

Test Bank Sample for Insect Ecology
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Calculator is allowed (translator is not allowed)

1. If some higher school students want to develop some science projects for their science exhibition. What will you suggest them to do on the subject of “insect ecology”?
2. Please explain the “Trophic relationships” in the ecological studies. How can you adapt the idea of “Tri-Trophic relationships” for pest control?
3. Almost all plants can produce various volatiles. What are the possible roles these volatiles may play? How can we adapt the specific plant volatiles for pest management?
4. “Fitness” can be interpreted by different ways. However, in biology or ecology field, fitness indicates a very unique meaning (an individual's ability to propagate its genes). Please try to design an experiment (briefly) to evaluate the effects of temperature on insect's fitness.
5. 影響昆蟲棲群密度變動之內在、外在因素有哪些？試闡述之。
6. 在作昆蟲生命表時常求其族群介量（population paramant），試述各族群介量之意義。
7. 何謂生態功能群（ecological functional group），請舉例說明之。
8. 為何農業生態系較自然生態系更易受害蟲為害？請舉例說明。
9. 試從攻擊與防禦的論點闡述捕食者與獵物間的關係與交互作用。
10. Please explain the term “plants as insect food: not ideal” (from view of plant nutrition and chemistry).
11. If some higher school students want to develop some baits for the common indoor ants found in Taiwan. What will you suggest them to do? What are the main components and their functions of these components in the baits?
12. Please describe the possible roles microorganisms may have on insects.
13. Why some insects become pests and what are the strategies you think can be used in pest management for organic crops?
14. Please explain the following phrase “diversification holds the clue to the control of pestiferous insects”.
15. 請討論氣候變遷對昆蟲在族群、群聚及生態系等不同階級的潛在衝擊。
16. 請說明「島嶼生物地理學(island biogeography)」理論，但是近年來為何我們改以「關聯族群（metapopulation）」理論，來探討與解釋分割棲所中昆蟲族群的變化？
17. 要瞭解昆蟲猖獗的時機及週期性是不容易的，請問影響族群發生的限制因子

- 或機制是什麼，闡述昆蟲棲群動態之涵義，並述評棲群密度變動之數種學說。
18. 試述社會性昆蟲如何互相交換訊息。
 19. 試從 Cost-benefit 觀點，說明選汰壓力對昆蟲體型大小的影響。
 20. Discuss the relative importance of insects as beneficial and deleterious components of ecosystems in relation to insect-human interaction. (10%)
 21. Natural enemy has been of fundamental basic in developing biological control measure in pest management. Discuss the factors (or components) for a successful biological control program.
 22. In your opinion, is there any conflict between today's agricultural productivity and biodiversity conservation? IF yes, using an example, discuss how can they be mitigated?
 23. The importance of climate change as a central theme in insect ecology has been recognized in these recent decades. Discuss the impacts on insects and what are the future researches in ecology that you may want to propose?
 24. Please explain the theory of co-evolution between insects and plants, are there lots of evidences to support this theory?
 25. Please explain the interspecific interaction types?
 26. Spatial distribution is an important part of ecology. Please describe the basic distribution patterns.
 27. What is the idea about "weed control by herbivorous insects"?
 28. Exponential growth and logistic growth are the basic models of population growth. Please give a thorough discussion on them.
 29. "Induced defense hypothesis" is one of the hypotheses on "plant and herbivore interactions". It means plant can be induced by intruders to produce something for defense. Lately, the induced defense has been separated into two types; (1) direct induced defense, and (2) indirect induced defense. Please explain what these two induced defenses are.
 30. The question about how nutritious is the food provided by a plant in terms of growth rate of larvae and ultimate mass and fecundity of herbivores is called "nutritional ecology". Please describe the major measurements (RGR, RCR, ...) researchers will take in "nutritional ecology" research.
 31. Above-ground and below-ground insects may be separated by feeding locations; but some interactions may occur between them. Please describe some possible interactions may happen between the above-ground and below-ground insects.

