生物策略表

類別	生物策略 (Strategy)
生物策略 STRATEGY	鮣魚吸盤的多功能抓握能力 (The Versatile Grip of Remoras' Suction Discs)
生物系統 LIVING SYSTEM	鮣魚 (*Echeneis naucrates*)
功能類別 FUNCTIONS	#暫時性附著 #Attach Temporarily
作用機制標題	獨特的結構使鮣魚能夠頑強的粘附在水下的各種表面。 (Unique structures give fish the ability to adhere tenaciously to a variety of surfaces under water.)
生物系統/作用機制示意圖 (確認版權、註明出處；畫質)	

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

鮣魚的堅持不懈(指堅持住在其他海洋生物上)係因其扁平頭部頂部的獨特吸盤結構。吸盤的外緣環繞著一個橢圓形的軟肉組織。這個唇緣會接觸到寄主的表面，無論是粗糙的鯊魚還是光滑的海豚。唇緣與表面緊密貼合，形成一個防漏的密封環境。水被抽出內部腔以在密封裝置內外產生壓力差。外部水壓的增加只會更強力地對密封環境施加壓力。這就是使鮣魚固定在原地的基本吸附力。

然而，更仔細觀察肉質組織，可以發現一個額外的加固特徵。在組織表面下方，有一層密集填充著長而細的、垂直排列的膠原纖維層，這是一種既堅固又具彈性的蛋白質。這些纖維容易被壓縮，但抗拉和抗斷裂的能力卻很強。這些特性有助於唇緣最大限度地接觸表面，以保護密封環境。它們還可以防止唇緣在鮣魚的寄主突然加速或改變方向時輕易滑動或滑落。

吸盤的內部被 10 到 30 層薄而平的組織所覆蓋，排列成兩列平行的行，就像羅馬戰艦上的槳或者你口腔頂部的脊狀物。這些被稱為鰭瓣，吸盤魚可以豎起以製造更多與宿主間的接觸面積，並增強吸附力。

這些鰭瓣內嵌有許多排列成行的尖刺狀礦物結構，稱為刺突，每個只有數毫米高。鮣魚會調整它們的鰭瓣位置，讓其中的微小刺突能夠緊緊抓牢寄主表面上的微小凹陷。這會產生阻止滑動的摩擦力。刺突有各種不同的尖端，這增加了至少一些刺突的形狀合適，能夠在當時可用的特定表面上獲得摩擦力的可能性。刺突有各種不同的尖端，增加了至少一些刺突在特定表面上獲得牢固抓地力的可能性。

放鬆鰭瓣使得鮣魚能在任何時候、任何地方自由地脫離。

A remora's stick-to-itiveness stems from a unique suction disc structure on the top of its flat head. The disc's outer edge is ringed with an oval of soft, fleshy tissue. This lip makes contact with the surface of a host, whether it is a rough-skinned shark or a smooth dolphin. The lip conforms closely to the surface and begins to create a leakproof seal. Water is pumped out of the interior cavity to create a pressure difference inside and outside the seal. Higher water

pressure outside just pushes harder against the seal. That's the basic suction that holds the remora in place.
But a closer look at the fleshy tissue reveals an additional reinforcing feature. Just under the tissue's surface is a layer that is densely filled with long, thin, vertically aligned fibers of collagen, a protein that is both strong and elastic. The fibers compress easily but resist stretching and breaking. Those properties help the lip maximize contact with surfaces to protect the seal. They also keep the lip from easily creeping or slipping when a remora's host speeds up or changes direction suddenly.
The interior of the disc is lined with 10 to 30 thin, flat layers of tissue, aligned in two columns of parallel rows, like oars on a Roman galley or the ridges on the roof of your mouth. These are called lamellae, and remoras can raise them up to make more contact with their hosts and enhance suction.
The lamellae are embedded with many rows of spiky mineral structures called spinules, each a few millimeters tall. Remoras position their lamellae so that the spinules grip into the tiny crevices on the surface of the host. That generates friction that deters slippage. Spinules have a variety of tip ends, increasing the likelihood that at least some spinules are suitably shaped to gain traction on the particular surface available at that time.
Releasing the lamellae then allows remoras to detach whenever and wherever they desire.

文獻引用 (REFERENCES)

「鮣魚能夠利用其背部吸盤附著於各種自然和人造海洋基質上。這個吸盤由一系列平行並排的鰭辮組成，他們與其他魚類的背鰭元素同源。背部鰭辮的小齒狀礦化組織突起被稱為棘突，據認為能增加鮣魚抵抗滑動的能力，從而增強摩擦力，保持對移動宿主的附著。」(Brooke E. Flammang 2015:218)

「屬於輻鰭魚家族的鮣魚科具有引人注目的能力，利用高度修改的背鰭形成黏著盤，能夠附著於各種海洋動物上，這使得它們能夠在高強度的流體剪切下搭乘快速游動的寄主。」」(Fuchao Hao 等人 2017:1)

「一個具啟發性的自然典範是鮣魚，它已進化出使用背部吸盤對宿主保持強力黏附的能力。我們發現，吸盤的獨特纖維結構由垂直排列的膠原纖維組成，使其具有各向異性的機械特性和增強的附著性能。」(Fuchao Hao :2020 :1207)

"The remora fishes are capable of adhering to a wide variety of natural and artificial marine substrates using a dorsal suction pad. The pad is made of serial parallel pectinated lamellae, which are homologous to the dorsal fin elements of other fishes. Small tooth-like projections of mineralized tissue from the dorsal pad lamella, known as spinules, are thought to increase the remora's resistance to slippage and thereby enhance friction to maintain attachment to a moving host." (Brooke E. Flammang 2015:218)

"Remoras of the ray-finned fish family Echeneidae have the remarkable ability to attach to diverse marine animals using a highly modified dorsal fin that forms an adhesive disc, which enables hitchhiking on fast-swimming hosts despite high magnitudes of fluid shear." (Fuchao Hao 2017:1)

"An inspiring natural model is the remora fish, which has evolved to retain powerful adhesion to hosts using a dorsal suction disc. We find that the remora suction disc has a unique fibrous

architecture of vertically oriented collagen fibers that enable anisotropic mechanical properties and enhanced adhesion performance." (Fuchao Hao :2020 :1207)

參考文獻清單與連結 (REFERENCE LIST) **Harvard 或 APA 格式**

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撰寫/翻譯/編修者與日期

熊翊呈翻譯 (2024/3/11)；陳柏宇編修 (2024/11/30)

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