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SCIENCE FOCUS 科言

Issue 034, 2026



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**Q&A with HKUST Ocean
Science Majors**
讀海洋科學的人：與科大學子對談

School of 理學院
Science



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Message from the Editor-in-Chief 主編的話

Dear Readers,

I hope you are enjoying the new school year so far. For those of you who receive this issue during the annual HKUST Information Day, I hope you realize a new dimension of studying science with us. Perhaps you may eventually contribute to the production of *Science Focus*, an experience shared by some of our previous student editors.

I am sure you have no problem recalling the chemical formula of calcium carbonate. But beyond the chemistry textbook, we bring you two articles in which calcium carbonate is considered in different ways. You will find out how biocement and eggshell are remotely linked. Have you ever wondered why it is so hard to swat a fly? Learn more in an article about how different visual systems evolved in a variety of animals. Finally, we tell a horror story from the natural world, on the origin of cordyceps flowers. Hopefully, it will not become your excuse for refusing delicious dishes at the dinner table in the future.

Are you thinking of studying ocean science in HKUST? We bring you the final article on our alumni interview series, in which an ocean science faculty member and recent graduates share their perspectives on this interdisciplinary subject. Do let us know if you have enjoyed this series. We certainly had fun reconnecting with our alumni!

親愛的讀者：

希望大家在新學年學習愉快。如果您是從本科入學資訊日收到本期雜誌，盼望您能發現在科大研習科學的全新視角。或許未來您會參與《科言》的製作，與我們許多歷屆學生編輯共享一段美好回憶。

相信大家對碳酸鈣的化學式一定記憶猶新。我們將為大家呈獻兩篇化學教科書範圍以外的文章，讓大家從不同角度審視碳酸鈣。您會發現生物水泥和蛋殼之間看似遙遠，卻緊密相連的聯繫。您有否好奇想過拍打蒼蠅為甚麼總是那麼難？在介紹不同動物視覺系統演化的文章中，您將會找到答案。最後，我們將講述一個來自大自然的恐怖故事——蟲草花的由來。希望這不會成為您日後在餐桌上拒絕這一美味佳餚的藉口。

您正考慮在科大修讀海洋科學嗎？我們為您帶來校友專訪系列的最後一篇文章，由海洋科學系講師和近期畢業生向大家分享他們對這個跨學科領域的看法。如果您喜歡這個專訪系列，歡迎隨時告訴我們。在訪問校友的過程中，我們確實得到許多樂趣！

主編 麥皓怡教授
敬上

Yours faithfully,
Prof. Ho Yi Mak
Editor-in-Chief

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What's Happening in Hong Kong? 香港科技活動

Fun in Winter Science Activities 冬日科學好節目

Any plans for this winter? Check out the following events!

計劃好這個冬天的好去處了嗎？不妨考慮以下活動！

Science for Everyone 全民科學

In celebration of the shared 35th anniversary of the HKUST and the Hong Kong Science Museum, "Science for Everyone" presents a dynamic series of activities, including popular science talks, hands-on workshops, immersive VR experiences, and a guided tour of the Hong Kong Science Museum — all designed to ignite curiosity and broaden scientific understanding across the community. We invite students, families, and community members to join us, be inspired, and take part in shaping a more scientifically informed future. Come discover the joy of science with us — let curiosity lead the way.

Period: January to February 2027

Venue: Hong Kong Science Museum and
HKUST Clear Water Bay Campus

為慶祝香港科技大學與香港科學館成立 35 周年，我們將以「全民科學」為主題，攜手舉辦一系列精彩活動，包括科普講座、互動工作坊、虛擬實境體驗及科學館導賞團，帶領公眾走進科學的奇妙世界，激發好奇心，拓闊視野。我們誠邀學生、家庭及社區人士踴躍參與，一同以好奇心開啟探索之旅，體驗科學精彩。

日期：2027 年 1 月至 2 月

地點：香港科學館及香港科技大學（清水灣校園）



Visit this website for more information.

請到此網頁查看活動詳情。

Shenzhou 13 – Space Travel 窗外是藍星之太空旅行

Experience Earth from 400 kilometers above with *Shenzhou 13 – Space Travel*, China's first space-filmed fulldome movie at the Hong Kong Space Museum. Captured directly by astronauts Zhai Zhigang, Wang Yaping and Ye Guangfu during their six-month mission, this show offers an immersive journey aboard the Tiangong Space Station. Viewers witness key milestones, including Wang Yaping's historic spacewalk, spacecraft docking and the assembly of space modules. The film also reveals daily astronaut life, from weightless workouts and water recycling, to celebrating Lunar New Year in space. Embark on this remarkable cosmic adventure without needing any astronaut training.

想從距離地面 400 公里的高空俯瞰地球嗎？正在香港太空館放映的中國首部太空拍攝球幕電影《窗外是藍星之太空旅行》可以為您實現這個願望。本片由航天員翟志剛、王亞平和葉光富於為期六個月的任務中親自拍攝，帶領觀眾踏上於天宮空間站裡的沉浸式旅程。觀眾將見證多項重要里程碑，包括王亞平的歷史性太空漫步、飛船在軌對接，以及空間站的建造過程。影片同時揭示了航天員的日常生活，從無重狀態下的運動、再生水循環，到在太空中慶祝農曆新年。現在無需接受航天訓練，快去展開這趟非凡的太空探索冒險！

Show Period: Now – February 14, 2027

Time: 3:30 PM and 8:00 PM
(Mon, Wed to Fri)
2:00 PM and 6:30 PM
(Sat, Sun and public holiday)

Venue: Space Theatre, Hong Kong Space
Museum

Admission fee: Standard admission:
\$40 (stalls), \$30 (front stalls)
Concession admission: \$20 (stalls),
\$15 (front stalls)

放映日期：現在至 2027 年 2 月 14 日

時間：下午三時半及八時正（一、三至五）
下午二時正及六時半（六、日及公眾假期）

地點：香港太空館天象廳

入場費：標準票：40 元（後座）；30 元（前座）
優惠票：20 元（後座）；15 元（前座）

A Living Scaffold: Biocement

建造會呼吸的「石屎森林」：生物水泥

By Roshni Printer

Introduction

In the past few centuries, we have relied on massive factories for producing cement to build our cities — but did you know that scientists are developing a novel way to manufacture cement with living organisms?

What is Cement?

Cement is a key component of concrete. When it is brought to building sites and mixed with water, cement paste can act as a binder which binds aggregates (small stones used in building) to form concrete [1]. The manufacture of cement requires large amounts of energy. During the process, raw materials are heated to 1,500°C, and tons of carbon dioxide are generated. The cement industry currently accounts for 5–8% of global carbon dioxide emissions [2]. While urban development continues to push the demand for building materials, researchers began to look toward some more eco-friendly ways to produce cement.

A Lesson From Nature: Biomineralization

Can we learn from nature? In fact, some of the most durable structural materials in nature are the products of biomineralization [3], which can be defined as “a process by which living organisms produce minerals.” Biominerals include phosphates, carbonates and sulfates, with corals, shells, anthills, tooth enamel and antlers being some common examples [3]. As biological reactions always occur under milder conditions, thus avoiding excessive use of energy, bioengineers are interested in identifying real-world applications of the process.

Enter Biocement

One such material under development is biocement, produced by living microbes through a process known as “microbially induced calcium carbonate precipitation (MICP) [4].” This process is a biochemical transformation orchestrated by soil bacteria like *Sporosarcina pasteurii* [5]. Unlike traditional cement, biocement is brewed at room temperature [6] using a blend of bacteria, urea, calcium salts, and a structural base such as sand, crushed stone or gravel [5, 7].

S. pasteurii is a species that grows well under alkaline environment and has a high urease activity [5]. Their cytoplasmic urease breaks down the urea ($\text{CO}(\text{NH}_2)_2$) that is transported or diffused into the cell to ammonia (NH_3) and carbonic acid (H_2CO_3), which is equilibrated to bicarbonate ions (HCO_3^-) at physiological pH. Because ammonia is a weak base, it accepts protons (H^+) and raises the pH of the environment. By Le Chatelier's principle, this shifts the carbonate equilibrium to generate carbonate ions (CO_3^{2-}) that will be transported out of the cell. In the presence of calcium ions from the added salts, calcium carbonate (CaCO_3) crystals precipitate out.

The catabolism of urea:
 $\text{CO}(\text{NH}_2)_2 + 2 \text{H}_2\text{O} \rightarrow 2 \text{NH}_3 + \text{H}_2\text{CO}_3$

The carbonate equilibrium:
 $\text{H}_2\text{CO}_3 \rightleftharpoons \text{HCO}_3^- + \text{H}^+ \rightleftharpoons \text{CO}_3^{2-} + 2 \text{H}^+$

The bacterial cell walls act as nucleation sites, growing large-sized and high-strength calcium carbonate

crystals that form a skeleton to bind loose aggregates, mimicking the properties of traditional cement [7].

The Amazing Properties of Biocement

One of the most amazing aspects of biocement is that its physical characteristics can be engineered by adjusting parameters like incubation time, temperature and aggregate materials [8]. This allows the precise manufacturing of biocement with ideal density, permeability and structural performance to cater specific industrial needs.

Furthermore, biocement can be self-healing [9, 10].

