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16 International Biology Olympiad

Beijing

July, 2005

Practical Examination

Part III

Total time available: 90 minutes

The 16th IBO Practical Tests

First name: Last name Country:

Code: 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

   exchange labs; competitors from part III and part IV exchange 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.

Practical Exam   Part-III **Animal anatomy and ecology**

This part contains three tasks:

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

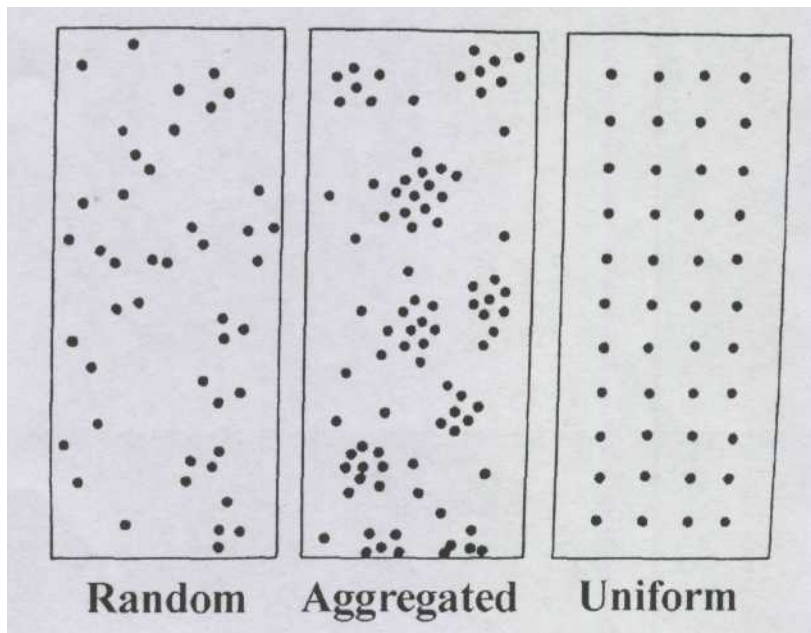Task 2. Classification of insects. (9.8 points)

Task 3, Shrimp anatomy (14.2 points)

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)

Random   Aggregated   Uniform

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).

If $S^2/m=0$, It is uniform distribution; If

$S^2/m=1$, it is random distribution; If S^2/m

>1, It is aggregated distribution。Here, m

$= (X_1+X_2+.. .+X_n)/n$

$S^2=[(X_1-m)^2+(X_2-rn)^2+...+(X_n-m)^2]/(n-l)$

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.

Materials:

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*.

Procedure

Count the number of the larva in Al, A4, B7, C5, D2, D7, E3, Fl, F6, and G3 (total

number of squares is 10), and determine the distribution pattern according to the

formula provided above.

Answer the following questions:

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

    A. 0.1

    B. 0

    C. 1

    D. 3.4

Question 2. The distribution pattern is (2 points)

      A. uniform distribution

      B. random distribution

      C. aggregated distribution

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

    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).

    B.   Choose only the four corner squares (Al, A7, Gl and G7) in sampling and calculate S^2 and m to determine the distribution patterns.

    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.

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

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

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

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

distribution,

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

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

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

The following is to estimate population size

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.

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.

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

    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.**

   A. The marking method should not alter animal's normal activity.

   B. Population immigration occurs regularly.

   C. No birth and no death during the experimental period.

   D. The population should have a uniform distribution.

   E. The marked time should not be shorter than the experimental time.

Question 7. If (1) it is found that 40 individuals are dead and 30 new individuals are added before recapture, (2) it is impossible to tell if the dead individuals are marked or not, (3) the new individuals are not marked, (4) recapture result is same as above, and (5) other conditions are same as above, the population size would be? (2 points)

A. Larger than you obtained in question 5.

B. Smaller than you obtained in question 5.

C. Impossible to determine.

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.**

A. *Opatrum subaratum* Faldermann

B. *Blaps femoralis femoralis* Fischer-Waidheim

C. *Coccinella septempunctata* Linnaeum

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

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

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

G. *Chtysochus 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)

Beetle	Answer A-G
1	
2	
3	
4	
5	
6	
7	

Key to 7 species of beetles

1 Tarsus segments of fore legs, middle legs and hind legs are type 5-5-4.

   Tarsus segments of foreleg, middle leg and hinder leg are type 5-5-5 or type 4-4-4 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 segments are type 4-4-4; body semicircular; there are 7 black round dots on the wing

   cases ....*Coccinella septempunctata* Linnaeum

   Tarsus segments are type 5-5-5; body not semicircular 4

4 3rd through 8th antennal segments are branchial.. 5

   Antennal segments threadlike 6

5 There is a notch at base of each wing case; there are many whiteand downytdots 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

Task 3. Anatomy of a shrimp (14.2 points)

Introduction

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.

