Country _____	Competitor# __ __ __

16th International Biology Olympiad

Beijing

July 2005

Practical Examination

Part III

Total time available: 90 minutes

The 16th IBO Practical Tests (實作題)

First name (名):

Last name (姓):

Country (國):

Code (考生編號):

Important:

1. Write your name and code on both task paper and answer paper sheets.
2. Make sure that all the results should be written on the answer paper unless otherwise instructed.
3. There are 4 parts in practical test. Each part has 90 min. You should start your **first** test according to last digit of your competitor code. For example, if you have a code of 221, your first practical test will be part I, if you have a code of 223, your first practical test will be part III.
4. Your **second** practical test is as follows: competitors from part I and part II switch labs; competitors from part III and part IV switch labs;
5. You go to your **third** practical test according to the following rules:

   If the last digit of your competitor code is 1, you go to practical test part III.

   If the last digit of your competitor code is 2, you go to practical test part IV.

   If the last digit of your competitor code is 3, you go to practical test part I.

   If the last digit of your competitor code is 4, you go to practical test part II.

You should follow the instructions from your guides when switching labs.

重要指示：

1. 在試卷及答案卷上都必須要寫姓名及考生編號。

2. 除非另有指示，所有答案必須要寫到答案紙上。

3. 實作題分為四個部分，每部分 **90** 分鐘。考生編號的最後一位數字，就是你應該開始的第一個實作部分。例如編號 **221** 的考生，第一個實作題是第一部分，編號 **223** 的考生，第一個實作題是第三部分。

4. 有關你第二個實作題的指示如下：第一部分與第二部分的考生交換實驗室；第三部分與第四部分的考生交換實驗室。

5. 有關你第三個實作題，必須遵守的指示如下：

如果考生編號的最後一位數字是 **1**，你應該做第三部分。

如果考生編號的最後一位數字是 **2**，你應該做第四部分。

如果考生編號的最後一位數字是 **3**，你應該做第一部分。

如果考生編號的最後一位數字是 **4**，你應該做第二部分。

在轉換實驗室時，必須遵守助教的指示。

Practical Exam Part-III (實作題：第三部分)

Animal anatomy and ecology (動物解剖及生態)

This part contains three tasks:

Task 1, determination of distribution pattern and estimation of population size. (16 Points)

Task 2. Classification of insects. (9.8 points)

Task 3, Shrimp anatomy (14.2 points)

此部分共包括三大題：

第一大題：決定動物分佈的類型並估計族群的大小（16 分）

第二大題：昆蟲的分類（9.8 分）

第三大題：蝦的解剖（14.2 分）

Task 1: Determination of distribution pattern and population size (16 points)

Introduction

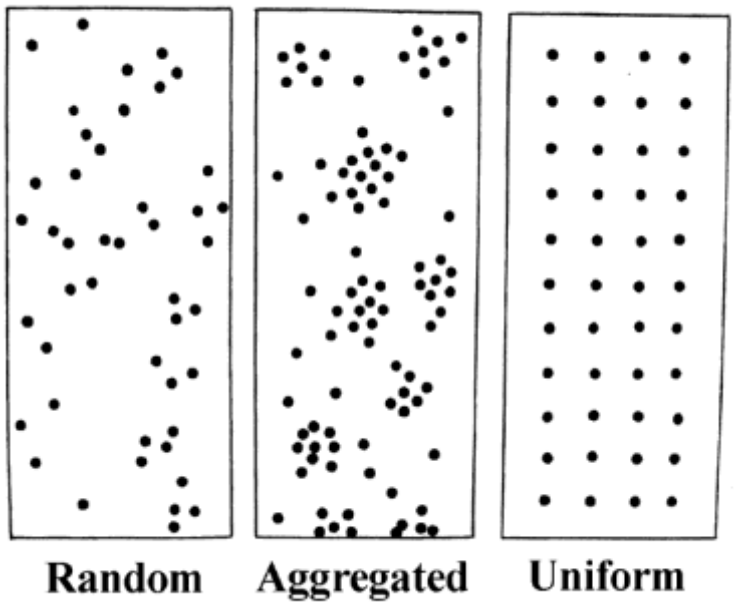
Tenebrio molitor is an insect and belongs to Coleoptera. It is living in places for food storage such as barns. A majority of life span of *T. molitor* is in its larval stage and its adult stage is quite short. In this experiment, you will study two ecological aspects of *T. molitor*: population distribution pattern and population size.