Some bacterial species produce spores that can remain dormant inside the material for long periods. If a crack forms, moisture and oxygen will enter the structure to “wake up” the spores to initiate the repairing process, synthesizing new calcium carbonate to seal the fissures from inside out. However, as some of such bacterial species may not be able to adapt to a highly alkaline environment, researchers are now identifying protective carriers to enhance the survival rate of bacterial spores in the concrete.

Future Directions Through Genetic Engineering

To increase the yield of calcium carbonate, scientists are investigating ways to

genetic engineer *S. pasteurii*. A possible direction includes transplanting a urea transport system to the species, or modifying the existing system in the species, if any, to increase intracellular urea concentration [5]. Scientists could also optimize the structure of the *S. pasteurii* urease to increase the efficiency of the enzyme



[5], or overexpress the urease gene (enhance the transcription and translation of the gene) to increase the concentration of the biocatalyst [9].

Potential Uses of Biocement

The self-healing properties of biocement make it a perfect material for future infrastructure construction. By incorporating bacteria into bridges and urban structures, we can harness them to actively seal the gaps, preventing moisture from reaching and corroding internal steel structures [9].

Therefore, biocement also acts as a powerful tool for structural rehabilitation. Large-scale underwater engineering marvels, such as old dams and tunnels, often suffer from high hydromechanical stress from the surrounding water [4]. Biocement can be injected into existing fissures to fortify these structures. The impermeability of the calcium carbonate formed can effectively reduce, or stop water flow across the structure, preventing catastrophic failures [4, 11].

Soil stabilization is another possible use. Loose terrain is vulnerable to erosion and landslides. MICP has demonstrated its potential to prevent erosion and landslides by holding loose sand particles together, although the efficacy is also subject to soil type and slope geometry [4, 7, 12].

Conclusion

After all, nature has spent millions of years perfecting its own kind of engineering. By letting bacteria do the work, we have the potential to build smarter cities that can “fix” themselves while using fewer scarce resources. This gives a whole new meaning to the phrase “concrete jungle.”

引言

在過去幾個世紀裡，我們一直依賴龐大的工廠製造水泥來建造城市——但你知道嗎？科學家正開發利用活生物製造水泥的嶄新方法！

甚麼是水泥？

水泥是混凝土（俗稱「石屎」）的關鍵成分。當水泥被送到施工現場並與水混合時，水泥漿便可作為黏合劑，將

骨材（建築用的碎石）黏在一起形成混凝土 [1]。製造水泥需要消耗大量能量，過程中原料需被加熱至 1,500°C，並產生數以噸計的二氧化碳。目前水泥工業佔全球二氧化碳排放量 5–8% [2]。隨著城市發展持續推動對建築材料的需求，研究人員開始尋求更環保的方法生產水泥。

大自然的啟示：生物礦化

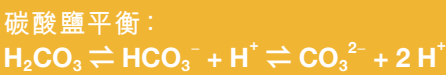
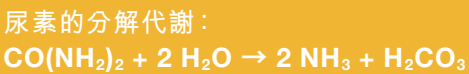
我們能向大自然學習嗎？事實上，自然界一些最耐用的結構材料都是生物礦化作用的產物 [3]。生物礦化可定義為「活生物產生礦物的過程」。生物礦物包括磷酸鹽、碳酸鹽和硫酸鹽，常見例子有珊瑚、貝殼、蟻丘、牙齒琺瑯質和鹿角 [3]。由於生物體內的反應都是在較溫和的條件下進行，能節省不必要的能量消耗，因此生物工程師渴望為生物礦化尋求現實世界的應用。

初探生物水泥

其中一種開發中的物料是活微生物透過「微生物誘導碳酸鈣沉澱作用」所產生的生物水泥 [4]。這個生物化學轉化過程由 *Sporosarcina pasteurii* 等土壤細菌主導 [5]。與傳統水泥不同，生物水泥是在室溫下 [6] 由細菌、尿素、鈣鹽，以及砂、碎石或礫石等結構基質的混合物轉化而成 [5, 7]。

S. pasteurii 是一種在鹼性環境下生長良好，而且具高尿素酶活性的菌種 [5]。該細菌細胞質中的尿素酶會把經運輸或擴散進入細胞的尿素（CO(NH₂)₂）分解成氨（NH₃）和碳酸（H₂CO₃）。碳酸在生理 pH 值下會以碳酸氫根離子（HCO₃⁻）的形態存在。由於氨是弱鹼，它會接受質子（H⁺）並提高周圍 pH 值，根據勒沙得利爾原理（Le Chatelier’s principle），這會進一步使碳酸鹽平衡偏向生成碳酸根離子（CO₃²⁻），該離子及後會被運輸至細胞外。由於最初添加的鈣鹽提供了鈣離子，使碳酸鈣（CaCO₃）晶體得以沉澱出來。

細菌的細胞壁是晶體核形成的地方，會長出大顆而堅硬的碳酸鈣晶體，形成用以黏合鬆散骨材的骨架，藉此模擬傳統水泥的特性 [7]。



生物水泥的驚人特性

生物水泥最令人驚嘆的特點之一，在於可以透過控制反應時間、溫度和骨材成分等參數調整其物理特性 [8]，使我們能精準製造具備理想密度、滲透性和結構性能的生物水泥，以滿足特定的工業需求。

此外，生物水泥還能具有自我修復功能 [9, 10]。某些細菌產生的孢子能在材料內部長期保持休眠狀態，一旦出現裂縫，水分和氧就會進入結構內「喚醒」孢子並啟動修復程序，由內而外合成新的碳酸鈣以填補裂縫。然而，由於未必每個菌種都能存活於極鹼的環境中，所以研究人員正尋找合適的保護載體，以提高細菌孢子在混凝土中的存活率。

以基因工程探索未來方向

為了提高碳酸鈣的產量，科學家正研究透過基因工程改造 *S. pasteurii*。可能的方向包括將尿素運輸系統移植至細菌中，若該細菌本身已含有尿素運輸系統，就可以透過改善現有系統以增加細胞內的尿素濃度 [5]。科學家亦可以改良 *S. pasteurii* 尿素酶的結構，以提高該酶的效率 [5]；或是透過過量表達尿素酶基因（即增加該基因的轉錄和轉譯），從而提高這種生物催化劑的濃度 [9]。

生物水泥的潛在用途

生物水泥的自我修復特性使其有望成為未來基建的理想材料。透過將細菌注入橋樑和城市建築，我們就能利用細菌主動填補縫隙，防止水分進入並腐蝕內部的鋼筋結構 [9]。

因此，生物水泥亦是強大的結構修復工具。老舊的水壩和隧道等大型水底建築往往需承受來自周圍水體的巨大水壓 [4]，將生物水泥注入已發現的裂縫可以鞏固結構，所產生的不透水碳酸鈣可以有效減弱，甚至截斷建築內外的水流，防止結構性崩潰 [4, 11]。

另一個可能用途是土壤穩定（soil stabilization）。鬆散的土壤容易導致侵蝕和山泥傾瀉，微生物誘導碳酸鈣沉澱作用透過將鬆散的砂粒黏在一起，展現了其預防土壤侵蝕和山泥傾瀉的潛力，儘管成效亦取決於土壤類型和斜坡形狀 [4, 7, 12]。

結語

畢竟大自然也花了數百萬年雕琢其獨特工藝，透過改派細菌上場，我們也許就能建造具自我修復能力的智慧

城市，同時減少消耗稀缺資源。這不是正為「石屎森林」一詞賦予全新意義嗎？

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Cordyceps Flowers: A Parasitic Horror Story

恐怖寄生故事：蟲草花是怎樣煉成的

By Roshni Printer

Have you ever wondered what it would feel like to be so hungry because there are parasites in your body draining all your nutrients? Imagine being so manipulated by a hidden invader that you simply couldn't stop eating, no matter how much food you gobbled down. This is how "cordyceps flowers" (蟲草花) flourish: by controlling their poor little hosts, silkworms. Next time when you are served a comforting bowl of

soup with cordyceps flowers, you might want to pause and drum up the courage for the first sip.

Cordyceps flowers are *Cordyceps militaris*, a parasitic fungus that infects silkworms [1, 2]. In a healthy silkworm caterpillar, a 12-carbon sugar called trehalose circulates through its blood. This disaccharide is formed by two glucose molecules, linked through a glycosidic bond that is different from the one in maltose. As the healthy caterpillar munches on leaves, the elevation in the caterpillar's blood sugar level eventually signals to the brain that it is full and satisfied. However, the case is totally different in an infected silkworm. The parasitic *C. militaris* expresses its trehalase gene and floods the caterpillar's bloodstream with the enzyme, which acts like molecular scissors to break down the 12-carbon trehalose into two six-carbon glucose molecules. For the fungus, this glucose is a feast, allowing it to flourish inside the host. But by wiping out the trehalose, the fungus completely

crashes the caterpillar's blood sugar level. This tricks the insect's body into a state of severe starvation, causing a surge in an appetite-stimulating neuropeptide called HemaP. Normally, when an animal has a parasitic infection, its natural defense mechanism is to lose appetite. By fasting, the animal can starve the parasite of the nutrients it needs to multiply [1]. However, the fungus-infected caterpillar feels as though it is starving to death, even though it is continuously eating. The zombie-like hungry insect enters a non-stop feeding cycle.

