Student Code: _____

22nd INTERNATIONAL BIOLOGY OLYMPIAD

July 10-17, 2011

Taipei, Taiwan

PRACTICAL TEST 3

ECOLOGY AND SYSTEMATICS

Total Points: 100

Duration: 90 minutes

Dear Participants,

- In this test, you have been given the following 2 tasks:
  Task I: Reconstruct the phylogenetic tree for the given spiders (60 points)
  Task II: Test of species association in a community (40 points)
- Check your **Student Code** on the **Answer Sheet** before starting the test.
- Write down your results and answers in the **Answer Sheet. Answers written in the Question Paper will not be evaluated.**
- Please make sure that you have received all the materials listed for each task. If any of the listed items is missing, please **raise your sign.**
- Use **pen only.** You can use a ruler and a calculator provided.
- **Check the condition of the spiders in the first 5 minutes.** If any of the legs is missing, please raise your **sign. No replacement of the spiders is possible after 5 minutes.**
- Stop answering and put down your pen **immediately** after the end bell rings.
- After test, our lab assistants will check the condition of the spiders and fill out the spider checklist at the end of your answer sheet. **Each undamaged spider in the original vial will get you one bonus point.** Please put down the Student Code after the check is done.
- Enclose both the **Answer Sheets** and **Question Paper** in the provided envelope after the spider check is finished. Our invigilator will collect it promptly.

Good Luck!!

親愛的參賽者：

- 在這個測驗中，你需要完成以下兩個任務：
  Task 1: 重建蜘蛛的親緣關係樹 (60 分)
  Task 2: 檢測一個物種群落中的物種伴生關係 (40 分)
- 作答前請檢查你的答案卷上的學生編碼是否正確
- 在 Answer Sheet 上寫下你的結果與答案。若將答案填寫在試卷上將不予計分
- 請確認你已獲得每個所列出的材料。若有任何材料遺漏**請舉牌**
- 不可用鉛筆作答，你可使用大會所提供的尺與計算機
- 請在五分鐘之內檢查所有蜘蛛標本的狀態，如果有任何蜘蛛的腳遺失，**請舉牌**。五分鐘之後若發現標本有任何問題將不再補發。
- 結束鈴響時請停止作答並把筆立刻放下
- 結束施測之後我們的實驗室助教會檢查所有蜘蛛標本的狀態並在你的答案卷末的表格中填入蜘蛛的清單。每有一隻沒有被破壞的蜘蛛標本就可以讓你多得一分。助教檢查完之後請填上學生編號。
- 助教檢查完你的蜘蛛標本狀態後，把答案券與試題裝在大會提供的信封中，然後我們的試場監試人員會立刻把它收走。

祝你幸運

Equipments and Materials:

Equipments:

1	Dissecting microscope	1
2	Four sheets of colored pictures and one sheet of black and white picture:	
	Figures (figure 1−3 to 1−12)	4
	Figure (figure 2-1)	1
3	Forceps	2
4	Petri dish	2
5	70% ethanol	1
6	Plastic dropper	1
7	1-m quadrat cardboard (represented by a small cardboard in the zip lock bag	1

Materials:

1	Four spider samples in glass vials (W, X, Y, Z)	1

工具與材料列表：

工具：

1. 解剖顯微鏡 x 1
2. 四張彩色圖片與一張黑白圖片
   Figures (Figures 1-3 to 1-12) x 4
   Figure (Figure 2-1) x 1
3. 鑷子 x 2
4. 培養皿 x 2
5. 70%酒精 x 1
6 塑膠滴管 x 1
7. 1-m 方格卡紙 x 1 (包在夾鍊袋中)

材料：

1. 四隻擺在玻璃管中的蜘蛛樣本(標記爲 W、X、Y、Z) x 1

TASK I: (60 points) 測驗一 (佔 60 分)