Materials and instruments

1. One shrimp. **Note:** you only have one shrimp.

2. Stereoscope

3. Scissors, needle, forceps, insect needles, operational knife.

4. Wax tray

Experiment

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

(1) External anatomy

Observe the shrimp carefully and answer the following questions.

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

    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
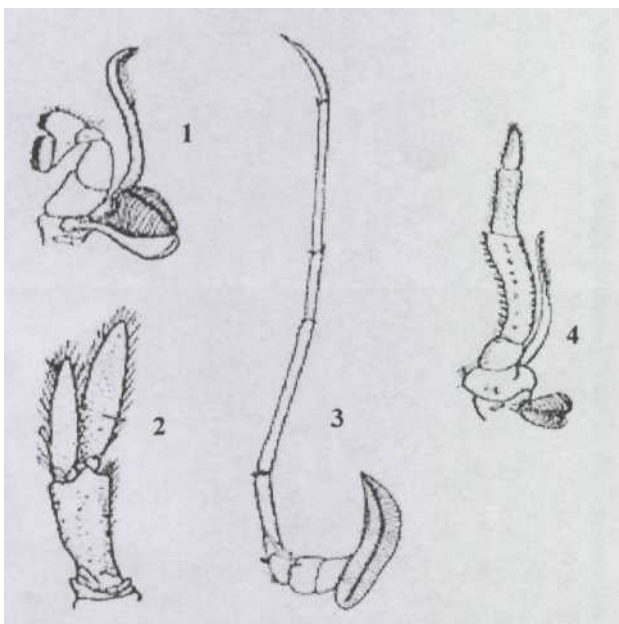
composed of? (2 points)

A. 1

B. 2

C. 3

D. 4

E. 5

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

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

(2 points)

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)

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

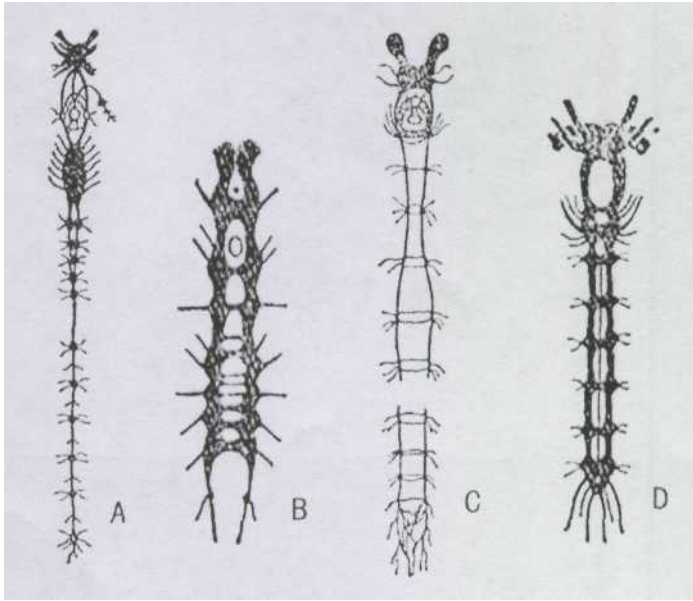D. 1: sensing and holding, 2: sensing and holding, 3: swimming, 4: walking

Anatomy of nervous system of the shrimp

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

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

A. Dorsal side of the anterior of the body.

B. Ventral side of the posterior of the body.

C. Ventral side of the whole body of the shrimp.

D. Dorsal side of the whole body of the shrimp.

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

Which nervous system is the nervous system of the shrimp you observed identical to?

(4.2 points)

A. Nervous system A.

B. Nervous system B.

C. Nervous system C.

D. Nervous system D.