III Southern-Summer School on Mathematical Biology

Miley Cyrus vs. Darth Vader

The manipulative parasite and the gliding ant

Group 6:
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Joyce Santos
Luciano Peres
Thiago Zahn
Willian Silva

INTRODUCTION

Manipulative parasites: parasite inducing phenotypic changes in their hosts that increase the probability of their transmission from one host to another.

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Host: ***Cephalotes atratus (Darth Vader ant)***
Parasite: ***Myrmeconema neotropicum***

INTRODUCTION

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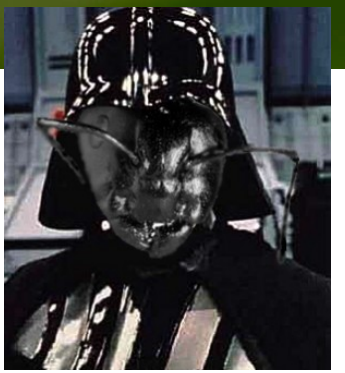

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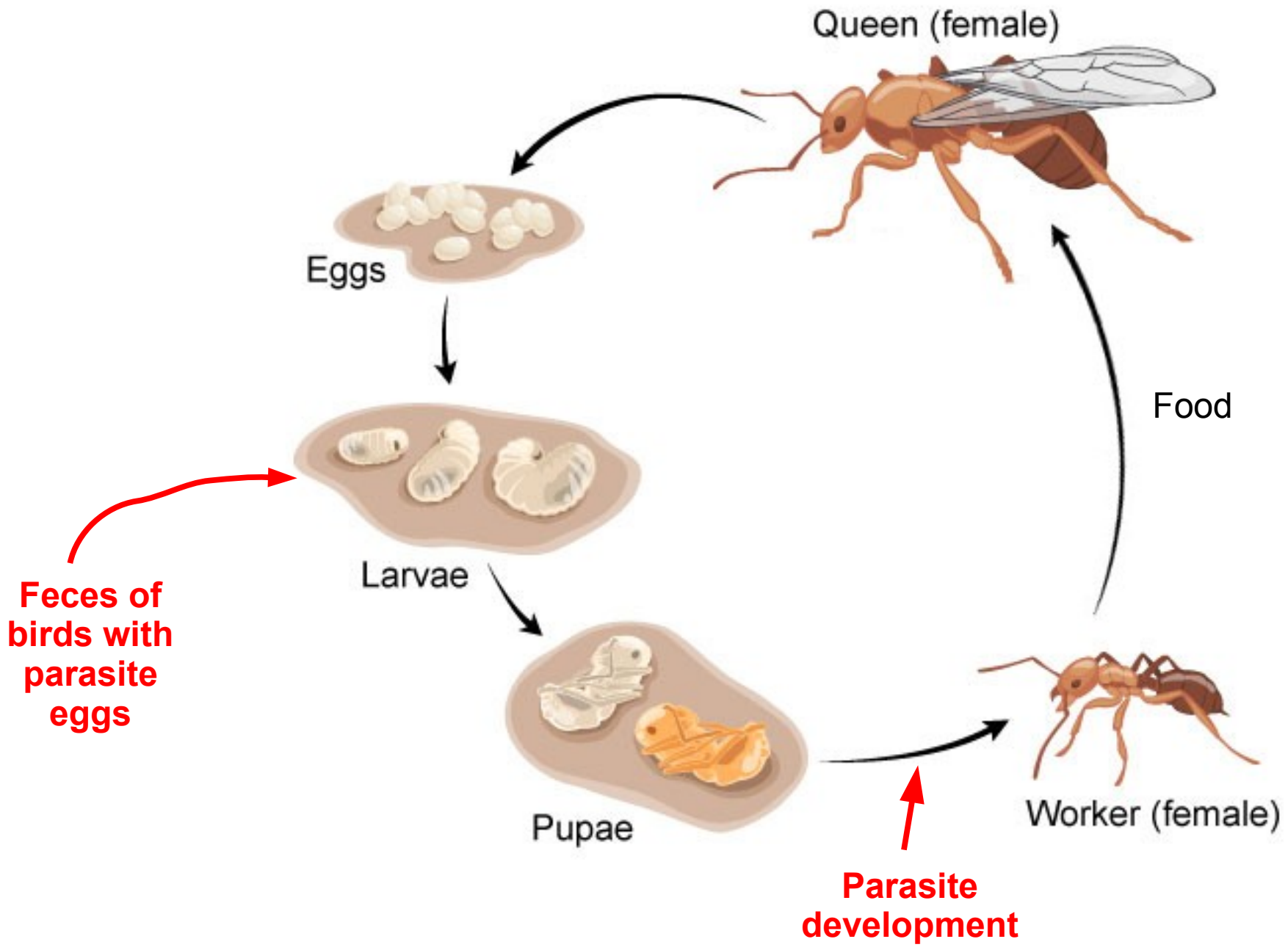

QUESTIONS

1. What initial infection rate can promote the establishment of the parasite in the colony?

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2. What predation rate can maintain the parasite in the colony?

3. What infection rate makes the colony collapse?

THEORETICAL DESIGN

Li

Ls

R

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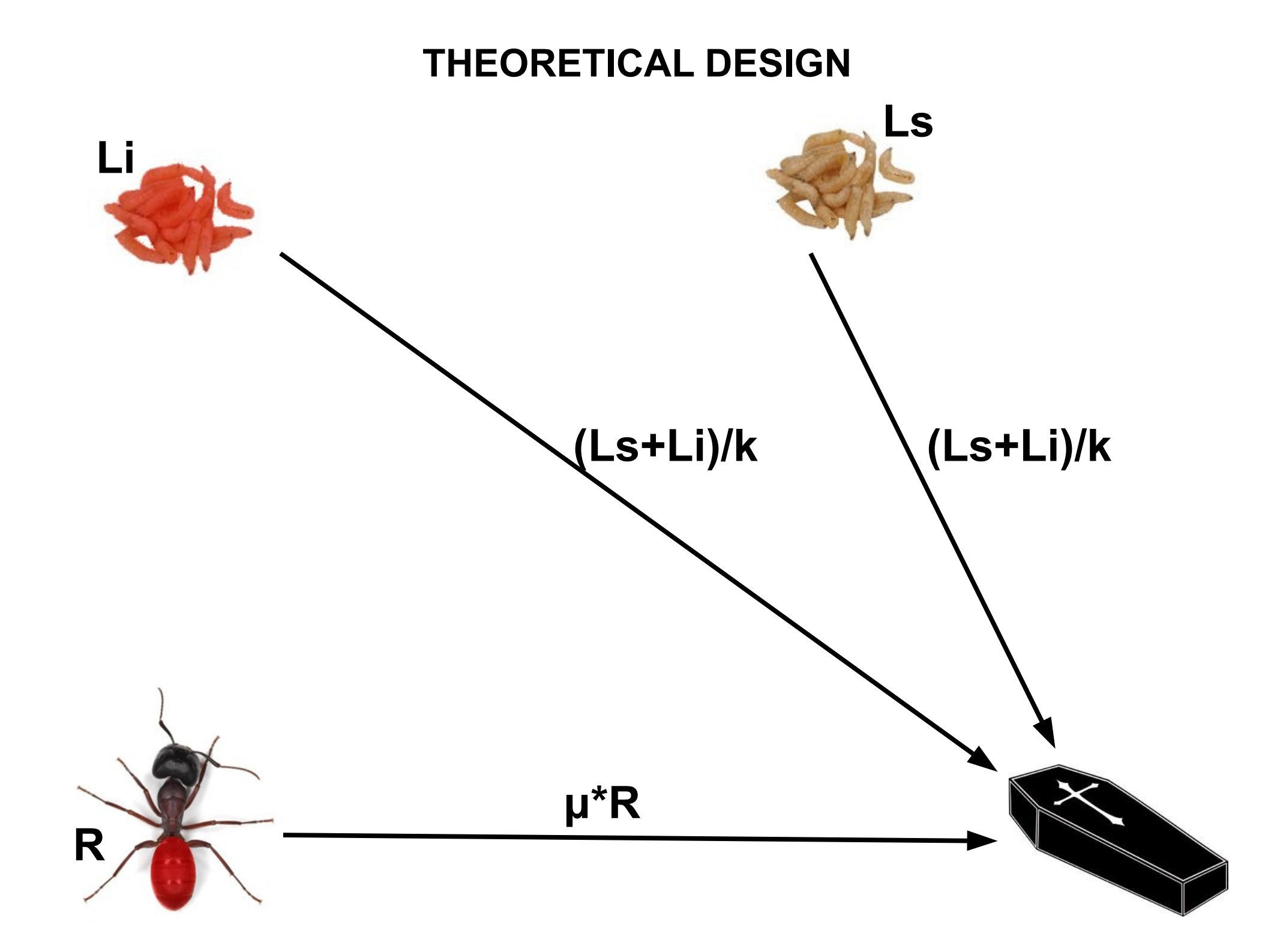