Reconstruct the phylogenetic tree for the given spiders

重建這些蜘蛛的親緣關係樹

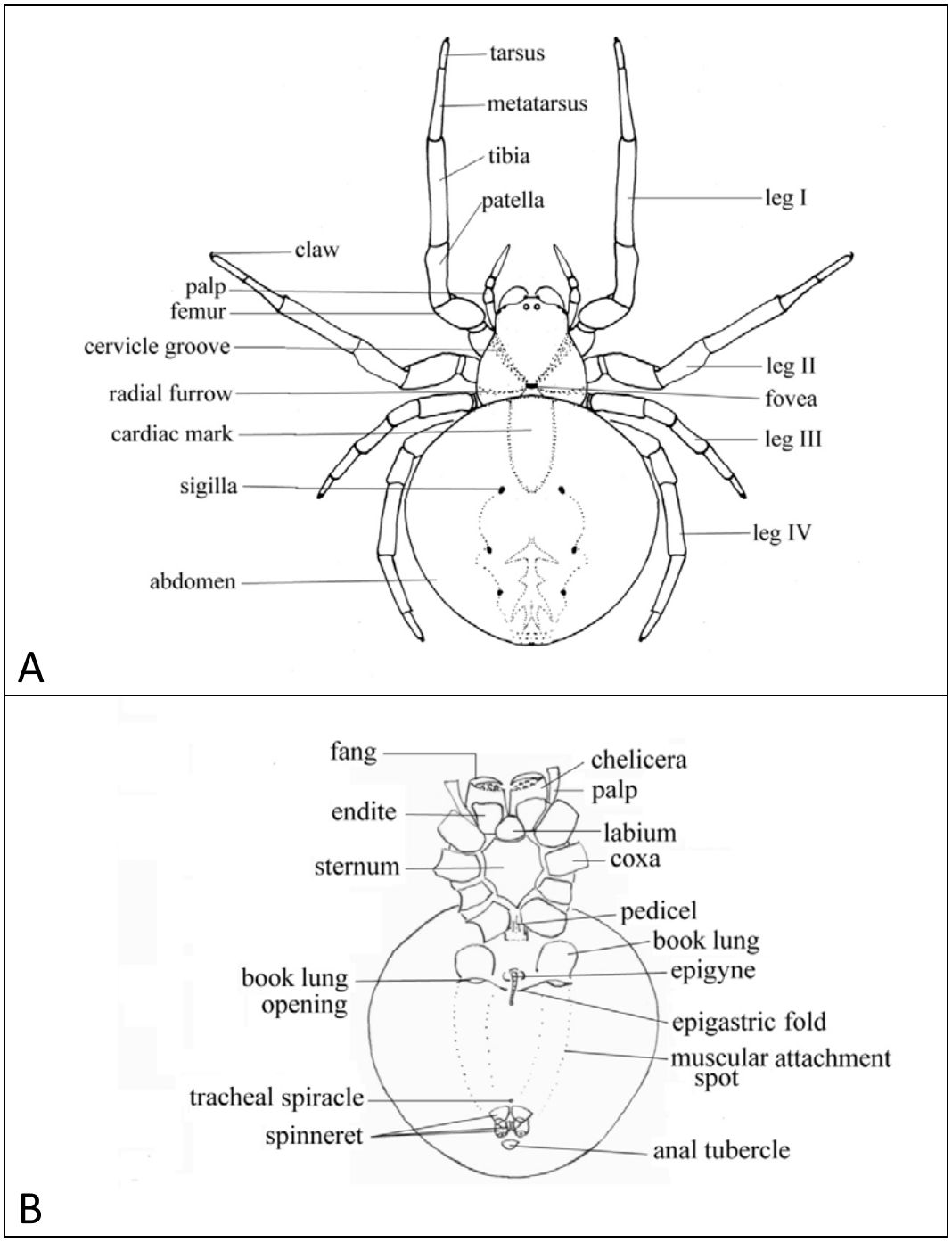


Figure 1-1 External morphology of spider. A. Dorsal view. B. Ventral view.
Figure 1-1 蜘蛛的外部形態 A. 背方觀 B. 腹面觀

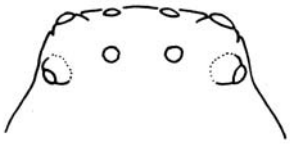
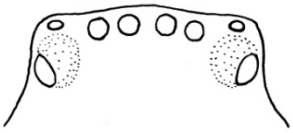
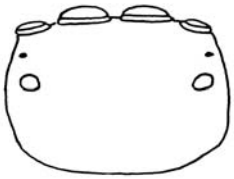
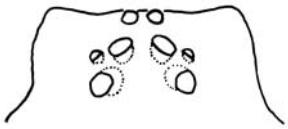
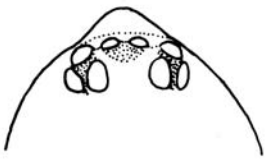
A: two transverse eye rows, with 4 eyes on each eye row 	B: two rows, with 6 eyes on the first eye row 	C: four rows, with 2 first row eyes smallest and 6 posterior eyes arranged in a hexagonal configuration 
D: three rows, with the 4 first row eyes much smaller than the others 	E: three rows, with the 2 anterior median eyes much larger than the others 	F: three rows, with 4 eyes on the second eye row 
G: eight eyes with one diad (a cluster of 2 eyes) and two triads (a cluster of 3 eyes) 	H: six eyes in two triads 	I: six eyes in three diads 

Figure 1-2 Eye arrangements (A key is provided on the following pages)

