25th INTERNATIONAL BIOLOGY OLYMPIAD

5 – 13 July 2014

INDONESIA

PRACTICAL TEST 4

實作 4

ECOLOGY AND ETHOLOGY

生態學及行為學

Total points: **100**

Duration: 90 minutes

COUNTRY:	.....
STUDENT:	.....

Dear Participants
親愛的參賽者

- The theme of this test is "**Biogeography and Biodiversity**". The test consists of three tasks:
  此一考試主題是生物地理學及生物多樣性。包括下列三項實作
  Task 1 : Island Biogeography (17 points)
  實作 1：島嶼生物地理學(17 分)
  Task 2 : Primary Succession after volcanic eruption
  實作 2：火山爆發後之初期演替
  Part A: Succession and plant community structure (22 points)
  A 部份：植物群落構造及演替(22 分)
  Part B: Dispersal biology of *Ficus* (30 points)
  B 部份：榕屬的散佈生物學(30 分)
  Task 3 : Speciation in song birds (31 points)
  實作 3：鳴禽的種化(31 分)
- Use the **Answer Sheet**, which is provided separately, to answer all the questions. Do not write or make any markings on the Question Paper.
  用另附的答案卷回答所有的問題。不要在試題卷上寫或做任何記號。
- Answers written in the Question Paper will **NOT** be evaluated.
  答案寫在試題卷上不做任何計分。
- Write your answers legibly in ink.
  用筆清楚的將答案寫在答案卷上。
- Please make sure that you have received all the material and equipment listed for all tasks. **If any items are missing, raise your hand immediately**.
  確認所有材料與設備，若有任何缺漏，請立刻舉手。
- Materials such as photographs and model fruits for Task 1 and 2 will be used by your country team mates. Please do not mark, damage, or take them with you. You may, however, mark on spectograms provided for Task 3.
- 在實作1及2所提供的實作材料如相片及模型果實，請勿做記號、毀損或取走，因為它們會被你國家的同伴使用。但你可以在實作3所提供的聲譜圖上做記號。
- Stop answering and put down your pen **immediately** when the bell rings.
  當鐘響時，請將筆放下，立刻停止作答。
- At the end of the test, place your Answer Sheet and Question Paper in the envelope provided. Our Assistants will collect the envelope from you.
  在考試結束時，將答案卷及試題卷放入所提供的封袋。
  大會助理將會來向你收集封袋。

Materials and Equipment

材料及設備

Material 材料	**Quantity** 數量	**Unit** 單位
Aerial photographs, coded A, B and C 標示有 A, B 和 C 編碼的空照相片	3	sheets 張
Model chips of *Ficus* fruits in one plastic bag 榕屬果實的模式小片（置於塑膠袋中）	30	chip 片
Sample of whole and dissected *Ficus* fruit 整個與解剖的榕屬果實樣本	1 ½	fruits 果實
Bird song spectrogram and oscillogram 鳥音的聲譜圖與頻波圖	9	Sheets 張
Blank paper for scrap paper 空白計算用紙	2	Sheets 張
Equipment 設備		
Calculator 計算機	1	piece 台
Ruler 尺	1	piece 把
Vernier caliper 微調測量尺	1	piece 把
Magnifying glass 放大鏡	1	piece 個
Color pencils 彩色鉛筆	4	pieces 枝
Pencil sharpener 削鉛筆機	1	piece 個
MP3/audio player with recording of bird song + earphone MP3 錄音筆內有已錄好的鳥音並附耳機	1	set 套

BIOGEOGRAPHY & BIODIVERSITY

生物地理學及生物多樣性

Indonesia is a megabiodiversity country consisting of over 17,000 islands, spanning from Sumatra island in the west, to Papua in the east (see aerial photograph coded A). The country's rich biodiversity can be attributed to its tropical setting, as well as its biogeographical history. The following three tasks concern several important concepts related to biogeography, colonization, succession, and speciation, using examples from Indonesia.

印尼是一個超級生物多樣性的國家，具有超過 17000 個島嶼所組成，涵蓋從西邊的蘇門答臘到東邊的巴布亞(參閱 A 空照相片圖)。這個國家的生物多樣性可以歸因於熱帶特性及其生物地理的歷史。

下列三個實作是用印尼的例證來說明幾個與生物地理學、生物移民或移入、演替及物種演化等有關的重要觀念。

Task 1. Island Biogeography (17 points)

實作 1. 島嶼生物地理學(17 分)

Introduction

前言

The Equilibrium Theory of Island Biogeography (MacArthur and Wilson, 1963, 1967) suggests that the number of species on an island represents an equilibrium between immigration of new species (i.e., addition of species) and local extinction (i.e., loss of species). The rate of new species immigration is affected by the island's distance from the mainland as a colonization source, while the rate of local extinction is affected by island size.

島嶼生物地理學的平衡理論是由兩位學者所提出的(MacArthur and Wilson, 1963, 1967)。

他們認為一個島上的物種數是由遷入新種數(即加入的新物種數)，及當地的物種滅絕數(即失去的物種數)，這兩個數量達成平衡時所呈現的結果。新物種移入速率受到島嶼與大陸(提供物種資源)距離的影響；而當地物種的滅絕速率則受島嶼面積大小的影響。

- Study the aerial photograph provided for Halmahera islands (coded B), which are on the eastern part of Indonesia, and locate the following five islands :
  檢視所提供的 Halmahera 群島空照相片(B 圖)，該群島位在印尼東方，由圖中找出下列 5 個島嶼：
  - Ternate (area 面積: 111.80 km^2)
  - Tidore (117.60 km^2)
  - Mare (6.04 km^2)
  - Moti (24.60 km^2)
  - Makian (113.12 km^2)

- Using the ruler provided, estimate the actual distance from the mainland of Halmahera to each island. Distance is measured as the shortest length connecting the outer edges of islands (example given in **Figure 1**).
  利用所提供的尺來估算 Halmahera 這塊大陸(大島)與其他各小島的距離，測量兩島外緣相距的距離為兩島的最短距離（如下圖 1 範例所示）

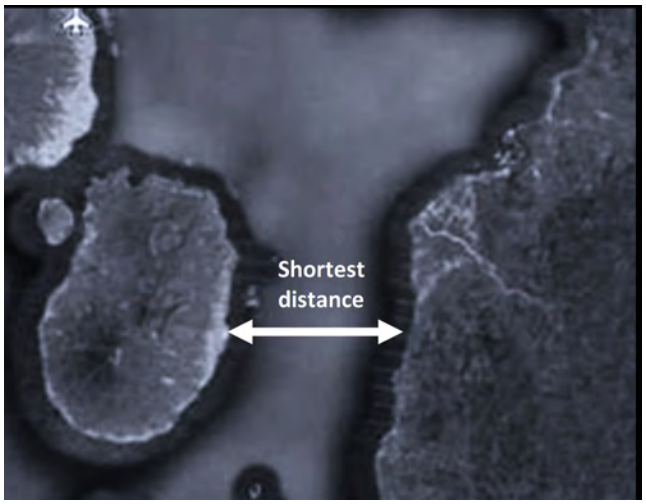


Figure 1. Measurement of shortest distance between islands.
圖 1．兩島間最短距離的測量

Question 1.1. (5 points) For each island, determine its distance from the mainland and record your measurements in the **Answer Sheet**.