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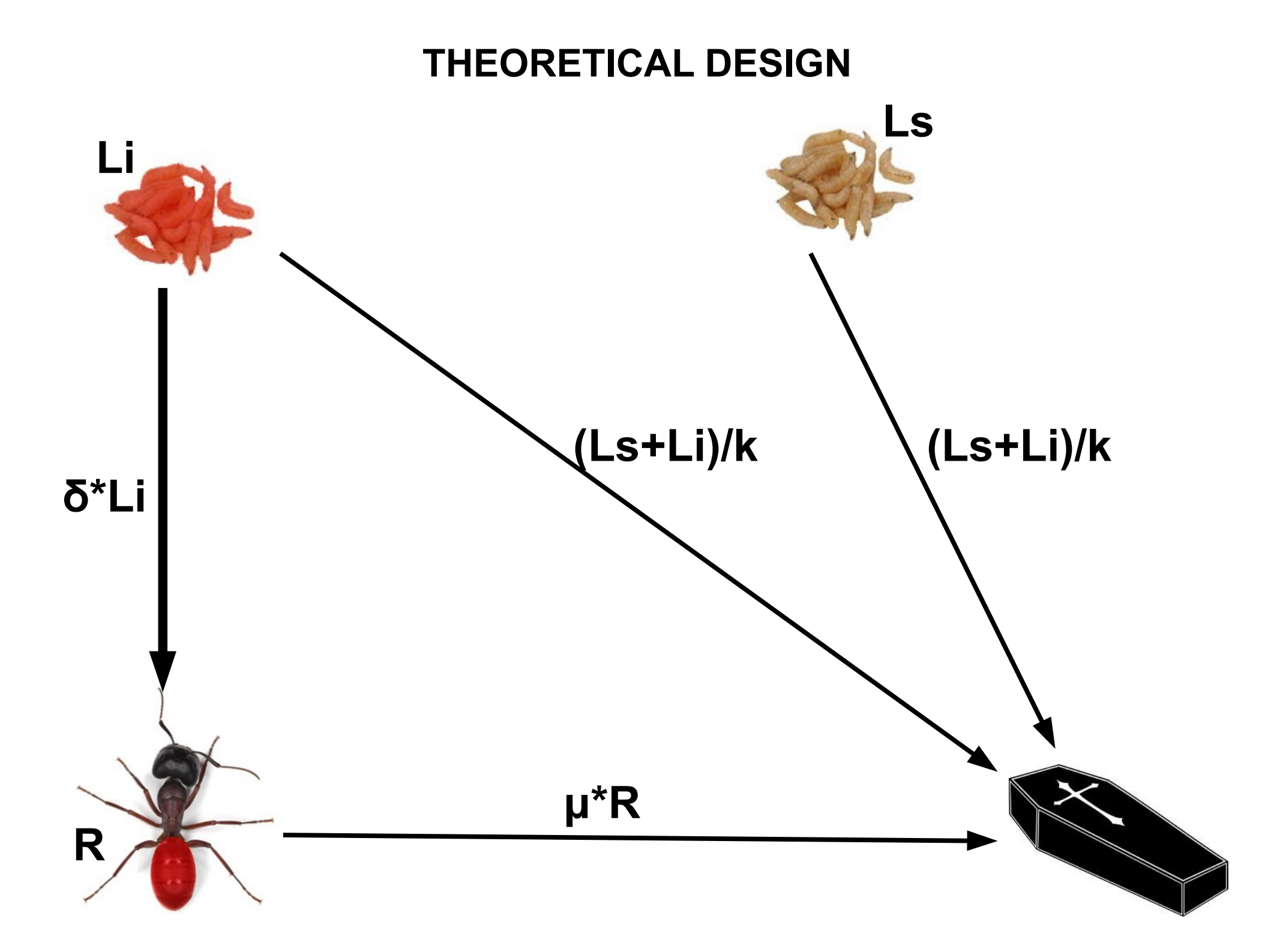

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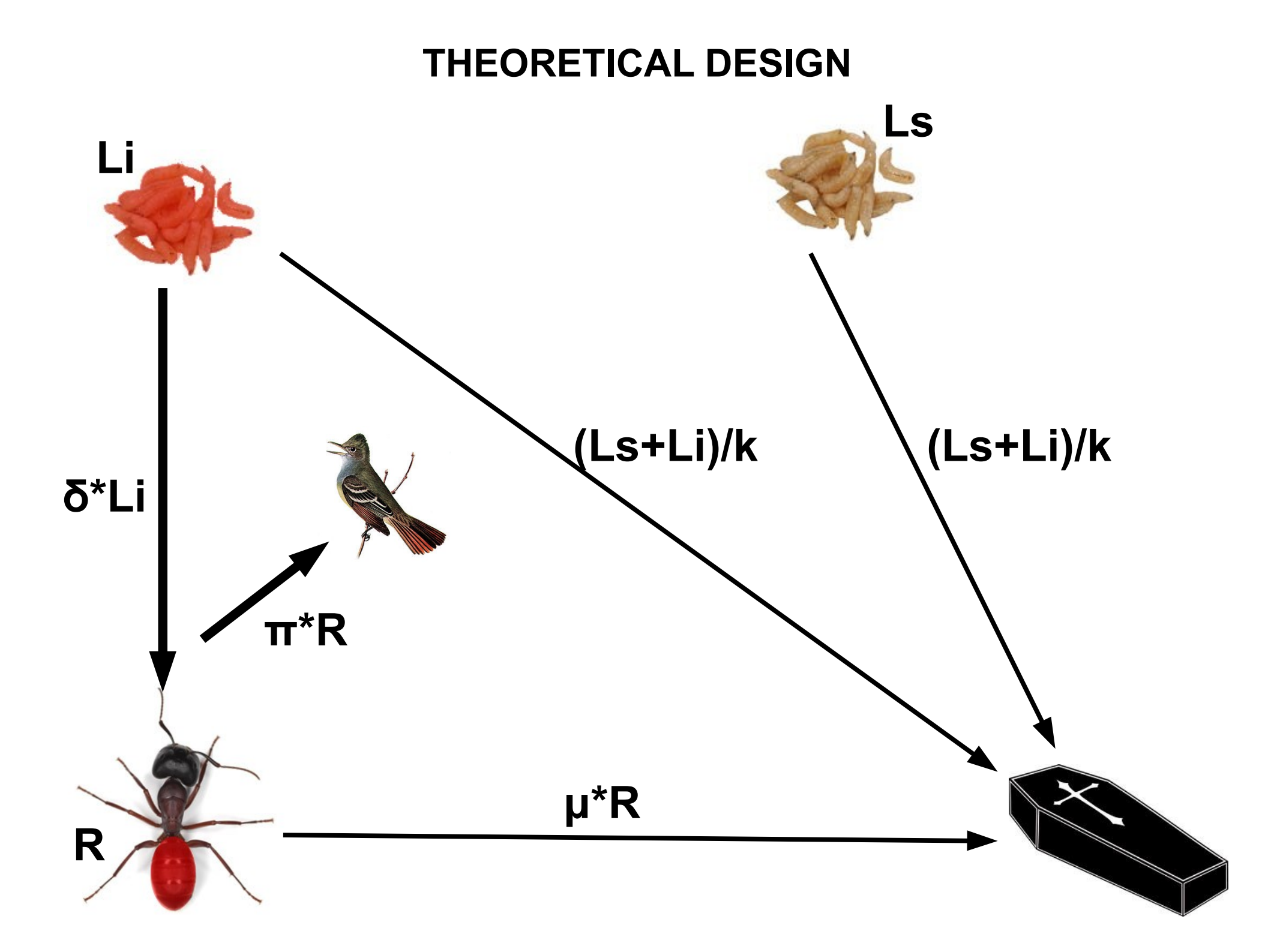

