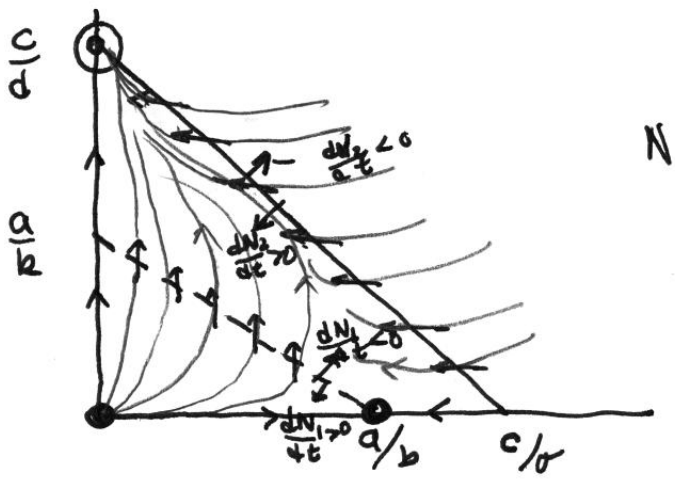
$\frac{dN_1}{dt} = N_1 (a - bN_1 - kN_2)$ $\quad \frac{dN_2}{dt} = N_2 (c - dN_1 - \sigma N_2)$

$N_1 = 0$ and $N_2 = \frac{a}{k} - \frac{b}{k} N_1$ is where $\frac{dN_1}{dt} = 0$. $N_2 = 0$ and $N_2 = \frac{c}{\sigma} - \frac{d}{\sigma} N_1$ is where $\frac{dN_2}{dt} = 0$

FOUR CASES

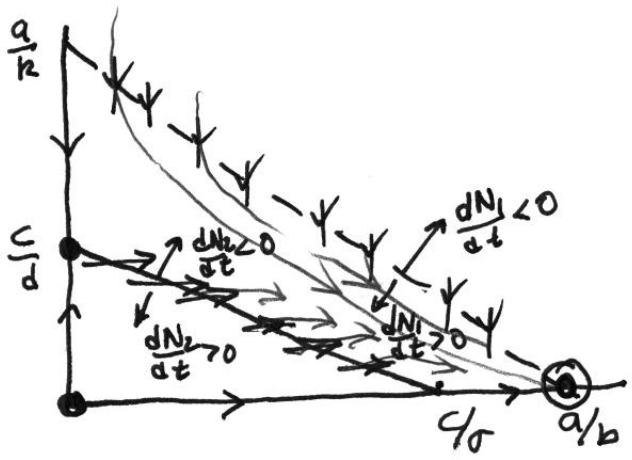
(i) $c/d > a/k$, $c/\sigma > a/b$ ($N_2$ suppresses $N_1$ more than itself; $N_1$ suppresses $N_2$ less than itself.)

$(N_{1e}, N_{2e}) = (0,0), (a/b, 0), (0, c/d)$ ● : stable equil. ⊙ : stable equil.




$N_2$ population always wins
no competition

(ii) $a/k > c/d$, $a/b > c/\sigma$ $N_2$ suppresses $N_1$ less than itself
$N_1$ suppresses $N_2$ more than itself

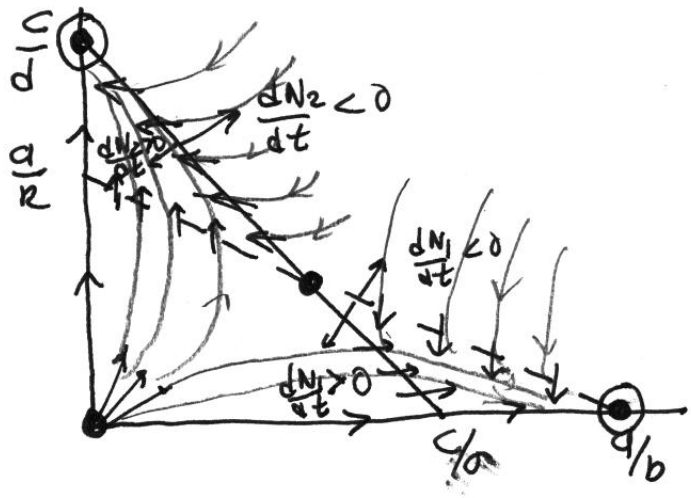



$N_1$ population always wins
no competition.