The fungus keeps the host alive long enough to spin itself into an unusually large silk cocoon. Once the silkworm pupates and is no longer useful for gathering food, the fungus finally kills the insect, consuming the massive load of nutrients from the pupa. The fungus then uses that stolen energy to burst bright orange, spore-bearing prongs directly out of the shell of the insect, which are exactly the cordyceps "flowers." These fruiting bodies release spores into the air to infect more caterpillars.

To prove that this metabolic manipulation was a crucial mechanism driven by the trehalase gene of *C. militaris*, scientists engineered a mutant version of the fungus by deleting the gene [2]. When silkworms were infected with this modified fungus,

the caterpillars did not overeat. Their blood sugar also remained stable, and their pupae grew to a completely normal size. By comparing the conditions of the host infected by wild fungus and by this mutant, the researchers proved that it wasn't the caterpillar's body acting out on its own, but instead, it was the single gene working to fatten up the host.

The fungus acquired this trehalase gene from insects probably through a process called horizontal gene transfer (HGT) [1, 2]. Unlike typical genetic inheritance, in which genetic information flows vertically from parents to offspring, HGT occurs when genetic material jumps between species. In other words, ancestors of *C. militaris* managed to "steal" the gene from the insect — likely due to their long-term association, *C. militaris* somehow absorbed relevant DNA fragments and integrated them into its genome.

While this life cycle sounds like horror to the silkworms, the *C. militaris* harvested is popularly used as a wellness supplement in traditional Chinese medicine for its ability to boost energy, support immunity, and nourish the lungs and kidneys [3–5].

So, the next time you sit down for dinner and find those bright orange "flowers" floating in your soup, take a moment to remember the journey they took to



get there. It turns out that the broth we eat is entirely paid for by the endless, zombie-like appetite of a tiny, hijacked caterpillar!

Horizontal Gene Transfer

Horizontal gene transfer has been discussed in our previous article titled “Does Life Evolve Like a Great Branching Tree?” in Issue 032. A typical example is the acquisition of antibiotic resistance genes by bacteria through transformation, transduction and conjugation.



您是否曾經幻想過，體內若有寄生蟲不斷吸收你的營養，那種極度飢餓的感覺會是怎樣？想像一下，現在你被無形的入侵者操縱，無論狼吞虎嚥地吃下多少食物，都絲毫沒有飽足感。這就是蟲草花透過控制可憐的小宿主——蠶蟲，從而茁壯成長的方式。下次當你在品嚐一碗撫慰人心的蟲草花湯品時——如果您還有勇氣喝下的話，不妨停下來反思這個美食背後的恐怖故事。

蟲草花 (*Cordyceps militaris*) 是一種寄生於蠶蟲的真菌 [1, 2]。健康蠶蟲的血液循環著一種稱為海藻糖的十二碳糖，這種雙糖由兩個葡萄糖分子組成，藉著與麥芽糖不同的糖苷鍵連結。隨著健康幼蟲啃食樹葉，其血糖濃度的上升最終會向大腦發出訊號，表示自己已經吃飽。然而，受感染蠶蟲的情況卻完全不同。寄生的蟲草花會表達海藻糖酶基因，使幼蟲血液充滿著這種酶，然後海藻糖酶就像分子剪刀一樣，將十二碳的海藻糖分解為兩個六碳的葡萄糖分子。對蟲草花而言，這些葡萄糖是一場盛宴，使其能於宿主體內茁壯成長。但藉著消耗海藻糖，蟲草花完全拖垮幼蟲的血糖水平。這能騙過昆蟲身體，使其陷入嚴重飢餓的狀態，導致一種能促進食慾，稱為 HemaP 的神經肽的濃度激增。通常當動物受寄生蟲感染時，其自然防禦機制是失去食慾。透過禁食，動物就能切斷寄生蟲繁殖所需的營養供應 [1]。可是，受感染的蠶蟲即使不停進食，卻仍然感到餓得要命，像喪屍般進入了無間斷進食的循環。

蟲草花會留宿主活口，直至蠶蟲吐絲結成異常巨大的蠶繭。一旦蠶蟲化蛹，不再具有搜集食物的利用價值時，蟲草花就會狠下毒手，全盤接收來自蠶繭的大量營養。接著，蟲草花會利用這些奪來的能量，破殼而出，長出大量鮮橘色、抱有孢子的觸手狀枝條——這就是所謂的蟲草「花」。這些枝條將孢子釋放到空氣中，感染更多蠶蟲。

為了證明蟲草花的海藻糖酶基因是操控代謝功能背後的關鍵機制，科學家透過刪除該基因改造蟲草花 [2]。

當蠶蟲受經基因改造過的蟲草花感染時，幼蟲並沒有出現過度進食的情況。牠們的血糖保持穩定，蛹亦是完全正常的大小。透過比較受野生蟲草花，和受經基因改造後蟲草花感染的宿主情況，研究人員證明了反常行為並非來自幼蟲本身，而是由於該單一基因作祟，使宿主致肥。

蟲草花很可能是透過稱為「水平基因轉移」的過程從昆蟲獲得海藻糖酶基因 [1, 2]。與遺傳訊息從親代「垂直」流向子代的典型遺傳模式不同，水平基因轉移是指遺傳物質在不同物種之間跳躍。換言之，蟲草花的祖先成功從昆蟲身上「偷走」海藻糖酶基因，大概是由於兩個物種長期接觸，蟲草花以某種方式吸收了相關的 DNA 片段並將其整合到自身的基因組中。

雖然這種寄生循環對蠶蟲來說活像一場恐怖故事，但採收得來的蟲草花在中醫學上具有養精氣、提升免疫力以及補肺益腎的功能，因而是眾所周知的調補食品 [3–5]。

所以，下次當你坐下來享用晚餐，看到湯裡飄浮著的鮮橘色「花朵」時，不妨回想一下它來到餐桌的過程。你會發現那碗滋補湯水背後盡是可憐蠶蟲的犧牲，營養價值全是源自蠶蟲被劫持後像喪屍般的無盡食慾！

水平基因轉移

我們曾在第三十二期文章〈演化樹真的是樹狀嗎？〉探討過水平基因轉移。其中一個例子是細菌透過轉化、轉導及接合的過程獲得抗生素抗性基因。



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WHY IS THE CHICKEN EGG SHAPED THE WAY IT IS?

雞蛋形狀的奧秘： 為何偏偏長這樣？

By Ian Cheng 鄭朗健

In the refrigerated section of almost any supermarket, rows of white or brown eggs sit neatly in stacks of cartons, waiting to be picked up by grocery shoppers. Their shape is a familiar asymmetric ellipse, as if they were cast from the same mold. So familiar that one rarely gives it a thought, as if it is synonymous with the word "egg." But why? Why are eggs shaped the way they are?

How Does the Chicken Egg Form?

To crack open the mystery of egg shape, we must first understand the biology of how chicken eggs form. Unlike the female reproductive organs of humans, a hen (an adult female chicken) consists only of a single ovary and an oviduct. While both female humans and hens begin development with two sets of ovaries and oviducts, only the left set matures in hens. The other set regresses before the hen hatches [1].

The ovary is where oocytes (the immature egg cells) mature and are released into the oviduct. Remarkably, the mature chicken oocyte – the yolk – is a single cell with a diameter of four to five centimeters [1].

This is about eight orders of magnitude larger than the human egg cell. In other words, if the human egg cell were the size of a tennis ball, the yolk would be roughly the size of a large lecture hall.

As the yolk passes through the oviduct, it slowly rotates, allowing egg white (albumen) to be deposited evenly around it [1]. The section toward the end of the hen's oviduct is called the isthmus. In this section, two layers of shell membranes form outside of the yolk, which serve as the foundation of the eggshell. The membraned egg then enters the shell gland (uterus). Calcite (calcium carbonate) crystals deposit onto the membrane, forming the eggshell [1].

What About the Shape of the Chicken Egg?

Like hen eggs, it is well known that eggs are generally pointed at one end and blunt at the other. Scientists have long speculated on the evolutionary reason behind this shape. One well-known hypothesis is that asymmetric eggs are selected among cliff-nesting birds as they roll in tight circles, which prevents egg loss [2].

In 2017, a large-scale study collected egg data of 1,400 avian species to study the evolutionary reasons behind the shape of the egg. They found that the shape of eggs varies on a spectrum of asymmetry and ellipticity, ranging from spherical, symmetrical eggs on the one end to asymmetrical and elliptical eggs on the other end. Interestingly, when scientists plotted a density map of the 1,400 species, most bird species lay more asymmetric and elliptical eggs than chickens do [2].

With a wide spectrum of egg shapes, what is the biological mechanism behind the shape of an egg?

The Biological Mechanism Behind Egg Shape

Scientists hypothesized that the shape of the egg is largely determined by the shell membrane [2]. Isn't it surprising? At first glance, the hard, thick eggshell seems to be the primary structure that upholds the egg. Yet, when the eggshell is dissolved by vinegar, the shape of the egg remains. If the eggshell were the sole determinant of the egg shape, the egg would collapse upon the removal of the eggshell. So, if the eggshell does not determine the shape, what does? An x-ray radiographic study has shown that a hen egg that has just passed into the shell gland has already taken up a well-defined shape [3].