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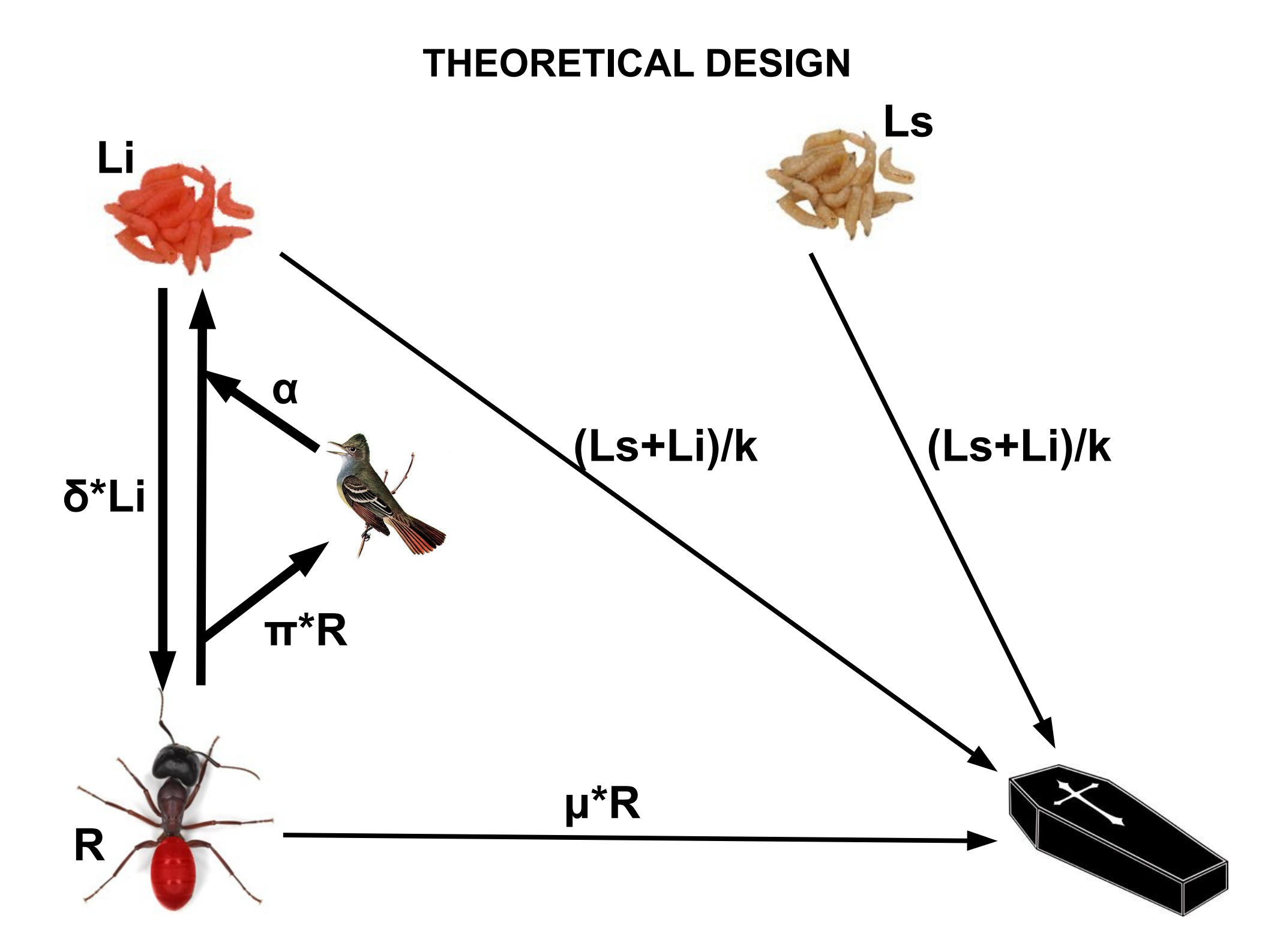

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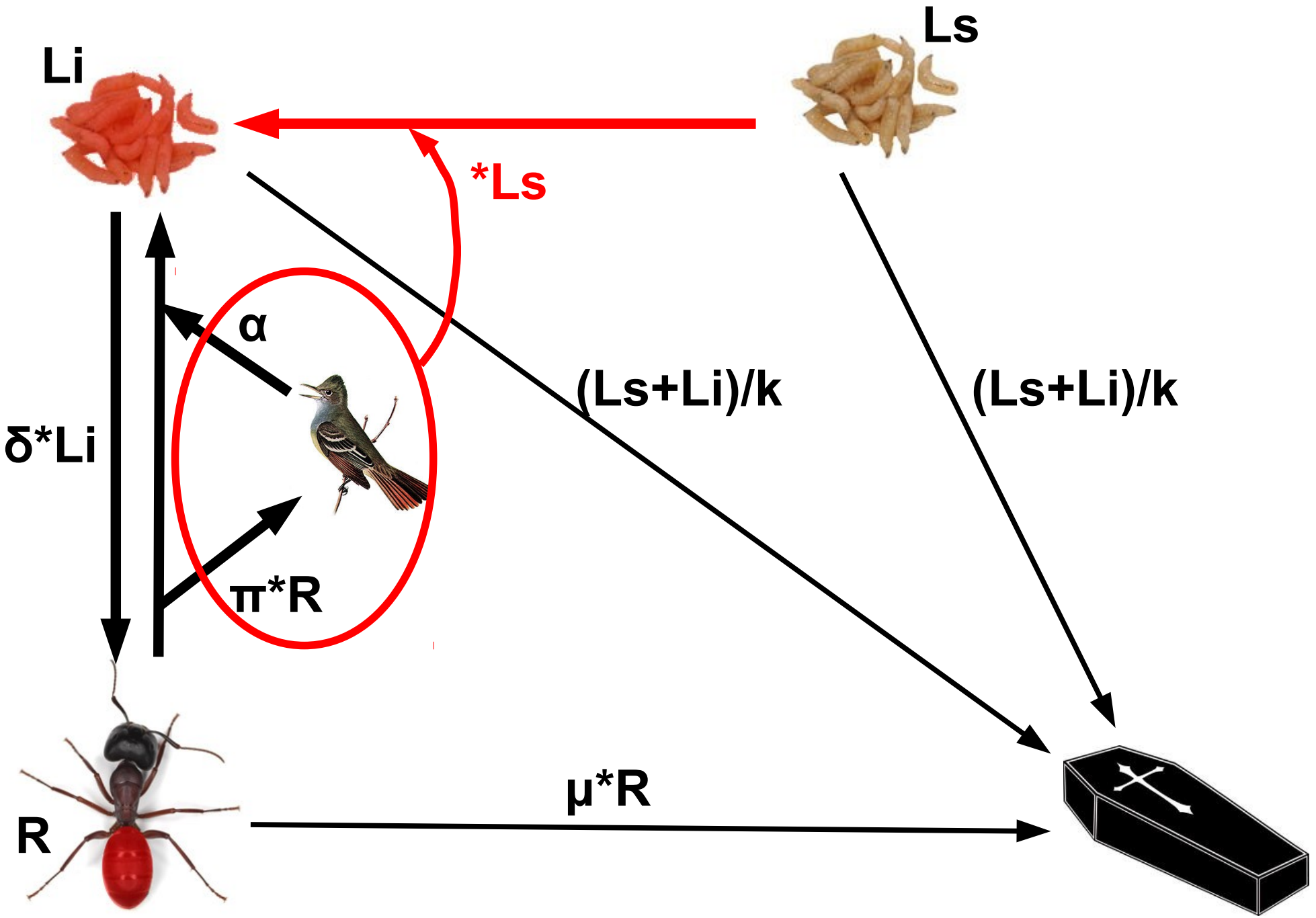