32. Please explain the term “plants as insect food: not the ideal” (from the view of plant chemistry)
33. Plants may produce some allelochemicals (secondary compounds) for defense against feeding of insect herbivores. However, insects specialize on the plant may be able to overcome this chemical obstacle. What are the possible ways the specialized insects deal with these potential harmful chemicals?
34. If a higher school student asks you to help to develop an artificial diet for *Pieris rapae* (cabbage white butterfly), what will you suggest him to do? What are the main components and their functions of these components you think are necessary to combine in the diet?
35. The term “Trophic relationships” was used frequently in the ecological studies. Please explain “Trophic relationships” and can you give some examples for the “Trophic relationships”?
36. “Fitness” can be interpreted by different ways. However, in biology or ecology field, fitness indicates a very unique meaning. Please identify what “fitness” means in ecological research?
37. Plant chemistry (phytochemistry) can be divided into primary and secondary metabolites. Please define primary and secondary metabolites and what are their possible roles in plant biochemistry?
38. Plant secondary metabolites may have multiple functions, please summarize what are the major three functions they are involved in many biotic and abiotic environmental factors.
39. What are “alkaloids” and what are their possible effects on insect herbivores?
40. What are “terpenoids” and what are their possible effects on insect herbivores?
41. What are “phenolics” and what are their possible effects on insect herbivores?
42. What are “glucosinolates” and what are their possible effects on insect herbivores?
43. What are “cyanogenics” and what are their possible effects on insect herbivores?

44. Almost all plants can produce various volatiles. What are the possible roles these volatiles may play?
45. To avoid self-toxic by the defensive chemicals, plant may store these toxic chemicals in cell compartments that are remote from metabolism (cell walls and vacuoles). Glucosinolates and the hydrolysis enzyme are store separately, please explain the story of “glucosinolates and the hydrolysis enzyme-myrosinase”.
46. Herbivores are confronted with relatively large amounts of noxious chemicals in their plant food. To avoid these chemicals’ harmful effects, herbivores have evolved different physiological mechanisms. Please describe the ways herbivores used to detoxify plant allelochemicals.
47. Food plant quality of herbivores may be affected by some environmental factors. Please discuss how some of the environmental factors, such as drought, air pollution, may affect insect’s host plant quality.
48. Please describe the possible roles microorganisms may have on insect-plant interactions.
49. Please give some examples about the application of molecular methodology on studying insect-plant interactions (molecular ecology).
50. Please explain the theory of co-evolution between insects and plants, are there lots of evidences to support this theory?
51. Why some insects become pests and what are the strategies you think can be used in pest management for organic crops?
52. Please describe the characteristics of herbivorous insect pest species?
53. Host-plant resistance is an important way controlling herbivorous insect populations. Conventional methods and biotechnology are the two major methods of resistance breeding. Please describe the two ways of resistance breeding.
54. Why polycultures may have fewer pests?

55. Please explain the trap-cropping system and how this method has been used worldwide?
56. What are the major plant-derived insecticides and antifeedants used worldwide lately?
57. What is the idea about “weed control by herbivorous insects”?
58. Please explain the following phrase “diversification holds the clue to the control of pestiferous insects”.
59. Please describe the basic theory about interspecific competition (using graphs, equations, isoclines, etc.)
60. Please describe the predation theory based on following equations (using graphs, equations, isoclines, etc.)
- $$\frac{dN}{dt} = aN - \alpha NP$$
- $$\frac{dP}{dt} = -bP + \beta NP$$
61. Please describe the predation theory based on following equations (using graphs, equations, isoclines, etc.)
- $$\frac{dN}{dt} = rN \left(1 - \frac{N}{K} \right) - \frac{kPN}{(N + D)}$$
- $$\frac{dP}{dt} = sP \left(1 - \frac{\tau P}{N} \right)$$
62. Timing of insect outbreaks and periodicity is not easy. What are the forcing factors or causative mechanisms involved in population cycles? What are the mechanisms involved with maternal effects and delayed influences on population density? What information do we need for the synthesis of hypotheses on insect population dynamics?
63. Models play an important role in predicting population dynamics. They have powerful heuristic values, stimulating thought and development of modifications in order to simulate natural systems more effectively. But how?
64. Age-specific demography is the quantitative analysis of characteristics of age-structured female population, particularly in relation to patterns of population

growth, survivorship, and reproduction. It is therefore closely allied to population dynamics. Please describe the theories of demography (using graphs, equations, etc.)