Based upon these observations, scientists developed a biophysical model able to predict the shape of a membranous egg with two factors: pressure difference across the shell membranes and variations of membrane properties. The pressure difference across membrane may arise from the fluid pressure within the egg sac, the elasticity and muscular contraction of the isthmus wall. Differences in how easily the membrane



stretches along the oviduct axis produce ellipticity, while variations in membrane material properties between the two halves of the egg give rise to asymmetry [2].

After the egg obtains its shell membrane, the formation of the eggshell begins in the isthmus just before the egg enters the shell gland. As the process starts, the shell gland secretes calcium carbonate around the egg. Anchored on the shell membrane are small calcite buds which act as a foundation to allow calcium carbonate to attach to [4]. As time passes, the eggshell thickens. After 18 to 20 hours, the eggshell becomes fully hardened, creating a rigid, fixed egg shape thereafter [1].

Evolution of Egg Shape

Now we understand the biological mechanism behind egg shapes, and the fact that most eggs are more asymmetrical and elliptical than chicken eggs. What could be the evolutionary needs that drive this trend?

From the data of the 1,400 avian species, researchers found a strong correlation between better flight ability and asymmetric eggs, elliptical eggs and larger egg sizes relative to body mass. They theorized that strong flight selects for avian species with a slimmer, more streamlined body, which limits the maximum stretchability of the isthmus or the uterus. In turn, the egg takes up a more asymmetrical and/or elliptical shape to maximize the egg volume without increasing its girth [2]. Perhaps this explains why chicken eggs are less asymmetric and less elliptical than those of most other birds. Interestingly, the researchers did not discover a correlation between cliff-nesting birds and asymmetrical eggs [2].

Conclusion

Every day, countless eggs are cracked open in kitchens around the world. The translucent egg white and the yellow yolk fall out of the shell into hot pans, following with sizzling sound, white smoke and the smell of oil. The humble shell gets tossed into the bin in the corner of the kitchen. To the average person, the shell is just a piece of packaging for the egg, something to be discarded without a second thought. Yet, as we have seen, its shape is the result of a delicate interplay between physical forces, biological structures and evolutionary pressures, refined over countless generations. Perhaps this raises a broader question: How many other everyday objects around us carry similarly hidden magnificent science, waiting to be "cracked open"?

幾乎所有超市的冷藏櫃中，一排排或白或啡的雞蛋整齊地排列在蛋盒裡，等待顧客挑選。它們呈不對稱的橢圓形，就像由同一個模具鑄造出來一樣。人們對這種形狀不曾多想，彷彿已經和「蛋」這個字劃上等號。但為甚麼呢？雞蛋為何是這個形狀？

雞蛋是如何形成的？

要解開雞蛋形狀之謎，我們先要了解雞蛋形成的過程。不同於人類女性生殖系統，母雞只擁有一個卵巢和一條輸卵管。雖然人類女性和母雞的胚胎發育初期都有兩套卵巢和輸卵管，但雌雞只有左側一套會發育成熟，另一側會在孵化前退化 [1]。

卵巢是卵母細胞（未成熟的卵細胞）成熟的地方，它其後會被釋放到輸卵管中。值得一提的是，成熟的雞卵母細胞只是單一細胞，但直徑可達四至五公分，那也就是大家熟悉的蛋黃 [1]。它比人類卵細胞大約大一億倍。換句話說，如果人類卵細胞是一個網球，那麼雞蛋黃的大小大約就是一間大型演講廳。

當蛋黃通過輸卵管時，它會緩慢旋轉，使蛋白能均勻地分泌在其周圍 [1]。母雞輸卵管近末端一段稱為峽部（isthmus），蛋黃在那裡會被兩層蛋殼膜包覆，那是蛋殼形成的基礎。接著，包覆著膜的蛋會進入殼腺（子宮），此時方解石（碳酸鈣）晶體開始沉積在膜上，形成蛋殼 [1]。

那麼雞蛋的形狀呢？

和雞蛋一樣，眾所周知普遍鳥類的蛋都是一端較尖，另一端較鈍。科學家長久而來都在推測這種形狀背後的演化原因。其中一個著名假說提出，在懸崖上築巢的鳥類在自然選擇下演化出不對稱的蛋，因為這個形狀的蛋會沿圓形軌跡滾動，有助減少蛋滾走的情況 [2]。

2017 年，一項大型研究蒐集了 1,400 種鳥類的數據，探討蛋形演化的原因。研究發現，蛋的形狀可按不對稱程度和橢圓程度畫成一個光譜，從接近球形且對稱的蛋，到

高度不對稱且細長橢圓的蛋都有。有趣的是，當研究人員在散點圖上標示這 1,400 個物種時，他們發現大多數鳥類所產的蛋都比雞蛋更不對稱和更為橢圓 [2]。

既然蛋的形狀存在如此不同的差別，究竟是甚麼生物學機制決定蛋的形狀呢？

蛋形背後的生物學機制

科學家的假說指蛋的形狀主要由蛋殼膜決定 [2]。這難道不令人驚訝嗎？乍看之下，堅硬而厚實的蛋殼似乎才是維持蛋形的主要結構。然而，當用醋溶解蛋殼後，雞蛋依然保持原有形狀。如果蛋殼是唯一決定蛋形的因素，那麼移除蛋殼後雞蛋理應立即塌陷。若蛋殼並不決定形狀，那麼真正的關鍵又是甚麼呢？有 X 光放射影像研究顯示，雞蛋在剛進入殼腺時，已經擁有相當明確的形狀 [3]。

基於這些觀察結果，研究人員建立了一套生物物理模型，能預測尚未形成硬殼的蛋的形狀，當中由兩個因素主宰：蛋殼膜內外承受的壓力差，以及蛋殼膜本身特性的差異。蛋殼膜內外承受的壓力差受卵囊內部液壓、峽部管壁彈性及其肌肉收縮影響。蛋殼膜沿輸卵管軸向的彈性不同會影響蛋的橢圓程度，而蛋殼膜上下兩半構成物質的差異則會產生不對稱的蛋形 [2]。

蛋殼膜成型之後，蛋殼會在進入殼腺前的峽部末端開始形成。殼腺在蛋的周圍分泌碳酸鈣，沉積在先前已於蛋殼膜表面形成的小碳酸鈣晶體上 [4]。隨著時間推移，蛋殼逐漸增厚。經過 18 至 20 小時後，蛋殼完全硬化，形成堅固蛋形 [1]。



蛋形的演化

現在我們明白塑造蛋形的生物學機制，也知道大多數鳥蛋比雞蛋更不對稱，且更為橢圓。到底演化背後的环境需求是甚麼呢？

從 1,400 種鳥類的數據中，研究人員發現飛行能力越強的鳥類，其蛋往往越不對稱，越為橢圓，而且尺寸亦會相對體形較大。他們推測，鳥類要擁有更強的飛行能力，便需要更纖細和更呈流線型的身體，但這樣的身體構造會限制峽部和子宮的擴張，故此蛋要變得更不對稱或（和）更長，才能在不增加周長的情況儘可能提升體積 [2]。這也許解釋了為甚麼雞蛋相對多數鳥類的蛋而言比較對稱和圓潤。值得一提的是，研究人員並未發現證據顯示在懸崖築巢的鳥類品種與不對稱蛋形相關 [2]。

結語

每一天，世界各地的廚房裡都有無數顆雞蛋被敲開，透明的蛋白與金黃色的蛋黃滑出蛋殼，直撲火燙的平底鍋，伴隨著滋滋作響的油香和升騰的白煙。同時，蛋殼被隨手丟進廚房角落的垃圾桶裡；普通人只視蛋殼為雞蛋的包裝，棄之亦不足惜。然而，正如我們現在知道，其形狀其實是物理作用力、生物結構與演化壓力之間的巧妙平衡，經歷無數世代的雕琢而成。這又引伸出另一個問題：又有甚麼其他日常事物，當中隱藏著了不起的科學原理，等待人們去發現呢？



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Do You See What I See? A Guide to Nature's Wildest Eyes

看到我所見的嗎？ 大自然最神奇的眼睛指南

By Daria Zaitseva

Introduction

Vision is an important sense we have. The human eye is often regarded as highly advanced, yet we are easily outperformed: A fly's visual response is sixfold faster than ours, and a mantis shrimp's range of color vision is quadruple our own [1]. Along the long history of evolution, most species developed their unique ways of looking at this world. We will explore some pioneers and champions of vision.

What Counts as Vision?