Distribution pattern of a population describes spatial relationship of individuals of the population. It is also useful in establishing a reliable sampling method for the interested populations. Generally speaking, there are three types of distribution patterns: random distribution, uniform distribution and aggregated (clumped) distribution (see the figure below)

第一大題：決定動物分佈的類型並估計族群的大小（16 分）

說明

黃粉甲蟲(*Tenebrio molitor*)屬於鞘翅目的一種昆蟲，生活於穀倉等儲存糧食的地方，生活史中大多為幼蟲期，成蟲期極短，在本實驗中要作黃粉甲蟲(*T. molitor*)二個生態的研究：族群的分佈類型及數量。一個族群的分佈類型代表著其個體在空間中的關係，並且在建立可靠的取樣方法上極為有用，一般來說，有三種分佈類型：隨機分佈、均勻分佈、叢生分佈（請看下圖）。



隨機　　叢生　　均勻

If you divide an area into smaller and identical squares and count individuals in each square, you will be able to distinguish the distribution patterns. If the distribution pattern is uniform, the square deviation (S^2) of your sampling will be zero. If the distribution pattern is random, you will get a typical Poisson distribution in your sampling. If the distribution pattern is aggregated, you will not be able to obtain a Poisson distribution in your sampling. Thus, it is possible to distinguish the three distribution patterns according to square deviation (S^2) and averages of your sampling (m).

假如你把一個區域分成較小而且的相等的方格並計算每個方格中的個體數，你就能區分以上的分佈類型。如果是均勻分佈，樣本的均方(S^2) 將為零；如果是隨機分佈，將會得到典型的 Poisson 分佈；假如是叢生分佈，你的樣本就不會得到 Poisson 分佈。因此，可以根據以樣本的均方(S^2)及平均(m)來區別這三種分佈的類型。

If $S^2/m=0$，It is uniform distribution； 若 $S^2/m=0$，是均勻分佈

If $S^2/m=1$，it is random distribution； 若 $S^2/m=1$，是隨機分佈

If $S^2/m>1$，It is aggregated distribution。 若 $S^2/m>1$，是叢生分佈

Here, $m = (X_1+X_2+\ldots+X_n)/n$

$S^2=[(X_1-m)^2+(X_2-m)^2+\ldots+(X_n-m)^2]/(n-1)$

X_1，X_2，…X_n represent the number of individuals in the square 1, 2, …. and square n, respectively, and n represents total number of squares you sampled.

X_1，X_2，…X_n 分別代表方格 1, 2, ….及方格 n 中的個體數目，n 代表你所取樣的方格總數。

Materials 材料方法:

A printed photo of a tray containing some *T. molitor* is provided. The tray is divided into 7 x 7 squares.

Task: determine the distribution pattern of *T. molitor*.

一張照片顯示一個搪瓷盤中放入黃粉甲蟲(*T. molitor*)，搪瓷盤分成 7x7 的方格作為計數方式

任務：決定黃粉甲蟲(*T. molitor*)分佈的類型

Procedure　實驗步驟

Count the number of the larva in A1, A4, B7, C5, D2, D7, E3, F1, F6, and G3 (total number of squares is 10), and determine the distribution pattern according to the formula provided above.

