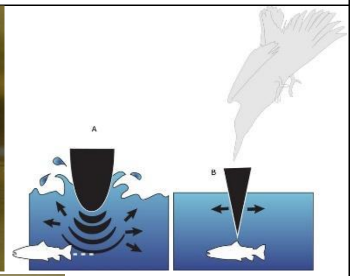
生物策略表

類別	生物策略 (Strategy)
生物策略 STRATEGY	啟發了新幹線設計的鳥喙 (The beak that inspired a bullet train)
生物系統 LIVING SYSTEM	翠鳥 (Kingfisher)
功能類別 FUNCTIONS	#在液體中/上移動 #在氣體中移動 #Move in/on Liquids #Move in/Through Gases
作用機制標題	翠鳥的鳥喙形狀使其可以潛入水中而不會產生水花 (The shape of the kingfisher beak allows it to dive into the water without splashing.)
生物系統/作用機制示意圖	   

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

介紹

身處小溪、池塘或大海旁邊時，您可能很幸運能看到翠鳥 (kingfisher)。遍布全球的翠鳥是一個包含 100 多個物種的科，牠們經常在水體 (water body) 處活動，顧名思義，牠們是捕捉魚類的大師。

翠鳥的捕魚方法看起來很簡單。翠鳥一旦發現魚（使用眼中的特殊減少眩光細胞 glare-reducing cell），就會離開棲息處 (perch) 並跳入水中用鳥喙抓住魚。但是，魚類具有難以戰勝的防禦策略。魚類身體上的特殊感受器 (receptor)（稱為體側線 lateral line）會感應周圍水流的擾動。水的突然擾動，例如鳥類潛下水時的壓縮波 (compression wave)，會使魚類尾巴一甩就逃走了。如果你曾經嘗試用手抓魚，那就會知道手一旦接觸到水，要避免牠們察覺是多麼困難。

策略

秘密在於翠鳥的鳥喙形狀。翠鳥鳥喙呈細長而狹窄的錐形，張開並進入水中而不會在水面下方產生壓縮波或在上方產生嘈雜的飛濺。錐形鳥喙尖細的末端在進入水中時只有非常小的表面積或阻力，並且均勻且逐漸變大的鳥喙橫截面進一步穿透到水中時，會使液體在其周圍順暢地流動。這使魚類在察覺到危險之前，讓翠鳥獲得關鍵的數毫秒抓到魚。鳥喙的長度非常關鍵：鳥喙越長，楔角 (angle of the wedge) 就越能逐漸擴大。較短，較胖或更圓的鳥喙會增加楔角，從而造成水花飛濺和壓縮波，使魚逃走。

Introduction

While beside a creek, pond, or at the ocean, you may have been fortunate to spy a kingfisher. Found the world over, kingfishers are a family of birds containing over 100 species, often visiting bodies of water, where, as their name suggests, they are masters at catching fish.

The method kingfishers use to catch fish seems simple enough. Once a kingfisher spies a fish (using special glare-reducing cells in its eyes), it leaves a perch and plunges into the water to grab it in its beak. Fish, however, have a defensive strategy that is hard to overcome. Specialized receptors along a fish’s body, known as a lateral line, sense disturbances in the flow of surrounding water. Any sudden movement of water—such as a compression wave from a diving bird—and fish are gone with a flick of the tail. If you’ve ever tried to catch a fish with your hands, you know how difficult it is to escape their detection as soon as your hand touches the water.

The Strategy

The secret is in the shape of the kingfisher’s beak. A long and narrow cone, the kingfisher’s beak parts and enters the water without creating a compression wave below the surface or a noisy splash above. The fine point of the conical beak presents little surface area or resistance to the water upon entry, and the evenly and gradually enlarging cross-section of the beak keeps fluid flowing smoothly around it as it penetrates further into the water column. This buys the bird crucial milliseconds to reach the fish before the fish knows to flee. The length of the beak is critical here: the longer it is, the more gradually the angle of the wedge expands. A shorter, fatter, or rounder beak would increase the wedge angle, resulting in a splash, a compression wave, and a fleeing fish.

文獻引用 (REFERENCES)

「鳥喙看起來良好地適應於避免空氣動力 (aerodynamic) 、流體動力 (hydrodynamic) 的阻力 (drag)。大多數鳥喙相對地呈錐形，相對於迎面而來的流動方向有較小的初始表面積，從而減少了瞬時的外形阻力 (profile drag)。而逐漸增加的橫截面積允許水流朝著動物較寬的中間部分時保持流線 (laminar)。」

「值得注意的是，在計算流體動力學 (computational fluid dynamics, CFD) 的模擬中，在三趾翠鳥屬 (*Ceyx*) 或魚狗屬 (*Ceryle*) 的翠鳥衝進水中時，鳥喙尖端沒有出現明顯的弓形波 (bow wave)。」

“Bird beaks appear well-adapted to avoid both aerodynamic and hydrodynamic drag. Most beaks are relatively cone-shaped, with a small initial surface area relative to the direction of oncoming flow—thus reducing immediate profile drag. The gradual increase in the cross-sectional area allows flow to remain laminar as it travels toward the wide middle section of the animal.” (Crandell et al. 2019: 1)

"Notably, no apparent bow wave, where water is pushed forward in front of the animal, appears at the tip of the Ceyx or Ceryle kingfisher bills in the CFD [computational fluid dynamics] simulations."

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

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

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