生物策略表

類別	**生物策略** (Strategy)
生物策略 STRATEGY	**葉片去除污染物** (Leaves remove pollution)
生物系統 LIVING SYSTEM	**落葉喬木** (Deciduous trees)
功能類別 FUNCTIONS	#獲取、吸收、或過濾化學物質 #獲取、吸收、或過濾氣體 #Capture, absorb, or filter chemical entities #Capture, absorb, or filter gases
作用機制標題	**樹葉從大氣吸收污染物並使用酵素將其分解** (Tree leaves take in pollutants from the atmosphere and use enzymes to break them down)
生物系統/作用機制示意圖	

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

當我們開車的時候會燃燒汽油產生空氣汙染，例如揮發性有機化合物 (volatile organic compounds, VOCs)。在大氣中，VOCs會和氧氣形成氧化揮發性有機化合物 (oxygenated VOCs, oVOCs)。oVOCs能以各種形式造成危害。例如它們可能轉變成懸浮微粒(aerosols)。這些微小粒子能影響陽光通過大氣層，進而對氣候造成負面影響。當人們吸入懸浮微粒時，引致嚴重的呼吸道問題 (respiratory problem)，像是氣喘 (asthma) 和肺氣腫 (emphysema)。部分oVOCs會與空氣中其它化學物結合產生各種汙染物，例如臭氧 (ozone)。當臭氧存於地表層空氣時，將會是有害毒物。但幸運的是，樹葉能夠從空氣中攝入oVOCs並將其分解，使它們的有害程度減弱。

樹木透過開闔葉片背面的孔洞來控制氣體進入，這些孔洞稱為氣孔 (stomata)。在吸入oVOCs之後，植物會立即開始製造一種能分解污染物的酵素，使其變得對植物有用而不會有毒性。事實證明如果臭氧也同時存在，樹木甚至能攝取並分解更多的oVOCs。這表示隨著大氣中有害的oVOCs及其它污染物增加，樹木會產生更多酵素來更快地去除它們。但是，樹木這種跟上 (keep pace) 有害的oVOCs增加以增加酵素的特性也有極限，就是在樹木到達其最大攝取量 (maximum uptake) 之後。

藉由這種機制，樹木可將有害的化學物轉變成對自己有用的物質。毒素不會在植物體中累積，因為植物會隨著污染物增加時產生更多酵素，而酵素只會在被需要時才會產生。

When we drive our cars we burn gasoline these produces air pollution such as volatile organic compounds, or VOC's. In the atmosphere, VOC's combine with oxygen to form oVOC's. oVOC's can cause damage in many ways. For example, they can turn into aerosols. These tiny particles can affect how sunlight gets through the atmosphere, which negatively impacts the climate. Aerosols can also cause serious respiratory problems such as asthma and emphysema when people breathe them in. Some oVOC's combine with other chemicals in the air to create different pollutants, such as ozone. When ozone is in the air at ground level, it can be a harmful toxin. Luckily, though, tree leaves are able to take up oVOC's from the atmosphere and break them down so they are less harmful.

Trees control how gases enter their leaves by opening and closing pores on the underside of their leaves, called stomata. After trees take up an oVOC, they quickly start producing an enzyme that breaks down the pollutant so that it can be useful, and not toxic, for the plant. It turns out that if ozone is also present, trees will uptake and break down even more oVOC's. This means that as the harmful oVOC's and other pollutants in the atmosphere increase, trees respond by producing more enzymes to remove them even faster. However, there is a limit to how much the trees can keep pace, and at some point trees reach their maximum uptake.

Using this system, trees can turn harmful chemicals into useful ones. The toxins do not build up in the plant because the plant produces more enzymes as pollution levels rise, and the enzymes are produced only when they are needed.

文獻引用 (REFERENCES)

「在這篇報導中，為了要研究植被 (vegetation) 對於氧化VOCs沉積作用 (deposition) 的影響，我們結合了實地觀察 (field observation) 與實驗室中的實驗和運輸模型 (transport modeling)。oVOCs代表了地球氧化性大氣 (oxidizing atmosphere) 中最大量的的有機碳化合物類別，深深地影響著地球的大氣物質組成。」(Karl 2010: 817)

「實地觀察顯示，植物透過固有的 (constitutive) 和誘導的(induced) 解毒機制 (detoxification mechanism) 而有效率地代謝oVOCs。因為非甲烷揮發性有機化合物 (nonmethane volatile organic compounds, NMVOCs) 進行大氣性光氧化作用 (atmospheric photooxidation) 的一般路徑會形成羰基 (carbonyl) 或羥羰基 (hydroxycarbonyl) 類化合物，這些發現對oVOCs的大氣演化 (atmospheric evolution) 有更多了解。」(Karl 2010: 818)

「落葉喬木 (deciduous tree) 的葉片，例如楓樹 (maple) 、楊樹 (aspen) 和白楊 (poplar)，吸收了比我們想像中還多的大氣污染物。這項研究涉及大氣中最豐富的一類碳基 (carbon-based) 粒子，也就是所謂的VOCs。[VOCs] 的主要來源來自汽車排氣(automobile

exhaust)、燃燒煤炭，以及其它的人類活動。一些大氣VOCs與氧氣結合而形成微小的空氣傳播粒子 (airborne particles)，又稱為oVOCs，這會阻隔大氣並導致暖化 (warming) 。[科學家]決定重新檢視落葉性植物如何與oVOCs產生相互作用 (interaction)，曝露在oVOCs中的植物增加了對這些化合物的攝取量，比原本預期還多了40%吸收量。」(Berkowitz 2010: 1)

"In this report, we combine field observations with laboratory experiments and transport modeling in order to investigate the influence of vegetation on the deposition of oxygenated VOCs [volatile organic compounds]. oVOCs represent the most abundant class of organic carbon and profoundly affect the chemical composition in Earth's oxidizing atmosphere." (Karl 2010: 817)

"The presented laboratory and field observations show that oVOCs can be efficiently metabolized by plants through constitutive and induced detoxification mechanisms. Because the general route of atmospheric photooxidation of NMVOCs goes through the formation of carbonyls and hydroxycarbonyls, these findings have consequences for understanding the atmospheric evolution of these oVOCs." (Karl 2010: 818)

"Deciduous tree leaves, such as those from the maple, aspen, and poplar, suck up far more atmospheric pollutants than previously thought. The study concerns the most abundant class of carbon-based particles in the atmosphere, so-called volatile organic compounds (VOCs)… a major source [of VOCs] comes from automobile exhaust, coal burning, and other human activities. Some atmospheric VOCs combine with oxygen to form tiny airborne particles called oxygenated VOCs (oVOCs), which insulate the atmosphere and lead to warming…[Scientists] decided to re-examine how deciduous plants interacted with oVOCs…Plants exposed to oVOCs increased their normal uptake of the compounds, absorbing 40% more than expected." (Berkowitz 2010: 1)

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

Karl, T., P. Harley, L. Emmons, B. Thornton, A. Guenther, C. Basu, A. Turnipseed, and K. Jardine. (2010). Efficient atmospheric cleansing of oxidized organic trace gases by vegetation. Science 330: 816-819. (http://science.sciencemag.org/content/330/6005/816)

Berkowitz, R. (21 October, 2010). Tree leaves fight pollution. Science Magazine News. Retrieved from: https://www.sciencemag.org/news/2010/10/tree-leaves-fight-pollution

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

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撰寫/翻譯/編修者與日期
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