計數在 A1, A4, B7, C5, D2, D7, E3, F1, F6 和 G3 方格(共 10 個方格)中的黃粉甲蟲(*T. molitor*)總數

Answer the following questions:　　回答下列問題：

Question 1. The value of S^2/m is: (2 points)　問題 1：求 S^2/m 的值 (2 分)

A.0.1

B.0

C.1

D.3.4

Question 2. The distribution pattern is (2 points)

問題 2：判斷黃粉甲蟲(*T. molitor*)族群分佈類型

A. uniform distribution　　均勻分佈

B. random distribution　　隨機分佈

C. aggregated distribution　　叢生分佈

Question 3. Which of the following will alter the answer of question 2 above: (2 points)（**Note, there could be more than one answer**）

問題 3：**(多選) 下列哪些方法會改變上題中族群分佈類型的判斷？**

A. Choose the same 10 squares in sampling, but reverse the sequential order in your sampling (i.e. start from G3 and finish with A1).

仍選取相同的 10 個方格，但將取樣的順序倒過來

B. Choose only the four corner squares (A1, A7, G1 and G7) in sampling and

calculate S^2 and m to determine the distribution patterns.

只選取位於角落的 4 個方格(A1, A7, G1 和 G7)來計算

C. Choose only the central five squares (D3, D4, D5, C4 and E4) in sampling and calculate S^2 and m to determine the distribution patterns.

只選取位於中央的 5 個方格來計算

D. Redo the sampling by choosing 10 squares randomly and calculate S^2 and m to determine the distribution patterns.

重新隨機取樣 10 個方格

Question 4. Which of the following descriptions about the relationship between population distribution pattern and individuals of the population is accurate? (2 points)

問題 4：下列有關族群分佈和族群內個體關係的描述，何者正確？

A. Repulsion among individuals of a population would lead to uniform distribution,

個體間互相排斥時會出現均勻分佈

B. Repulsion among individuals of a population would lead to random distribution,

個體間互相排斥時會出現隨機分佈

C. Attraction among individuals of a population would lead to uniform distribution,

個體間互相吸引時會出現均勻分佈

D. When the position of each individual is independent of other individuals, it would lead to aggregated distribution.

個體間互相吸引時會出現叢生分佈

E. When the position of each individual is independent of other individuals, it would lead to uniform distribution.

個體間為互相獨立時會出現均勻分佈

The following is to estimate population size　估計族群數目

Population size is one of the most important factors in population ecology. A very useful tool to estimate population size is Mark-recapture method. In this method, animals are trapped and captured. The captured animals are marked with tags, collars, etc, and released immediately. After certain period of time, traps are set again to capture animals from same population. A proportion of marked (recaptured) animals in the second trapping is assumed equivalent to the proportion of marked animals in the total population. The population size (N) can be estimated by the following equation:

$N=M\times R/P$

Where M is the number of marked individuals in first capture, R is the number of individuals in second capture, P is the number of individuals in second capture that are marked.

在族群生態學中族群數目是一個很重要的因子，族群數目的統計方法有許多種，其中標記再捕法是動物族群數量估計中常用的方法。在某地區有一動物族群，其個體數量為 N，第一次捕獲進行標記的個體數量為 M，放回經過一段時間後，再捕獲的個體數量為 R，其中有標記的個體數量為 P。族群總數中標記個體的比例 (M/N) 與再捕取樣中標記個體的比例 (P/R) 相同，由此可以估計族群的總數為　$N= M \times R / P$

In the population of *T. molitor*, 100 individuals are marked with red dots near their tails. These marked *T. molitor* were first released and mixed with other individuals of the population. A second capture was performed and the result is shown in the printed photo provided.

在黃粉甲蟲(*T. molitor*)族群中，利用紅色標記的個體有 100 隻，放回後再捕獲的結果顯示於相片中。

Question 5. The population size of the *T. molitor* is: (3 points)

問題 5：黃粉甲蟲(*T. molitor*)的族群數量 (3 分)

A. 550

B. 600

C. 610

D. 627

Question 6. In mark-recapture method, it is assumed that the ratios of M/N and P/R are identical. Which of the following is/are required to assure accurate estimation of population size? (3 points) **Note, there could be more than one correct answer.**