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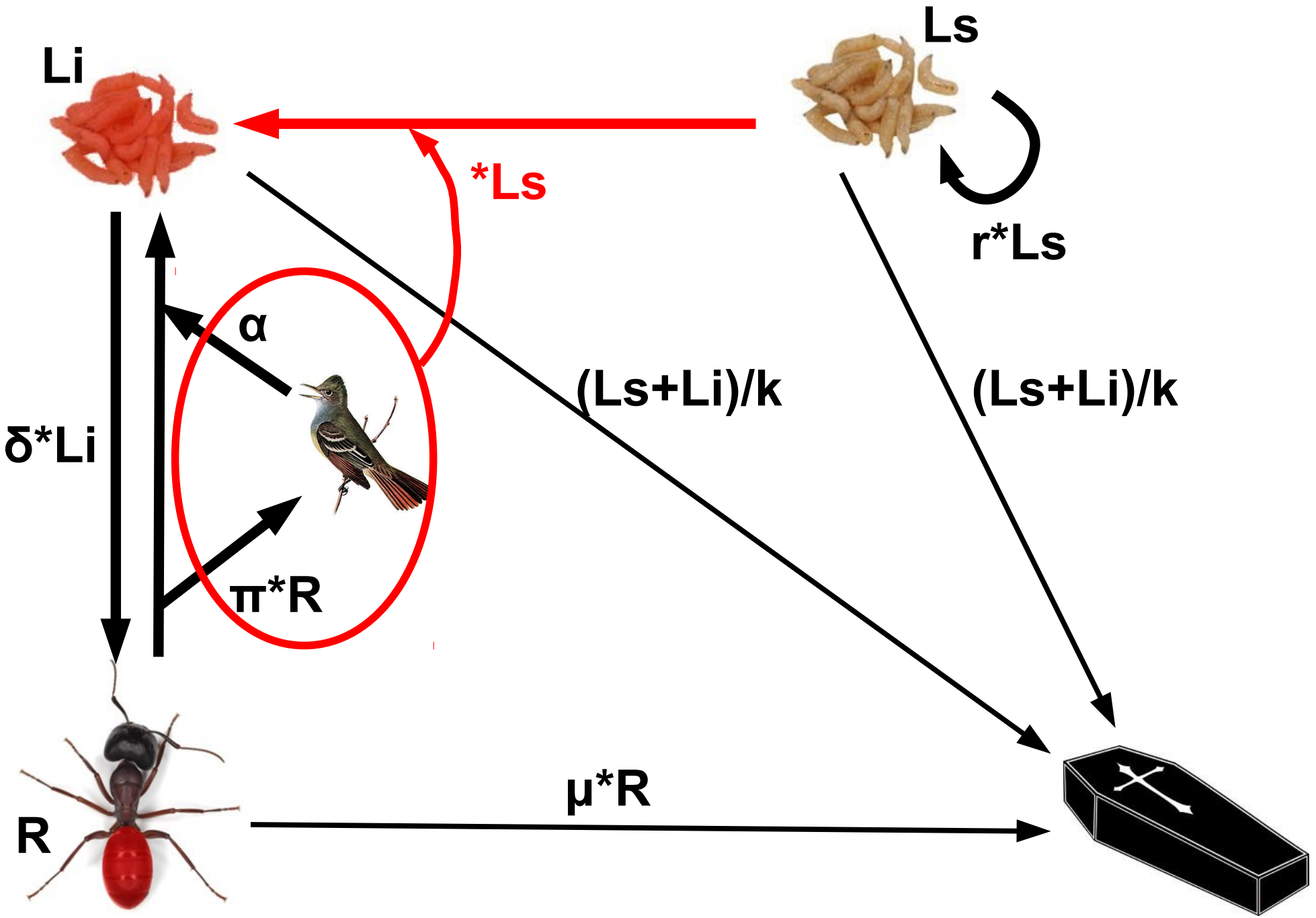

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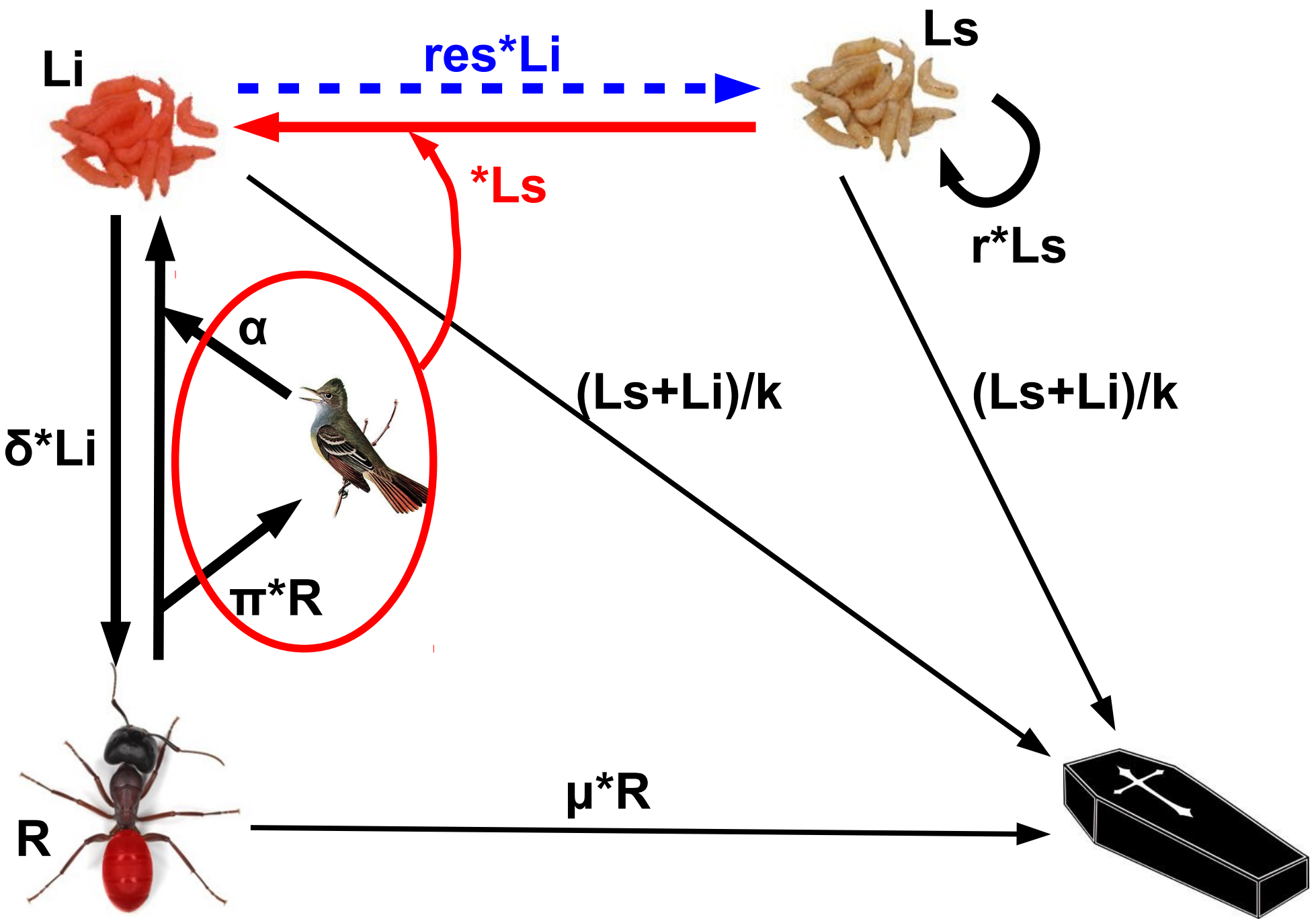

MATHEMATICAL MODELS

$$\frac{dL_s}{dt} = rL_s\left(1 - \frac{L_s + L_i}{k}\right) - \alpha\pi L_s R$$

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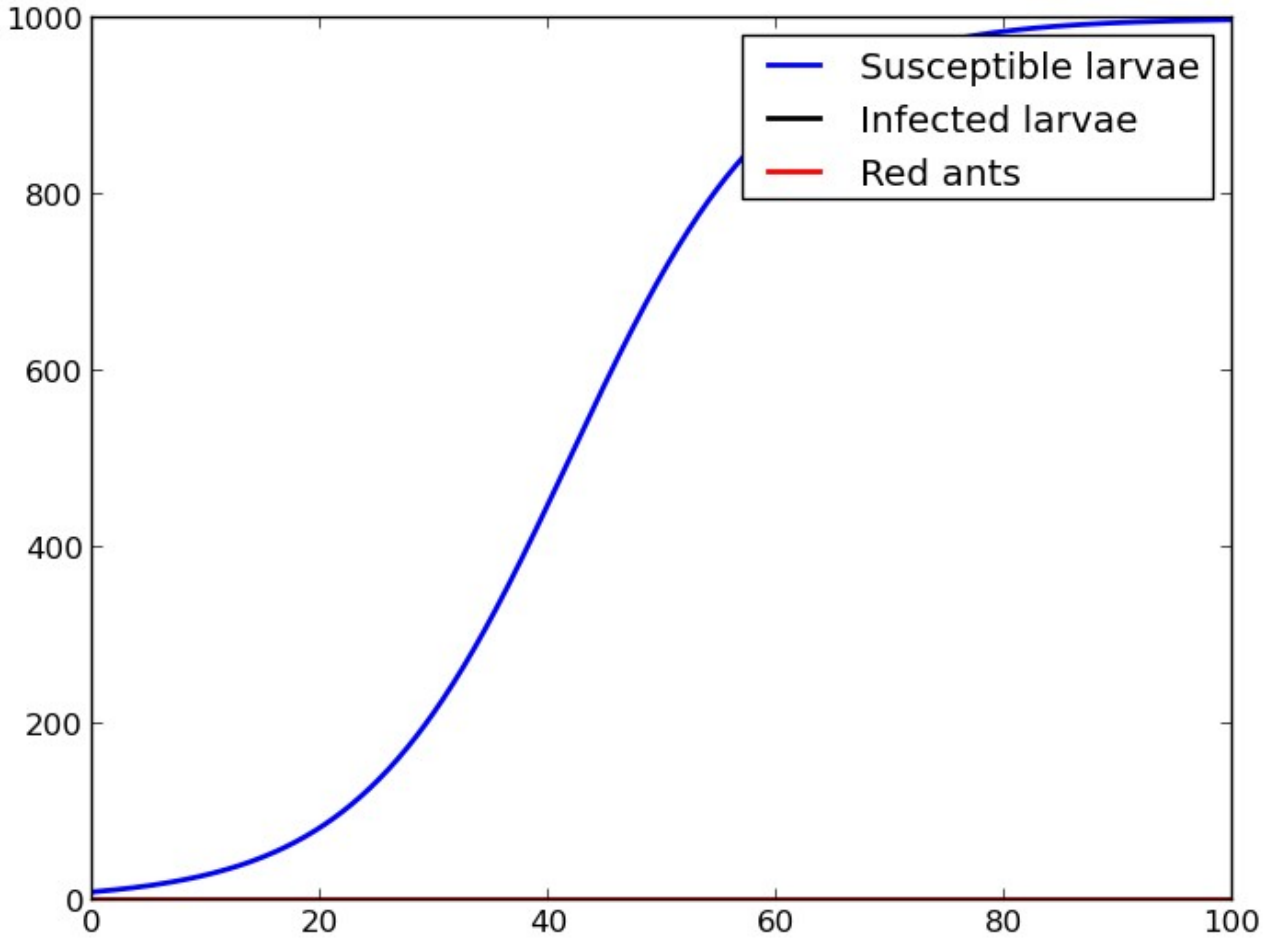
$$\frac{dR}{dt} = L_i\delta - (\pi + \mu)R$$

