

1. (12 points) The graph below shows competition isoclines for two species.

a) What is the equation for the intercept marked by a "y"  $\frac{K_1}{\alpha}$  [2pts]

b) The arrow with ?? indicates the isocline for (circle one):  $N_1$   $N_2$  [2pts]

c) At point A, is species 1 (circle one): increasing decreasing [1pt]

d) At point A, is species 2 (circle one): increasing decreasing [1pt]

e) At point B, is species 1 (circle one): increasing decreasing [1pt]

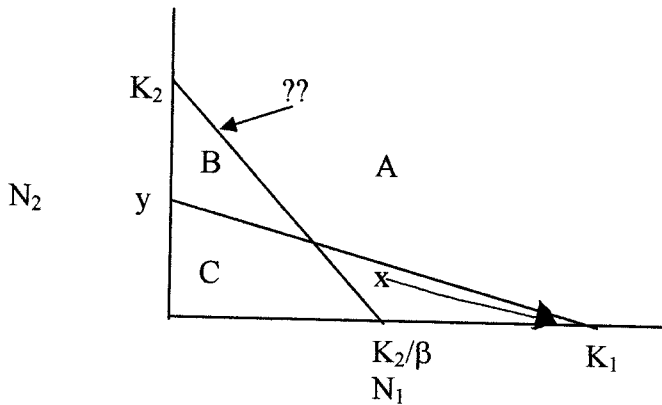
f) At point B, is species 2 (circle one): increasing decreasing [1pt]

g) At point C, is species 1 (circle one): increasing decreasing [1pt]

h) At point C, is species 2 (circle one): increasing decreasing [1pt]

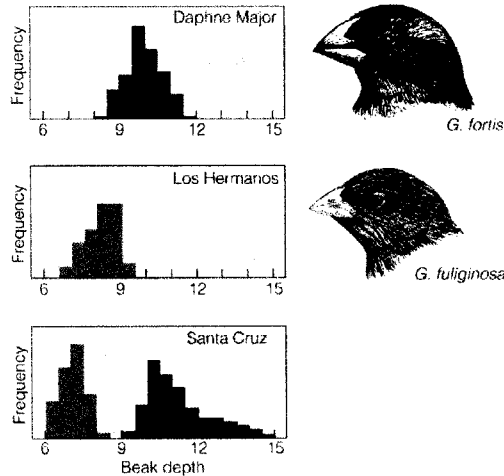
i) Please draw in the population trajectories starting at "x" and going to equilibrium.

[2 pts]



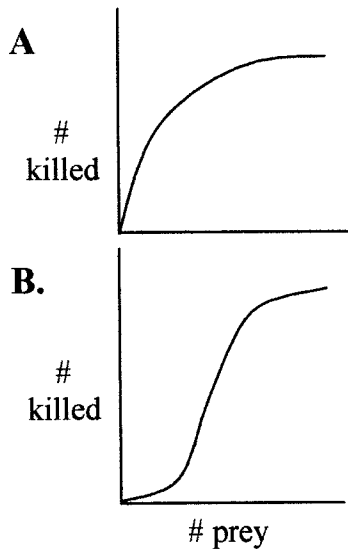
2. (8 points) What is character displacement? You might want to use seed harvesting ants or Darwin's finches to illustrate your point.

**When there is too much niche overlap, selection will favor a displacement in key traits to minimize competition. Individuals suffering more interspecific competition will leave fewer offspring. The distribution of mandible sizes for finches (and ants) will shift if competitors are present relative to distributions when they are alone.**



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3. (8 points) These graphs describe two types of functional responses of predators to different numbers of prey. Which is most likely to lead to a stable number of prey, A or B? Why?



**Type B. is more likely to lead to a stable number of prey because at low prey densities the predators will switch to another prey and at high densities predators will eat a high percentage of the prey regulating the prey population.**

4. (6 points) For the questions below, use the following equation:  $dN_2/dt = -d_2N_2 + b(cN_1N_2)$

What is  $N_2$ ? **the number of predators**

What is  $c$ ? **the efficiency of catching prey**

What is  $b$ ? **the efficiency of converting captured prey into new predators (reproduction)**

5. (12 points) Answer the following questions based on the graph.

a) When the prey are at their carrying capacity, how many prey will there be?