問題 1.1.(5 分) 測量每個小島與大陸的距離，並寫在答案卷上。

Question 1.2. (10 points) Fill in the appropriate islands whose rates of colonization and extinction have been depicted in the graph in the **Answer Sheet**, using the island codes provided below:

問題 1.2. (10 分) 利用下列所提供的島嶼代碼及圖像，請在答案卷上選擇並填入符合物種遷入及滅絕速率的島嶼。

Code 代碼	Island 島嶼
A.	Ternate
B.	Tidore
C.	Mare
D.	Moti
E.	Makian

Question 1.3. (2 points) Which <u>two</u> islands listed have the largest number of species in equilibrium?

問題 1.3. (2 分) 下列哪**<u>兩個島嶼</u>**具有最大的物種平衡數量？

A. Ternate
B. Tidore
C. Mare
D. Moti
E. Makian

Task 2. Primary Succession After Volcanic Eruption (52 points)

實作 2. 火山爆發後的初級演替(52 分)

Introduction

前言

The Krakatau islands are a small volcanic group located in the strait of Sunda which separates the large islands of Java and Sumatra (see aerial photograph coded C). In 1883, Mount Krakatau produced one of the most catastrophic volcanic eruptions in human history and a new volcanic island, Anak Krakatau (Child of Krakatau) emerged in 1927 and is still active today.

Sunda 海峽位於爪哇及蘇門答臘的大島間，其中有一個火山型的 Krakatau 小群島。(請參閱空照圖 C)。在 1883 年，Krakatau 火山產生了人類有史以來極端毀滅的大爆發。其後一個新的火山島 Anak Krakatau (Child of Krakatau，Krakatau 火山之子)在 1927 年出現，到現在仍是活躍的。

Part A : Succession and Plant Community Structure

A 部份：演替及植物群落結構

Anak Krakatau has now become a habitat for a variety of flora and fauna. Table 1 presents part of the data collected on plant species richness and abundance on Anak Krakatau in 1934, 1949, 1963, 1979 and 1991. Using data from Table 1, compare the plant community structure on Anak Krakatau across these years, using diversity and similarity indices.

Anak Krakatau 島現在成為一個具有多樣的動植物相環境。表 1 為 1934, 1949, 1963, 1979 及 1991 年在 Anak Krakatau 島上收集的部份植物資料，包括了植物種類及豐富度。根據表 1 所呈現的資料，計算多樣性及相似性指數來比較 Anak Krakatau 島上各年份間植物群落的結構。

Table 1. List and abundance of plant species on Anak Krakatau.
表 1. Anak Krakatau 島植物名錄及豐富度

No	**Life Form*** 生活型式	**Plant Species** 植物種類	**Habitat**** 棲地	**Plant Abundance** 植物豐富度 **(number of individuals per unit area)** (單位面積中的植株數)				
				1934	**1949**	**1963**	**1979**	**1991**
1	T	*Calophyllum inophyllum*	I	0	0	1	3	35
2	H	*Canavalia rosea*	C	1	0	3	7	37
3	T	*Casuarina equisetifolia*	C	0	0	2	8	59
4	T	*Cocos nucifera*	C	0	0	2	11	69
5	S	*Eupatorium odoratum*	C	0	0	3	17	121
6	T	*Ficus septica*	I	0	0	0	5	16
7	T	*Hibiscus tiliaceus*	C	2	0	8	26	56
8	H	*Imperata cylindrica*	C	0	0	15	94	256
9	H	*Ipomoea pes-caprae*	C	18	15	37	80	212
10	H	*Nephrolepis hirsutula*	C	15	12	30	58	278
11	T	*Nypa fruticans*	C	0	0	2	11	87
12	T	*Pandanus tectorius*	C	2	0	8	28	101
13	T/S	*Pongamia pinnata*	C	2	0	0	0	65
14	H	*Saccharum spontaneum*	I	0	0	5	19	189
15	T	*Samanea saman*	I	0	0	2	3	45
16	S	*Scaevola taccada*	C	0	0	2	18	37
17	H	*Spathoglottis plicata*	I	0	0	0	0	28
18	T	*Tamarindus indica*	I	0	0	0	2	21
19	T	*Terminalia catappa*	I	0	0	3	4	121
20	H	*Vigna marina*	C	2	3	4	5	46
		DIVERSITY INDEX (H') 多樣性 指數**(H')**		**??**	**0.94**	**2.17**	**2.33**	**2.70**

**T=tree, H=herb, S=shrub; **I=inland, C=coast*

**T=木本, H=草本, S=灌木; **I=內陸, C=海岸*

- The Shannon-Wiener diversity index (H') as in Table 1 is calculated using the formula below.

表一中的 Shannon-Wiener 多樣性指數(H')計算公式如下：

$$H' = -\sum_{i=1}^{n}(p_i \ln p_i)$$

where : H'= diversity index

H'=多樣性指數

p_i = the proportion of the i^{th} species

p_i =第 i^{th} 物種所佔的比例

ln p_i = the natural logarithm of p_i

ln p_i= p_i 取自然對數

n = the number of species in the community

n =群落中的物種數

Question 2.1. (3 points). The diversity index for vegetation on Anak Krakatau in 1934 was:

問題 2.1.(3 分) 在 1934 年，Anak Krakatau 島上植物的多樣性指數是：

A. 0.70
B. 0.83
C. 0.95
D. 1.40
E. 1.73

- The similarity between two communities is often expressed using indices, such as the following Sørensen similarity index: 兩個群落間的相似性，經常是利用指數來呈現，例如下列 Sørensen 相似性指數 (similarity index)

$$\beta = \frac{2c}{S_1 + S_2}$$

where : β = similarity index

β =相似性指數

c = number of species common to both communities

c =在兩個群落中相同的物種數

S_1 = number of species in community 1

S_1 =群落 1 的物種數

S_2 = number of species in community 2

S_2 =群落 2 的物種數

β values range from 0 (no species overlap) to 1 (complete overlap)

β 值由 0（物種無重疊）到 1（物種完全重疊）

Question 2.2. (5 points) Calculate the similarity between pairs of observation years of Anak Krakatau vegetation using the Sørensen index. Record your results in the table in the **Answer Sheet**.