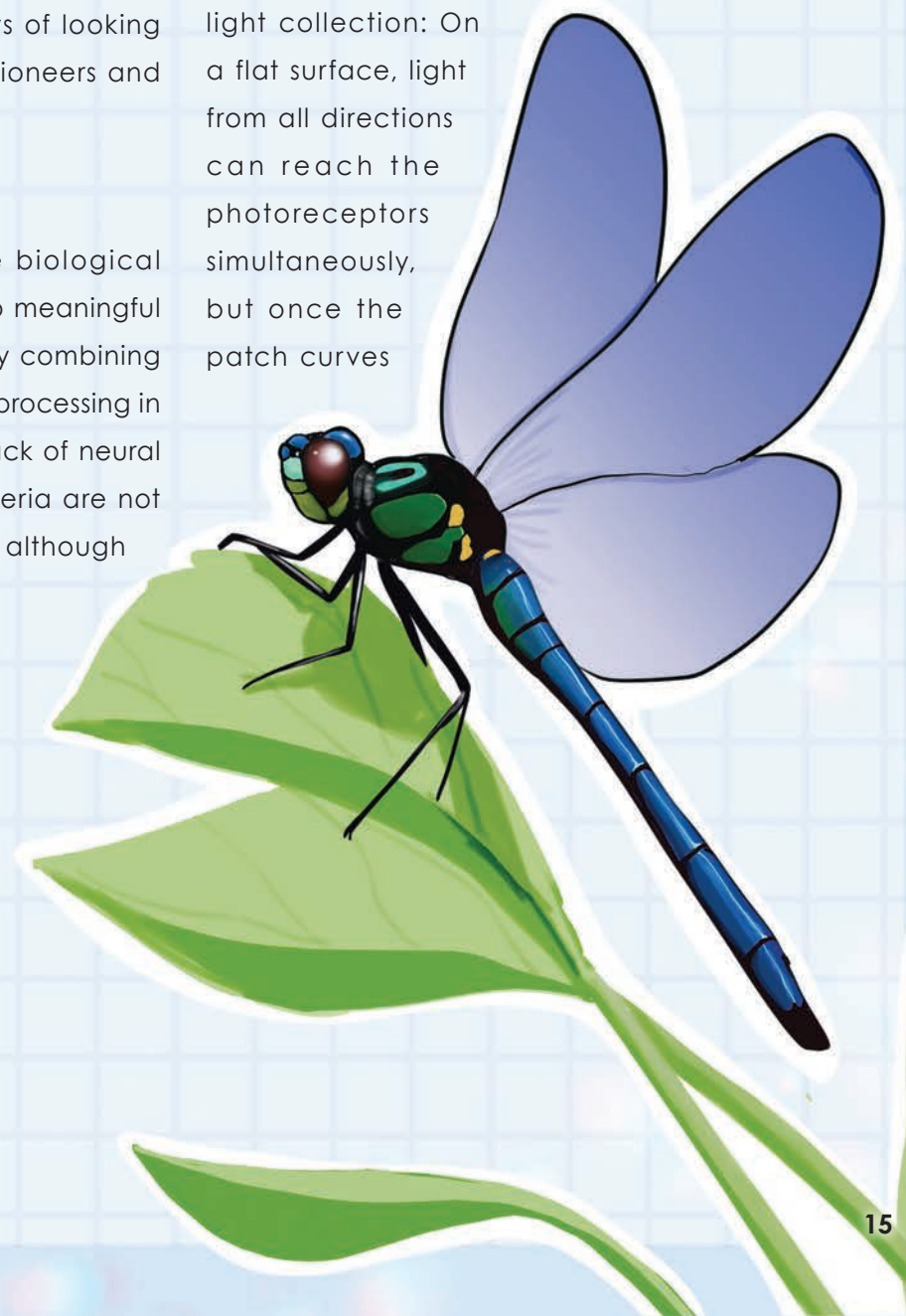
"Vision" can be defined as the biological ability to detect and convert light into meaningful information about the environment by combining photoreception in the eye with neural processing in the nervous system. Because of the lack of neural processing element, plants and bacteria are not generally considered to have vision, although they can perceive and react to light.

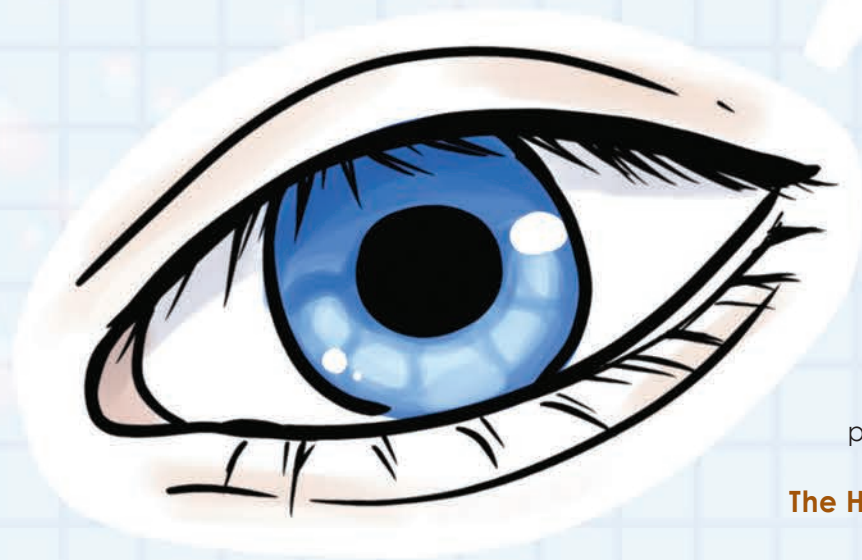
How Did Vision Come About?

Before we delve into how vision first came about, we must consider cells that are sensitive to light. These simple photoreceptors can only sense whether light is present; they cannot "see" clear images without a lens and a sufficiently complex nervous system to process visual information [2]. These light sensors can drive basic functions

like phototaxis, the movement toward or away from light, and circadian rhythm, the internal biological clock of an organism.

Along the evolution to a more complicated eye, the flat neural tissue containing photoreceptors sinks inward, creating a small dip called a pigment cup [2, 3]. This indentation changes the physics of light collection: On a flat surface, light from all directions can reach the photoreceptors simultaneously, but once the patch curves





primitive brain that had been evolved for visual processing. Eureka! We no longer have to choose between a bright, blurry image and a sharp, dark image; we can finally see a bright, highly focused picture.

The Human Eye

The modern human eye represents a fascinating culmination of this lineage. Unlike most other primates, humans evolved a highly visible white sclera surrounding the iris, creating a frame with a stark contrast that allows us to track each other's gaze. This is a crucial adaptation for emotion perception and social interaction [6]. Our flexible, muscle-controlled lenses dynamically distort to shift focus between close-up and distant objects. At the same time, the visual cortex works every second to stitch these inputs together, seamlessly erasing our blind spots and flipping the retina's upside-down images into a cohesive, three-dimensional world.

The Compound Eye of Insects

While humans process one main visual image at a time, most insects operate on a completely different system designed for split-second reaction, where information is processed simultaneously using high-speed parallel pathways [7]. Insects, like dragonflies and ants, have compound eyes made up of thousands of microscopic units called ommatidia, where light is refracted by a corneal lens and a crystalline cone before reaching the photoreceptor region containing visual pigment. Each ommatidium detects an image at a slightly different angle, giving insects an incredible ability to track motion. While humans can only resolve

movement slower than 30 images per second, some bees and flies can track motion at up to 200 images per second! That's why when you try to swat a fly, it sees your hand clearly in extreme slow motion!

The Compound Eye of Mantis Shrimps

While mantis shrimps are a common seafood on our dinner table, did you know that they also have a compound eye with photoreceptors that detect 12 colors from ultraviolet to red [8]? Surprisingly, these marine creatures are not good at differentiating colors. Humans can perceive colors in the whole visible spectrum because we have a well-developed brain to analyze the raw signals received from three types of color cones (red, green, and blue). By comparing the relative intensities of those signals, our brain can "mix" the three primary colors to perceive the colors of the rainbow. However, mantis shrimps can barely do so with their small brains [9]. They can only see discrete colors directly detected by those 12 photoreceptors. Across the ommatidia in their compound eye, only a thin band of six rows of ommatidia in the middle is responsible for color vision. As a result, they must physically roll their eyes to see the color of an object.

Conclusion

Ultimately, the diversity of eyes shows that sight never evolved all at once, but rather sculpted over 600 million years by the relentless pressure of survival. What began as a humble cluster of light-sensitive cells gradually specialized into an astonishing array of optical tools, from high-speed insect

