生物策略表

類別	生物策略 (Strategy)
生物策略 STRATEGY	兩種鳥蛋的色素驅動寄生軍備競賽 (Two Egg Pigments Drive Parasite Arms Race)
生物系統 LIVING SYSTEM	鳥類 (Birds)
功能類別 FUNCTIONS	#保護動物 #Protect From Animals #修改光及顏色 #Modify Light/Color #共同進化 #Coevolve
作用機制標題	鳥類使用兩種顏色的無限組合來模仿其他物種的卵，或將自己的卵與入侵者區分開來。 (Birds use infinite combinations of just two colors to mimic other species' eggs or to distinguish their own eggs from invaders.)
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)

在許多文化中，蛋象徵著生命、更新和重生。因此，裝飾蛋是人類最古老的藝術形式之一，至少可以追溯到 60,000 年前，這並不奇怪。

在自然界的其他地方，一些鳥類的蛋色和圖案已經經歷更長時間的適應，達到了數千萬年的規模——不是為了藝術，而是為了生存。 這些鳥類正處於一種“巢寄生”之間的拉鋸戰，它們將卵潛入其他物種的巢穴，而“宿主”可能會被愚弄來飼養外來雛鳥。

只有大約百分之一的鳥類是巢寄生。然而，這種特性在鳥類中至少演化了七次，表明它具有明顯的優勢。巢寄生減輕了父母的責任，節省了築巢、孵化雞蛋和飼養雛鳥所需的能量——它們的宿主必須消耗能量。一些巢寄生鳥類，如牛鸝屬 (brown cowbird)，是通吃者 (generalist)。通吃者們沒有採用“詭計”來掩飾它們的卵，而是將它們存放在許多不同物種的巢穴中，試圖最大限度地增加它們遇到無法檢測到外來卵的宿主物種的機會。

另一方面，一些巢寄生鳥類與特定的宿主物種共同演化。普林斯頓大學感官生態學、演化和行為學助理教授 Mary Caswell Stoddard 博士將這種共同進化的競爭描述為“軍備競賽 (arms race)”，其中顏色通常是首選武器。

有些演化出羽毛或其他特徵，導致孵化的雛鳥與宿主相似。其他則模仿宿主蛋的顏色，使用所有鳥類用來染色蛋殼的兩種色素——藍綠色的膽綠素 (biliverdin) 和銹褐色的原卟啉 IX (protoporphyn IX)。但是宿主可以通過演化的對策進行反擊。

Stoddard 說，這些色彩策略發展緩慢。“通常我們談論的是數百年或數千年。這些都是長期的過程，”她說。但最近的研究指出一些物種可能能夠更快地適應，在大約 50 年內改變顏色。

In many cultures, eggs symbolize life, renewal, and rebirth. So, it's not surprising that decorating eggs is one of the oldest forms of human art, dating back at least 60,000 years.

In the rest of nature, egg colors and patterns of some birds have been adapting for far longer, on the scale of tens of millions of years—not for the sake of art, but for survival. These bird species are in a kind of tug-of-war between "brood parasites" that sneak their eggs into other species' nests and "hosts" that may be fooled into raising the foreign chicks.

Only about one percent of bird species are brood parasites. However, this trait has evolved at least seven times in birds, demonstrating it has clear advantages. Brood parasitism offloads parental duties, conserving the energy needed to build nests, hatch eggs, and raise fledglings—energy their hosts must expend instead. Some brood parasites, like the brown cowbird, are generalists. Rather than engaging in "trickery" to disguise their eggs, generalists deposit them in the nests of many different species, attempting to maximize the chance they'll encounter a host species that can't detect foreign eggs.

On the other hand, some brood parasites coevolve with a specific host species. Dr. Mary Caswell Stoddard, assistant professor of sensory ecology, evolution, and behavior at Princeton University, describes this coevolutionary competition as an "arms race," where color is often the weapon of choice.

Some evolve plumage or other traits that cause hatched fledglings to resemble their hosts. Others mimic host egg colors, wielding the same two pigments that all birds use to dye their eggshells—biliverdin, which is blue-green, and protoporphyn IX, which is rusty brown. But the hosts can fight back with evolutionary countermeasures.

Stoddard says that these tint tactics evolve slowly. "Often we're talking hundreds or thousands of years. These are long-timescale processes," she said. But recent research indicates some species may be able to adapt more rapidly, changing colors within about 50 years.

文獻引用 (REFERENCES)

“這個系統的共同演化動力學寫在卵上：首先宿主進化出卵子排斥，然後巢寄生鳥類演化出擬態，然後宿主演化出多態性/簽名，然後巢寄生鳥類通過使自己的卵多樣化來偽造這些簽名。 在普里尼亞杜鵑鳥系統中，一些宿主似乎正在贏得這場軍備競賽，最近產生了一種綠色的卵，巢寄生鳥類尚未演化出與之匹配的卵形。”

“The coevolutionary dynamics of this system are written on the eggs: first hosts evolve egg rejection, then parasites evolve mimicry, then hosts evolve polymorphisms/signatures, then parasites forge those signatures by diversifying their own eggs. In the prinia-cuckoo finch system, some hosts appear to be winning this arms race, having recently produced a green egg colour to which the parasites have not yet evolved a matching egg morph.”

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

Colour, vision and coevolution in avianbrood parasitism

Philosophical Transactions of the Royal Society B | Mary Caswell Stoddard and Mark E. Hauber
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