問題 2.2. (5 分) 計算

在**答案卷**上，利用 Sørensen 指數來計算表格中相對應的兩個年度 Anak Krakatau 島上植被相似性，將你的結果填寫在表內。

Question 2.3. (2 points) Using data from Question 2.2, the vegetation on Anak Krakatau was most different between observations conducted in the years:

問題 2.3. (2 分)　利用問題 2.2 的資料，在 Anak Krakatau 島上植被差異最大的年份：

A. 1934 and 1949
B. 1949 and 1963
C. 1963 and 1979
D. 1979 and 1991
E. 1949 and 1991

Question 2.4. (4 points) Indicate, using the data above, whether the following statements are true or false.

問題 2.4. (4 分)　用上述的資料指出下列敘述，何者正確或錯誤：

A. Plant species richness at a particular observation year is always higher than the previous observation year.
   在某一年度觀察到的植物種類豐富度，一定較前年所觀察到的豐富度高
B. Vegetation in 1979 shows lower species evenness compared to 1963 (evenness is defined as H' divided by the natural logarithm of the number of species).
   1979 年的植物平均指數低於 1963 年（平均指數的定義是 H'／物種數的自然對數值）
C. On Anak Krakatau, the first pioneer plant species were dispersed by sea.
   在 Anak Krakatau 島，第 1 個先驅植物種類是經由海洋散佈過來的
D. On this island, the first pioneer plant species were woody plants.
   在 Anak Krakatau 島，第 1 個先驅植物是木本植物

Question 2.5. (6 points) Using the data from Table 1, plot the number of species colonizing the coastal and inland areas of Anak Krakatau against time (in years) in the graph provided in the **Answer Sheet**.

問題 2.5. (6 分)　利用表 1 的資料，將 Anak Krakatau 島的海岸 (coastal) 及內陸 (inland) 的植物物種數隨時間（年）的變化曲線，畫在答案卷所提供的方格紙上。

Question 2.6 (2 points) Based on your graph, state whether the following statements are true or false.

問題 **2.6. (2 分) 根據你所做的圖，判斷下列敘述何者正確或錯誤。**

A. The coastal colonization of Anak Krakatau stabilized after 45 years.
在 Anak Krakatau 島上的海岸植物在 45 年後達到穩定狀態

B. The inland colonization of the island occurred 15-30 years after that of the coast.
島上內陸植物的移入比海岸植物晚 15-30 年

Part B: Dispersal Biology of *Ficus*

B 部份：榕屬植物的散佈生物學

The size of a plant's fruit and seed is related to its ability to disperse and colonize new sites. Three different species of fig (*Ficus*) are found on Anak Krakatau, i.e., *Ficus hispida*, *Ficus septica* and *Ficus variegata* (Table 2).

植物果實及種子的大小與其散佈及移入新地區能力有關。在 Anak Krakatau 島上發現了 3 種榕屬植物，分別為 *Ficus hispida*, *Ficus septica* and *Ficus variegata* (表 2)

Table 2. Description of fruits of *Ficus* species found on Anak Krakatau

表 2. 在 Anak Krakatau 島上發現榕屬植物描述

Species **物種**	**Fruit Description** **果實的**描述
Ficus hispida	having the form of a pear, greenish yellow, diameter 24-35 mm. 梨狀，黃綠色，直徑 24-35 mm
Ficus septica	globular, light green, longitudinally ribbed with many pole warts, diameter 15-25 mm. 球狀，淺綠色，柱狀的疣突物呈垂直脊型分佈， 直徑 15-25 mm
Ficus variegata	globular, red with white lines and blotches, or yellowish green, diameter 20-25 mm 球狀，紅底有白線及白點，或黃綠色，直徑 20-25 mm

- On your table, you will find a bag containing a mixture of 30 *Ficus* "fruits" (*they are not actual fruits, but are acrylic chips that are representative of the actual form and size of the original fruits*). Each chip has a serial number printed on it.
  在你的桌上，你會發現一個袋子裡面裝了 30 個榕屬的果實（他們不是真正的果實，但是是由壓克力製成的且與實際形狀及大小相同的標本），每一個模型標本有依序標號。
- Observe the morphology and color of the fruits and separate them according to species.
  根據果實的形態及顏色分出各物種。

- Using the Vernier caliper provided, measure the diameter of each fruit, i.e., the widest part of the fruit, as in the example below. Record your measurements in millimeters (Precision: two places after the decimal point).
  用微調測量尺，測量每一個果實的直徑，即果實最寬的部份，如下圖所示。以 mm 表示你的測量值（準確值在小數點後 2 位數）

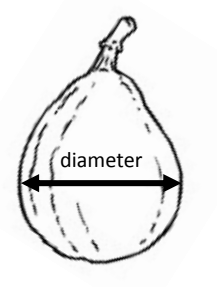


Figure 2. Example of fruit diameter measurement at the widest part.
圖 2. 在果實最寬的部份進行半徑測量的圖例

Question 2.7. (15 points) Enter your measurements of all fruits into the table in the **Answer Sheet**. Be sure to record your data in the appropriate species column and according to the serial number printed on each fruit. After all fruits have been measured, calculate the average diameter and standard deviation for each species.
問題 2.7. (15 分)　在答案卷上填寫所有果實的測量值，根據每個果實的序號，將其填寫在正確的物種欄位裡面。在測量完所有的果實後，計算不同物種果實平均直徑及標準差。

Question 2.8. (8 points) Using your data from Question 2.7, draw a bar graph, to illustrate the size comparison among fruits of the three species. You may use the color pencils provided. Draw a bar graph with standard deviation
問題 2.8. (8 分)由問題 2.7 所得的資料，畫直條圖，以顯示此 3 種植物果實的大小，你可用所提供的彩色鉛筆來表示。並在每個直條上標示標準差。

Fig fruits are highly variable and are consumed by almost all taxa of terrestrial vertebrates, such as birds and bats. Birds have a relatively narrow gape, lack teeth, have tetrachromatic vision and a poor sense of smell. Bats have teeth, eat fruit piecemeal, are mostly nocturnal, and have a keen sense of smell. Birds usually prefer seeds/fruits with a size of around 11.3 mm, while bats can eat fruits greater than 50 mm in diameter.

榕屬果實具有很高的變異性，且幾乎被所有的陸棲脊椎動物群所取食，例如鳥類及蝙蝠。鳥類有相對比較窄的嘴喙開口，沒有牙齒，有高度顏色的辨識但嗅覺很差；蝙蝠具有牙齒，可以咬碎果實，大多數為夜行性，有非常好的嗅覺。鳥類喜歡吃大小約 11.3 mm 的種子或果實，蝙蝠則吃直徑大於 50 mm 的果實。

Question 2.9. (4 points) Indicate whether the following statements are true or false.