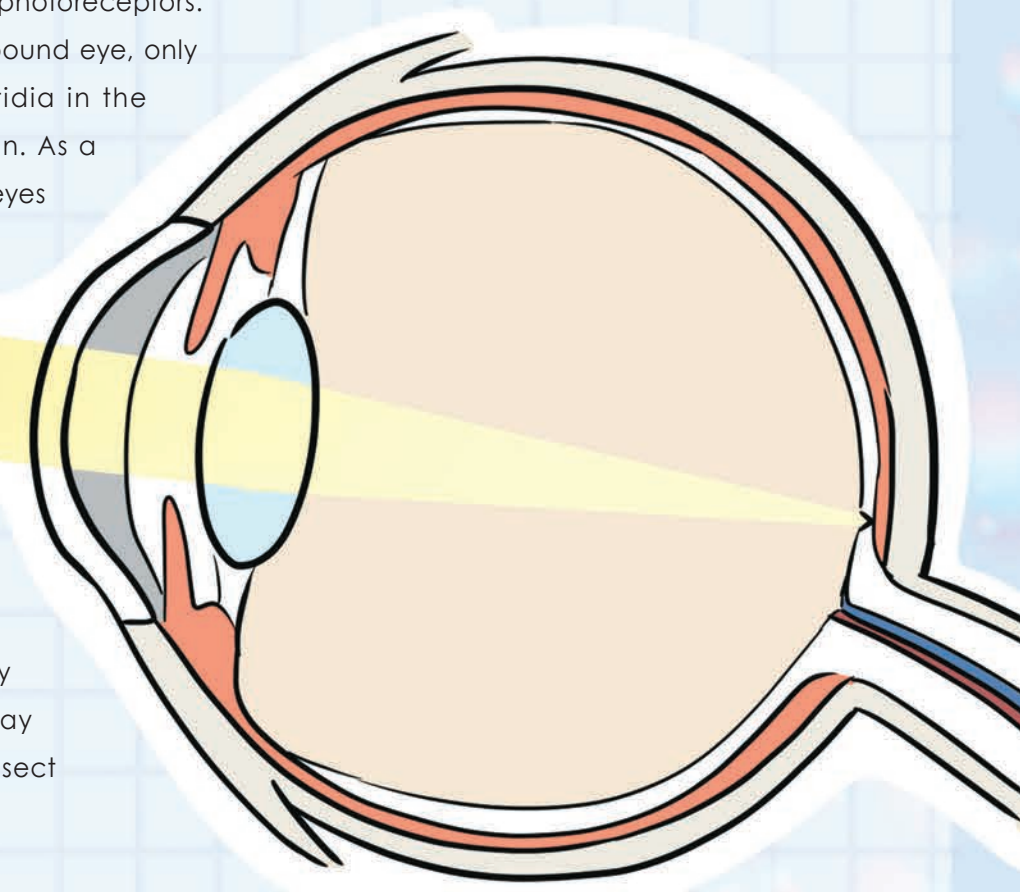
compound systems to the detail-oriented eyes of humans. In the grand theater of evolution, nature has spent eons proving that there is always more than one way to look at this fascinating world.

引言

視覺是我們的重要感官。人類的眼睛極其發達，卻容易被比下去：蒼蠅的視覺反應速度是我們的六倍，而瀨尿蝦的色彩感知範圍則是我們的四倍 [1]。在漫長的演化歷史中，大多數物種都發展出獨特的方式去觀察世界。我們將探索一些視覺領域的先鋒與皇者。

怎樣才算視覺？

「視覺」可以定義為透過結合眼睛的感光作用，與神經系統的資訊整理，將偵測到的光線轉化為有關周圍環境有用資訊的能力。由於缺乏處理資訊的神經結構，植物和細菌雖然能探測並對光線作出反應，但通常不被視為擁有視覺。



視覺最初從哪裡來？

在探討視覺從何而來之前，我們必先提及對光線敏感的細胞。這些簡單的感光細胞只能感知光線是否存在，在沒有晶體以及足夠複雜的神經系統來處理視覺資訊的情況下，它們無法「看見」清晰的影像 [2]。這些感光細胞可以驅動一些基本反應，例如趨光性（向著或背離光線移動）以及晝夜節律（生物體內的生理時鐘）。

在通往結構更複雜的眼睛演化過程中，載有感光細胞的扁平神經組織向內凹陷，形成稱為「色素杯」（pigment cup）的小凹槽 [2, 3]。這種凹陷改變了收集光線的物理：來自各個方向的光線可以同時到達扁平表面上的感光細胞，然而一旦感光區域彎曲成杯狀，來自右側的光源就只會照射到杯狀結構左側的細胞上，同時在右側投下陰影。生物自此能夠辨別光線的方向。

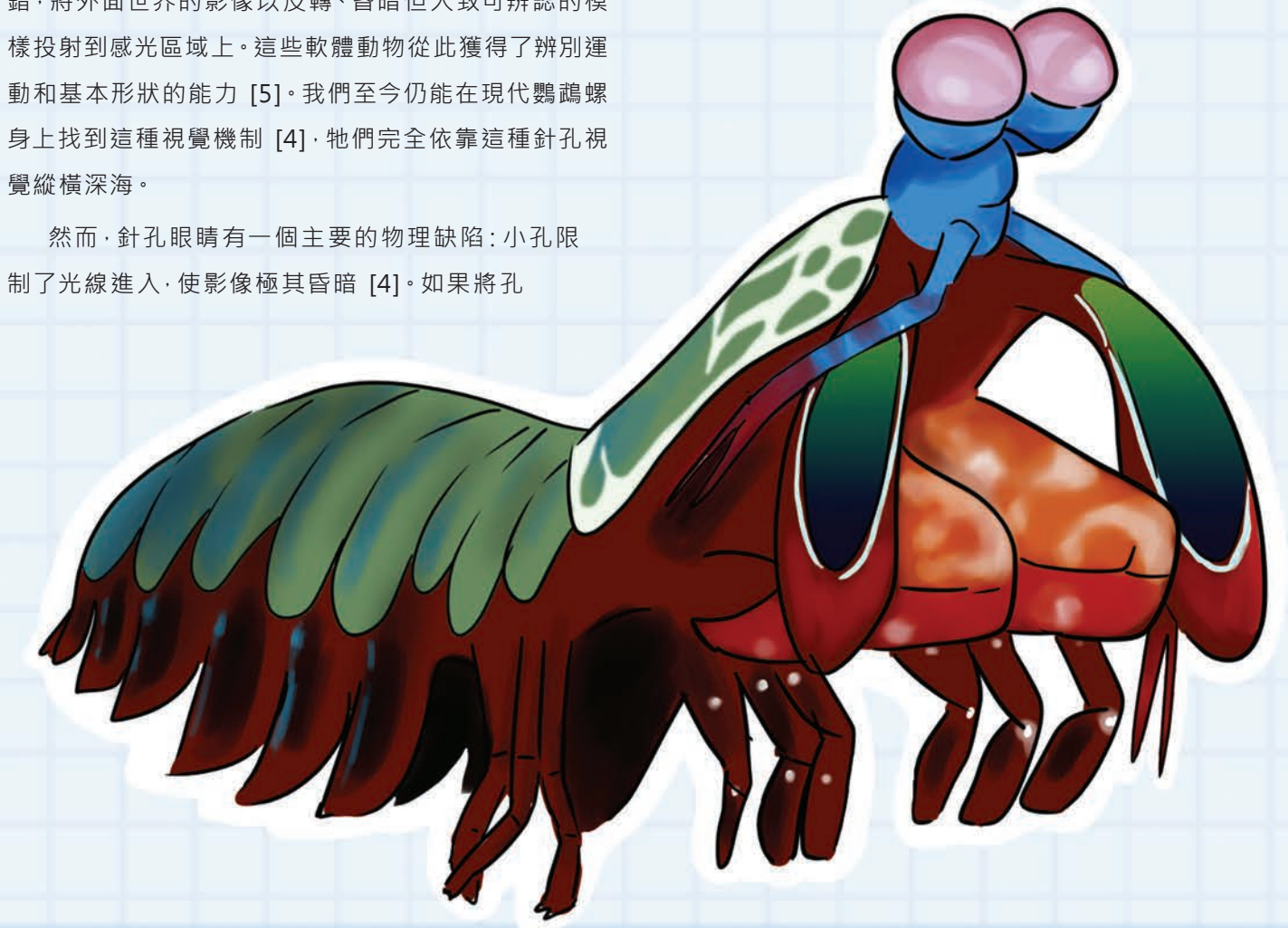
在某些軟體動物中，色素杯繼續向下陷入 [4]。其邊緣進一步向內彎，使頂部的開口縮小，形成狹窄的小孔。類似於針孔相機，這種狹窄的結構迫使光線聚焦並交錯，將外面世界的影像以反轉、昏暗但大致可辨認的模樣投射到感光區域上。這些軟體動物從此獲得了辨別運動和基本形狀的能力 [5]。我們至今仍能在現代鸚鵡螺身上找到這種視覺機制 [4]，牠們完全依靠這種針孔視覺縱橫深海。

然而，針孔眼睛有一個主要的物理缺陷：小孔限制了光線進入，使影像極其昏暗 [4]。如果將孔

開大讓更多光線進入，影像就會變得完全模糊。幸好演化提供了另一種解決方案：晶體 [2]。位於色素杯開口處的晶體透過折射，將分散的光線聚焦成投射在視網膜上的單一清晰影像，隨後視覺資訊會傳送到能處理視覺資訊的原始大腦。太棒了！我們不再需要在「明亮但模糊」與「清晰但昏暗」之間作出選擇，我們終於可以看到明亮而高度聚焦的畫面了。

人類眼睛

現代人類眼睛可說是這一演化進程的頂峰。與其他大多數靈長類動物不同，人類演化出圍繞在虹膜周圍、極為顯眼的白色鞏膜。眼白作為鮮明的框，讓我們能追蹤彼此目光，這是對感知情緒和社交互動極為重要的適應性特徵 [6]。我們具彈性的晶體能隨肌肉控制改變形狀，在遠近物體之間切換焦點。與此同時，視覺皮層每分每秒都在處理輸入的資訊，將其無縫拼接在一起，以消除我們的盲點，並將視網膜上的上下倒轉的影像轉化為一個連貫的三維世界。



