生物策略表

類別	生物策略 (Strategy)
生物策略 STRATEGY	種皮及酵素保護種子 (Seed coat and enzymes protect seed)
生物系統 LIVING SYSTEM	荷花 *Nelumbo nucifera* (Sacred lotus)
功能類別 FUNCTIONS	#應付機械磨損 #保護免受過多液體危害 #保護免受真菌危害 #保護免受氣體危害 #保護免受光危害 #保護免受溫度危害 #Manage mechanical wear #Protect from excess liquids #Protect from fungi #Protect from gases #Protect from light #Protect from temperature
作用機制標題	荷花的種子透過堅硬的種皮及修復酶可存活達數千年 (Seeds of lotus remain viable for thousands of years via hard seed coat and repair enzymes.)
生物系統/作用機制示意圖	

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

文獻引用 (REFERENCES)

「在西方國家，鮮少人知道荷花 (*Nelumbo nucifera*)。然而，荷花在遠東的亞洲被當成農作物栽培已經有超過三千年，在那裡它們被使用作食物、藥物，並在宗教及文化活動中佔有重要地位。擁有世界上最長種子壽命（1300 年）的紀錄就是來自中國遼寧省西堡子 (Xipaozi) 的蓮蓬（中國古物）。採自西堡子的 200-500 歲蓮蓬（碳-14 定年法，14C dates）的五個後代最近已發芽，成為了第一例從直接定年 (directly dated) 的果實中培育出幼苗的案例。西堡子的蓮蓬保存於乾涸的古代湖底之中，已經曝露在低劑量的 γ 射線（γ-radiation）中長達數百年（土壤累積輻射 0.1-1.0 Gy）。從古代蓮蓬中長出的後代出現變異 (abnormalties)，與被較高劑量照射過的各種現代幼苗相似。雖然這些荷花幼苗在外表型出現變異，但證據表明累積劑量 (accumulated dose) 在 3 Gy 內的古代種子活性並不會受到影響。這些蓮蓬的荷花後代，亦即是有史以來最長期的放射生物學 (radiobiological) 實驗的產物，其第一及第二年的生長特徵在這裡概括描述（快速的早期生長、外表型異常、缺乏活力、地下莖發育不良，以及在第二年生長中有低光合作用活性）。這些荷花的染色體組織情況、外表型及生理（從逆境中迅速恢復、熱穩定蛋白、蛋白質修復酶）的層面也被討論。尚未解決的重要問題亦有可能引起種子科學界的成員對於最近在西堡子採集到的古

代種子的研究興趣，尤其是在老化 (ageing) 及修復 (repair) 的層面。」(Shen-Miller 2002: 131)

「Shen-Miller 說：『荷花的秘密可能就是它的種皮 (seed coat)。種皮非常堅硬，被製造來防止水分及空氣進入並破壞種子。』。荷花亦受到一系列強大的修復酶所保護，例如異天門冬胺酸甲基轉移酶 (L-isoaspartyl methyltransferase) 以及其它的蛋白質，能減輕種子受到的傷害、抵抗真菌侵襲，以及幫助種子在嚴苛的溫度下存活。Shen-Miller 說：『荷花是科學上的寶藏。」，這種花能夠透過修復老化的分子損害來揭示可提升生活質量 (quality of life) 的生物化學特性。」(Brown 2001: 1884-1885)

"In the West, lotus (*Nelumbo nucifera* Gaertn.) is relatively little known. However, for more than 3000 years, lotus plants have been cultivated as a crop in Far-East Asia, where they are used for food, medicine and play a significant role in religious and cultural activities. Holder of the world's record for long-term seed viability (1300 years) is a lotus fruit (China Antique) from Xipaozi, Liaoning Province, China. Five offspring of this variety, from 200-500-year-old fruits (14C dates) collected at Xipaozi, have recently been germinated, and are the first such seedlings to be raised from directly dated fruits. The fruits at Xipaozi, preserved in a dry ancient lakebed, have been exposed to low-dose γ-radiation for hundreds of years (having an accumulated soil irradiation of 0.1-1.0 Gy). Offspring from these old fruits show abnormalities that resemble those in various modern seedlings irradiated at much higher doses. Although these lotus offspring are phenotypically abnormal, the viability of old seeds was evidently not affected by accumulated doses of up to 3 Gy. Growth characteristics of first- and second-year lotus offspring of these fruits, products of the longest-term radiobiological experiment on record, are summarized here (rapid early growth, phenotypic abnormalities, lack of vigour, poor rhizome development and low photosynthetic activity during second-year growth). Aspects of their chromosomal organization, phenotype and physiology (rapid recovery from stress, heat-stable proteins, protein-repair enzyme) are discussed. Important unsolved problems are suggested to elicit interest among members of the seed science community to the study of old fruits recently collected at Xipaozi, with particular emphasis on aspects of ageing and repair." (Shen-Miller 2002: 131)

"The secret of the sacred lotus may be its seed coat,' says Shen-Miller. 'The coat is very hard, built to prevent water and air from entering and degrading the seed.' The sacred lotus is also blessed with a hardy collection of repair enzymes, such as L-isoaspartyl methyltransferase and other proteins that minimize seed damage, resist attacks by fungi, and help the seed survive harsh temperatures. 'The lotus is a scientific treasure,' remarks Shen-Miller, adding that the flower could reveal biochemical traits that boost quality of life by repairing the molecular damage of aging." (Brown 2001: 1884-1885)

參考文獻清單與連結 (REFERENCE LIST)

Shen-Miller, J. (2003). Sacred lotus, the long-living fruits of China antique. *Seed Science Research* 12: 131-143. (https://doi.org/10.1079/SSR2002112)

Brown, K. (2001). Patience yields secrets of seed longevity. *Science* 291: 1884-1885. (https://science.sciencemag.org/content/291/5510/1884)

延伸閱讀

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

https://en.wikipedia.org/wiki/nelumbo_nucifera
https://www.onezoom.org/life/@nelumbo_nucifera
https://eol.org/pages/596454

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AskNature 原文連結

https://asknature.org/strategy/seed-coat-and-enzymes-protect-seed/