問題 **2.9. (4 分)請指出下列敘述何者正確或錯誤**

A. Bats will choose fruit colors such as green, yellow, pale, orange or brown, i.e., colors that do not contrast with its surroundings.
蝙蝠選擇果實的顏色如綠色、黃色、淺色、橘色或棕色，即顏色與環境的對比不鮮明

B. Birds eat *Ficus benjamina*, another species with red fruits that are 9.8 mm in diameter.
鳥類吃 *Ficus benjamina*，是一種具有紅色、半徑在 9.8 mm 榕果的榕屬植物

C. Based on fruit size, *Ficus hispida* is more likely to rely on bats for its dispersal than *Ficus septica.*
根據果實的大小，*Ficus hispida* 的散佈較 *Ficus septica* 更有可能依靠蝙蝠

D. Birds will eat *Ficus variegata*.
鳥類會吃 *Ficus variegata* 果實

Using a magnifying glass, observe the sample of *Ficus* fruit on your table. This 'fruit' is actually a unique structure called syconium, which has many flowers on its inner surface. The syconium is pollinated by specialized fig wasps, which enter and pollinate the flowers as they lay eggs in the ovules. The syconium is essential for wasp larvae development and their eventual mating.
用放大鏡觀察桌上榕屬果實的樣本。這果實具有非常獨特的構造，稱做“隱果(syconium)”，其內壁有許多的花。此隱果是藉著榕果小蜂進入隱果內在子房產卵時完成授粉。這隱果對於小蜂幼蟲的發育及成長交配是非常重要的。

Question 2.10. (3 points) Based on the above information and observation, indicate if each of the following statements is true or false.
問題 2.10. (3 分) 根據上述的資料和觀察，指出下列敘述何者正確或錯誤

A. The *Ficus* syconium contains both male and female flowers.
隱果同時包含了雄花和雌花

B. The interaction between *Ficus* and fig wasps is not mutualistic.
榕屬植物和榕果小蜂的交互作用不屬於互利共生(mutualistic)

C. The relationship between these two species is an example of coevolution.
這兩個物種之間的關係是共同演化的例子

Task 3. Speciation in Songbirds (31 points)

實作 3. 鳴禽的物種演化(31 分)

Introduction

前言

Songbirds communicate to other animals using clear sound or vocal signals, which are important cues for both intra- and interspecific recognition.

鳴禽以清楚的聲音或訊號與其他動物溝通，這種聲音溝通是種內及種間重要的識別機制。

An ornithologist has been studying several songbirds in the tropical forests of Indonesia and uses song variations to investigate bird speciation. He analyses all songs using spectrograms (sonograms) and oscillograms, which are produced by an instrument called a sound spectrograph (sonograph). A spectrogram, which is a plot of sound frequency (pitch) on the vertical axis against time on the horizontal axis, reveals (1) the frequency range and (2) the duration of the song. The oscillogram plot is the variation in amplitude (loudness) against time.

一位鳥類學家在印尼熱帶林中研究好幾種鳴禽，用歌唱的變異研究鳥的物種演化，他利用聲譜分析儀取得聲譜圖(spectrogram)及頻波圖(oscillogram)，來分析所有曲目。聲譜圖是垂直軸的聲音頻率對應水平軸的時間，其顯示出(1)頻率的範圍及(2)曲目的進行時間。頻波圖是曲目在時間軸上顯現出不同強度的變化圖。

Bird sounds typically consist of: **call** (short and simple) and **song** (long and complex). In addition to a repertoire ("collection") of song types, birds also produce pure tonal or whistled sounds that can be modulated/varied in both frequency and amplitude. A typical spectrogram and oscillogram, with explanation is given below:

典型的鳥類鳴聲包括：**鳴叫**（短而簡單）及**歌唱**（長而複雜）。鳥類除了具有各種不同的歌唱型式外，也會產生單純的音調或哨音，其單純的聲音亦可有頻率及音波的變化。

一個典型的聲譜圖及頻波圖，可由下列的例子來說明：

R

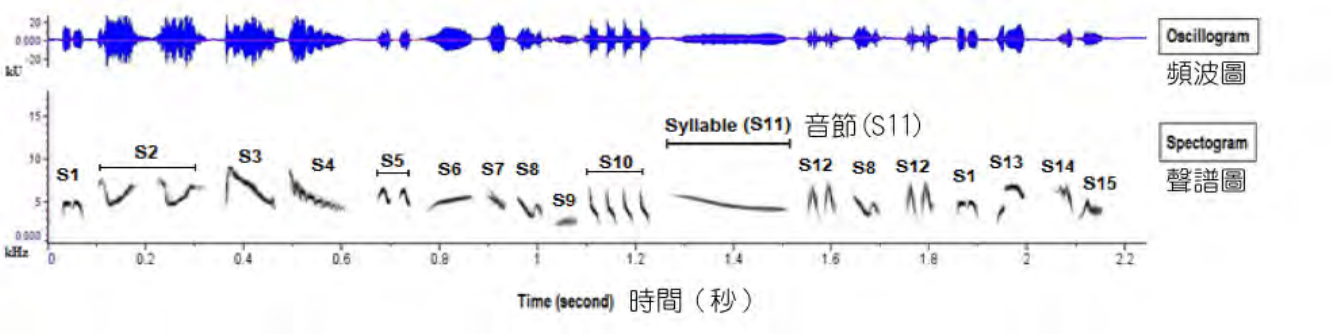
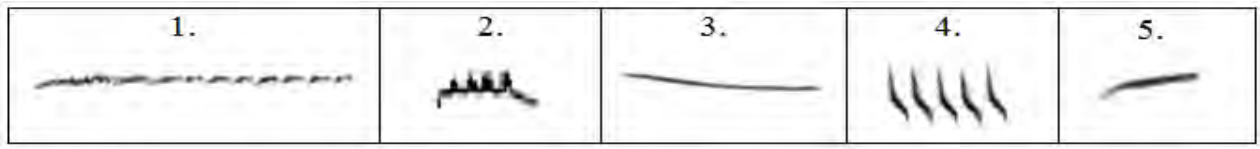


Figure 3. Spectrogram and oscillogram of different syllables from a songbird's repertoire.
圖3. 一個鳴禽的曲目中，聲譜圖和頻波圖中不同音節的變化

- Syllable (S): One or more continous traces, consisting of one, two or three elements, which appear together in a sequence
  音節(S)：一或多個連續的軌跡，包括 1 或 2 或 3 個元素組成，呈連續性出現
- Syllables can be distinguished according to the syllable's frequency range
  音節可以根據其頻率範圍來分辨
- Syllable Repertoire (SR): number of different syllables in a song (Fig. 3, ∑SR =15)
  音節曲目(SR)：在一首歌曲裡面所具有的不同音節的數目(圖 3, ∑SR =15)

You have been provided with the spectrograms of nine individual songbirds. Your task is to analyze all the spectrograms using the terminologies described above, and identify different groups of songbirds. You have also been given an MP3 player and ear phone to listen to the recorded songbirds (see Appendix B if needed).
你有 9 隻鳴禽的聲譜圖。你的工作是要根據上述所提供的專有名詞來分析所有的聲譜圖並分辨出不同鳴禽的類群，另根據你所具有的 MP3 錄音筆及耳機來聽鳴禽的聲音（如有必要，可參考附錄 B 的說明）