昆蟲的複眼

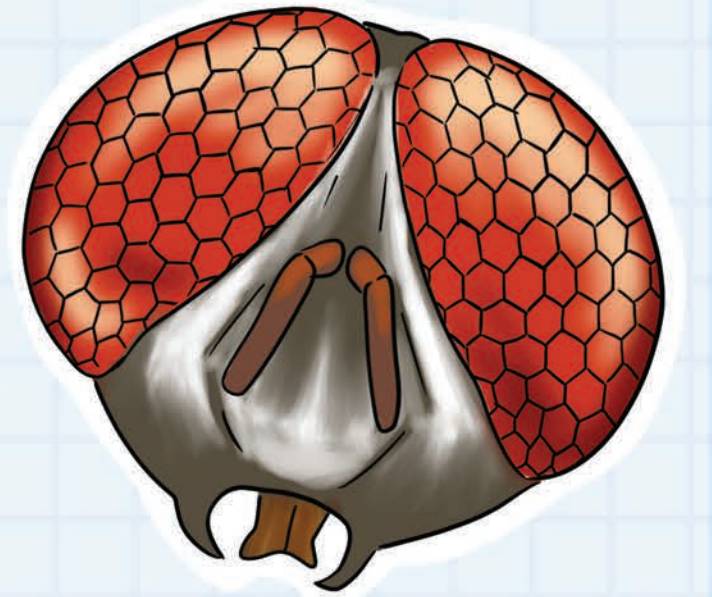
人類同時只能處理一個主要視覺影像，但大多數昆蟲擁有一個專為瞬間反應而設的視覺系統。這種截然不同的系統利用多組高速通道同時處理資訊 [7]。像蜻蜓和螞蟥等昆蟲擁有由數以千計隻小眼構成的複眼，光線會先經小眼內的角膜晶體和晶椎體折射，然後才到達含有視覺色素的感光區域。每顆小眼以稍稍不同的角度偵測影像，賦予昆蟲絕佳的視力去追蹤移動中的物體。當人類只能分辨每秒慢於 30 幅影像的動態，某些蜜蜂和蒼蠅能追蹤每秒高達 200 幅影像的動態！這就是為甚麼當你試圖拍打蒼蠅時，牠能像慢動作回放一樣清楚看見你的手。

瀨尿蝦的複眼

瀨尿蝦是餐桌上會出現的常見海鮮，但你知道嗎？牠們擁有與別不同的複眼，當中包含能辨識由紫外光到紅光之間 12 種顏色的感光器 [8]！然而，瀨尿蝦並不擅長區分顏色。人類之所以能感知整個可見光譜中的顏色，是因為我們擁有發達的大腦去分析從三種視錐細胞（紅、綠、藍）接收到的原始訊號。透過比較這些訊號的相對強度，我們大腦就能「混合」這三種原色，使我們看見彩虹的連續色彩。可是，瀨尿蝦體積較小的大腦卻無法做到這一點 [9]，牠們只能看見由 12 種感光器直接偵測到的離散顏色。在充滿小眼的複眼當中，只有中間六排小眼組成的狹長區域負責彩色視覺，因此牠們必須上下旋轉眼珠才能看清事物的顏色。

結語

眼睛的多樣性說明視覺並非一蹴而就演化成今天的樣子，那是在長達六億年的歲月裡，經歷殘酷的生存壓力雕琢而成的結果。從最初一簇微不足道的感光細胞，到昆蟲的高速複眼系統，以及人類能專注於細節的眼睛，可以看出自然逐漸演化出多姿多彩的光學結構。在悠久的演化大舞台上，大自然以時間力證：看待世界的方式，永遠不止一種。



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Q & A with HKUST Ocean Science Majors

讀海洋科學的人： 與科大學子對談

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In high school, students may only be exposed to conventional science subjects, so what exactly is ocean science?

在中學階段，學生接觸的大多是傳統科學科目，那麼究竟甚麼是海洋科學呢？



Cindy

In secondary school, physics, chemistry, biology and geography are usually taught as separate subjects. However, the ocean is an enormous and complex system, so fully understanding it requires an interdisciplinary approach. Physical oceanography examines ocean currents, tides and ocean modeling; chemical oceanography investigates how pollutants and toxic substances react and disperse in seawater, and biological oceanography focuses on marine organisms and how they respond to environmental changes.

中學通常把物理、化學、生物和地理分開教授，但海洋本身是一個龐大而複雜的系統，因此要完整理解它，便需要運用不同領域的知識。物理海洋學研究洋流、潮汐和海洋模型；化學海洋學探討污染物和有毒物質的化學作用，以及它們如何在海中擴散；生物海洋學則集中研究海洋生物，以及它們如何應對環境變化。



Andy

In secondary school, science is usually divided into separate subjects — physics, chemistry and biology. But university-level ocean science isn't neatly split. A single ocean phenomenon often requires explanations from several disciplines. It isn't just about listing different kinds of knowledge side by side; it's about how to draw on multiple disciplines at once.

在中學階段，科學通常劃分為獨立科目，例如物理、化學和生物，但大學程度的海洋科學並不能被清晰地分割。要解釋一個海洋現象，往往需要運用多個學科的知識，因此海洋科學並非只是把不同範疇的知識並列在一起，而是如何綜合不同學科來理解海洋。

What inspired you to study ocean science? 甚麼啟發你修讀海洋科學？



Harun

I love marine life ever since I was young. As a child, I often asked my parents to take me to Ocean Park. As I grew older, I enjoyed going to the beach to see starfish and other creatures. In secondary school, I once considered studying nursing, hoping to work in a profession that can help others. But later, while exploring different undergraduate programs, I learned that the ocean science program at HKUST would let me study the ocean in depth. I didn't know there was such an option in Hong Kong. That reminded me of my love for the ocean, so it was natural for me to choose ocean science. But I have never given up my wish to help others — not always humans, though, as I'm now working on marine conservation to save animals. Meanwhile, I'm a primary school teacher. I hope I can raise environmental awareness and arouse students' interest in wildlife, making the hard conservation work more effective in the future.

我從小就喜歡海洋生物。小時候，我經常叫父母帶我去海洋公園。隨著逐漸長大，我享受到海邊觀賞海星和其他生物。中學時，我曾經考慮修讀護理學，因為希望可以從事能幫助別人的職業。後來在了解不同大學課程時，我發現香港科技大學原來有海洋科學課程，可以讓我深入研究海洋。當時我不知道香港有這樣的科目可以選擇，這再次喚起我一直以來對海洋的熱愛，所以最後自然地選擇了海洋科學。不過，我從來沒有放棄「幫助別人」的想法，只是受助者未必是「人」，因為我正參與海洋保育項目去保護動物。與此同時，我是一名小學教師，希望透過教育提升學生的環保意識，並培養他們對野生動物的興趣，播下種子，令艱難的保育工作在未來更有效。



Andy

When I first entered university, I wasn't entirely sure of my direction. At first, I hoped to take a science program with some artificial intelligence elements and explore more possibilities. Many research questions do not have a simple or predetermined answer. What attracted me to ocean science is that we can collect samples and carry out fieldwork. We can consider how to incorporate artificial intelligence and monitoring technology into ocean research. This process of exploring the unknown drew me toward ocean science. Rather than focusing on abstract theories, I prefer exploring questions by experimental approaches — to search for evidence by conducting fieldwork.

剛升讀大學時，我還未完全確定自己想走的方向。最初，我希望修讀一些結合人工智能的理學課程，藉此探索更多可能。很多研究問題都沒有簡單或預設的答案，海洋科學吸引我的地方在於我們可以親自採集樣本和進行實地考察，亦可以思考如何把人工智能和監測技術應用到海洋研究中，這種不斷探索未知的過程令我對海洋科學產生興趣。相比起只專注於抽象理論，我更喜歡透過實驗探索問題，實地考察去尋找證據。

The ocean covers most of the planet. What is still unknown out there that you find most exciting?

海洋覆蓋了地球大部分表面，當中有甚麼未知最令你最感興趣？



Cindy

What excites me most is that we are still discovering new deep-sea species every year. Because it is hard for us to reach the deep sea due to extreme water pressure, the encounters with those creatures are precious. Deep-sea animals may have no eyes or may have evolved special features, such as light-producing organs, to adapt to the dark, high-pressure environment. Discovering a new species is only the first step. We still need to understand why it exists, what role it plays in the ecosystem, and whether its appearance or disappearance signals that the environment is changing. These unanswered questions are what makes deep-sea research so exciting.

最令我興奮的是我們每年仍發現新的深海物種。由於深海水壓極高，人類難以抵達，因此每次與深海生物相遇都非常難得。為了適應黑暗和高壓環境，深海生物可能沒有眼睛，亦可能演化出一些特殊構造，例如會發光的器官等。不過發現新物種只是第一步，我們仍需了解牠們為何在此，在生態系統中扮演甚麼角色，以及牠們的出現或消失是否反映了海洋環境正在變化。正是這些尚未解答的問題令深海研究如此令人興奮。



Harun

What surprises me most is that some marine organisms may unexpectedly make important contributions to humanity. For example, scientists can find compounds with medicinal potential in marine organisms, such as corals and sponges. Some of which even help with cancer research. This suggests that nature may already hold answers to long-standing questions. Unfortunately, human activities may destroy the habitats of certain species, or even wipe them out, before we realize their value. So, exploring the ocean is exciting on one hand, while on the other it reminds us of the urgent need for conservation.

