

# Immediate Awareness and Effective Response to Climate Warming 及早發現與有效因應氣候暖化

去年(2007)2月出爐的馬政府氣候變遷小組之報告，從大空間的概念考慮長時間的環境變遷議題。該報告指出，科學結論已有9成的把握認為全球暖化已是事實。全球生命之未來已籠罩在氣候暖化的陰影下。這個智明的重大意涵是：「即使任何國家之生態管理毫無瑕疵，還是不能保證不受全球環境變遷帶來的負面衝擊。」因此，地球上任何地區的生態管理，必須納入氣候變遷之因應策略，尤其是靠近極地、寒溫帶、低地的近海等地區，或具有季節性寒冷氣候之山區，必須及早因應全球暖化之效應。

台灣的國家公園中有許多地區分布在海拔3000公尺以上，冬季常有降雪的機會，連低海拔的陽明山也偶有冬雪，所以那裡的生物長期以來對寒冬的環境已有若干適應能力，也就是說凍寒也是該處生物的棲息地環境特質。植物的生理現象及生長發育(長根、抽芽、展葉、開花、結實、種子發芽、小苗成活等等)與季節性的氣象及水文的關係密切，同時與棲息地內的動物之互動關係(如授粉、種子播遷、有機物分解作用)也密不可分。例如太魯閣國家公園境內的南湖大山，因為地處偏遠與環境孤立，高山特有種植物比例極高，且適應每年的冬季積雪環境，我們關心的是全球日趨暖化是否會衝擊它們？

In February 2007, the Intergovernmental Panel on Climate Change published a report that considered issues of long-term environmental change from a broad spatial concept. The report pointed out that scientific results have most likely confirmed global warming as a fact. Life on the planet is exposed to the threat of climate warming. The statement is significant in that, "even sound ecological management by any country will not guarantee protection against the negative impacts brought by global environmental changes." Therefore, ecological management executed in any area on this planet must incorporate response strategies to climate changes. Management strategies in areas near the Arctic and in cold temperate and low-lying coastal zones, or mountain areas of seasonal coldness should be immediately responded to effects of global warming.

Many areas in Taiwan's national parks are above 3,000m in elevation. In the winter these areas often have snow, and even Yangmingshan at a lower elevation of 1,000m would occasional see snow. Organisms in these areas have long evolved adaptation to cold winters, meaning freezing coldness is a characteristic of the environment in which these organisms inhabit. The physiology and growth development (such as rooting, budding, leafing, flowering, fruiting, seeding, and seedling survival) of plants are closely tied to seasonal climate and hydrology, as well as interactive relationships (such as pollination, seed dispersal, organic matter decomposition) with animals in their habitat. For instance, Nan-hu Mountain in Taipko National Park has many high mountain endemic species due to its remote location and isolated environment, and these species are adapted to the snow that accumulates there every winter. We are concerned about the impact they face brought about by the recent warming climate around the globe.

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如果過去長期的環境條件因為最近人類活動造成氣候之物理與化學性質（如氣溫、降水分布與雨水化學等）劇烈改變，植物之生長的生理與發育能否適應及抗病蟲害的免疫力能否維持，與其他生物的原有互動關係是否會有丕變，這些生態關係因氣候變遷而使得生命充滿了許多不穩定性的未來。

許多研究指出，某些冷溫帶地區有每年提早暖化的現象，造成植物可能提早抽芽及開花。此時授粉動物（如蜂、蝶、蛾等昆蟲）若未能提早展開活動，則會衝擊開花植物的繁殖行為及種子的活力。依食物網的緊密關係，植物的物候尤其會影響各階的消費性動物。

食物網是一個相當複雜的關係，影響生態系的整體運作。因為各植物對天氣變化有不同的反應，此可能擾亂植物與動物間原有的長久關係，進而影響整個生態系的健康與穩定。即使植物與動物能因氣溫上升而往較高海拔或較高緯度遷移，但是該處之土壤與水的條件不一定能配合這些新移民，是則它們依然可能無法一起遷往新生育地並在該處立足。

國家公園的管理，必須更前瞻評估未來「全球暖化」可能對公園內的生命之各種潛在之威脅，因而要有「及早發現與有效因應氣候暖化」的想法與做法。☉

Long-term environmental conditions have drastically altered due to changes in physical and chemical climatic factors (such as temperature, pattern and chemistry of precipitation, etc.) from recent human activities. Can physiology and growth development of plants adapt to the environmental changes, and can they maintain their resilience against potential outbreaks of diseases and insects? Will their interaction with other organisms change? Due to climatic changes, these ecological relationships are facing an uncertain future.

Many researches indicate that budding and flowering occur earlier than long-term phenomena when the warm season arrives earlier each year. If pollinators (such as bees, butterflies, moths and others) are not active early, the reproduction behavior and seed vitality of flowering plants would be affected. As a food chain is intricately linked, changes in phenology of plants would especially have a greater effect on consumers in different levels.

A food chain is a highly complicated network that can be affected by the overall ecological functions of an ecosystem. Since each plant reacts to climate warming differently, the existing relationship between plants and animals would certainly be disrupted and further affect the health and stability of the entire ecosystem. Even if plants and animals can migrate to higher elevation or altitude to avoid the escalating temperature, the soil and hydrological conditions in new habitats might not necessarily accommodate these migrants. In the end these species would still be unable to establish in the new habitat.

National park management must be more forward-looking and include assessment of various potential threats brought onto organisms in the park by global warming. This demands ideas and actions of immediate awareness and effective response to climate warming. ☉