問題 6：在標記再捕法中假設總體中標記個體的比例(M/N)與再捕取樣中標記個體(P/R)的比例相同，下列哪些是確保這種估計方法正確所必須的條件？**(多選)**

A. The marking method should not alter animal's normal activity.
標記方法必須不影響動物的正常活動

B. ~~Population~~ Immigration occurs regularly.
遷移是有規律的發生

C. No birth and no death during the experimental period.
在實驗期間沒有個體的出生或死亡

D. The population should have a uniform distribution.
族群應為均勻分佈

E. The marks on the organisms should last longer than the experimental time.
在蟲體上標記維持的時間應較實驗時間為長

Question 7. If after the experiment, additional information is obtained that 40 individuals died and 30 individuals moved in between marking and recapture, the new estimated population size would be? (2 points)

問題 7：假如實驗後，發現在做完標記與再捕取樣之間有 40 隻個體死亡，30 隻新個體遷入，那麼所估計的族群數量將為何？

A. Equal to what you obtained in question 5.

等於問題 5 所得到的族群數量

B. Equal to or smaller than you obtained in question 5.

小於或等於問題 5 所得到的族群數量

C. Equal to or smaller than you obtained in question 5.

小於或等於問題 5 所得到的族群數量

Task 2. Classification of insects. (9.8 points)

Instruction

There are seven specimens of beetles in the tray on your table. You are required to name each of them according to the key next page. You will need to use stereoscope, forceps and needle. **Note, damage of specimen will lead to point subtraction from your final score of practical test.**

第二大題：昆蟲的分類（9.8 分）

指示：在你桌上的盤中有七個甲蟲的標本（代號及學名如下），請根據下面的檢索表分別為牠們命名，你可以使用顯微鏡、鑷子、解剖針。**特別注意：如果你損壞了標本，將會被扣分。**

A. ***Opatrum subaratum*** Faldermann

B. ***Blaps femoralis femoralis*** Fischer-Waldheim

C. ***Coccinella septempunctata*** Linnaeum

D. ***Potosia brevitarsis*** **(Lewis)**

E. ***Popillia quadriguttata*** **(Fairmaire)**

F. ***Polyzonus fasciatus*** **(Fairmaire)**

G. ***Chrysochus chinensis*** **Baly**

Question 8. Fill in the table below according to your classification result and mark them on your answer sheet: (1.4 x 7 = 9.8 points)

8. 將你分類的結果填入下表，別忘了答案一定要畫在你的答案卷上

Beetle 甲蟲	Answer A-G 答案代號
①	
②	
③	
④	
⑤	
⑥	
⑦	

Key to 7 species of beetles

1 Tarsus of fore legs, middle legs and hind legs have 5-5-4 segments.....**2**

Tarsus segments of foreleg, middle leg and hinder leg are 5-5-5 or 4-4-4 segments….....**3**

2 Body size small and flat; there is a triangular notch at anterior edge of the labrum; wing tip at end of wing case invisible..... ***Opatrum subaratum*** Faldermann

Body size large and elevated; straight at anterior edge of the labrum; wing tip visible at end of wing case in male individual ..... ***Blaps femoralis femoralis*** Fischer-Waldheim

3 Tarsus have 4-4-4 segments; body semicircular; there are 7 black round dots on the wing cases……..***Coccinella septempunctata*** Linnaeum

Tarsus have 5-5-5 segments; body not semicircular…….. **4**

4 3rd through 8th antennal segments are lamellate (branchial).……..……..**5**

Antennal segments threadlike …… **6**

5 There is a notch at base of each wing case; there are many whiteand downy dots in shapes of stripes, clouds, or waves on the pronotum and wing cases…...…… ***Potosia brevitarsis*** **(Lewis)**

There is no notch at base of wing cases; no downy dots on the pronotum and wing cases……..…….……***Popillia quadriguttata*** **(Fairmaire)**

6 Body elongate and cylinder-like; compound eyes are reniform; antenna at frontal processes; there are 2 yellowish transverse strips on each wing case……***Polyzonus fasciatus*** **(Fairmaire)**

Body thickset and oval; round compound eyes; body color deep green, blue, glaucous or indigo; no transverse strips on wing cases……..…***Chrysochus chinensis*** **Baly**