Figure 1-2 蜘蛛單眼的排列型式

A. 排列成兩排，一排有四個單眼

B. 排列成兩排，第一排有六個單眼

C. 排列成四排，第一排只有兩個最小的單眼，其它六個單眼圍成一個近似六角的型式

D. 排列成三排，前方四個單眼在尺吋上是最小的

E. 排列成三排，前面兩個中單眼最大

F. 排列成三排，第二排有四個單眼

G. 共有八個單眼，其中有一個”兩眼集合組”及兩個”三眼集合組”

H. 只有六個單眼然後有兩個”三眼集合組”

I. 有六個單眼然後有三個”兩眼集合組”

Legends and Abbreviations of figures 1-3 to 1-12

Figure 1-3 Book lungs. A. Two pairs. B. One pair.
Figure 1-4 Spinnerets. A. Three pairs. B. Two pairs.
Figure 1-5 Cribellum. A. Absent. B. Present.
Figure 1-6 Calamistrum on metatarsus IV. A. Absent. B. Present.
Figure 1-7 Tarsi claw. A. Three claws. B. Two claws.
Figure 1-8 Claw tufts. A. Absent. B. Present.
Figure 1-9 Base of anterior spinnerets (AS). A. Widely separated. B. Close or in contact.
Figure 1-10 Grades of legs. A. Prograde. B. Laterigrade.
Figure 1-11 Tibia and metatarsus of legs I and II with series of long spines interspersed with much shorter setae. A. Absent. B. Present.
Figure 1-12 Double-rowed trichobothria on femora IV. A. Absent. B. Present.

Figures 1-3 以及 1-12 的蜘蛛特徵狀態圖說與縮寫

Figure 1-3 書肺(book lung) A. 兩對 B. 一對
Figure 1-4 績絲器(spinnerets) A. 三對 B. 兩對
Figure 1-5 篩器，輔助績絲器官(Cribellum) A. 沒有 B. 有
Figure 1-6 第四後跗節(metatarsus)上的基節櫛狀構造(calamistrum) A. 沒有 B 有
Figure 1-7 爪(tarsi claw) A. 三個 B. 兩個
Figure 1-8 爪的毛束 A. 沒有 B. 有
Figure 1-9 前績絲器(AS)的基部 A. 遠遠地分離 B. 接近或連在一起
Figure 1-10 步足型式 A. 前行性(往前放) B 側性性(往兩側放)
Figure 1-11 第一對與第二對足的脛節(tibia)與後跗節有一系列的長刺，而這些長刺間雜有短剛毛 A. 沒有 B. 有
Figure 1-12 第四對步足腿節上是否有感覺毛簇(trichobothria) A. 沒有 B. 有

1-1 Key to species of some common spiders

There are many living creatures in the world. For unfamiliar creatures, scientists usually choose a suitable key, the most commonly used tool, to find out its name. A key uses the dichotomous statements (a or b) of diagnosed characters to divide a larger group of taxa into two smaller subgroups (indicated by numbers or taxon names). Beginning with the number 1, choose a more likely statement (a or b) for the specimen and then go to the number shown at the end of the statement, and so on. Go through the key, until a taxon name is shown. A key for some common spiders of the world is given below.

1-1 一些常見蜘蛛的檢索表

世界上有很多各式各樣的生物，對於不熟悉的生物，生物學家通常會選擇一些合適的檢索表，試著找到這些生物的名稱。所謂二叉式檢索表(非 a 即 b)也就是使用一些鑑識特徵把生物一步一步地分成不同類群。在以下的檢索表中，請由 1 開始，選擇你認爲你在標本上所看到的特徵狀態(a 或 b)，然後依次檢索直到物種的學名被鑑定出來。以下是一些全球常見蜘蛛的檢索表。