Note: In each case $\frac{dN_1}{dt} > 0$ below the dashed line,
$\frac{dN_1}{dt} < 0$ above the dashed line
$\frac{dN_2}{dt} < 0$ above the solid line
$\frac{dN_2}{dt} > 0$ below the solid line

(iii) $c/d > a/k$ $\quad a/b > c/\sigma$

$N_2$ suppresses $N_1$ more that itself. $N_1$ suppresses $N_2$ more than itself.




Either $N_1$ or $N_2$ wins

Competitive exclusion

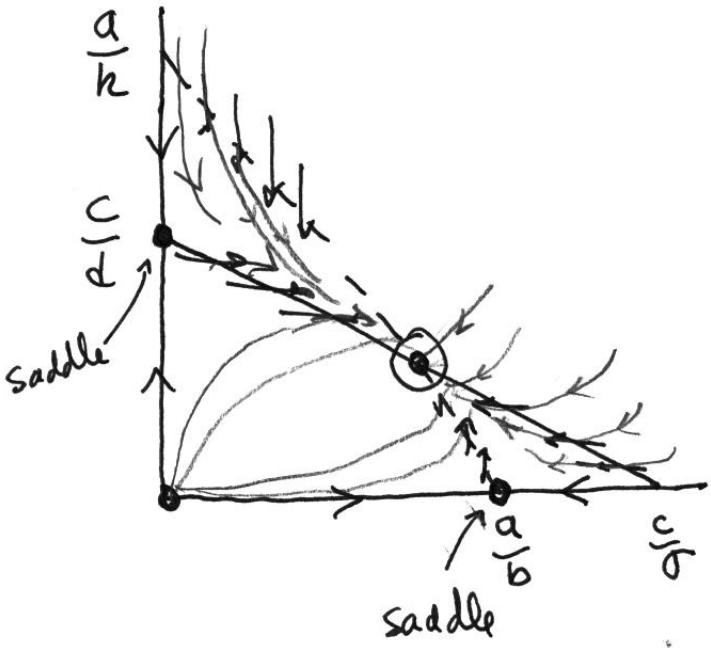
Species cannot co-exist.

(iv) $c/d < a/k$ , $a/b < c/\sigma$

$N_2$ suppresses $N_1$ less than itself.

$N_1$ suppresses $N_2$ less than itself.

"Weak interaction" leads to stable coexistence.



(iii) $c/d > a/k$ $\quad a/b > c/\sigma$

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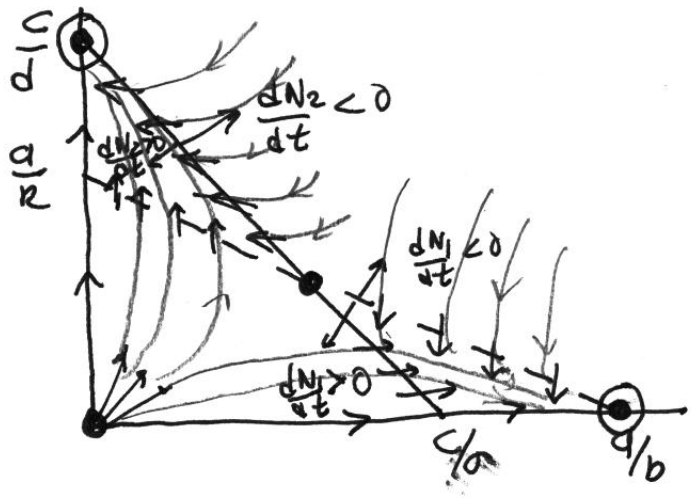


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