七種甲蟲的檢索表

1 第一、二、三對腳的跗節各有 5- 5- 4 節.....**2**

第一、二、三對腳的跗節各有 5- 5- 5 節或 4 - 4 - 4 節 ….....**3**

2 體型小而扁平；下唇前緣有一個三角形缺口；翅的尖端被鞘翅蓋住不可見

..... ***Opatrum subaratum*** Faldermann

體型大而隆起；下唇前緣呈直線；在雄性個體鞘翅可以見到翅的尖端

..... ***Blaps femoralis femoralis*** Fischer-Waldheim

3 跗節各有 4 - 4 - 4 節，身體半圓形，鞘翅上有七個圓點 …..***Coccinella septempunctata*** Linnaeum

跗節各有 5-5-5 節，身體非半圓形……..... **4**

4 觸角的第三至第八節呈多層(分枝狀)…….……..……..……..**5**

觸角的各節呈線狀…….…… **6**

5 鞘翅基部各有一個缺口；前胸背板及鞘翅上有許多長條形、雲狀、波浪狀等白色絨毛狀斑點.……. ***Potosia brevitarsis*** **(Lewis)**

鞘翅基部沒有缺口；前胸背板及鞘翅上沒有斑點……***Popillia quadriguttata*** **(Fairmaire)**

6 身體細長呈圓柱狀，複眼腎形，觸角位於額突上，鞘翅上各有兩條黃色橫帶……***Polyzonus fasciatus*** **(Fairmaire)**

身體細長呈粗壯卵圓形，複眼圓形，身體藍綠色或紫藍色，鞘翅上無橫帶

……..…***Chrysochus chinensis*** **Baly**

Task 3. Anatomy of a shrimp (14.2 points)　第三大題：蝦的解剖（14.2 分）

Introduction　指示

Shrimps belong to Crustacea in Arthropoda. They have heteronomous segmentation. The shrimp provided for your exam has a body of 21 segments with exoskeleton and jointed appendages.

蝦屬於節肢動物門甲殼綱，身體各體節有不同的形態(異律分節，heteronomous)。實驗所提供的蝦子由 21 個體節組成，有堅硬的外骨骼，附肢具關節，附肢的形態因適應而有很大的變化。

Materials and instruments　材料及指示

1. One shrimp.　**Note:** you only have one shrimp.
2. Stereoscope
3. Scissors, needle, forceps, insect needles, operational knife.
4. Wax tray

1. 蝦一隻　**注意：你只有這一隻**
2. 解剖顯微鏡
3. 解剖用具：剪刀、解剖針、鑷子、昆蟲針、解剖刀
4. 解剖盤

Experiment　實驗

Experiment contains two parts: external anatomy of the shrimp and nervous system anatomy of the shrimp.

本實驗含兩部分：蝦的解剖及神經系統

(1) External anatomy　　外部形態

Observe the shrimp carefully and answer the following questions.

仔細觀察並回答下列問題：

Question 9. How many pairs of appendages are there in shrimp's head, thorax and abdomen, respectively? (2 points)

問題 9：蝦的頭部、胸部及腹部各有幾對附肢？

A. 2, 4, 10

B. 5, 8, 6

C. 4, 5, 8

D. 3, 6, 7

Question 10. Find the mouthparts of the shrimp and separate the appendages that form mouthparts.

How many appendages are the mouthparts composed of? (2 points)

問題 10：完整的取下蝦口器的附肢，口器是由幾對附肢組成？

A. 1

B. 2

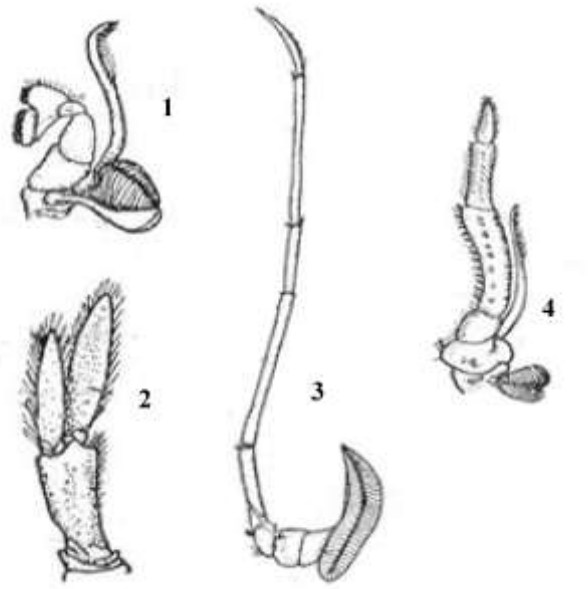
C. 3

D. 4

E. 5

Questions 11-12. Observe the schematic structures of appendages in the figure below.