Question 3.1. (1 points) Which of the syllable types below are unmodulated frequency traces?
問題 3.1. (1 分) 下列哪些音節屬於沒有群組音頻變化的軌跡？



A. 1
B. 2
C. 3
D. 4
E. 5

Question 3.2. (18 points) Count the number of different syllables for each song from the nine spectrograms provided and enter them into the table in the **Answer Sheet**. Different syllables in a song can be more clearly distinguished by comparing between the oscillogram and the spectrogram.
問題 3.2. (18 分) 由提供的 9 條聲譜圖，計算每一條曲目中不同音節的數量，將結果填入答案卷的表中。曲目中的不同音節可以較清楚地從比較頻波圖及聲譜圖的差異來分辨。

Question 3.3. (3 points) Assign the individual songbirds to three putative species groups A, B and C, based on the closeness of their syllable repertoires as well as their characteristic spectrograms.
問題 3.3. (3 分) 根據曲目中音節的相似性及聲譜圖的特性，將各個鳴禽歸入其可能所屬的 3 個假想的物種 A、B 及 C。

Question 3.4. (8 points) Compare the syllable repertoire of the two species groups that have the highest and lowest numbers of syllables, identified in Question 3.3, using the two-sample t-test with 95% confidence level (Appendix A). Tabulate the results of your analysis in the **Answer Sheet**.

問題 3.4. (8 分) 比較由問題 3.3 所得的兩群物種，其最高及最低的音節數目，利用針對雙樣本的 t 統計(two-sample t-test)在 95%信賴水準的條件下進行分析（附件 A）。將所得結果填入答案卷表格中。

Question 3.5. (1 points) Assuming that difference in syllable repertoires implies different species, indicate which of the following statements are correct.

問題 3.5. (1 分)　假設曲目中的音節差異代表不同的物種，指出下列敘述何者是正確的

A. The two groups belong to the same species.
   這兩群是屬於同種
B. The two groups belong to two different species.
   這兩群是屬於不同種

APPENDIX A: Student t-test

附件 A: 學生 t 檢測分析

Statistical analysis by Student t-test can be used to compare between two groups. The calculated value is interpreted according to the t-table value at the significance level (i.e., if the calculated value ≥ table value, the null hypothesis is rejected and it can be concluded that the difference is greater than what would be expected by chance; or if the calculated value < table value, the null hypothesis is accepted and it can be concluded that the observed difference could have been the result of chance).

學生 t 檢測分析可用來比較兩個不同的群組。其計算所得的數據可根據 t 表(t-table)值所提供的顯著水準來進行檢測（即假設計算所得的數據大於或等於(≥)表中所提供的值，則推翻虛無假說，即可下結論為所得的差異是大於機會變異所造成；若所得數據小於(<)表中所提供的值，則接受虛無假說，即可下結論為觀察所得的差異是由於機會所造成的）。

$\overline{X_1}$ = mean of sample 1

$\overline{X_2}$ = mean of sample 2

n_1 = number of subjects in sample 1

n_2 = number of subjects in sample 2

S_1^2 = variance of sample 1 = $\frac{\sum (X_1 - \overline{X_1})^2}{n_1}$

S_2^2 = variance of sample 2 = $\frac{\sum (X_2 - \overline{X_2})^2}{n_2}$

$\overline{X_1}$=樣本 1 的平均

$\overline{X_2}$=樣本 2 的平均

n_1= 樣本 1 的數量

n_2=樣本 2 的數量

S_1^2=樣本 1 的變方

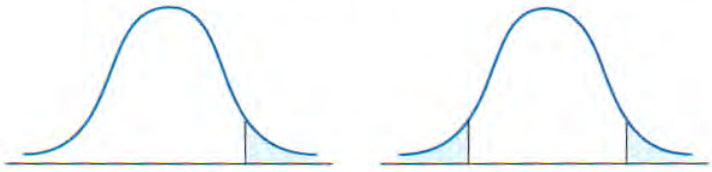
S_2^2=樣本 2 的變方

$$t = \frac{\overline{X_1} - \overline{X_2}}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

統計表

Statistical Tables **Table *t* - distribution** t - 分佈表

Table entries are values of t corresponding to proportions in one tail or in two tails combined
表內數據的呈現為 t 值在單尾或雙尾組合所呈現的比例



單尾
(左或右)

雙尾
組合

t 表

t Table

累積或然率 cum. prob	$t_{.50}$	$t_{.75}$	$t_{.80}$	$t_{.85}$	$t_{.90}$	$t_{.95}$	$t_{.975}$	$t_{.99}$	$t_{.995}$	$t_{.999}$	$t_{.9995}$
單尾 one-tail	0.50	0.25	0.20	0.15	0.10	0.05	0.025	0.01	0.005	0.001	0.0005
雙尾 two-tails	1.00	0.50	0.40	0.30	0.20	0.10	0.05	0.02	0.01	0.002	0.001
df											
1	0.000	1.000	1.376	1.963	3.078	6.314	12.71	31.82	63.66	318.31	636.62
2	0.000	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	22.327	31.599
3	0.000	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	10.215	12.924
4	0.000	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.000	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	0.000	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	0.000	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	0.000	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	0.000	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	0.000	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	4.144	4.587
11	0.000	0.697	0.876	1.088	1.363	1.796	2.201	2.718	3.106	4.025	4.437
12	0.000	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	0.000	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	0.000	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	0.000	0.691	0.866	1.074	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	0.000	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	0.000	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	0.000	0.688	0.862	1.067	1.330	1.734	2.101	2.552	2.878	3.610	3.922
19	0.000	0.688	0.861	1.066	1.328	1.729	2.093	2.539	2.861	3.579	3.883
20	0.000	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	0.000	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831	3.527	3.819
22	0.000	0.686	0.858	1.061	1.321	1.717	2.074	2.508	2.819	3.505	3.792
23	0.000	0.685	0.858	1.060	1.319	1.714	2.069	2.500	2.807	3.485	3.768
24	0.000	0.685	0.857	1.059	1.318	1.711	2.064	2.492	2.797	3.467	3.745
25	0.000	0.684	0.856	1.058	1.316	1.708	2.060	2.485	2.787	3.450	3.725
26	0.000	0.684	0.856	1.058	1.315	1.706	2.056	2.479	2.779	3.435	3.707
27	0.000	0.684	0.855	1.057	1.314	1.703	2.052	2.473	2.771	3.421	3.690
28	0.000	0.683	0.855	1.056	1.313	1.701	2.048	2.467	2.763	3.408	3.674
29	0.000	0.683	0.854	1.055	1.311	1.699	2.045	2.462	2.756	3.396	3.659
30	0.000	0.683	0.854	1.055	1.310	1.697	2.042	2.457	2.750	3.385	3.646
40	0.000	0.681	0.851	1.050	1.303	1.684	2.021	2.423	2.704	3.307	3.551
60	0.000	0.679	0.848	1.045	1.296	1.671	2.000	2.390	2.660	3.232	3.460
80	0.000	0.678	0.846	1.043	1.292	1.664	1.990	2.374	2.639	3.195	3.416
100	0.000	0.677	0.845	1.042	1.290	1.660	1.984	2.364	2.626	3.174	3.390
1000	0.000	0.675	0.842	1.037	1.282	1.646	1.962	2.330	2.581	3.098	3.300
z	0.000	0.674	0.842	1.036	1.282	1.645	1.960	2.326	2.576	3.090	3.291
	0%	50%	60%	70%	80%	90%	95%	98%	99%	99.8%	99.9%
	Confidence Level										

信賴水準

APPENDIX B: MP3 Player User Guide
附件 B:MP3 錄音筆的使用指南

On your MP3 player, you will find 4 buttons which are: mode button, play button, hold button and volume button (see Figure A).

