

生物策略格式

KJC, 2019/10/21

類別	生物策略 (Strategy)
生物策略 STRATEGY	以水翼形的喙部將獵物拉近 (Hydrofoil-shaped bill draws prey closer)
生物系統 LIVING SYSTEM	琵鷺 <i>Platalea leucordia</i> (Spoonbills)
功能類別 FUNCTIONS	#獲取、吸收、或過濾生物 #分配液體 #在液體中/上移動 #Capture, absorb, or filter organisms #Distribute liquids #Move in/on liquid
作用機制標題	琵鷺藉其水翼狀的喙產生渦流，將水生獵物拉近 (The hydrofoil-shaped bill of the spoonbill draws aquatic prey closer by generating swirling flows)

生物系統/作用機制
示意圖



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

琵鷺 (spoonbill) 是一種擁有獨特鳥喙形狀的大型涉禽。如其英文名，可知其喙是長的，且具寬圓的末端。琵鷺在淺水區取食，並以浮在水中或泥底上的魚類、甲殼類、昆蟲為食。如同許多鳥類般，琵鷺以其喙直接抓住可見或可觸及的獵物；然而，對可能無法就近看到的獵物，琵鷺似乎還擁有一個能牽引獵物的策略。當琵鷺行走在淺水區時，會低下頭，在水中將其喙以弧形方向從一邊掃往另一邊。喙的頂部為圓形，而底部則近乎扁平。以橫截面來看，其形狀稱為水翼 (hydrofoil) [若在空氣移動中則為氣翼 (airfoil)—翼 (wing) 是較為人熟知的]。當水翼在水中移動時，流經水翼圓頂的水流，較在平坦底部流動的水流快。上述情形發生的原因是水必須同時在水翼的另一端相遇 (質量守恆定律)。

水翼上下流速的差異，會產生一股向上的動力，相當於飛機機翼在空氣中產生的上升力。同時，因水流的差異，在水翼尖端處會形成水漩渦。這股水漩渦稱為端渦 (tip vortex)，且研究人員相信琵鷺會以此收集獵物。

當琵鷺水翼形的喙掃過水中時，會產生一股動力與喙端渦。渦流可以攪動淺水將小型獵物拉離水底，或促使游動的獵物移動至水層中。一旦靠近琵鷺的嘴，琵鷺就可用其喙感應到獵物，並將之捕捉。

此策略是由 Dimitri Smirnoff 和 Philip Samuel 所提供的。

Spoonbills are large wading birds with a distinct bill shape. As the name suggests, the bill is long with a wider rounded end. Spoonbills catch their food in shallow water, where they eat fish, crustaceans, and insects that can be floating in the water or on the muddy bottom. Like many birds, the spoonbill uses its bill to grasp directly at prey that is visible and within reach; however, it also appears to have a strategy for drawing prey that it might not even see closer. As the spoonbill walks through shallow water, it dips its head down and sweeps its bill from side to side in an arc through the water. The top of the bill is rounded while the bottom is nearly flat. In cross section, this shape is called a hydrofoil (or airfoil if it moves through air—more commonly known as a wing). As a hydrofoil moves through the water, water flowing over the rounded top of the hydrofoil travels faster than water flowing under the flatter bottom. This occurs because the water has to meet at the end of the hydrofoil at the same time (law of conservation of mass). This difference in flow speeds above and below the hydrofoil generates an upward force much like an airplane wing generates lift in air. At the same time, the difference in flow results in areas of swirling water at the tips of the hydrofoil. This swirling water is called a tip vortex, and it's what researchers believe the spoonbill uses to gather prey.

As the spoonbill's hydrofoil-shaped bill sweeps through the water, it generates a force and a bill-tip vortex. This vortex can stir up and draw small prey off the bottom of the shallow water or stimulate mobile prey to move in the water column. Once near the spoonbill's mouth, it can then sense and capture the prey with its bill.

This strategy was contributed by Dimitri Smirnoff and Philip Samuel.

文獻引用 (REFERENCES)

「一個與琵鷺相關的特徵是喙的形狀：上顎和下顎皆為背腹面扁平，上顎從切面看是凸面，下顎則是包入上顎的，因此形成一個幾乎扁平的表面。整個喙都是寬的，在遠端變得更寬。在此所提出的假說，是琵鷺使用其寬扁的喙並以喙端橫掃而釋出的漩渦，會在底部產生水動力學上的吸力，能干擾及移動獵物。要達成此目的，喙則被當作水翼來使用。此分析預測，與實驗結果顯示 (1) 在進食時，喙端保持接近水底，(2) 喙的浸沒深度與橫掃速度成反比，以及 (3) 喙掃過水中獵物時，會造成獵物在水層中被抬升。」(Weihs and

Katzir 1994: 649)

“...A related feature of spoonbills is the shape of the bill: both upper and lower mandibles are dorso-ventrally flattened, the upper mandible being convex in cross section while the lower is tucked in, to result in an almost flat surface. The bill is wide throughout and broadens at the distal end. The hypothesis presented here is that spoonbills use their broad, flattened bills and lateral sweeping to shed a vortex off the tip of the bill that results in hydrodynamic suction on the bottom, which disturbs and moves prey. To achieve this, the bill is used as a hydrofoil. The analysis predicts, and experimental results show that (1) in feeding, the tip of the bill is kept close to the bottom, (2) there is an inverse relationship between bill immersion depth and sweeping speed, and (3) bill sweeping over submerged prey results in the prey being lifted into the water column.” (Weihs and Katzir 1994: 649)

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生物系統延伸資訊連結 (LEARN MORE ABOUT THE LIVING SYSTEM/S)

<https://en.wikipedia.org/wiki/Spoonbill>

文章貢獻/編修者與日期:

郭嘉陽翻譯 (2018/04/30) ; 吳皓編修 (2019/11/03) ; 譚國鏊翻譯/編修 (2020/06/30) ; 紀凱容編修 (2020/11/26) ; 施習德編修 (2020/12/28)

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<https://asknature.org/strategy/hydrofoil-shaped-bill-draws-prey-closer/>