65. Age-stage, two-sex demography is the quantitative analysis of characteristics of age-stage-structured two-sex population, particularly in relation to patterns of population growth, survivorship, and reproduction. It is therefore closely allied to population dynamics. Please describe the theories of demography (using graphs, equations, etc.)
66. Spatial distribution is an important part of ecology. Please describe the basic distribution patterns using equations.
67. Sequential sampling is different simple sampling program. Please give a comprehensive discussion on sequential sampling.
68. Thermal summation $K = (T - T_0)D$ is usually used to express the relationship between the developmental rate and the ambient temperature. Please explain the equation and use following data to find the thermal summation (K) and the lower developmental threshold (T_0).
- | | | | | | |
|--------------------|----|----|----|----|----|
| Temperature (°C) | 10 | 15 | 20 | 25 | 30 |
| Developmental time | 45 | 30 | 20 | 16 | 12 |
69. Taylor's power law is widely used to describe the relationship between the mean number of insects and the variance of all sampling units. Please give a thorough discussion on it.
70. Exponential growth and logistic growth are the basic models of population growth. Please give a thorough discussion on them (using equations, graphs, etc.)
71. Biodiversity is a hot issue. MacArthur (1972) wrote "*Those who have used diversity to mean a number combining aspects of both the number of species and the evenness of their abundances have wasted a great deal of time in polemics about whether or some other measure is "best."*" Is MacArthur's critic justified?
72. In biodiversity study, many scientists used Shannon-Wiener index and Simpson's index. Please give the equations and discuss the scientific meaning of these

indices.

73. In biodiversity study, some scientists used log series to fit data of numbers of individuals in different species. Please describe this method.
74. For a rational sampling program, the sample size is dependent on the distribution pattern. In general, you have to take more samples for aggregated distribution than that for random distribution. Please describe the methods you know to determine the sample size.
75. What is “disc equation”? Please give a thorough discussion on it.
76. Conservation of endangered species is a hot topic. What kind of data should you collect before you can start a conservation program?
77. The small size of insects plays an important role in the survival, distribution, and abundance of insects. Please discuss it.
78. Please name the major components and processes in ecosystems.
79. Please discuss “semiochemicals”.

98/01 I

1. A high school student wants to compare the population growth potential of silkworms (*Bombyx mori*) reared on an artificial diet and on mulberry leaves. You are aware that the only way to do this effectively is to collect life table data for these two diets. Please help them to design the experiment and to analyze the data.
2. Predation theory is very important in biological control. Please thoroughly discuss predation theory. You should discuss Lotka-Volterra predation, Type I, II, and III functional responses, disc equation, etc.
3. What is “logistic growth”? Please thoroughly discuss it (using equations, charts, etc.) Is the logistic model applicable? If so, with which type of organisms?
4. Sampling is important not only in biodiversity surveys, but also in pest management. What are the major considerations involved in obtaining accurate

data through sampling?

5. The codling moth is not established in Taiwan, and preventing its introduction is a continuing priority. If we know that apples imported from the US are normally infested with codling moth at a rate of 0.1%, what sample size (how many apples) should be taken at the quarantine station in order to detect whether the freight is infested with codling moth with 95% confidence?

98/01 II

1. If a high school student ask you to help to develop an artificial diet for silkworm (*Bombyx mori*), what will you suggest him to do? What are the main components and their functions of these components you think are necessary to combine in the diet?
2. Plant chemistry (phytochemistry) can be divided into primary and secondary metabolites. Please define what primary and secondary metabolites are. In addition, plant secondary metabolites may have multiple functions, please summarize what are the major functions they are involved in many biotic and abiotic environmental factors.
3. The defensive chemicals produced by plants may toxic to plants themselves as well as to insect herbivores. Plants and herbivores have evolved different physiological mechanisms to deal with these problems. Please describe the ways plants and herbivores used to avoid or detoxify plant allelochemicals.
4. Please describe the characteristics of herbivorous insect pest species, and why these insects become pests and what are the strategies you think can be used in pest management for organic crops?
5. What are the major plant-derived insecticides and antifeedants used worldwide lately?

98/02 I

1. The term “Trophic relationships” was used frequently in the ecological studies. There are some players here, host plants, herbivorous insects, and herbivores’ natural enemies (predators and parasitoids). Please describe the possible interactions (direct or indirect) may occur between these organisms.
2. In Brassicaceae plant species, most of them contain the secondary chemicals called “glucosinolates”. What are glucosinolates and what are the possible roles

glucosinolates may play in the interactions between plants, herbivorous insects (generalists vs. specialists), and their natural enemies?

3. Host-plant resistance is an important way controlling herbivorous insect populations. Please illustrate the major idea of using host-plant resistance for pest control. In addition, please describe the current main methods used for plants' resistance breeding.
4. Invasive weeds can be managed with different considerations. Both "bottom-up" and "top-down" control may achieve some effects. Please illustrate the ideas of using these two methods in weed control.