問題 11-12：觀察下圖中附肢的構造，判斷其功能



Question 11. Could you find all of these appendages on the shrimp provided to you? (2 points)

問題 11：你能找出圖中所有的附肢嗎？

A. Yes

B. No

Question 12. Sequentially from appendage 1 through appendage 4 shown in the figure, the main functions of these appendages are: (2 points)

問題 12：上圖中附肢 1 到附肢 4 的功能分別為何？

A. 1: Walking, 2: swimming, 3: sensing and holding, 4: sensing and holding

B. 1: Swimming, 2: sensing and holding, 3: swimming, 4: sensing and holding

C. 1: sensing and holding, 2: swimming, 3: walking, 4: sensing and holding

D. 1: sensing and holding, 2: sensing and holding, 3: swimming, 4: walking

A. 1: 步行, 2: 游泳, 3: 感覺及捉握, 4: 感覺及捉握

B. 1: 游泳, 2: 感覺及捉握, 3: 游泳, 4: 感覺及捉握

C. 1: 感覺及捉握, 2: 游泳, 3: 步行, 4 感覺及捉握

D. 1: 感覺及捉握, 2: 感覺及捉握, 3: 游泳, 4: 步行

Anatomy of nervous system of the shrimp 蝦神經系統的解剖

Dissect the shrimp and locate the nerve cord. Answer the following questions.

解剖蝦找出神經索，並回答下列問題：

Question 13. The nerve cord of the shrimp is located at: (2 points)

問題 13：蝦的神經索位於何處？

A. Dorsal side of the anterior of the body. 身體前半部的背側

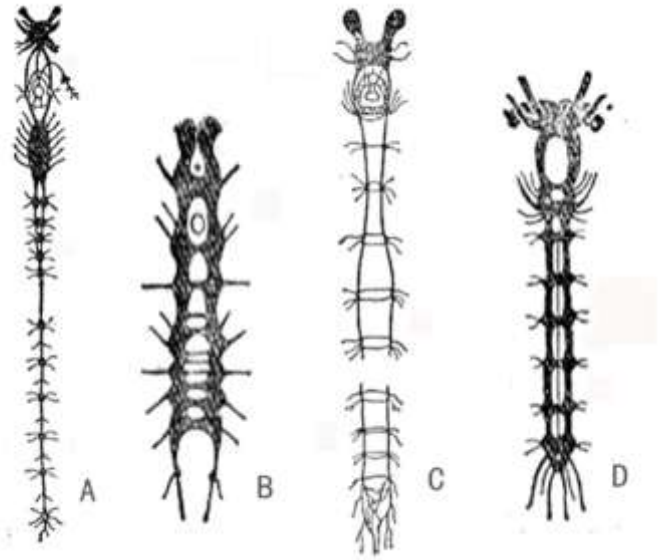
B. Ventral side of the posterior of the body. 身體後半部的腹側

C. Ventral side of the whole body of the shrimp. 蝦全身的腹側

D. Dorsal side of the whole body of the shrimp. 蝦全身的背側

Question 14. There are 4 types of nervous systems schematically shown in the figure below.

問題 14：下圖為四種神經系統類型的圖示



Which nervous system is the nervous system of the shrimp you observed identical to? (4.2 points)　你所觀察蝦的神經系統與何者為同一類型？

A. Nervous system A.　神經系統 A

B. Nervous system B.　神經系統 B

C. Nervous system C.　神經系統 C

D. Nervous system D.　神經系統 D