Key to species of some common spiders

1a Two pairs of book lungs (Fig. 1-3A) ……2
1b One pair of book lungs (Fig. 1-3B) …… 3
2a 3 pair of spinnerets (Fig. 1-4A)……. ***A. aus***
2b 2 pair of spinnerets (Fig. 1-4B) …….. ***M. bus***
3a With a cribellum in front of the spinnerets (Fig. 1-5B), and a calamistrum on metatarsus IV (Fig. 1-6B) ……***Z. cus***
3b Without the cribellum and calamistrum (Figs. 1-5A, 1-6A) ……4
4a With six eyes ……5
4b With eight eyes …… 6
5a six eyes in three diads (Fig. 1-2I) …… ***S. dus***
5b six eyes in two triads (Fig. 1-2H) …… ***P. eus***
6a Tarsi with two claws (Fig. 1-7B), with or without claw tufts …… 7
6b Tarsi with three claws (Fig. 1-7A), never with claw tufts (Fig. 1-8A) …… 10
7a Eyes in three or four rows (Figs. 1-2C, D, E, F) …… 8
7b Eyes in two rows (Figs. 1-2A, B) …… 9
8a Eyes arranged in 4-2-2 three rows; with a pair of remarkably large anterior median eyes (AMEs) (Fig. 1-2E)……***T. fus***
8b Eyes arranged in 2-4-2 three rows (Figs. 1-2F); AMEs not as above …… ***C. gus***
9a Base of both anterior spinnerets separated from each other or wide apart (Fig. 1-9A); Legs prograde (Fig. 1-10A) …… ***Z. hus***
9b Bases of both anterior spinnerets in contact (Fig. 1-9B); Legs prograde (Fig. 1-10B) …… ***T. kus***
10a Eye group hexagonal, eyes arranged in 2-2-2-2 four rows (Fig. 1-2C)…… ***O. lus***
10b Eye group not hexagonal…… 11
11a Eyes in two rows (Figs. 1-2A, B)…… 12
11b Eyes in three rows (Figs. 1-2D, E, F)……***P. mus***
12a Tibia and metatarsus of legs I and II armed with series of long spines interspersed with much shorter setae (Fig. 1-11B) ……***M. nus***
12b Legs I and II without such spine arrangement…… 13
13a Femora IV with a proximal cluster of double-rowed trichobothria (Fig. 1-12B) …… ***L. ous***
13b Femora IV without such trichobothria (Fig. 1-12A)…… ***N. pus***

一些常見蜘蛛的檢索表

1a 有兩對書肺 (Fig. 1-3A)……2
1b 有一對書肺 (Fig. 1-3B)……3
2a 三對績絲器 (Fig. 1-4A)……A. aus
2b 績絲器只有兩對 (Fig. 1-4B)……M. bus
3a 績絲器前面有一個 cribellum (Fig. 1-5B), 在第四對足的後跗節有一個 calamistrum (Fig. 1-6B)……Z. cus
3b 績絲器沒有 cribellum 也沒有 calamistrum (Fig. 1-5A, 1-6A)……4
4a 有六個單眼……5
4b 有八個單眼……6
5a 六個單眼以三個"二眼集合體"型式出現 (Fig. 1-2I)……S. dus
5b 六個單眼以兩個"三眼集合體"型式出現 (Fig. 1-2H)……P. eus
6a 跗節有兩爪(Fig. 1-7B), 有或沒有跗節毛束……7
6b 跗節有三爪(Fig. 1-7A), 絕對沒有跗節毛束(Fig. 1-8A)……10
7a 單眼以三排或四排型式排列(Figs. 1-2C, D, E, F)……8
7B 單眼以兩排型式排列(Figs. 1-2A, B)……9
8a 三排單眼排列成 4-2-2 的型式，兩個中單眼(AMEs)特別大(Fig. 1-2E)……T. fus
8b 三排單眼排列成 2-4-2 的型式(Figs. 1-2F)，兩個中單眼非屬以上型式……C. gus
9a 兩個前方的績絲器基部遠遠分離(Fig. 1-9A), 步行足是往前伸的 (Fig. 1-10A)……Z. hus
9b 兩個前方的績絲器基部連結(Fig. 1-9B), 步行足往兩側伸 (Fig. 1-10B)……T. kus
10a 單眼排列成六邊型, 以 2-2-2-2 四排型式出現 (Fig. 1-2C)……O. lus
10b 單眼並不排列成六邊型……11
11a 單眼排列成兩排(Figs. 1-2A, B)……12
11b 單眼排列成三排(Figs. 1-2D, E, F)……P. mus
12a 第一對與第二對步足的脛節與後跗節有一整排長刺中間雜有短剛毛(Fig. 1-11B)…M. nus
12b 第一對與第二對步足沒有這種構造……13
13a 第四步足腿節遠體端具有兩排的感覺毛簇(Fig. 1-12B)……L. ous
13b 第四步足腿節沒有這樣的毛簇(Fig. 1-12A)……N. pus

Now, you have four spider specimens coded W to Z, respectively, as shown on outside of the vials. Please key out all these spiders and mark some of their characters with aid of figures 1-1 to 1-12. (**Caution!** You may take out the specimen from the vials for identification. When you do so, you should place a spider in the petridish with some 70% alcohol to examine its characters under the stereomicroscope. Because the spider's body is very fragile, the most ideal way to handle the specimen is gently grasping its legs with forceps to move it in or out from the vial. Don't break spider's body and its legs. Undamaged spiders in their original vials will get extra points as bonus. Please handle everything with care! Spiders should be kept in 70% alcohol at any time to prevent desiccation).