98/02 II

1. Life tables give the most comprehensive description of population ecology. Please thoroughly discuss the experimental design and theory of life table.
2. Biological control is one of the important strategies in pest management, especially in organic farming. Please discuss the major factors (or components) for a successful biological control program.
3. Biodiversity is an important issue. Harper and Hawksworth (1994) questioned, however, "Is it (biodiversity) just a new linguistic bottle for the wine of old ideas – a changed fashion label designed to attract funding - or does it refer to new and fundamental questions in science?" MacArthur (1972) wrote "Those who have used diversity to mean a number combining aspects of both the number of species and the evenness of their abundances have wasted a great deal of time in polemics about whether or some other measure is "best." " Dewdney criticized "The area of species-abundance distributions and biodiversity studies is riddled with guesswork and an almost complete lack of scientific discipline." Please give your scientific reasoning.
4. Please give a thorough discussion on "thermal summation" by using formulae, statistical method, its application, etc.

99/01 I

1. Glucosinolates are the major secondary chemicals in Brassicaceae plants. Please describe the possible defensive role of glucosinolates? In addition, please explain why some of the specialist insects can deal with the glucosinolates?
2. "Induced defense hypothesis" is one of the hypotheses on "plant and herbivore interactions". It means plant can be induced by intruders to produce something for defense. Lately, the studies about induced defense have been mostly focused on the indirect induced defense. Please explain what this indirect induced defense is and why it attracted most attention?

3. Please explain the following phrase “diversification holds the clue to the control of pestiferous insects”.
4. Many people think organic farming practice is better than conventional farming system. In addition, many people believe crops grown in organic farming system would suffer less pest and disease problems. Do you think so, and how to design experiment to test the hypothesis?

99/01 II

1. Please discuss the development of life table theories (Exponential growth, logistic growth, Lewis-Leslie matrix, Birch’s method, and the age-stage, two-sex life table.) Please write all you know (equations, graphs, etc.).
2. Please discuss the fixed number sampling and sequential sampling.
3. Mass rearing of natural enemies is a critical component in biological control, but how?

99/02 I

1. “Fitness” can be interpreted by different ways. However, in biology or ecology field, fitness indicates a very unique meaning (an individual's ability to propagate its genes). Please try to design an experiment (briefly) to evaluate the effects of temperature on insect’s fitness. (15%)
2. Please define what plant secondary metabolites are and what major roles the plant secondary metabolites may play. (15%)
3. Plants and animals (insects) may emit some volatile chemicals for various purposes. How the volatiles emitted by animals (insects) and plants might be used for the purpose of insect pest management? (10%)
4. Please explain the following phrase “diversification holds the clue to the control of pestiferous insects”. (10%)

99/02 II

1. Please discuss the development of life table theories (Exponential growth, logistic growth, Lewis-Leslie matrix, Birch’s method, and the age-stage, two-sex life table.) Please write all you know (equations, graphs, etc.).
2. Please discuss the concept of thermal summation by using equations.
3. Please discuss the differences between predators and parasitoids.

100/02 I

1. Age-specific demography is the quantitative analysis of characteristics of age-structured female population, particularly in relation to patterns of population growth, survivorship, and reproduction. It is therefore closely allied to population

dynamics. Please describe the theories of demography (using graphs, equations, etc.). Give definition to each term. Discuss problems with female age-specific life table. (25 points)

2. Thermal summation $K=(T-T_0)D$ is usually used to express the relationship between the developmental rate and the ambient temperature. Please explain the equation and use following data to find the thermal summation (K) and the lower developmental threshold (T_0). (15 points)

Temperature ($^{\circ}\text{C}$)	10	15	20	25	30	35
Developmental time	55	33	22	16	12	16

3. Please describe the predation theory based on following equations (using graphs, equations, isoclines, etc.). (10 points)

$$\frac{dN}{dt} = aN - \alpha NP$$

$$\frac{dP}{dt} = -bP + \beta NP$$

(Translator and computer are not allowed. Calculator is allowed.)

100/02 II

1. What is “disc equation and functional responses”? Please using equations or graphs and give a thorough discussion on it.
2. Exponential growth and logistic growth are the basic models of population growth. Please give a thorough discussion on them.
3. Please explain the interspecific interaction types?
4. Please identify what “life table” means? Give a thorough discussion on it.
5. The term “r- and K-selection” was used frequently in the ecological studies and evolutionary problems. Please explain “r- and K-selection” and can you give some examples for the “r- and K-selection”?