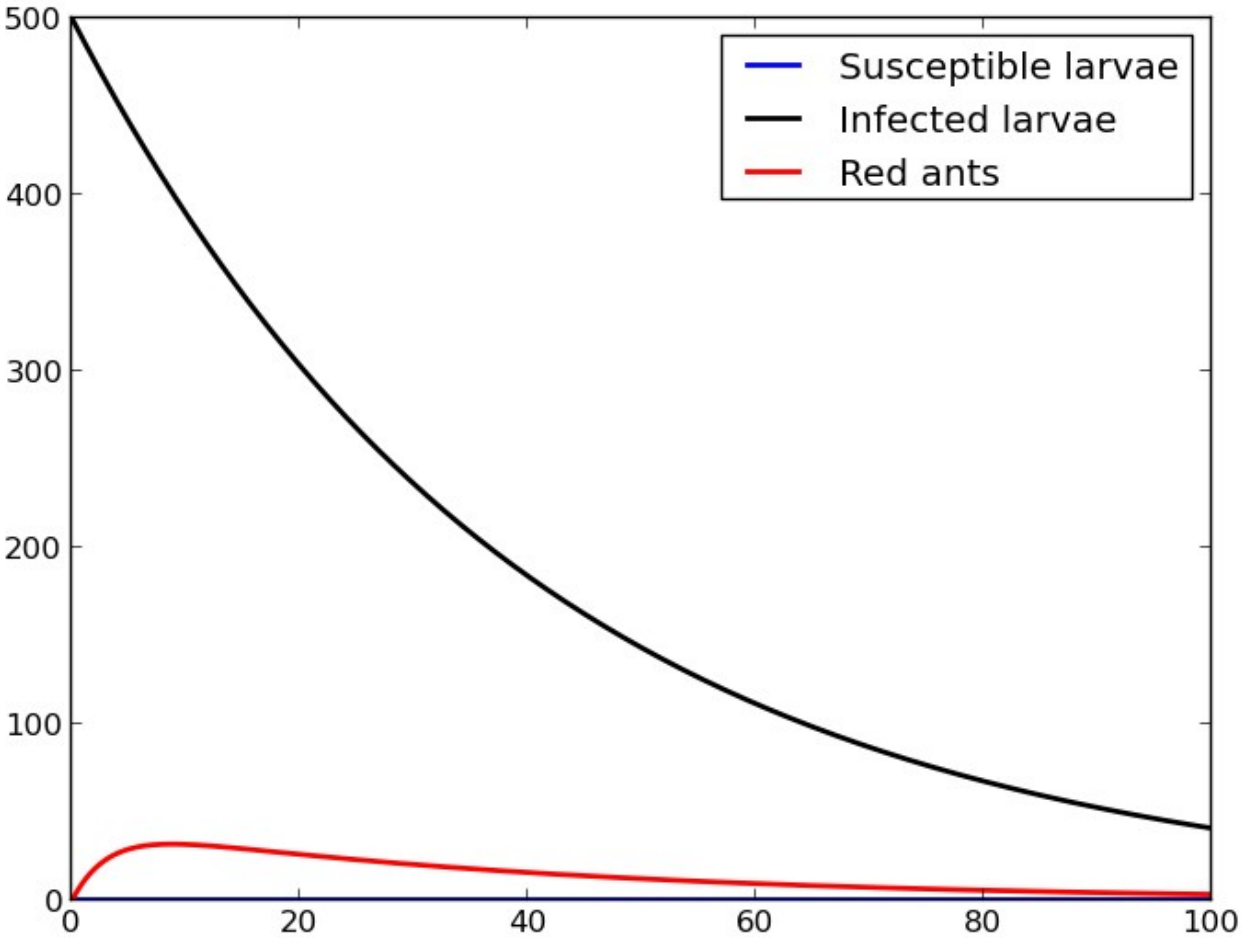
RESULTS

Control Simulations



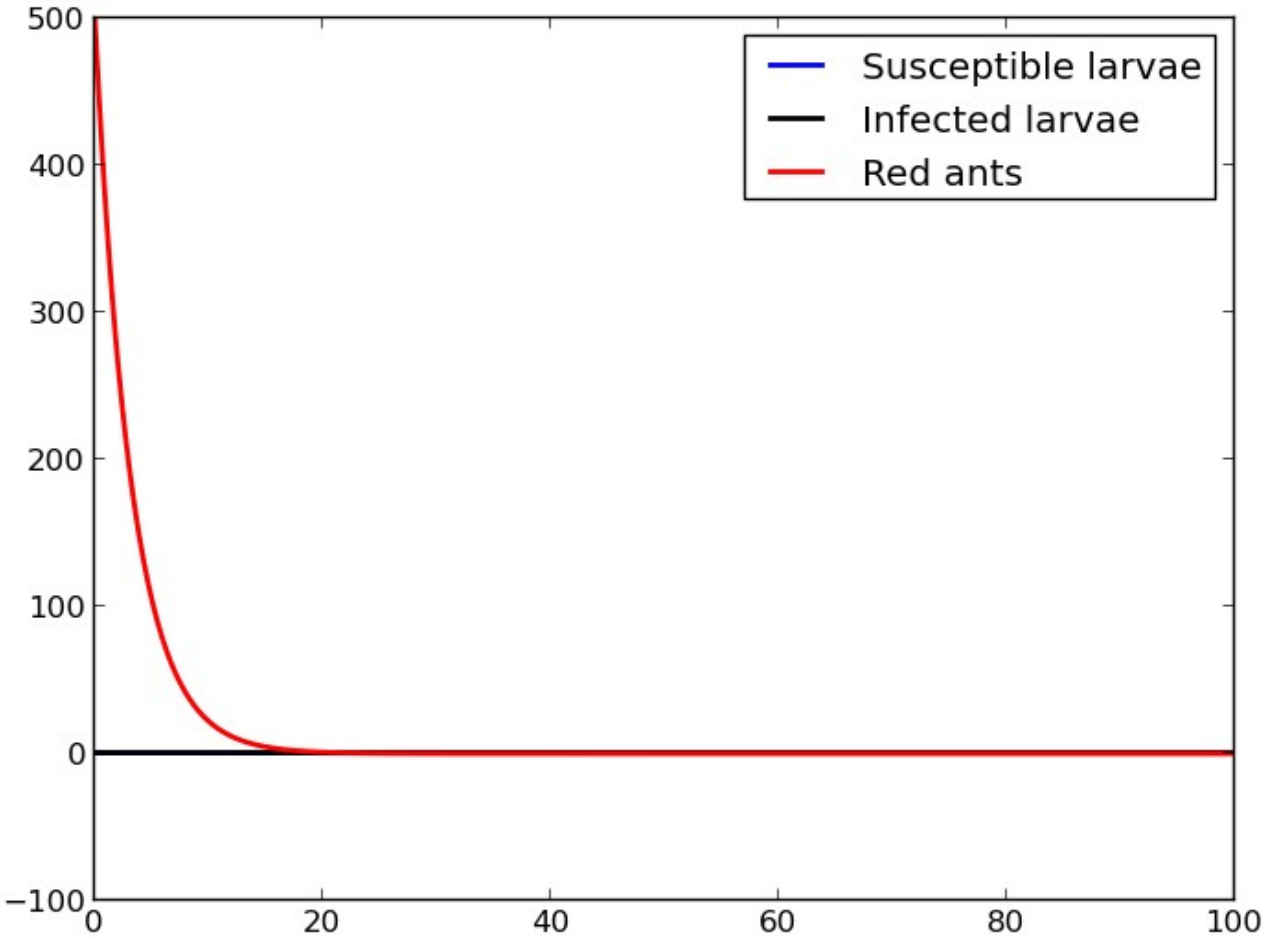
Ls = 10 **Li = 0** **R = 0** **K = 1000**

