※ 注意：請於試卷內之「選擇題作答區」依序作答。

I. Multiple choices (2 points each)

1. Which description below about C3 and C4 plants are INCORRECT?

A. Among all plant families, the grass family has the highest number of species using the C4 photosynthetic pathway.

B. Photosynthesis in C3 plants lead to lower ^{13}C fractionation compared to that in C4 plants.

C. C4 photosynthesis is evolutionarily younger than C3 photosynthesis.

D. C4 plants are in general more efficient in water usage than C3 plants.

2. In a forest ecosystem, the majority of the net primary production _____.

A. becomes dead organic matter.

B. is consumed by herbivores.

C. stays within the plants for multiple years.

3. "An alien species whose populations are surviving and reproducing beyond the location of introduction" is the definition of an _____.

A. Introduced species

B. Exotic species

C. Non-native species

D. Invasive species

E. Naturalized species

4. "Some animals may reduce metabolic rate to save energy. This behavior may last for several months during summer." The sentence above describes _____.

A. hibernation

B. torpor

C. estivation

D. deep sleep

5. Net primary production (NPP) is _____.

A. amount of solar energy captured by algae in oceans and converted into the biomass.

B. total primary production by all primary producers in the ecosystem.

C. the amount of biomass, produced by autotrophs, which is available to the consumers in the ecosystem.

D. the amount of biomass produced by heterotrophic consumer organisms.

E. none of the above.

6. Annual actual evapotranspiration (AET), which represents the total amount of water that evaporates and transpires off a landscape during one year, and is measured in mm of water per year, is influenced by _____.

A. temperature and air humidity.

B. precipitation and air humidity.

C. precipitation and temperature.

D. precipitation and wind speed.

E. wind speed and solar radiation.

7. After landslide happens and the part of the mountain slope slides down into the valley, vegetation slowly recovers by primary succession. At the initial stage of the succession, plants growing on the landslide are limited by _____.

A. nitrogen.

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B. phosphorus.
C. both nitrogen and phosphorus.
D. light availability.
E. too steep slope.

8. Naturally, all the nitrogen present in the nitrogen cycle comes from _____.
A. industrial fixation of nitrogen by producing artificial fertilizers, which are then used to grow the crop.
B. release of nitrogen during the litter decomposition process in the soil.
C. nitrogen fixation activity of some organisms (e.g. bacteria associated with roots of leguminous plants), and lightning.
D. emissions of nitrates from the cars, motorbikes and factories.
E. decomposition of animal bodies.

9. During the secondary succession in the forest, with time the number of woody species _____.
A. decreases, being highest at the initial stages of the succession.
B. increases and then levels off, being highest in the climax vegetation.
C. does not change – pioneer species at the early stage of the succession are slowly replaced by the same number of climax species in the late stage.
D. is unpredictable and depends on the forest system under study.
E. none of the above.

10. In the famous experiment conducted to prove that Island biogeography theory works, scientists (Simberloff & Wilson) used patches of mangrove islands in the coastal region of Florida. They separated the islands into control and treatment ones, and then _____.
A. killed all insect in the treatment islands and then tracked for one year how fast the islands near and far from the mainland will be recolonized.
B. cut mangroves in the treatment islands and then tracked for one year how fast they will grow back.
C. introduced invasive insect species to all islands and tracked for one year how quickly they will be outcompeted by native species.
D. killed all insect in the control islands and then tracked for one year how fast they will be recolonized by the insect from the surrounding treatment islands.
E. counted all species in treatment islands and compared their number with control islands.

11. Anthropogenic climate change _____.
A. decreases the global temperature and influences mostly the tropical and subtropical forests, which more often suffer from frost events.
B. warms the ocean water and causes the change in the directions of the ocean currents; as a result, there is more rain in dry areas, leading to such anomalies as flowering deserts.
C. is a directional change in global climate, which lasts for several decades, and is likely caused by human activities.
D. does not exist, because scientists never found any evidence of it.
E. can be stopped by planting trees.

II. Explain the following terms (3 points each) ※ 注意：請於試卷內之「非選擇題作答區」作答，並應註明作答之題號。

12. Thermal neutral zone
13. Complex life cycle
14. Character displacement
15. Niche

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16. Climax community
17. Urban heat island

※ 注意：請於試卷內之「非選擇題作答區」作答，並應註明作答之題號。

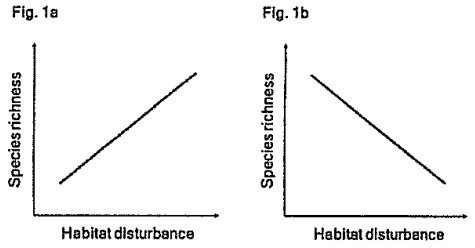
III. Short answer questions (10 points each; answer in Chinese or English, expect for Question No. 23)

18. (A) Write down the equations of exponential and logistic population growth models and explain the terms. (B) What is the main ecological reason that differentiates the two types of population growth? (C) During the phase of initial invasion and range expansion, which population growth model does an invasive species usually follow?

19. Body size is a functional trait ecologists and evolutionary biologists often examine. (A) Please explain the importance of body size for individual performance, species interactions, and ecosystem functions. (B) Predict how species body size across altitude in Taiwan will respond to climate warming based on ecological concepts.

20. (A) Define specialist predators and generalist predators. (B) What are the strengths and limitations of applying each of them individually in biocontrol programs?

21. Species richness is often affected by habitat disturbance. A student found a positive correlation between species richness and the degree of disturbance in habitat (Fig. 1a). However, another student found a negative correlation (Fig. 1b). Please explain the underlying mechanisms for each pattern.



22. (A) Define "phenological shifts". (B) Explain how a shift in the flowering phenology of a plant species may indirectly affect other plant species through plant-pollinator interactions.

23. The rate of decomposition can be measured using tea-bag decomposition experiment, at which a pair of commercial tea-bags (e.g., Lipton) with green and rooibos tea are buried into the soil for three months, and then excavated and amount of decomposed tea measured. Use this method to see how the rate of decomposition changes along the elevation gradient in Taiwan; namely, compare decomposition in three types of the forest: lowland rain forest (500 m asl), submontane evergreen broadleaf forest (1200 m asl) and mountain cloud forest (2000 m asl). Define the hypothesis which can be tested, describe the study method, and describe what you expect to find (will decomposition increase or decrease with elevation, and why?) (*Answer in English*)

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