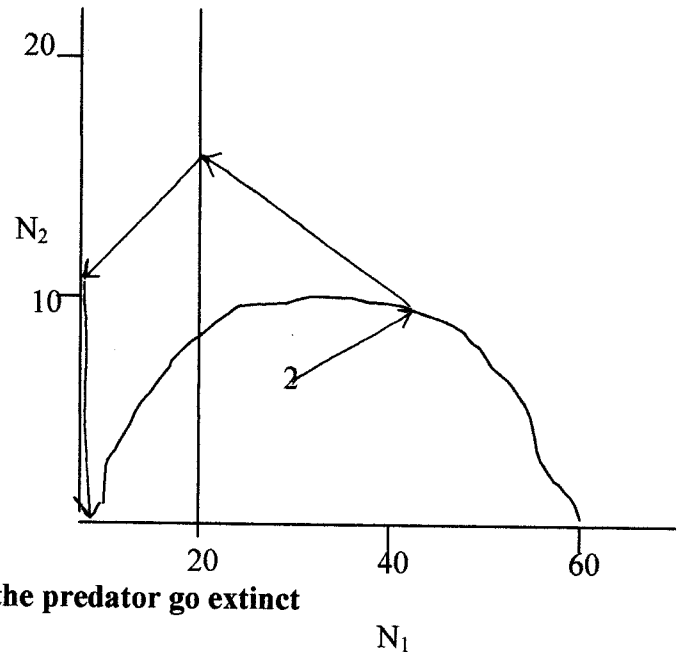
60

b) When the prey are at their carrying capacity, how many predators will there be?

0

c) On the graph at point "2", draw the vector showing how the populations of predator and prey would change (draw vector all the way to equilibrium). **Will spiral such that the prey and the predator go extinct**

d) Why does the prey isocline curve down on the right? (why is it humped?)



**The prey isocline is curved on the right because of density-dependent regulation of prey population size. As the prey population nears carrying capacity (K), fewer and fewer predators to are necessary to maintain  $dN/dt=0$ .**

6. (14 points) We know that herbivory is bad for plants and we know that effective defenses have evolved, yet not all species of plants are well defended. Discuss the costs and benefits of defense, and how these tradeoffs might lead to differences in optimal defense levels.

**Direct costs depend on investment and are the same for all plants.**

**Indirect or opportunity costs depend on plant growth rate.**

**The benefits of defense are influenced by:**

**1) the abundance of herbivores in a habitat**

**2) the impact of a given amount of herbivory, which is higher for slow-growing plants with long-lived leaves.**

7. (8 points) What are the mechanisms and benefits to a plant of **inducing** secondary metabolites.

**When plants are damaged by herbivores, they release Jasmonic acid, which is systemic and causes the upregulation of defense genes. The benefit of inducing secondary metabolites is that plants only pay the cost of defense when they are damaged.**

8. (12 points) Explain how the mutualisms between plants and animal pollinators might have evolved. What is the origin of this mutualism and what are the steps that must have occurred.

**Originally, flowers were wind pollinated and floral visitors ate pollen and ovules which was detrimental to the plant. However, some floral visitors accidentally transferred pollen. Plants evolved traits to protect ovules and pollen via adaptations such as a closed carpel to protect ovules and glass shards and toxins to protect pollen. Pollen is expensive because it is full of protein, thus, the evolution of nectar production allowed plants to provide a cheap reward to pollinators and to protect their pollen. As floral visitors became less damaging, less costly, and actually beneficial in terms of transferring pollen, plants evolved traits to attract them. These include visual and olfactory cues such as bright colors and pungent smells. Finally, to increase the likelihood that their pollen would be transferred to a conspecific, plants developed traits to limit the number of species of pollinators and to ensure fidelity. These traits include long corolla tubes, timing of floral displays, and specialized rewards such as chemicals for orchid bees.**

9. (16 points) True and False (circle correct answer)

- T    F    Bycatch for world fisheries is about 30%.
- T    F    More than 50% of all commercial fishing stocks are over-exploited
- T     F    Today, only 10% of prescription medicines come from natural products.
- T     F    Parasite life cycles are always completed within a single host species.
- T     F    Competition between strains of a disease inside the host will select for reduced virulence.
- T    F    Transmission frequencies increase under conditions of host crowding.
- T     F    Transmission frequencies are higher for diseases that are transmitted via direct contact as compared to water borne.
- T     F    Increased transmission frequencies select for reduced virulence.
- T    F    The introduction of the virus to control rabbit populations in Australia increased host resistance and decreased virus virulence.

10. (4 points) **Circle** at least 2 species that have sustainable fisheries and are ok to eat.  
**Cross out** (with an X) at least 2 species that are on the "avoid" list. It's ok to leave two species without marks (though they are on your card which should be in your wallet).

<del>Chilean Sea Bass</del>	<input checked="" type="radio"/> Catfish	<del>Beluga Caviar</del>
<input checked="" type="radio"/> Pacific Halibut	<del>Shark</del>	<del>Atlantic Cod</del>