Control Simulations



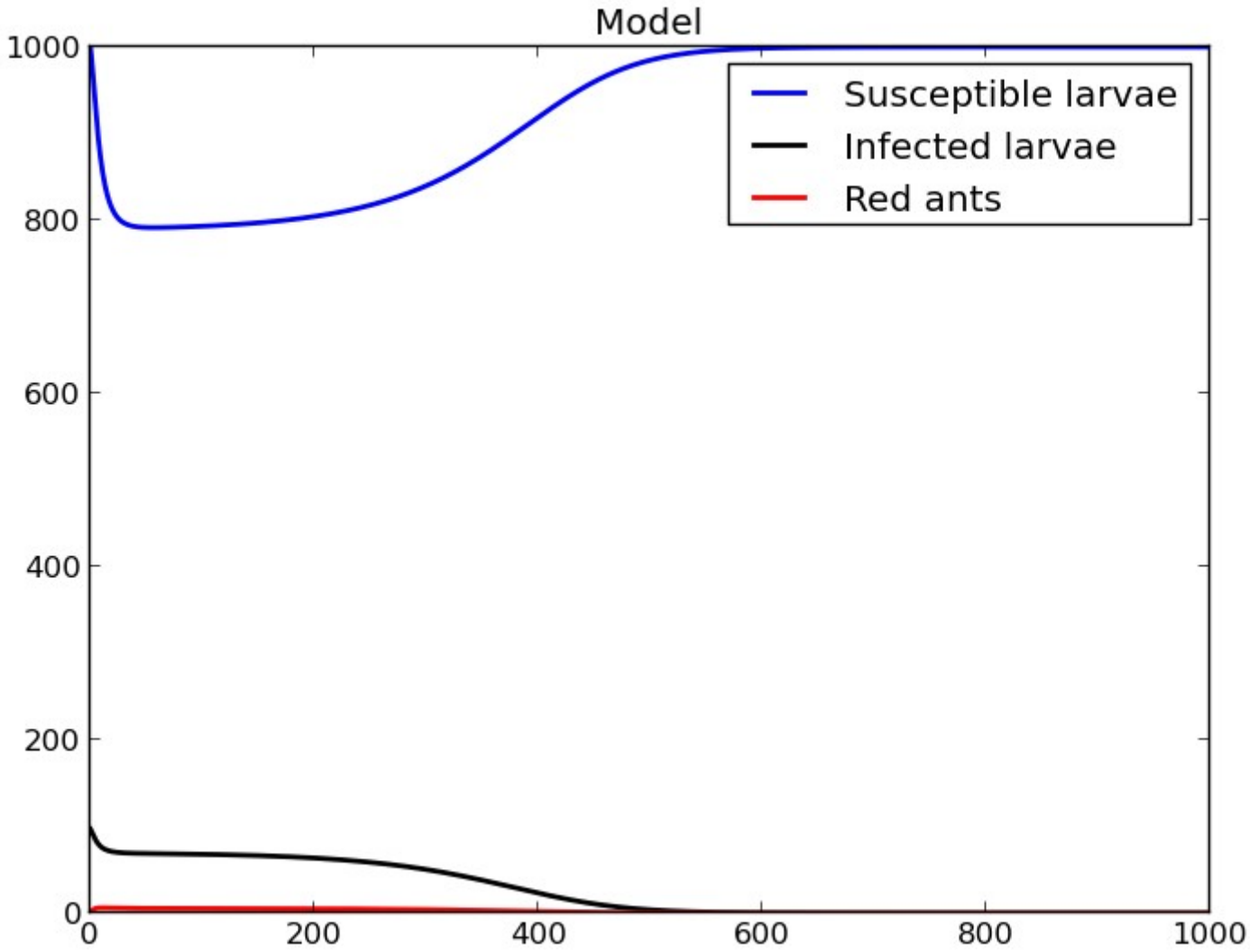
Ls = 0 **Li = 500** **R = 0** **K = 1000**

Control Simulations



Ls = 0 **Li = 0** **R = 500** **K = 1000**

What initial infection rate can promote the establishment of the parasite in the colony?