在你的 MP3 錄音筆上，有 4 個按鈕，分別是模式鈕、撥放鈕、鎖停鈕和音量控制鈕(參看圖 A)

- The mode button (1) can be used to go forward to the next song (by turning the button right) or backward to the previous song (by turning the button left). This mode button can also be used as an OK button to choose the selection in the root menu by pressing down.

  模式鈕(1)可用來前進轉換到下一首歌（將鈕向右推）或後退至前一首歌（將鈕向左推）。

  這模式鈕也可以用來作為 OK 鈕，藉由按下該鈕來選擇首頁的基本選單。

- The play button (2) is used to play a song or to pause a song. This button is also used to turn the MP3 player on/off.

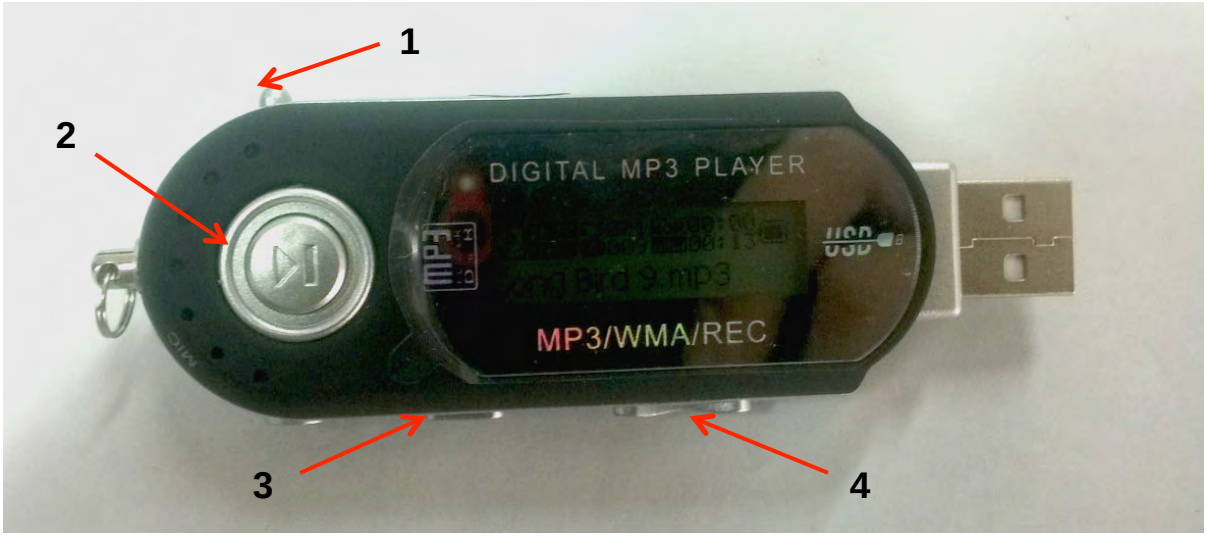
  播放鈕(2)用來播放或暫停一首歌，此鈕也用來開關 MP3 錄音筆。

- The hold button (3) is used to freeze this MP3 player so no button will be responsive as long as the hold button is on the left position.

  鎖停鈕(3)是用來暫停 MP3 錄音筆，當此鎖停鈕在左側的位置其他任何鈕的功能皆無法進行。

- The volume button (4) is used to raise the volume (the + button) or to reduce the volume (the – button)

  音量調節鈕(4)是用來增加音量(+ 鈕)或減低音量(– 鈕)



To play a song, first turn on your MP3 player (by pressing the play button more than 3 seconds), then select music (the musical note icon, spelled MSC) from the main menu (Figure B) then press the mode button on the MP3 player's upper left corner. Here you will find your songbird's song, with each song title numbered according to the respective sonogram. Push the play button to play the song. Turn the mode button right for going forward to the next song, or turn left for going backward to the previous song. You can also hold the button right to fast-forward the song you are listening to and hold left for reversing backward. On the screen upper right corner, you can see the time and duration of the song.

要播放一首歌曲，首先打開 MP3 錄音筆(藉著壓下撥放鈕超過 3 秒以上)，然後選擇音樂(音樂的音符符號，以 MSC 來表達)主選單(圖 B)，然後按下在 MP3 錄音筆左上角的模式鈕。在此你可找到你的鳴禽曲目，每條歌曲皆有根據其聲譜圖進行編號。壓下撥放鈕來播放歌曲。將模式鈕向右推，便會到下一條曲目，或者是向左推來退後到前一條歌。你也可以用鎖停鈕往右來快轉你所聽的歌，亦可用鎖停鈕往左來回轉。在螢幕右上方的角落你可讀取歌曲的播放進行時間及歌曲的長度。

Figure B. MP3 Main Menu

圖 B. MP3 主選單

25th INTERNATIONAL BIOLOGY OLYMPIAD

5 – 13 July 2014

INDONESIA

PRACTICAL TEST 4

ECOLOGY AND ETHOLOGY

生態學及行為學

ANSWER SHEET

答案卷

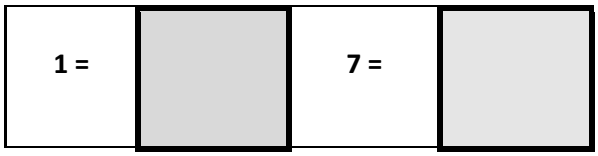
Total points: **100**

Duration: 90 minutes

COUNTRY:	.....
STUDENT:	.....

The answers have to be given either with a tick (√) or with Arabic numbers. The numbers "1" and "7" can look very similar in handwriting. To make sure that those two numbers can be well distinguished by the IBO staff, please write them as you normally would into the following box.

