1.2.3 Quiz: From Weak to Strong Competition

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Question 1

1/1 point (graded)

In the case of weak competition, the coexistence equilibrium point is $(2/3, 2/3)$. Wes noted that the x-coordinate is less than the x-coordinate of the equilibrium (1,0) and the y-coordinate is smaller than the y-coordinate of the equilibrium (0,1).

Which of the following is a biological interpretation of this statement?

- This means that when there is weak competition, the population size of species X is 2/3 the carrying capacity of species Y and the population size of Y is 2/3 the carrying capacity of species X.
- This means that when there is weak competition, species X does not reach its full carrying capacity (the capacity when Y is not present) and similarly for Y. ✔
- This means that when there is weak competition, species X and Y can never drive the other species to extinction.
- None of the above.

Explanation

The equilibrium (1,0) corresponds to the carrying capacity of X when Y is not present (since $x(t) = 1$ and $y(t) = 0$). However, when $y(t) \neq 1$, there is competition from Y and we've seen that trajectories approach (2/3, 2/3). This means $x(t) \to 2/3$, or species X can only reach 2/3 of its carrying capacity. The same is true for species Y because of the symmetry of the system.

To think about this more concretely, imagine that competition means that species X and species Y both eat a certain type of vegetable in the garden as part of their diet. The existence of species Y means that there is less of this type of vegetable left for species X. So the effective carrying capacity for species X decreases, and similarly for species Y. Thus, with any competition at all, the coordinates of the coexistence equilibrium must each be less than 1.

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Answers are displayed within the problem

Question 2 - Think About It

1/1 point (graded)

We've now seen what happens when competition parameter $\beta = \frac{1}{2}$.

Use the dynamic graph in Desmos to explore the effect of increasing the competition parameter β. What happens to the null clines and equilibria of the system? Record your observations.

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At bsta=1 there are infinite numbers of equilibrium points,
at beta > 1 again there are 4 equilibrium points.
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Thank you for your response.

This will be discussed in the next video

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Answers are displayed within the problem

Question 3

1/1 point (graded)

Let's consider the case when $\beta = 2$. We'll call this level "strong" competition. In this case the system looks like:

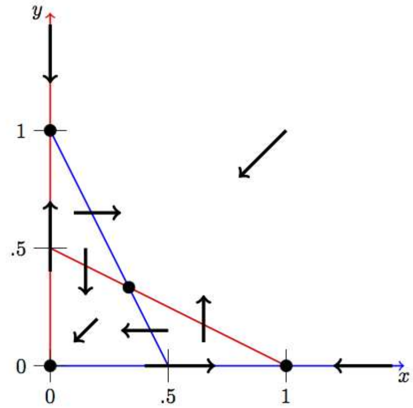
$$\frac{dx}{dt} = x(1-x) - 2xy$$

$$\frac{dy}{dt} = y(1-y) - 2xy$$

On a separate sheet of paper, do a phase plane analysis of the system, including identifying the null clines and sketching arrows to indicate the direction of the system along the null clines and in the regions they create.

Then choose the phase plane below which corresponds to your work.

A.



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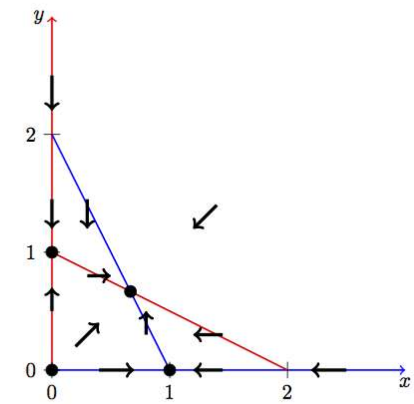

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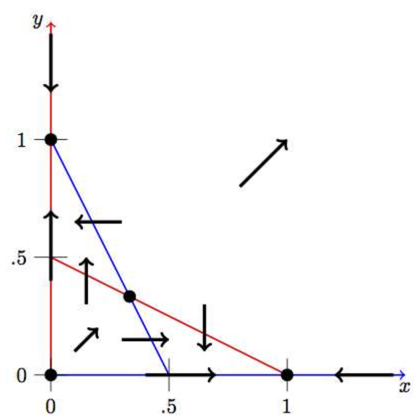

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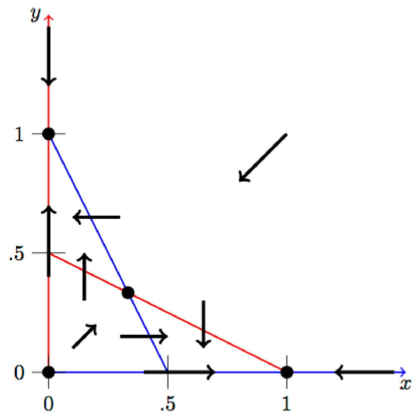

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Explanation

The nullclines for $\frac{dx}{dt} = 0$ are $x = 0$ and $y = \frac{1}{2} - \frac{1}{2}x$. The nullclines for $\frac{dy}{dt} = 0$ are $y = 0$ and $y = 1 - 2x$.

The equilibrium points are $(0, 0)$, $(1, 0)$, $(0, 1)$ and $(1/3, 1/3)$.

We use the sign of dx/dt to orient the nullclines where $dy/dt = 0$. We use the sign of dy/dt to orient the nullclines where $dx/dt = 0$.

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Answers are displayed within the problem

Question 4

1/1 point (graded)

Consider the system with strong competition:

$$\frac{dx}{dt} = x(1 - x) - 2xy$$

$$\frac{dy}{dt} = y(1 - y) - 2xy$$

Assuming we start with some members of both species X and Y, which are possible long-term behaviors of the system according to your phase plane analysis?

- [x] Species X goes extinct, Species Y approaches its carrying capacity ✔
- [x] Species Y goes extinct, Species X approaches its carrying capacity ✔
- [ ] Species X and Y both go extinct
- [ ] Species X and Y both approach their carrying capacities
- [x] Species X and Y both approach a population level below their carrying capacity ✔
- [ ] None of the above.

✔

Explanation

The next video discusses this question as well.

There are three possibilities, depending on the starting populations. For most initial conditions, either one or the other of the species will go extinct and the other will reach its carrying capacity. For example, if we start in the northwest triangle, the solution trajectory goes toward (0,1) meaning X goes extinct and Y approaches its carrying capacity.

In a very particular case, Species X and Y will both approach a stable population level below 1. This is theoretically possible but not biologically, as is discussed in the next section.

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Answers are displayed within the problem

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