現在你手上有四隻分別標示爲W, X, Y與Z的蜘蛛(如小試管外面標示所顯示)。請使用Figs. 1-1到1-12的圖片來鑑定這些蜘蛛（注意，你可以把蜘蛛拿出這些小管，當你使用這些標本時應該把牠們擺在培養皿上並使用70%的酒精在解剖顯微鏡底下檢查)。由於蜘蛛的身體很脆弱，你最好使用鑷子來夾取標本並把標本再裝回去。不要把蜘蛛的身體或腳弄壞，若標本未被破壞則可得到額外的分數，蜘蛛一定要全程在70%酒精中受檢。

Q1.1.1 (4 points for each correct spider; 16 points total) Match each spider code with the taxon name respectively in your **Answer Sheet**. Note: each spider code can only be used once, or the grades of these cells will not be counted.

Q1.1.1 (一隻正確鑑定蜘蛛得4分，共計16分)
將蜘蛛的編號與名字分別配對，並在你的答案卷上把蜘蛛編號填在正確的格子中。每一隻蜘蛛的編號只能使用一次，否則重覆的編號都不予計分。

Q1.1.2 (0.65 points for each cell; 13 points total) If a spider has the characters listed in the left column of the table in your **Answer Sheet**, indicate with a "＋" and if the character is absent, indicate with a "－". **(Penalty of 0.2 points for each wrong answer, minimum 0 point)**

Q1.1.2 (一小格得0.65分，共計13分)
把你鑑定出來的蜘蛛的特徵依據表中左列特徵填入其狀態，有填"+ "，沒有填"-"。(每一小格錯會倒扣0.2分，扣到零分爲止)

1-2 Reconstruct a phylogenetic tree for eight spiders

Data matrix 1-1 represents character entries (a to t) for a group of hypothetical organisms A to H. Based on Data Matrix 1-1, Taxon A serves as the outgroup and the rest 7 species (Taxa B to H) are ingroups. Character state 0 represents the pleisiomorphy (ancestor character) and states 1-6 are apomorphies (derived characters). "-" represents missing characters. We may reconstruct a cladogram (cladistic tree) by using the synapomorphies (shared derived characters). Each change represents one step of the evolutionary events (indicated by the character and its state, e.g., e-5, t-4). The following tree (Figure 1-13) is the only resulting most parsimonious cladogram that shows all the character changes on the tree. Numbers 1 to 15 represent 15 steps of the tree.

1-2 重建八種蜘蛛的親緣關係樹

以下特徵矩陣代表了八種假想物種(A-H)的特徵(a-t)。根據這個矩陣，A 是外群而其它的類群是內群。0 代表祖徵，"-"代表缺失特徵。1-6 代表衍徵。我們可使用共有衍徵來重建其支序圖。每一個特徵在某分支上的變化表示一個演化事件的步驟(例如 e-5, t-4)。圖 Figure1-13 所顯示的樹是唯一的最簡約樹，並顯示所有節上的特徵變化，而 1-15 代表這棵樹上的 15 個變化。

Data Matrix 1-1 (特徵矩陣 1-1)

Taxa	Character													
	a	**b**	**c**	**d**	**e**	**F**	**g**	**h**	**m**	**n**	**o**	**p**	**s**	**T**
A	0	0	0	0	0	0	0	0	0	0	0	0	0	-
B	1	1	0	1	5	0	0	1	1	1	0	0	2	-
C	1	1	0	1	6	0	0	0	0	0	0	0	2	-
D	1	1	0	1	3	0	0	0	0	0	0	0	2	-
E	1	1	0	0	1	0	0	0	0	0	0	0	1	3
F	1	1	0	0	1	0	0	0	0	0	1	0	1	4
G	1	1	0	1	4	0	0	1	1	1	0	0	2	-
H	1	1	0	0	1	0	1	1	1	1	0	0	2	-

