高中生物科野外考察課程
Senior Secondary Biology Field Study Course

窺探看不見的生物世界
Looking into the Invisible Biological World

姓名Name _____ 組別 Group _____ 日期 Date: _____

學習目標 Learning goals:

完成課程後，學生應能 After the course, students should be able to:

1. 有效操作儀器進行觀察 Effectively operate equipment to do observation ;
2. 進行詳細的生態觀察 Conduct detailed ecological observation;
3. 以多個方式記錄生物現象 Use multiple methods to record biological phenomena;
4. 解釋生物與生物之間的關係 Explain relations between living organisms;
5. 解釋生物與環境之間的關係 Explain relations between living organisms and the physical environment;
6. 與他人合作進行考察 和資料整理工作 Cooperate with others to do field investigation and data processing;
7. 製作簡單科學報告 Make simple scientific report;
8. 欣賞大自然之美和尊重生物 Appreciate the wonder of nature and respect living things.

程序 Schedule

9:15 - 09:45	簡介 Briefing
09:45 - 12:00	考察 Field work
12:00 - 13:00	午膳 Lunch
13:00 - 15:30	實驗、資料整理 Lab. work, data processing
15:30 - 16:15	分組匯報Group presentation
16:15 - 16:30	討論及總結 Discussion & summary

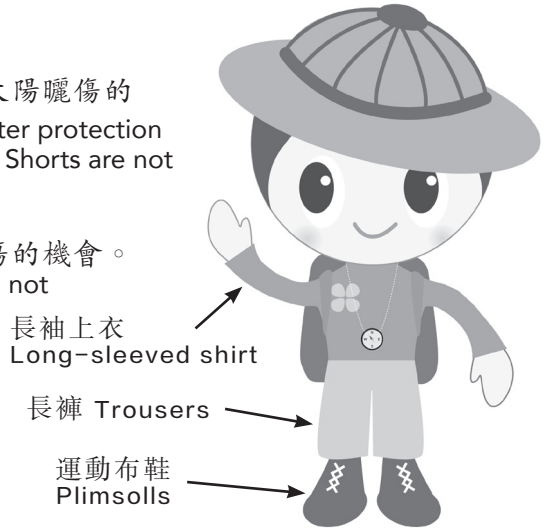
儀器和工具 Equipment and tools

1	平板電腦 Tablet computer	
2	熱成像攝影機Themal imaging camera	
3	解剖顯微鏡 Dissecting microscope	
4	WiFi 顯微鏡 WiFi microscope	
5	夾子微距鏡頭 Clamping macro lens	
6	超高速攝影機 Ultra high speed video recorder	
7	掃描式電子顯微鏡 Scanning Electron Microscope	

衣著 Clothing:

1. 穿著長袖上衣和長褲能更有效防止蚊蟲叮咬，亦可減低被太陽曬傷的機會，不應穿著短褲。 Long-sleeved shirt and trousers for better protection against mosquito and insect bites, as well as preventing sunburn. Shorts are not recommended.

2. 不應穿著拖鞋或涼鞋，而應穿著運動布鞋，以減低腳部受傷的機會。
A pair of plimsolls for preventing injuries. Slippers and sandals are not recommended.



安全 Safety:

1. 避免踏足陡斜和濕滑的岩石和泥土表面。
Avoid stepping on steep and wet rock surfaces and soil surfaces.

2. 切勿闖入植物生長茂密的地方，以免觸及蜂巢或被植物割傷。
To prevent being attacked by wasps from disturbed wasp nests or being injured by plant leaves and thorns, do not get into places with dense vegetation.

選擇下列一至兩個選項

Select one or two of the following six options

1. 生態系統內的溫度變化 Temperature variation within an ecosystem

選擇一個生境系統或生態系統的一部份，利用熱成像相機拍攝熱成像照片，以顯示生態系統內各種生物和非生物構成部份的溫度差異；同時用熱成像相機量度各目標生物和非物的確實溫度；用溫度計準確量度調查範圍的空氣溫度。

描述調查範圍的溫度差異並列舉可能的成因 ， 討論這些溫度差異的生物學和生態學意義。

Select an ecosystem, or part of an ecosystem, use the thermal imaging camera to take themal images showing temperature variation amongst different living and non-living components of the ecosystem. At the same time, measure the exact temperature of selected objects remotely using the same device. Use a thermometer to accurately measure the air temperature of the study area.