答案可以用打勾(√)或填寫阿拉伯數字。數字 1 及 7 在手寫時常看起來相似，有時會造成混淆，為了讓 IBO 的人員能夠分辨，請將你平時手寫時此兩數字，填在下圖方格中。



Biogeography and Biodiversity

生物地理學及生物多樣性

TASK 1. ISLAND BIOGEOGRAPHY

實作 1. 生物地理學

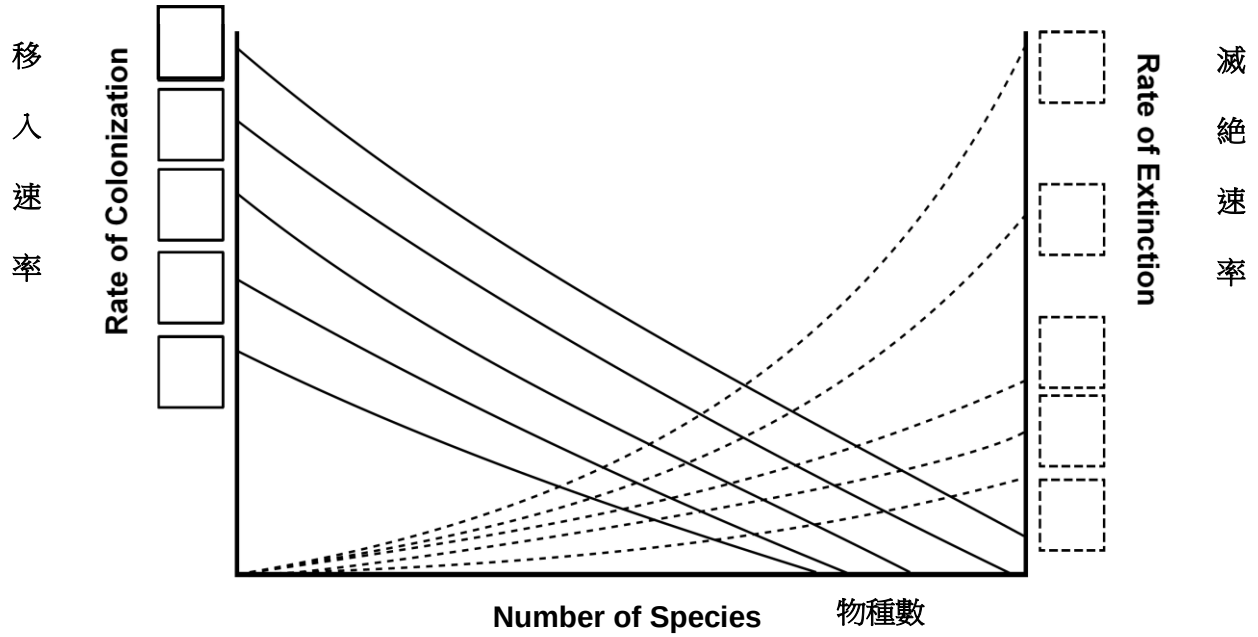
Question 1.1 (5 points: 5 x 1**)**

問題 1.1(5 分: 5 x 1)

No.	Island 島嶼	Distance from mainland (km) 與大陸的距離**(公里)**
1.	Ternate	
2.	Tidore	
3.	Mare	
4.	Moti	
5.	Makian	

Question 1.2 (10 points: 10 x 1). Fill in the boxes along the graph axes with the appropriate island codes**.**

問題 1.2 (10 分: 10 x 1). 在軸線旁的方格中填入適當的島嶼代碼。



Question 1.3 (2 points: 2 x 1)

問題 1.3 **(2 分: 2 x 1)**

Place a tick (√) mark in the box of your selected correct answer.

請將正確答案勾選(√)在適當的方格中。

A	B	C	D	E

TASK 2. PRIMARY SUCCESSION AFTER VOLCANIC ERUPTION
實作 2. 火山爆發後初期演替

Part A : Succession and Plant Community Structure

A 部份：演替及植物群落構造

Question 2.1 (3 points)

問題 2.1 (3 分)

Place a tick (√) mark in the box of your selected correct answer.

請將正確答案勾選(√)在適當的方格中。

A	B	C	D	E

Question 2.2 (5 points; 10 x 0.5)

問題 2.2 (5 分; 10 x 0.5)

Fill in your calculated similarity indices in the boxes provided.

將你所計算出的相似性指標填入下列的方格中。

Year	**1934**	**1949**	**1963**	**1979**	**1991**
1949					
1963					
1979					
1991					

Question 2.3 (2 points)

問題 2.3 (2 分)

Place a tick (√) mark in the box of your selected correct answer.

請將正確答案勾選(√)在適當的方格中。

A	B	C	D	E

Question 2.4 (4 points: 4 x 1)

問題 2.4 (4 分: 4 x 1)

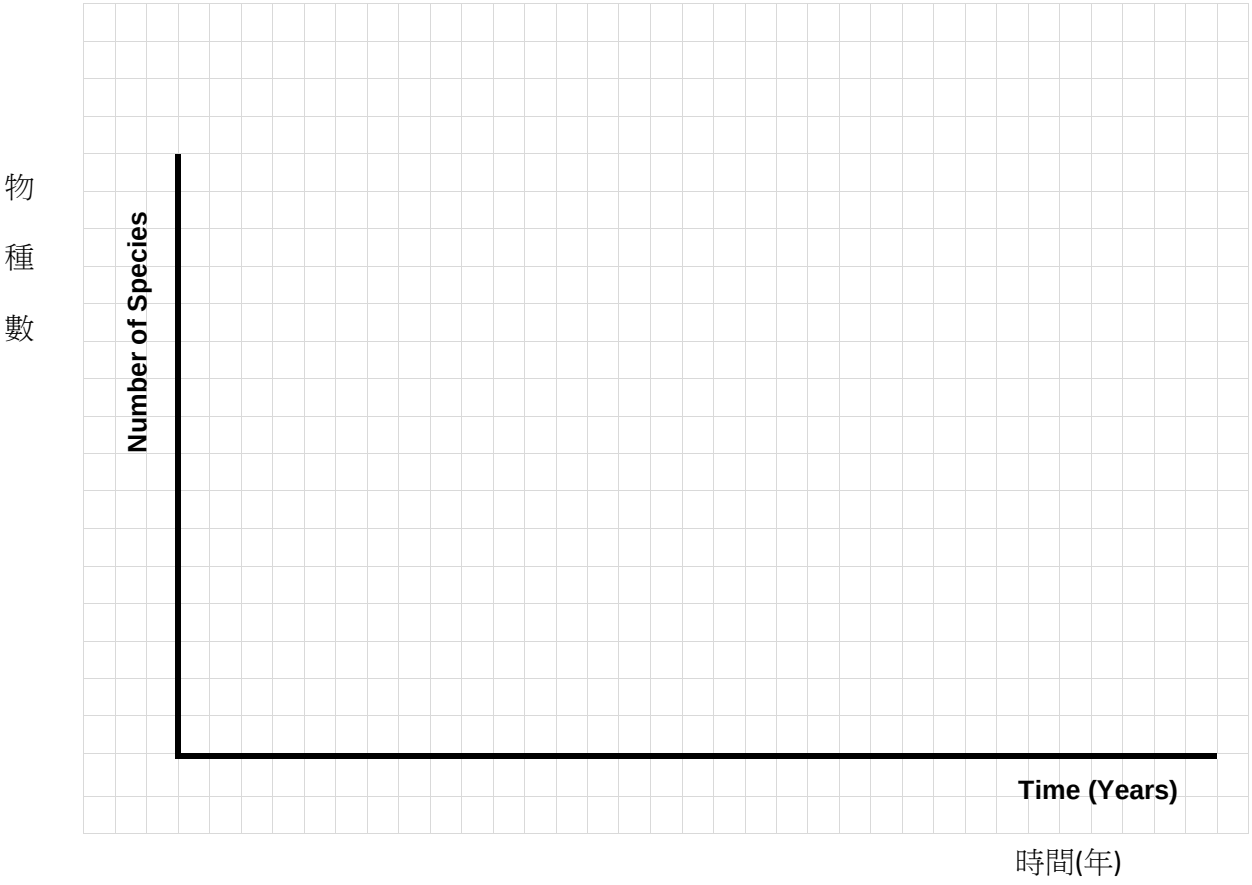
Place a tick (√) mark in the box of your selected correct answer.

