

國立成功大學

111學年度碩士班招生考試試題

編 號： 59

系 所： 生命科學系

科 目： 生態學

日 期： 0220

節 次： 第 3 節

備 註： 不可使用計算機

※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

問題 1~3: 選擇； 問題 4: 簡答 (解釋名詞)； 問題 5~10: 申論 (注意時間分配)

1. Read the text and answer the questions at the end. [12% in total]

Consider an asexual population in which one individual reproduces r individuals every unit time step (e.g., per day and per year). The parameter r is called intrinsic growth rate and the population dynamics are formulated as follows.

$$\frac{dN}{dt} = rN(t)$$

The parameter r represents the net population growth, and the population growth rate can be separated into birth and death processes. That is,

$$\frac{dN}{dt} = rN(t) = (A) - (B)$$

where the parameters b' and d' are the per-individual birth and death rates, respectively. These parameters are almost constant when the population exhibits exponential growth at small sizes. However, they may change as the population grows because of density dependence.

$$b' = b - aN(t)$$

$$d' = d + cN(t)$$

where the per-individual birth and death rates decreases and increases, respectively, with population size due to intraspecific competition. As a result, the population dynamics are re-formulated as follows.

$$\frac{dN}{dt} = (A) - (B) = (b - d) \left(1 - \frac{N(t)}{C} \right) N(t)$$

This is called logistic population growth in which the denominator (C) quantifies the maximum population size supported by the environment and is referred to as (D) . Although the population growth generally decreases with population size, it sometimes increases with population size because of (E) effect. For such a situation, the logistic growth model can be extended as follows.

$$\frac{dN}{dt} = (b - d) \left(1 - \frac{N(t)}{C} \right) N(t) \left(\frac{N(t)}{X} - 1 \right)$$

where the parameter X is set smaller than (C) . In this form, population size decreases to zero if the initial population size $N(0)$ is smaller than X because the population growth rate dN/dt is negative, and otherwise population size goes to (D) . Overall, the population dynamics converges to either (D) or zero depending on the initial condition. This situation is one example of **alternative stable states**.

1-1. Fill in mathematical terms in (A)~(C) using the parameters in the text. [1% for (A) and (B), 2% for (C)]

1-2. Fill in ecological terms in (D) and (E). [2% for each]

1-3. The theory of alternative stable states explains that a system exhibits different dynamics depending on the initial condition. Select ALL appropriate examples of alternative stable states from the options below. [4%]

- Lotka-Volterra competition model predicts that the dominant species excludes the minor species if interspecific competition is greater than intraspecific competition.
- Once forests are lost, it is difficult to grow trees even if rainfall is sufficient, because the soil environments become degraded.
- Eutrophication increases phytoplankton thereby decreasing water transparency and macrophyte at the bottom. As a result, nutrients are released from the sediments and further promotes eutrophication. On the contrary, water is transparent under oligotrophic conditions where macrophyte are dominant and maintain the oligotrophic situations by stabilizing the sediments.
- Climate change can threaten biodiversity, but the impact is not always predictable. For example, if a predator population exhibits range shifts or phenology shifts, its prey populations may enjoy lower predation pressure and increase their abundances. Therefore, climate change may increase or decrease biodiversity at least locally.

(e) Coral reefs provide habitats for herbivorous fishes while herbivorous fishes feed on macroalgae, competitors of corals. This indirect mutualism contributes to marine biodiversity but has been destroyed by fishing activity of humans. Marine protected areas have been developed to restrict fishing activity. Nevertheless, corals and biodiversity do not always recover therein.

2. Some key terms of spatial ecology are described below. Select appropriate words from the options at the end to fill in blanks. [1% for each and 12% in total]

Landscapes are spatially (A)___ areas characterized by diverse habitats, ranging from natural systems (e.g., forests and lakes) to human-dominated systems (e.g., agricultural and urban areas). **Habitat** (B)___ is defined as the degree to which a landscape facilitates or impedes movement of organisms among habitats.

Metapopulations are assemblages of local populations inhabiting (C)___ of patches. **Local populations** are coupled by migration over unsuitable environments called (D)___ . **The persistence of local populations** is determined by a balance between local extinction and (E)___ . **Metapopulation models** generally predict that with habitat loss or (F)___ , species goes extinct before all habitats are lost. **Exceptionally**, the (G)___ model predicts that extinction does not occur as a result of stable population sources.

Metacommunities consist of collections of local communities linked by dispersal of multiple (H)___ species. **Four major models** have described metacommunity dynamics: (I)___ models assume that all species are equal and diversity is maintained by dispersal and speciation, (J)___ models relate species distributions and abundances to local environments, (K)___ models emphasize the movement of individuals from good to poor habitats, and (L)___ models emphasize trade-offs in species traits (e.g., colonization versus competition).

Word options (choose your answers here!):

biotic homogenization, boundary, clusters, colonization, connectivity, corrido, disturbance, engineering, equilibrium, fragmentation, heterogeneous, homogeneous, island biogeography, interacting, keystone, Levins, MacArthur, mainland-island, matrix, neighborhoods, networks, neutral, patch dynamics, pioneer, random, recruitment, regional biodiversity, shifting mosaic, source-sink, species sorting, survival, turn-over, urbanization

3. Read the text and answer the questions at the end. [1% for each and 6% in total]

Endothermic animals maintain body temperature at a relatively constant level due to internal heat production through metabolic processes. Larger body size (A)___ the dissipation of heat by reducing the surface area relative of body size, and therefore, mass-specific metabolic rate tends to (B)___ with body size. As a result, there is a geographic trend for body size to (C)___ with decreasing mean annual temperature or increasing latitude. Numerous studies have documented changes in body size for local populations under climate change, which generally have shown a recent (D)___ in average body size.

In contrast to endothermic animals, environmental temperatures have direct effect on body temperature and metabolic rates in ectothermic animals. Ectothermic animals have a limited range of temperatures over which they can maintain metabolic processes and activities. Their metabolic activity generally (E)___ with temperature and, therefore, climate warming has greater effects on the metabolic rates of ectotherms in (F)___ climates.

3-1. Fill in "increase(s)" or "decrease(s)" in (A) to (E).

3-2. Fill in "warmer" or "cooler" in (F).

4. Explain the following ecological terms (18%; 3% each)
 - (a) metapopulation
 - (b) age-specific fecundity
 - (c) cohort
 - (d) biochemical oxygen demand (BOD)
 - (e) realized niche
 - (f) zonation of species
5. *Climate change and biodiversity loss* are interlinked events. Apart from global warming, list 4 climate change factors and briefly describe their roles in biodiversity loss. (12%)
6. While global human population continues to grow, the growth rate has declined over the past 60 years. Discuss the major factors, including biotic and abiotic ones, that ultimately causes such a decrease. (5%)
7. Discuss why animals may aggregate to form large colonies seasonally or year-round, and overnight at some same sites together. Think of all possible explanations, and distinguish them in terms of cost and benefits to animals. (10%)
8. Explain (a) what phenotypic plasticity (PP) is? (3%); (b) Why PP is related to ecology of any particular species? (4%); (c) How PP can be proved or disproved present experimentally? (5%; total 12%)
9. Give an example of "**indirect effect**" and discuss its significances for community structure and implications for conservation (8%)
10. Under what kind of environmental conditions would you expect to find "**r-selected**" versus "**K-selected**" species? (5%)