Describe the temperature variations and list out possible causes. Discuss the biological and ecological implications of the temperature variations.

2. 螞蟻與白楸的花外蜜腺 Ants and Panicled Mallotus extrafloral nectaries

揀選三株或更多不同的白楸，利用縮時攝影技術記錄螞蟻在花外蜜腺(位於葉的基部)上的活動。記錄每株白楸的特徵，包括大小、位置、生境等；記錄每片被調查的葉片的差異，包括大小、位置、成熟程度等。若時間許可，在肖梵天花上做同樣的研究。

描述白楸花外蜜腺上螞蟻的活動，與肖梵天花上的同樣活動作比較。討論這些活動可能的生態學意義。

Selected 3 or more different Panicled Mallotus plants, use time-lapse photography to record activities of the ants on the extrafloral nectaries located at the leaf base. Record the characteristics of each studied plant - size, location, habitat, etc.; and the variations of individual leaves studied - size, location, maturity, etc. If time permits, do the same study on Rose Mallow.

Describe the activities of ants on the extrafloral nectaries of Panicled Mallotus plants, compare with those on Rose Mallow plants. Discuss the possible ecological implications of such activities.

3. 葉的表皮變化 Variations of Leaf epidermis

從五種或更多的不同植物上，各取一片成熟的葉片。記錄每種植物的特徵和生長環境。利用解剖顯微鏡和電子顯微鏡在不同放大倍數下觀察和攝取影象紀錄。

描述和比較不同植物的葉的表皮結構，討論這些表皮結構變化的生態學意義。

Collect a mature leaf sample from each of the 5 or more different species of plant. Take notes of the characteristics and growing environment of each plant species. Observe and take images of the upper and lower epidermis of each sample under different magnifications, using dissecting microscope as well as scanning electron microscope.

Describe and compare the structure of the epidermis of the different plant species. Discuss the ecological implications of the various epidermal structures.

4. 蚜蟲與植物 Aphids and plants

在草穗(花序)、嫩葉、嫩枝、花蕾、花柄上找尋蚜蟲群體。研究兩種不同寄主植物上的蚜蟲群體，辨識寄主植物。進行實地觀察，並攝取影像紀錄，特別是顯示蚜蟲上的螞蟻活動(如有)的影像。輕柔地切除載有蚜蟲群體的植物結構，觀察並且攝取相片和影片，以顯示蚜蟲與寄主的關係。用解剖顯微鏡和電子顯微鏡觀察與蚜蟲身上與其取食方式和生存環境有關的結構。

描述蚜蟲與寄主植物的關係 ，與及蚜蟲與螞蟻的關係。 討論蚜蟲的身體結構與其取食方式和生存環境的關係 。

Look for aphids colonies on grass inflorescences (flower cluster), young leaves, young shoots, flower buds, flower stalks. Study aphid colonies on two different host plants. Identify the host plants. Do *in situ* observations and take pictorial records especially about ants' activities on the aphids (if any). Gently cut the plant structure with the aphids colony. Observe and take images and movies showing the relations between the aphids and the host. Use dissecting microscope and electron microscope to observe the aphid body structure related to its mode of feeding and its living environment.

Describe the relations of aphids and their host plants. Discuss how the body structure of aphid is related to its mode of feeding and its living environment.