請將正確答案勾選(√)在適當的方格中。

Statement 敘述	True 正確	False 錯誤
A		
B		
C		
D		

Question 2.5 (6 points)

問題 2.5 (6 分)



Question 2.6 (2 points: 2 x 1)

問題 2.6 (2 分: 2 x 1)

Place a tick (√) mark in the box of your selected correct answer.

請將正確答案勾選(√)在適當的方格中。

Statement 敘述	True 正確	False 錯誤
A		
B		

Part B : Dispersal Biology of *Ficus*
B 部份：榕屬植物散佈生物學

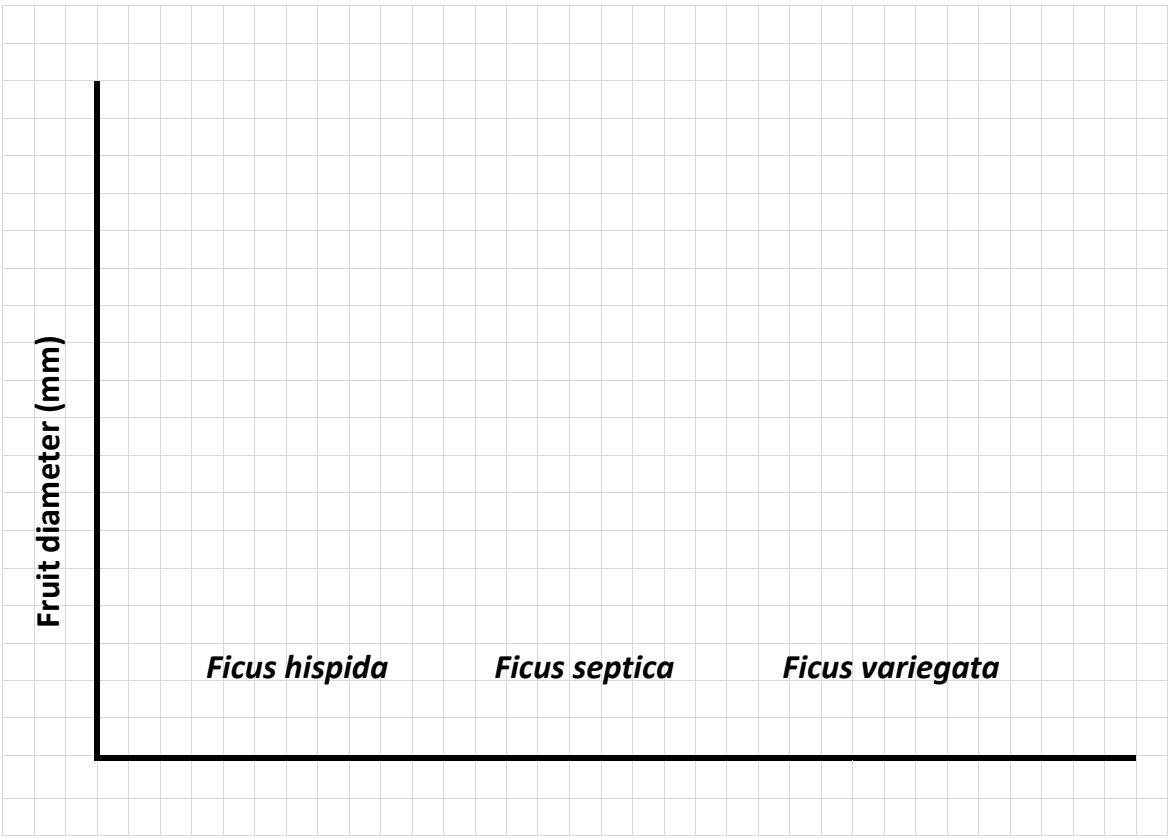
Question 2.7. (15 points)
問題 2.7. (15 分)

Fruit Serial Number 果實編號	Fruit Diameter (mm) 果實直徑(公厘)		
	Ficus hispida	*Ficus septica*	*Ficus variegata*
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
Mean 平均值			
Std. Dev. 標準差			

Question 2.8. (8 points)

問題 2.8. (8 分)

果實直徑(公厘)



Question 2.9 (4 points: 4 x 1)

問題 2.9 (4 分: 4 x 1)

Place a tick (√) mark in the box of your selected correct answer:

請將正確答案勾選(√)在適當的方格中。

Statement 敘述	True 正確	False 錯誤
A		
B		
C		
D		

Question 2.10 (3 points: 3 x 1)

問題 2.10 (3 分: 3 x 1)

Place a tick (√) mark in the box of your selected correct answer:

請將正確答案勾選(√)在適當的方格中。

Statement 敘述	True 正確	False 錯誤
A		
B		
C		

TASK 3. SPECIATION IN SONGBIRDS

實作 3. 鳴禽的種化

Question 3.1 (1 point)

問題 3.1 (1 分)

Place a tick (√) mark in the box of your selected correct answer.

請將正確答案勾選(√)在適當的方格中。

A	B	C	D	E

Question 3.2 (18 points: 9 x 2)
問題 3.2 (18 分: 9 x 2)

Songbird Number 鳴禽編號	Syllable Repertoire 曲目中不同的音節數
1	
2	
3	
4	
5	
6	
7	
8	
9	

Question 3.3 (3 points: 3 x 1)

問題 3.3 (3 分: 3 x 1)

Group 群	Songbird Number 鳴禽編號
A	
B	
C	

Question 3.4 (8 points: 2 x 4)

問題 3.4 (8 分: 2 x 4)

	Group .... 群	**Group .... 群**
Mean within group 群內平均值		
Variance within group 群內變方		

Calculated t-value 計算的 t 值	
Table t-value t 表內的 t 值	

Question 3.5 (1 point)

問題 3.5 (1 分)

Place a tick (√) mark in the box of your selected correct answer.

請將正確答案勾選(√)在適當的方格中。

A	B

_____ END OF PAPER _____