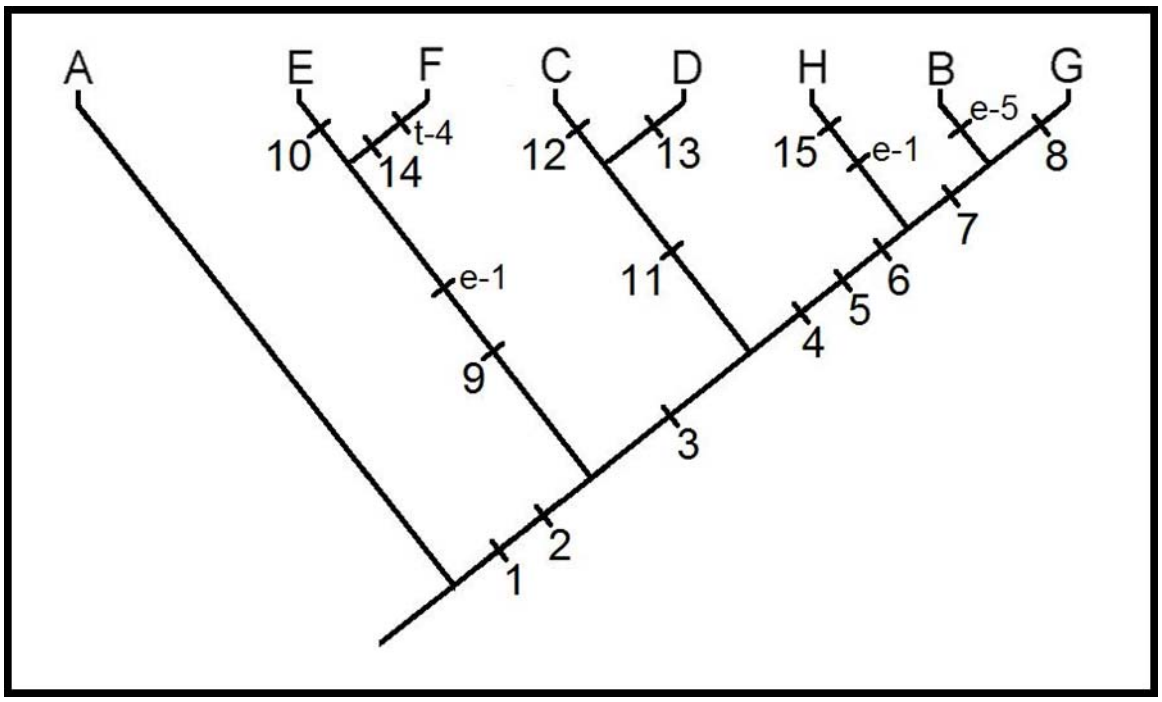


Figure 1-13 The most parsimonious cladogram reconstructed from data matrix 1-1.
由矩陣 1-1 所得之最簡約樹

Q1.2. (1.2 points for each cell; 18 points total) Fill in the character code and state (e.g., e-1) in the answer sheet for each of the 15 steps.

請把 1-15 各步所代表的特徵變化(例如 e-1)填入答案卷中

1-3 Based on the cladogram (figure 1-13), answer following questions:
Q1.3.1. (2 points) How many steps of the cladogram are there in total?
Q1.3.2. (2 points) Besides character e-1, which character is homoplasious (i.e., not homologous characters)?
Q1.3.3. (2 points) Which of the following taxon is the sister group of taxon {C, D}?
(A) {E, F} (B) {H, B, G} (C) {F} (D) {H} (E) {B, G}
Q1.3.4. (Each correct answer will get 0.4 points, 2 points total) Mark with an "X" in the "True" cell in the **Answer Sheet** if the characters given below appeared prior to the evolution of character m-1 in the cladogram, otherwise in the "False" cell.

根據 1-13 圖所顯示的支序圖回答以下的問題：
Q1.3.1 (2 分) 這棵樹長到底總共有幾步
Q1.3.2 (2 分) 除了 e-1，還有那個特徵具有趨同演化
Q1.3.3 (2 分) 請問(C, D)的姐妹群爲何？
(A) {E, F} (B) {H, B, G} (C) {F} (D) {H} (E) {B, G}
Q1.3.4 (每一正確答案得 0.4 分，共 2 分) 以下那些特徵變化發生在 m-1 之前？若正確在答案卷中的 True 欄打 X，若錯誤請在 False 欄打 X

Character
s-1
s-2
a-1
g-1
d-1

Q1.3.5. (1 point for each cell; 5 points total) To what kind of grouping do the following taxa belong? Use code "I" for polyphyletic, "II" for paraphyletic, or "III" for monophyletic grouping.

以下五個分類群屬於什麼型的分類群？I 表示多系群，II 表示多系群，III 表示單系群

Taxon
{H}
{B, C, G, H}
{C, D, E, F}
{B, G, H}
{B, E, G}

TASK II: (40 points) 測驗二 (40 分)
Test of species association in a community
測試一個生物群落中的物種伴生狀態

The basic idea of community organization is that species tend to be associated in a nonrandom manner. One way to understand their association conditions is to use a 2 × 2 contingency table (Table 2-1-0): If a sample contains both species x and y, it is defined as type "a". If a sample contains only species y, species x, or no species, then it is defined as type "b", "c", or "d" respectively.

對於生物群落的基本概念是"物種之間的伴生或依存關係實際上傾向於非逢機"。如果要瞭解一個群落中的物種伴生狀態其中一種方法就是使用一個二維表格(如 Table 2-1-0 所示)：如果一個樣區包含了 X 與 Y 兩個物種，那麼這種狀態被標記爲 a，然後如果一個樣區只有 Y、X、或都沒有，則分別被標記爲 b、c、或 d。

Table 2-1-0

	Species x		
Species y	Present	Absent	Total
Present	A	b	a+b
Absent	C	d	c+d
Total	a+c	b+d	n

n = a + b + c + d (所有出現狀況之總合爲 n)
Probability of obtaining species x P(x) = (a+c)/n (獲得 X 物種的機率)
Probability of obtaining species y P(y) = (a+b)/n (獲得 Y 物種的機率)
Joint probability (JP): the probability of both species x and y are present
JP = P(x) × P(y) (兩個物種都存在的機率)
Expected joint occurrences = n x JP (兩物種皆存在狀況之期望值)