5. 節肢動物的活動 Locomotion of arthropods

利用超高幀速攝錄(每秒960幀)，拍攝節肢動物的活動，例子包括：蜜蜂、胡蜂、蠅、蝴蝶、蜻蜓等昆蟲的拍翅；草蜢、蟋蟀、跳蛛、蟬等節肢動物的跳躍；千足、螞蟻、甲蟲等的快速走動。用正常幀速(25fps)播於影片並仔細分析。

描述(計量的和定性的)錄得的節肢動物的活動，討論對應的生物學和生態學意義。

Use ultra-high speed (960fps) videography, take records of arthropod's locomotion. Examples are wing flapping of bees, wasps, flies, butterflies, dragonflies, etc.; jumping of grasshoppers, crickets, jumping spiders, planthoppers, etc.; running of millipedes, ants, beetles, etc.. Playback the recorded videos at normal frame rate - 25fps and analyze carefully.

Describe the recorded arthopod locomotion qualitatively and quantitatively. Discuss respective biological and ecological implications.

6. 白花鬼針草與薊馬 Beggar-ticks and Thrips

收集幾朵白花鬼針草 (*Bidens alba*) 的花序，用解剖顯微鏡觀察每朵花序上薊馬的分佈和活動。拆解花序並收集每朵花序內的薊馬。分辨薊馬的不同生命史階段，並數算每個階段的個體數量。用掃描式電子顯微鏡觀察薊馬的微細結構。

描述薊馬與白花鬼草的關係。討論薊馬的的身體結構與其取食方式和生存環境的關係。

Collect several samples of mature inflorescences of Beggar-ticks (*Bidens alba*). Using dissecting microscope to observe the distribution and activity of the thrips on the each inflorescence. Dismantle each inflorescence and collect the thrips. Distinguish different development stages (egg, early instar nymph, final instar nymph and adult) and count the number of individuals of each stage. Observe fine structure of the thrips under scanning electron microscope.

Describe the relations of the thrips and the Beggar-ticks. Discuss how the body structure of thrip is related to its mode of feeding and its living environment.

7. 榕管薊馬 Leaf-gall thrips of Ficus

在細葉榕 (*Ficus microcarpa*) 找尋裝載薊馬的葉包，估計受感染的樹葉百份比。摘取一代表性的葉包樣本，小心打開葉包，用解剖顯微鏡觀察。分辨薊馬的不同生命史階段(卵、初齡若蟲、終齡若蟲、成蟲)，並數算每個階段的個體數量。用掃描式電子顯微鏡觀察薊馬的微細結構。

描述薊馬與鈿葉榕的關係。討論薊馬的身體結構與其取食方式和生存環境的關係。

On a Chinese Banyan (*Ficus microcarpa*), look for folded leaves containing thrips. Estimate percantage of infected leaves. Collect a representative sample of infected leaf. Carefully unfold the leaf. Study under dissecting microscope. Distinguish different development stages (egg, early instar nymph, final instar nymph and adult) and count the number of individuals of each stage. Observe fine structure of the thrips under scanning electron microscope.

Describe the relations of the leaf-gall thrips and the Chinese Banyan. Discuss how the body structure of thrip is related to its mode of feeding and its living environment.

8. 榕小蜂 Fig wasps

在一棵榕樹上，用相機拍攝停留在榕果表面的榕小蜂(如有)。收集幾棵成熟的榕果，小心地切開兩半，用解剖顯微鏡觀察。分辨雄性和雌性榕小蜂、幼蟲和不同種類的小蜂(有些是寄生於榕小蜂體內的寄生性小蜂)；數算各類別的個體數目。用掃描式電子顯微鏡觀察榕小蜂的微細結構。

描述榕小蜂與榕樹的關係。討論榕小蜂的身體結構與其取食方式和生存環境的關係。

On a fig tree, take photos for any fig wasp staying on the surface of figs. Collect a few samples of mature fig. Carefully cut the fig into 2 halves. Observe under dissecting microscope. Distinguish male and female fig wasps (both dead and alive), larvae (if any), and different types of wasps (some are small parasitic wasps which parasitize the fig wasps) and count the number of individuals of each category. Observe fine structure of the fig wasps under scanning electron microscope.

Describe the relations of the fig wasps and the fig tree. Discuss how the body structure of a fig wasp is related to its mode of feeding and its living environment.