changes-shape/