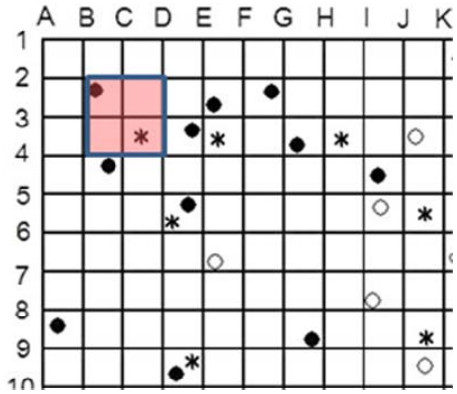
Significant level for Chi-squared statistical test (χ^2) (卡方分析的顯著水準)

Significance level (α) / Df	0.05	0.01
1	3.841	6.635
2	5.991	9.210
3	7.815	11.345

Figure 2-1 is a distribution map of two plant species, Plant-A (○) and Plant-B (●), and a sympatric spider species, Spider (✻), in a hypothetical community. Each square is 0.5 × 0.5 m^2.
圖 2-1(見下頁)顯示一個假想群落中 A 植物(○)、B 植物(●)以及一種伴生蜘蛛(✻)的分布圖。每一個方格爲 0.5 x 0.5 平方公尺

2-1 Association between Plant-A (○) and Spider (✻) analyzed by quadrat method.
Put a 1-m square quadrat on Figure 2-1 using the following 40 randomly assigned coordinates as the center (i.e., 2 × 2 complete squares) and determine the type of each quadrat.
以樣框法分析 A 植物與蜘蛛的伴生關係，作法如下：使用一個一公尺見方的樣框與以下 40 種逢機抽選的點作爲該方格的中心點(也就以每個點爲中心會有 2 x 2 個小方格)

N-11, S-8, F-10, Q-18, O-16, K-2, L-4, M-17, M-4, H-17
X-2, K-11, T-19, M-8, P-10, G-8, B-19, M-19, S-10, O-12
J-18, D-7, B-17, I-11, B-10, G-13, V-16, C-3, F-5, R-15
L-2, Q-11, R-5, G-11, K-10, T-10, X-9, R-3, O-3, F-16



C-3 for example (此爲 Fig.2-1 之圖例，並標記出 C-3 作爲例區)

Q2.1.1. (1 point each; 9 points total) Write down your results in Table 2-1-1 and complete all the blank cells.
在答案卷上的 Table2-1-1 寫下結果，並回答以下五個問題

Answer the following in your Answer Sheet:
Q2.1.2a. (0.6 points) Calculate P (Plant-A) 計算 A 植物出現的機率
Q2.1.2b. (0.6 points) Calculate P (Spider). 計算蜘蛛出現的機率
Q2.1.2c. (0.6 points) Calculate JP (Plant-A and Spider) 計算兩者皆出現的機率
Q2.1.2d. (0.6 points) Calculate the expected joint occurrences 兩者皆出現之狀況的期望值
Q2.1.2e. (0.6 points) Two species are more likely to be positively associated if the actual observation of the joint occurrence is greater than the expected one, and negatively associated if the actual observation is smaller than the expected one. What kind of association exists between the Plant-A and Spider? [Answer Code: P for positive association, N for negative association.]
如果兩個物種都出現的觀測值比起期望值爲高，那麼我們就說兩物種的伴生關係是正相關，若較期望值爲低則爲負相關。所以植物 A 與蜘蛛的伴生關係爲何？P 表正相關 N 表負相關。

2-1-3 A simple Chi-squared statistical test (χ^2) with one degree of freedom (df = 1) is calculated as follows:
在自由度爲 1 的情況下，如何計算 χ^2 的公式

$$n = a + b + c + d$$
$$\chi^2 = \frac{n\,(ad-bc)^2}{(a+b)(c+d)(a+c)(b+d)}$$

Q2.1.3. (2 points) Based on Table 2-1-1, Calculate χ^2**. (to the fourth decimal place)**
根據你所完成的 Table 2-1-1 計算 χ^2 並取到小數點第四位

2-1-4 The strength of the association between the two species can be estimated from a coefficient (V) defined as follows:
V 這個係數被拿來估計兩個物種伴生關係的強度，而 V 值的範圍由-1(強烈負相關)到+1(強烈正相關)而 0 表示無相關。

$$V = \frac{ad - bc}{\sqrt{(a+b)(c+d)(a+c)(b+d)}}$$

The V value varies from -1 (strongly negative association) to +1 (strongly positive association) and it is zero when there is no association.