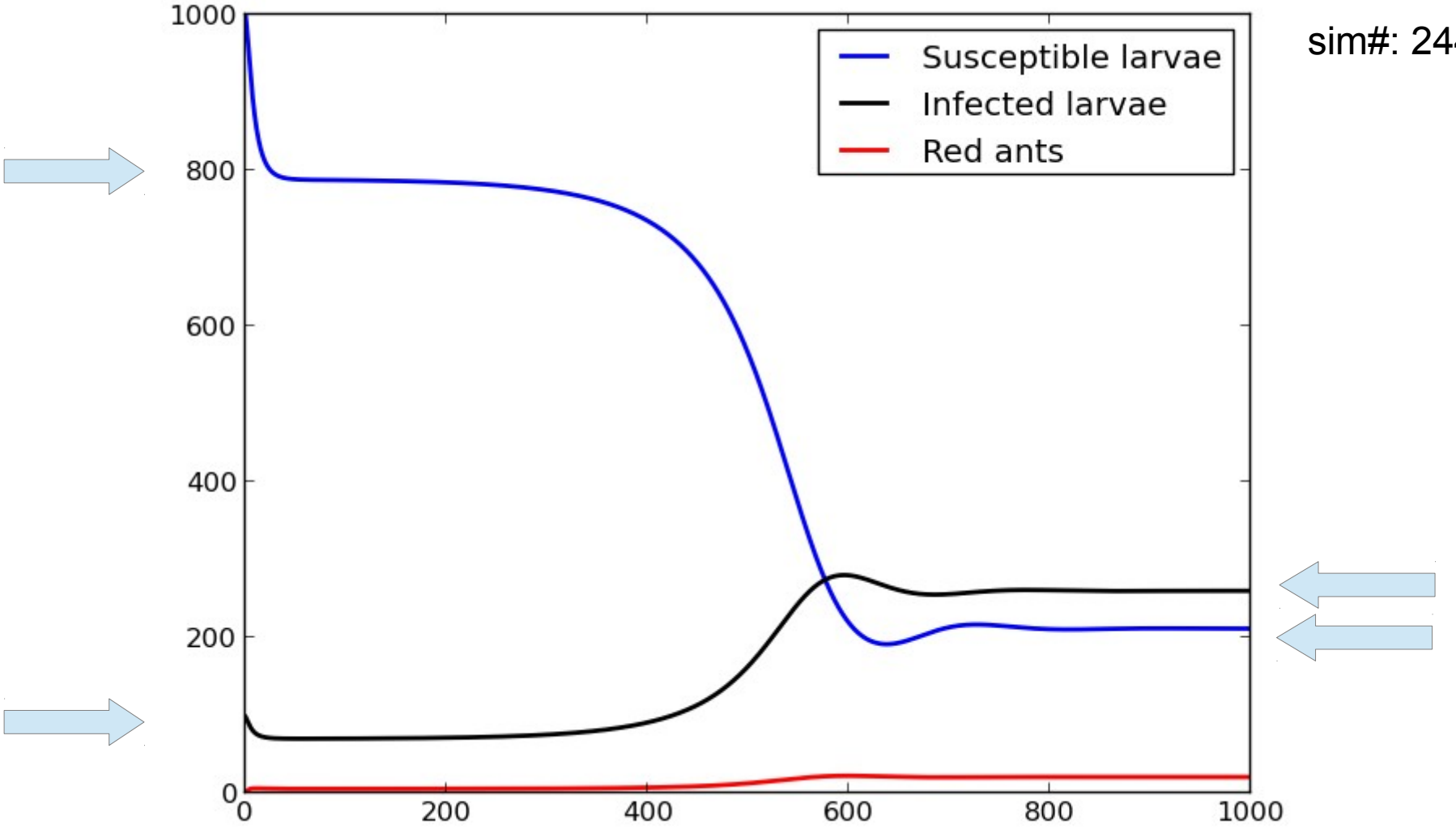
sim#: 243

α = 0.01
Π = 0.28
δ = 0.025

μ: 0.025
K = 1000
r = 0.11

Ls = 1000
Li = 97
R = 0

sim#: 244

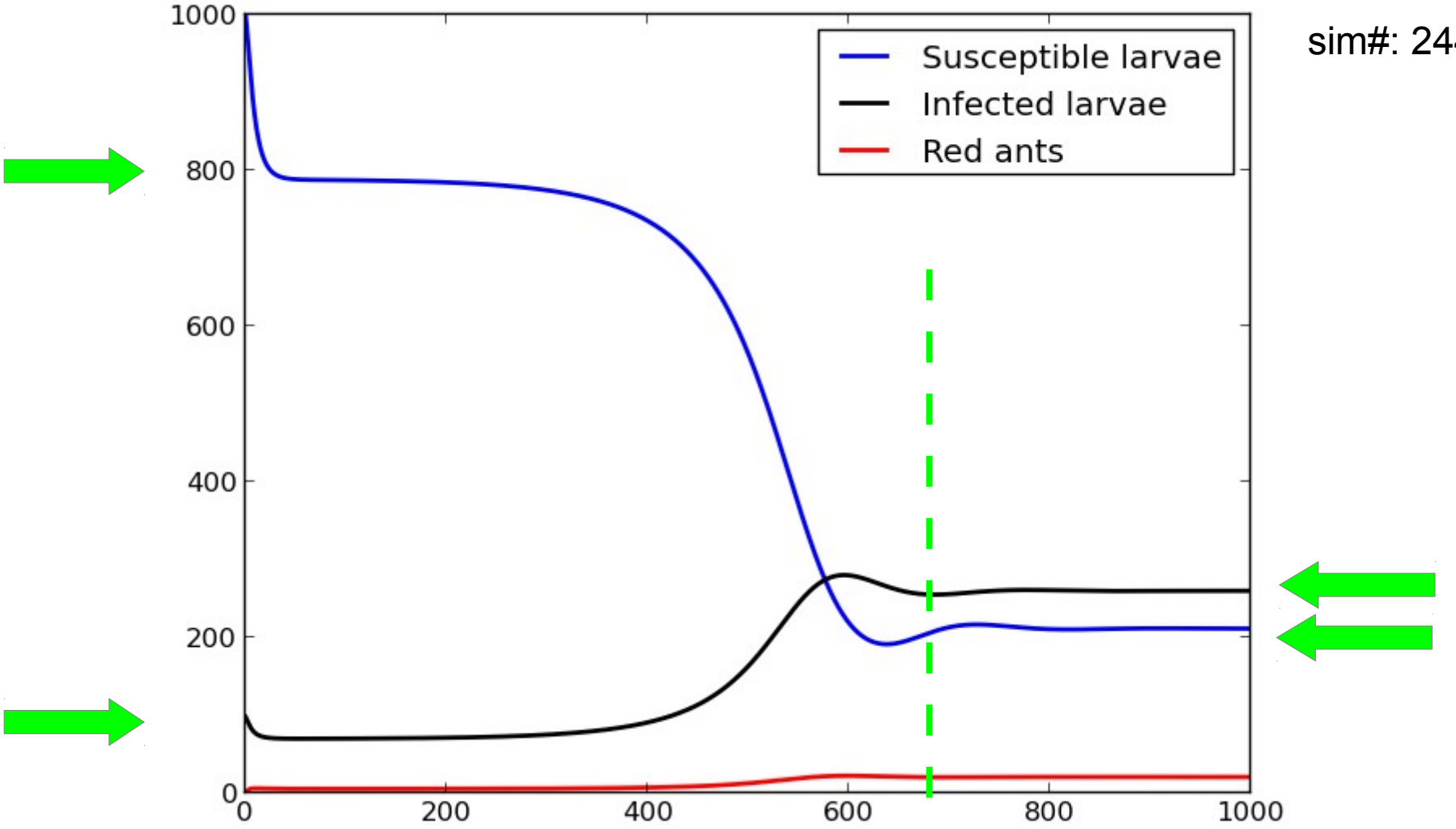


α = 0.01
Π = 0.28
δ = 0.025

μ: 0.025
K = 1000
r = 0.11

Ls = 1000
Li = 98
R = 0

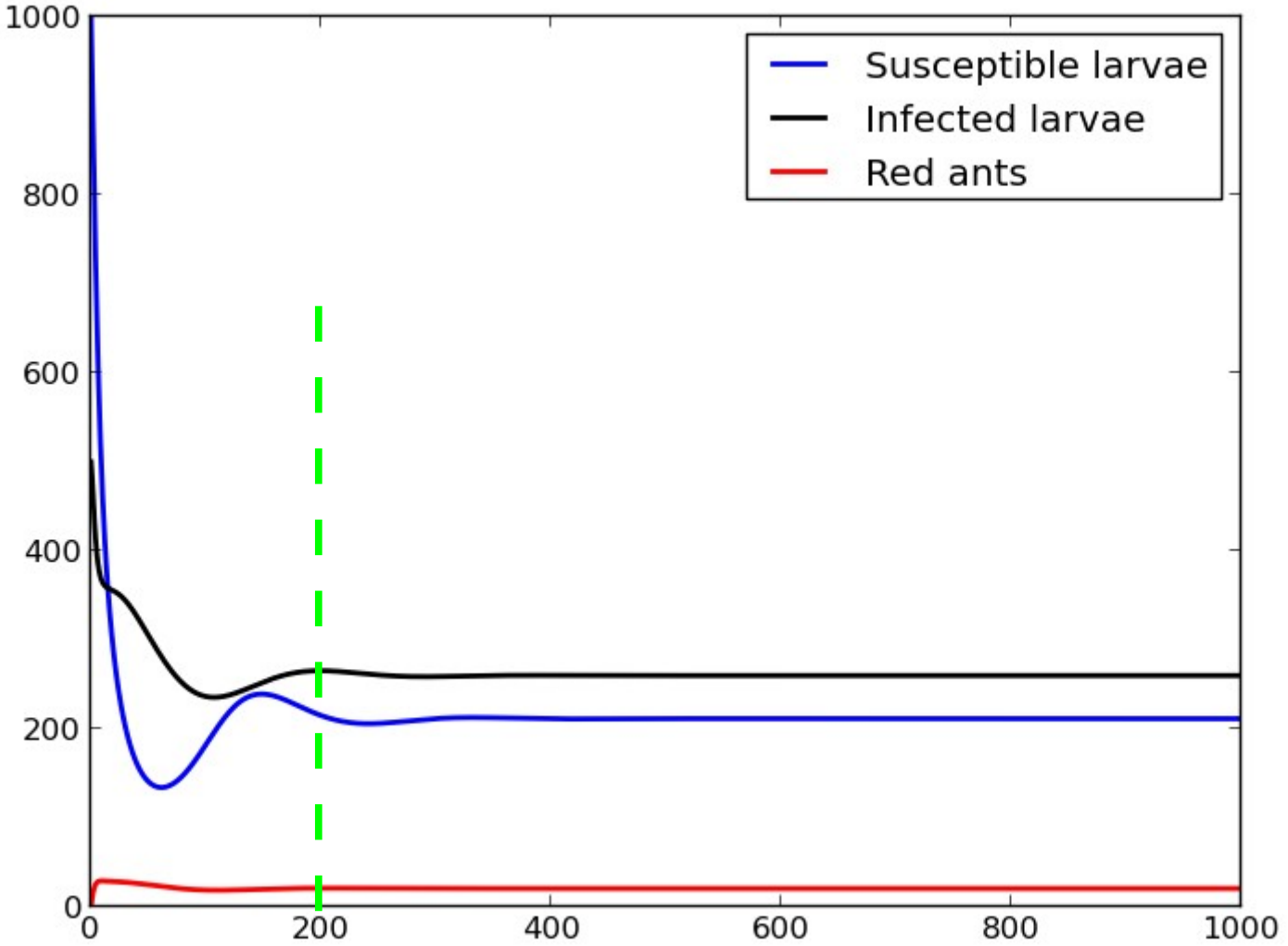
sim#: 244



α = 0.01
Π = 0.28
δ = 0.025

μ: 0.025