101/01 I

1. The term “Trophic relationships” was used frequently in the ecological studies. Please explain “Trophic relationships” and can you give an example for the “Trophic relationships” using fire ant? (15%)
2. Almost all plants can produce various volatiles. What are the possible

roles these volatiles may play? How can we adapt the specific plant volatiles for pest management?(15%)

3. Please describe the possible roles microorganisms may have on insect-plant interactions. (10%)
4. Why some insects become pests and what are the strategies you think can be used in pest management for organic crops? (10%)

101/01 II

1. 在生物學或生態學領域，Fitness 並不是只能用單一意義就可以被解釋清楚，請針對生態研究上的定義說明 Fitness 為何?(10%)
2. 要瞭解昆蟲猖獗的時機及週期性是不容易的，請問影響族群發生的限制因子或機制是什麼？生態學家提出許多不同的假說來解釋族群的動態機制，請申論之。(20%)
3. 昆蟲的體型小，在存活、分佈及豐度上有什麼重要意義，請詳述之。(10%)
4. 請討論氣候變遷對昆蟲在族群、群聚及生態系等不同階級的潛在衝擊。(10%)

102/02 I

1. Please explain the term " plants as insect food : not the ideal " (from the view of plant chemistry)(15%)
2. Plants may produce some allelochemicals(secondary compounds) for defense against feeding of insect herbivores. However, insects specialize on the plant may able to overcome this chemical obstacle. What are the possible ways the specialized insects deal with these potential harmful chemicals?(15%)
- 3.To avoid self-toxic by the defensive chemicals, plant may store these toxic chemicals in cell compartments that are remote from

metabolism (cell walls and vacuoles). Glucosinolates and the hydrolysis enzyme are stored separately; please explain the story of "glucosinolates and the hydrolysis enzyme-myrosinase".(20%)

102/02 II

1. Sampling is important not only in biodiversity surveys, but also in pest management. What are the major considerations involved in obtaining accurate data through sampling? (10%)
2. Almost all plants can produce various volatiles. What are the possible roles these volatiles may play? (10%)
3. Food plant quality of herbivores may be affected by some environmental factors. Please discuss how some of the environmental factors, such as drought, air pollution, may affect insect's host plant quality. (10%)
4. Please explain the theory of co-evolution between insects and plants, are there lots of evidences to support this theory? (10%)
5. Why some insects become pests and what are the strategies you think can be used in pest management for organic crops? (10%)

104/01 I

1. Please explain the following phrase "diversification holds the clue to the control of pestiferous insects".(10%)
2. Lots of insects feed on plants and we call them herbivores. However, "plants as insect food: not the ideal ". How can we prove this statement ? (10%)
3. The term "Trophic relationships " was used frequently in the ecological studies. Please explain "Tri-Trophic relationships" and can you give an example for the "Tri-Trophic relationships" using the small white butterfly (*Pieris rapae*)?(15%)

4. To avoid self-toxic by the defensive chemicals, plant may store these toxic chemicals in cell compartments that are remote from metabolism(cell walls and vacuoles). Glucosinolates and the hydrolysis enzyme are store separately; please explain the story of “glucosinolates and the hydrolysis enzyme-myrosinase”.(15%)

104/01 II

1. 要瞭解昆蟲猖獗的時機及週期性是不容易的，請問影響族群發生的限制因子或機制是什麼，闡述昆蟲棲群動態之涵義，並述評棲群密度變動之數種學說。(20%)。
2. 請說明「島嶼生物地理學(island biogeography)」理論，但是近年來為何我們改以「複族群(metapopulation)」理論，來探討與解釋分割棲所中昆蟲族群的變化?(20%)。
3. 試述社會性昆蟲如何互相交換訊息。(20%)
4. 試從 Cost-benefit 觀點，說明選汰壓力對昆蟲體型大小的影響。(20%)
5. 何謂昆蟲的彈性生活史特性(plasticity in life-history traits)? 其對昆蟲的適存(fitness)有何意義?(20%)

104/02 I

1. Please explain the theory of co-evolution between insects and plants, are there lots of evidences to support this theory?
2. Please explain the interspecific interaction types?
3. Spatial distribution is an important part of ecology. Please describe the basic distribution patterns.
4. What is the idea about “weed control by herbivorous insects”?
5. Exponential growth and logistic growth are the basic models of population growth. Please give a thorough discussion on them.

104/02 II

1. Discuss the relative importance of insects as beneficial and deleterious components of ecosystems in relation to insect-human interaction. (10%)
2. Natural enemy has been of fundamental basic in developing biological control measure in pest management. Discuss the factors (or components) for a successful biological control program. (10%)
3. In your opinion, is there any conflict between today's agricultural productivity and biodiversity conservation? IF yes, using an example, discuss how can they be mitigated? (15%)
4. The importance of climate change as a central theme in insect ecology has been recognized in these recent decades. Discuss the impacts on insects and what are the future researches in ecology that you may want to propose? (15%)