


生物策略格式

KJC, 2019/10/21

類別	生物策略 (Strategy)	
生物策略 STRATEGY	鳥喙將食物吸入嘴裡 (Bird bill draws food into mouth)	
生物系統 LIVING SYSTEM	西濱鶻 <i>Calidris mauri</i> (Western semipalmated sandpiper)	
功能類別 FUNCTIONS	#獲取、吸收、或過濾生物 #分配液體 #Capture, absorb, or filter organisms #Distribute liquids	
作用機制標題	鶻的喙用水的表面張力，將食物吸入嘴裡 (The bill of the sandpiper draws food into its mouth using water's surface tension.)	
生物系統/作用機制示意圖		
作用機制摘要說明 (SUMMARY OF FUNCTIONING MECHANISMS)		
<p>西濱鶻 (<i>Calidris mauri</i>) 是一種在美國海岸過冬的水鳥。利用其長喙在泥沙中戳刺，西濱鶻可撿取小型獵物，像是海洋蠕蟲、甲殼類和昆蟲。牠也可以吃漂浮在水中的微小浮游生物，但這類獵物太小，無法個別戳刺或啄食。為了吃浮游生物，西濱鶻採用一種叫做「表面張力運送」的策略。</p> <p>水具有由水分子間吸引力所產生的表面張力。在氣-水的界面上，表面張力會傾向於保持盡可能的小。將水向外擴張並產生更多界，則需耗能。水分子也會被角蛋白 (keratin) 吸引，角蛋白是構成鶻喙的蛋白質材料。當西濱鶻沿著岸邊涉水時，會將牠的喙浸入水中並就像鑷子般抓住浮游生物。然後將喙拉離水面，並稍微打開它。喙端上富含浮游生物的水滴，會黏在喙的上下面，並伸展開來，產生一個氣-水的界面。當西濱鶻持續張開喙時，水滴也會繼續伸展。然後將水滴往上移動，朝向嘴巴，水的表面張力則會減少伸展的界面面積。如此可將水滴中的微小浮游生物運送到喉嚨處，再加以吞嚥。</p>		

The western sandpiper (*Calidris mauri*) is a shorebird that spends its winters on the coasts of the US. Probing in mud and sand with its long bill, the sandpiper picks up small prey like marine worms, crustaceans, and insects. It can also feed on tiny plankton floating in the water, but these prey are too small to probe or peck at individually. To eat plankton, the western sandpiper uses a strategy called “surface tension transport.”

Water has a surface tension that results from attractive forces between water molecules. At an air-water interface, this surface tension tends to keep the interface as small as possible. Spreading water out and creating more interface takes energy. Water molecules are also attracted to keratin, the protein material that makes up the sandpiper’s bill. As it wades along the shore, the sandpiper dips the tip of its bill into the water and grasps at plankton like a pair of tweezers. It then lifts its bill out of the water and opens the bill slightly. The plankton-rich drop of water at the bill tip sticks to the upper and lower bill and stretches apart, creating an air-water interface. As the sandpiper continues to open its bill, the water drop continues to stretch. Water’s surface tension then reduces the stretched interface area by moving the drop up towards the sandpiper’s mouth. This delivers tiny plankton in the water drop to the throat where they can be swallowed.

文獻引用 (REFERENCES)

「相較於大部分食浮游生物者 (planktivore) 採濾食方式，這些小型鳥則是「鏟取」獵物。但會將獵物置於鳥喙尖端，而非咽喉處。雖然鳥喙只是稍微張開，卻產生一氣-水的界面，如同 fig. 5.8a。然後水則發揮其作用 – 將水滴從喙尖向上且向後移動，表面張力則可減少界面的面積。」(Vogel 2003: 107)

「表面張力運送獵物，是一種攝食機制，利用獵物周遭水分的表面張力，使其可從喙尖運送到口部…關於威氏瓣蹼鷗、西濱鷗及姬濱鷗進食機制，由實驗室的研究，證實了這三個物種在水中攝食時，皆使用表面張力來運送獵物。(Rubega 1997: 488)

「表面張力運輸 (STT) 是一種在淺水區取食小型獵物的小型到中型涉禽中常見的攝食機制。這些鳥類使用 STT 比以往的模型中預測的理論值還要快約 3.6 倍，而且當小型獵物密度足夠高時能夠有高進食效率。」(Estrella et al. 2007: 1244)

“Instead of filtering, as do most planktivores, these small birds ‘tweezer’ prey. But that puts the prey at the tip of the bill, not the pharynx. Gaping the bill slightly, though, creates an [air-water] interface, as in fig. 5.8a. The water then does its part – surface tension reduces the area of interface by making the droplet of water move up and back from the bill’s tip.” (Vogel 2003: 107)

“Surface tension prey transport is a feeding mechanism employing the surface tension of water surrounding prey to transport prey from bill tip to mouth...Laboratory investigations of the feeding mechanics of Wilson’s Phalarope *Phalaropus tricolor*, Western Sandpiper *Calidris mauri*

and Least Sandpiper *Calidris minutilla* demonstrated that all three use surface tension transport of prey when feeding in water.” (Rubega 1997: 488)

“...STT [surface-tension transport] is a common feeding mechanism in small or medium-sized shorebird species that feed on small prey items in shallow water. Birds using STT transported $\leq 3.6\times$ faster than the theoretical value predicted by a previous model and can achieve high intake rates when foraging on high densities of available small prey items.” (Estrella et al. 2007: 1244)

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.

Rubega, M. A. (1997). Surface tension prey transport in shorebirds: how widespread is it? *Ibis* 139: 488-493. (<https://doi.org/10.1111/j.1474-919X.1997.tb04663.x>)

Estrella, S. M., J. A. Masero, and A. Pérez-Hurtado. (2007). Small-prey profitability: field analysis of shorebirds' use of surface tension of water to transport prey. *The Auk* 124: 1244-1253. ([https://doi.org/10.1642/0004-8038\(2007\)124\[1244:SPFAOS\]2.0.CO;2](https://doi.org/10.1642/0004-8038(2007)124[1244:SPFAOS]2.0.CO;2))

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/Calidris_mauri

文章貢獻/編修者與日期:

宋季庭翻譯 (2019/05/20)；朱天愛編修 (2019/12/28)；吳皓編修 (2020/01/04)；譚國銜翻譯/編修 (2020/08/05)；紀凱容編修 (2020/11/26)；施習德編修 (2020/12/28)

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