
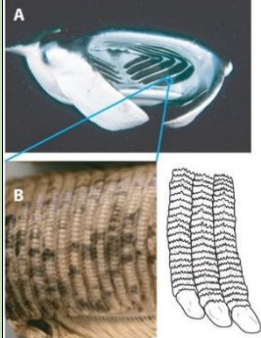


生物策略表

類別	生物策略 (Strategy)	
生物策略 STRATEGY	過濾系統能抗堵塞 (Filtration system is resistant to clogging)	
生物系統 LIVING SYSTEM	鬼蝠魞 <i>Manta birostris</i> (Giant manta ray)	
功能類別 FUNCTIONS	#獲取、吸收、或過濾生物 #Capture, absorb, or filter organisms	
作用機制標題	獨特的過濾系統使鬼蝠魞能獲取微小顆粒而不會堵塞 (Unique filtration system allows manta rays to capture small particles without clogging.)	
生物系統/作用機制 示意圖	 	
作用機制摘要說明 (SUMMARY OF FUNCTIONING MECHANISMS)		
<p>鬼蝠魞 (manta ray) 是鯊魚的近親 (close relative)，被測量到可超過 20 英尺長。牠們透過在游泳時將富含浮游生物 (plankton-rich) 的水帶進口中來攝食。牠們過濾並攝取 (ingest) 浮游生物，然後將剩餘的水沖出鰓裂 (gill slit)。</p> <p>鬼蝠魞使用不同於傳統過濾法的方式來過濾浮游生物。最常見的過濾器類型是篩型過濾器 (sieve filter)，包含顆粒的液體通過膜 (membrane)，而膜上的孔洞比顆粒小。這使水能通過，但顆粒會留下。</p> <p>篩網過濾器包括從過濾義大利麵的廚房濾鍋 (kitchen colander) 到產生超純水 (ultrapure water) 的膜過濾器 (membrane filter)。另一種過濾器機制是水溶膠過濾法 (hydrosol filtration)，例如暖通空調系統 (HVAC system) 中的纖維過濾器 (fiber filter)，以及用於無袋</p>		

真空吸塵器 (bagless vacuum cleaner) 的旋風過濾法 (cyclonic filtration)。許多過濾系統的主要缺點是它們易於堵塞，因為隨著時間的流逝，它們收集的顆粒會堆積。另外，許多系統往往會隨著流體流動越快而堵塞得越快，因為顆粒也會堆積得越快。

但是鬼蝠魞的過濾系統具有極強的抗堵塞能力，並且可以在非常高流速下運作。它是如何做到的呢？鬼蝠魞使用成陣列的葉狀裂片將食物顆粒彈離過濾器。流經葉狀裂片的水會形成複雜的水流，水流中的食物顆粒會撞擊裂狀葉片並流走。這甚至使魞魚保留的食物顆粒往往比孔洞還小。從過濾器彈離 (ricochet off) 的顆粒則會集中在口腔(mouth cavity) 內，使魞魚能夠將其吞食。

Manta rays are close relatives of sharks and can measure more than 20 feet across. They eat by bringing plankton-rich water into their mouths as they swim. They filter and ingest the plankton and then flush the remaining water out their gill slits.

The manta ray filter the plankton using a method different from traditional filtration. The most common type of filter is a sieve filter, where a fluid containing particles is passed through a membrane that has pores smaller than the particles. This allows the water to pass through but leaves the particles behind.

Sieve filters include everything from a kitchen colander that strains pasta to membrane filters that produce ultrapure water. Other filter mechanisms are hydrosol filtration, such as the fiber filters in HVAC systems, and cyclonic filtration, used in bagless vacuum cleaners. The main drawback of many filtration systems is that they are prone to clogging, because over time the particles they collect builds up. In addition, many systems tend to clog quicker the faster the fluid flows, because particles are building up more quickly.

However, the manta ray's filtration system is extremely resistant to clogging and can operate at very high flow rates. How does it do it? Manta rays use arrays of leaf-like lobes to bounce food particles away from the filter. Water passing over the lobes creates a complex pattern of current flow, and food particles in the flow hit the lobes and move away. This allows the fish to retain food particles that are oftentimes even smaller than the pores. The particles that ricochet off the filter become concentrated in the mouth cavity, allowing the fish to ingest them.

文獻引用 (REFERENCES)

參考文獻清單與連結 (REFERENCE LIST)

Divi, R. V., Strother, J. A. and Paig-Tran, E. M. (2018). Manta rays feed using ricochet separation, a novel nonclogging filtration mechanism. *Science advances* 4: eaat9533. (<https://advances.sciencemag.org/content/4/9/eaat9533>)

延伸閱讀:

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

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

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AskNature 原文連結

<https://asknature.org/strategy/filtration-system-is-resistant-to-clogging/>