最令我驚訝的是，有些海洋生物會以意想不到的方式，為人類帶來重要貢獻，例如科學家可以從珊瑚、海綿等海洋生物中發現具有藥用潛力的化合物，其中一些甚至能應用於癌症研究中。這讓我們了解到大自然本身可能早已蘊藏一些我們尋求已久的答案。可惜的是，在我們真正了解某些物種的價值前，人類活動可能就已經破壞其棲息地，甚至令它們滅絕。因此，探索海洋一方面令人感到興奮，另一方面亦提醒我們保育工作的迫切性。



Andy

For me, it is the fact that there are still many interactions between the ocean, the atmosphere and the land that we have yet to understand. I'm especially interested in physical oceanography. In my spare time, I use the Windy mobile app to observe changes in wind direction, waves and weather systems, and to see how they influence one another. Although we can now use computer models to predict changes in the ocean and atmosphere, the predictions are not fully accurate. There are many complex relationships yet to be studied. For example, how sea temperature affects the formation and intensity of typhoons, and how the movement of the ocean currents and atmospheric circulation gives rise to phenomena such as El Niño and La Niña. If we could grasp these changes more accurately, we could predict extreme weather further in advance and allow the government to take necessary measures. That is what makes ocean science both interesting and meaningful to me.

對我來說，那是海洋、大氣和陸地之間有待理解的相互作用。我對物理海洋學尤其感興趣，平時有空的時候，我會用 Windy 手機應用程式觀察風向、海浪和天氣系統的變化，看看它們如何互相影響。雖然我們已經可以利用電腦模型預測海洋和大氣變化，但預測並非完全準確，當中還有很多複雜關係值得研究，例如海水溫度如何影響颱風的形成和強度，以及洋流和大氣環流如何導致厄爾尼諾和拉尼娜等現象。如果我們能更準確地掌握這些變化，就有機會提早預測到極端天氣，讓政府及早採取應變措施。這正是我覺得海洋科學既有趣，又有意義的地方。

Are there any interesting fieldwork experiences or independent projects you can share with us?

有沒有一些有趣的考察經歷或項目可以與我們分享？



Cindy

In recent years, I've focused on exploring how interactive technology can spark students' interest in ocean science. Classes can be much more interesting than just having a teacher explaining things at the blackboard.

With the support of the University, we initiated a project called "Marine XR." After putting on a virtual reality (VR) headset, students can explore from the sea surface down to the deep sea through this "immersive" experience, appreciating different marine organisms and learning more about marine ecology and conservation issues through mini games.

Besides VR, we also worked with other universities to create a set of marine life trading cards that incorporate augmented reality (AR). Students simply scan a card with their phone, and then a three-dimensional marine animal pops up along with information on its habitat, conservation status and other relevant information.

The advantage of VR is its strong sense of immersion: It feels as though you're really beneath the sea, especially valuable for students who can't swim or are afraid of water. However, in a large class that involves several hundred students, it's difficult to provide enough VR equipment for everyone, so we use the cards to reach a wider audience. In the future, we also hope to integrate artificial intelligence and add multilingual support to the system. Perhaps also introducing interactions between organisms in the game, making the learning of ocean science more vivid and engaging.

近年我專注研究如何利用互動科技提升學生對海洋科學的興趣。相比只由老師站在黑板前講解，我相信課堂可以變得更有意思。

在大學鼎力支持下，我們開展了名為「Marine XR」的計劃。戴上虛擬實境裝置後，學生可以透過「沉浸式」體驗，從海洋表面探索到海底，觀察不同海洋生物，並透過小遊戲認識更多海洋生態和保育議題。

除了虛擬實境之外，我們亦與其他大學合作，設計了一套結合擴增實境的海洋生物卡牌。學生只要用手機掃描卡牌，畫面便會出現立體的海洋生物，以及其棲息地、保育狀況與其他相關資料。

虛擬實境的優點是沉浸感強，讓人宛如置身海底一樣，對於不諳泳術或怕水的學生特別有用。然而，在有數百名學生的大型課堂裡，要為每個人準備穿戴裝置並不可行，因此我們選用卡牌讓更多學生參與其中。未來，我們希望把人工智能和多國語言加入系統，或許還可以在遊戲中加入生物之間的互動，令學習海洋科學更生動吸引。

Do you have any advice for high school students thinking of studying ocean science?

你有甚麼建議給予考慮修讀海洋科學的高中生？



Cindy

I would advise secondary school students to stay curious, keep an open mind, and not limit their future to a few traditional careers too early. Ocean science is an interdisciplinary subject, so interested students should keep up their foundations in the sciences, particularly physics, chemistry and biology, while knowledge of geography also helps. Students can also put their interests into practice, for example by volunteering for environmental conservation, joining nature tours, taking part in ecology day camps and doing internships. Those who can swim may also consider learning how to dive. Only by trying it out can you discover whether you enjoy working outdoors, in a laboratory, or at sea for long periods. The career paths open to ocean science graduates are very diverse: Besides Ocean Park, you can go on to further study, or work for environmental conservation organizations, schools, environmental education groups, the Hong Kong Observatory or consultancies, in areas such as fisheries, climate modeling, geographic information systems and environmental impact assessments. The most important thing is to understand your own personality and interests, and then to explore a direction that suits you through different opportunities.

我會建議中學生保持好奇心和開放態度，不要太早把自己的未來局限於少數傳統職業。海洋科學是一門跨學科的科目，因此有興趣的同學應打好科學基礎，尤其是物理、化學和生物，而地理方面的知識亦有幫助。學生亦可以把興趣付諸實踐，例如參與環境保育義工、自然導賞團、生態日營及實習。如果懂得游泳，可以考慮學習潛水。只有親身嘗試過，才會知道自己是否喜歡在戶外、實驗室，或海上長時間工作。海洋科學畢業生的出路十分多元，除了進入海洋公園工作之外，也可以繼續深造，或加入環境保育機構、學校、環境教育團體、香港天文台或顧問公司，從事漁業、氣候模型、地理資訊系統 (GIS)、環境影響評估等不同範疇的工作。最重要的是要先了解自己的個性和興趣，再透過不同機會探索適合自己的方向。



Harun

When choosing what to study, many students and parents first consider career prospects, and some even assume that studying ocean science only leads to working for Ocean Park. In fact, ocean science deals with issues such as climate change, coastal protection, land reclamation, wave erosion, extreme weather and urban development. These fields will need professionals in the years ahead. My advice is to start from your own interests. If you love the ocean, geography, nature and animals, ocean science will suit you very well. You can go out to see whether you enjoy outdoor activities. Another benchmark is whether you have great empathy for the environment. If you feel heartbroken when you see the environment being damaged and have the urge to make the world a better place, you should join us!

在選擇大學學科時，很多學生和家長都會首先考慮就業前景；有些人甚至以為，修讀海洋科學後就只能到海洋公園工作。其實海洋科學涉及的範疇十分廣泛，包括氣候變化、海岸保護、填海、海浪侵蝕、極端天氣及城市發展等，這些領域未來都需要專業人才。我建議選科時先從自己興趣出發，如果你喜歡海洋、地理、大自然和動物，海洋科學將會是適合你的選擇。你可以外出走走，看看自己是否真的享受戶外活動。另一個可以考慮的因素，是你是否對環境抱有強烈的同理心：如果你看到環境受破壞時會感到難過，同時又想令世界變成更美好的地方，那就應該加入我們！

Harun

My final-year research project investigated the number and distribution of horseshoe crabs on a mudflat on Lantau. There are only four species of horseshoe crab in the world today, two of which can be found in Hong Kong. My study site was one of the few places where both species occur on the same mudflat. During one peak-season survey, I found around 40 juvenile horseshoe crabs, which was an encouraging number. However, the site is not a protected area, and activities such as digging for oysters and clams damage the seagrass beds and the habitat of juvenile horseshoe crabs. This research drove home to me that even when we know a species is already under threat, the actual conservation measures may still be insufficient.

Another experience that left a deep impression on me was volunteering with a sea turtle conservation project in Malaysia. Because Hong Kong does have records of sea turtles appearing and laying eggs, there are relatively few opportunities for the public to take part in such conservation work. Many people therefore may not understand how sea turtles lay eggs, how the eggs hatch, and the survival threats the turtles currently face. I hope in the future Hong Kong can offer more opportunities like this, so that people can learn through practical experiences and become willing to take real action to protect marine ecosystems.

我的畢業研究是調查大嶼山一片泥灘上馬蹄蟹的數量和分佈。現時全球只剩四種馬蹄蟹，其中兩種可以在香港找到，而我的研究地點正是少數能在同一片泥灘找到這兩個品種的地方。在一次繁殖旺季的考察中，我找到大約 40 隻年幼馬蹄蟹，數目令人鼓舞。不過那裡並非受保護地區，眼見一些挖螺、蜆等活動，它們會破壞海草床，以及年幼馬蹄蟹的棲息環境。這次研究讓我深深體會到，即使我們知道某些物種正面臨威脅，但實際保育措施可能仍然不足。

另一段令我印象深刻的經歷，是到馬來西亞參與海龜保育的義工工作。香港其實也有海龜出沒，甚至有上岸產卵的紀錄，但一般市民能親身參與這類保育工作的機會相對較少，因此很多人可能不太了解海龜如何產卵，龜蛋如何孵化，以及海龜目前正面對的生存威脅。我希望將來香港能提供更多這類機會，讓大眾透過親身體驗認識更多，從而願意付諸行動去保護海洋生態。

Visit the following webpage to read the Complete interview!

瀏覽以下網頁以閱讀完整專訪！