Q2.1.4a. (2 points) Calculate the V value from Table 2-1-1. **(to the fourth decimal place)**
計算 2-1-1-表中所得之 V 值到小數點第四位

Q2.1.4b. (2 points) According to the V value, what can be hypothesized about the strength of the association exists between the two species? (Mark your answer with an "X" in the cell on the **Answer Sheet**)
根據 V 值，請在答案格中以 X 標示這兩個物種的伴生關係強度落在何等級

2-2 The following table shows data using 40 randomly placed 2-m square quadrats.
以下這個表顯示以 40 個逢機放置的 2 公尺見方樣框所得到的數據

Table 2-2-1

Plant-A(○)	Spider (✻)		Total
	Present	Absent	
Present	14	16	30
Absent	8	2	10
Total	22	18	40

The expected joint occurrence is 16.5 兩者皆出現狀況的期望值爲 16.5
The Chi-squared statistical test (χ^2) with one degree of freedom (df = 1) is calculated as $\chi^2 = 3.3670$. 在自由度爲 1 的狀況下進行卡方分析得 $\chi^2 = 0.3670$
V = -0.2901 V 值爲-0.2901

Based on Table 2-2-1 answer following questions:

Q2.2.1a. (2 points) What kind of the association exists between Plant-A and Spider? [Answer Code: P for positive association, N for negative association]

Q2.2.1b. (2 points) According to the V value, what strength of the association exists between the two species? (Mark your answer with "X" in the cell given in the **Answer Sheet**)

2.2.2. (6 points total) Mark with an "X" on the **Answer Sheet** for each statement whether it is true or false.

Q2.2.2a. (2 points) Both tests of association using 1-m and 2-m square quadrats (sections 2-1 and 2-2) allowed us to reject the null hypothesis of random distribution.

Q2.2.2b. (2 points) The larger the quadrat size used, the more accurate the results.

Q2.2.2c. (2 points) Increasing the sampling efforts in the quadrat method should improve the accuracy of the results of species association.

根據 Table 2-2-1 回答以下問題：

Q2.2.1a (2 分) A 植物與蜘蛛的伴生關係爲何？(P 表正相關，N 表負相關)

Q2.2.1b (2 分) 那麼根據 V 值，這兩種生物伴生關係的強度落在何等級？(以 X 填入表格)

2.2.2 (共 6 分)，回答以下陳述爲"是"或"否"並以 X 填註

Q2.2.2a (2 分) 無論是使用 1m 或 2m 見方的樣框(sections 2-1 與 2-2)都讓我們拒絕物種伴生關係爲逢機的假說

Q2.2.2b (2 分) 樣框尺吋越大結果就會越精確

Q2.2.2c (2 分) 若在樣框法上增加取樣數，應該可以增進物種伴生研究結果的精確性

2-3 Association between Plant-A (○) and Plant-B (●) analyzed by the nearest neighbor method. Tally up the frequencies of the nearest neighbor of each plant systematically for all individuals. Fill in the totals in the table printed in the Answer Sheet.

Q2.3.1. (0.5 points for each cell; 3 points total) Write down your results in Table 2-3-1 and complete all the blank cells.

Q2.3.2a. (2 points) Based on Table 2-3-1 with one degree of freedom (df = 1), calculate χ^2. **(to the fourth decimal place)**

Q2.3.2b. (3 points) Are these two plant species randomly distributed, associated or segregated? (Mark your answer with an "X" in the cell)

根據完整的圖 2-1，以最近鄰法系統性地整理每株植物最近鄰居的出現頻度，來評估 A 植物與 B 植物之間的伴生狀況，並把結果填在答案卷中"。

Q2.3.1 (1 格 0.5 分, 共 3 分) 把結果填入 Table2-3-1 中

Q2.3.2a (2 分) 根據 Table 2-3-1 結果以及自由度爲 1 的狀況計算 χ^2 至小數點第四位

Q2.3.2b (3 分) 這兩種植物的分布是逢機？伴生？或完全無關？以 X 填入正確的答案格

2-4 Answer questions: Mark with an "X" on the Answer Sheet for each statement whether it is true or false. **(4 points total)**

Q2.4.1. (2 points) The null hypothesis of the χ^2 test for the nearest neighbor method is that both Plant-A and Plant-B are randomly distributed.

Q2.4.2. (2 points) Using the nearest neighbor method to test species association can avoid the quadrat-size effect.

2-4 請問以下陳述爲"是"或"非"？請以 X 標記在答案格中

Q2.4.1 (2 分) χ^2 test 對"最近鄰法"的虛無假說是"A 植物與 B 植物皆爲逢機分布"
Q2.4.2 (2 分) 以"最近鄰法"可避免樣框法所產生的問題