K = 1000
r = 0.11

Ls = 1000
Li = 98
R = 0

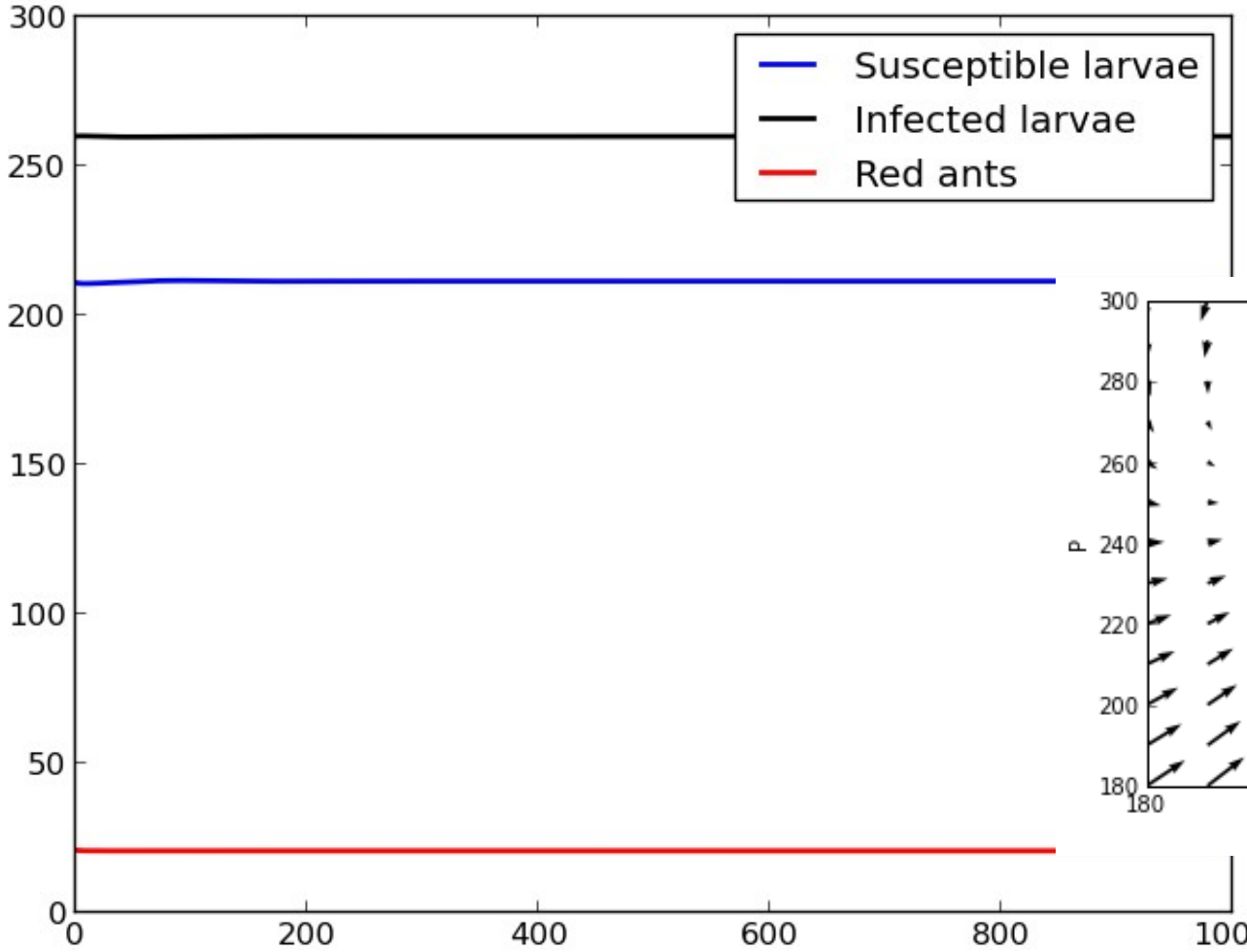


sim#: 256

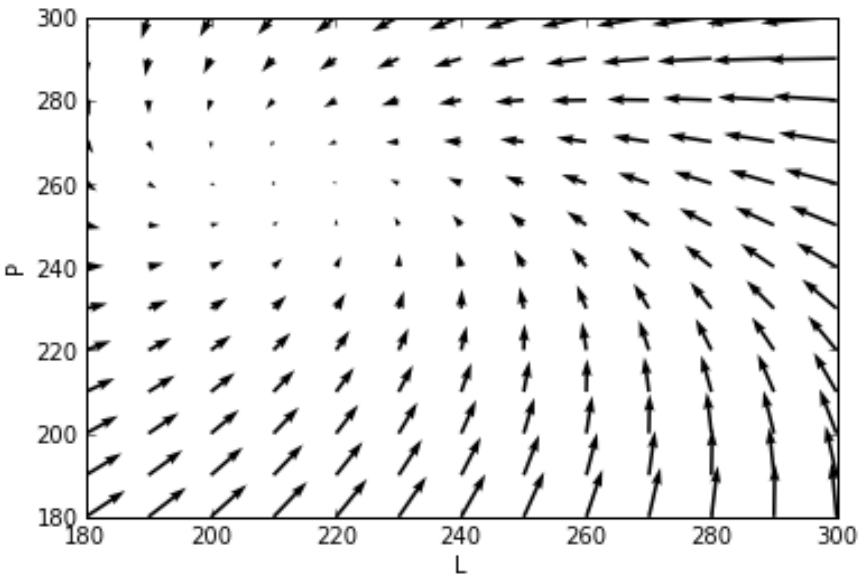
α = 0.01
Π = 0.28
δ = 0.025

μ: 0.025
K = 1000
r = 0.11

Ls = 1000
Li = 500
R = 0



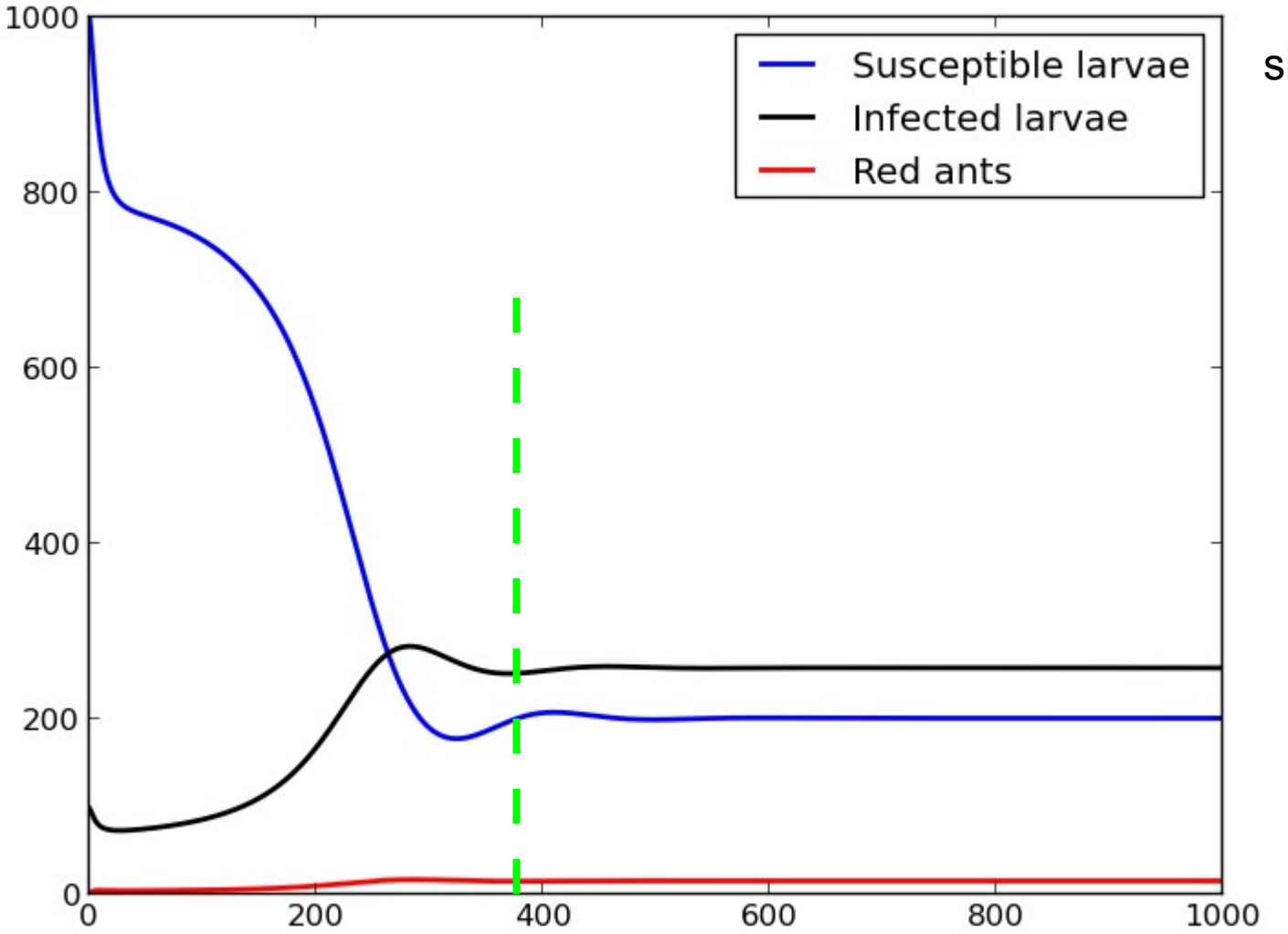
sim#: 257



α = 0.01
Π = 0.28
δ = 0.025

μ: 0.025
K = 1000
r = 0.11

Ls = 211
Li = 260
R = 21

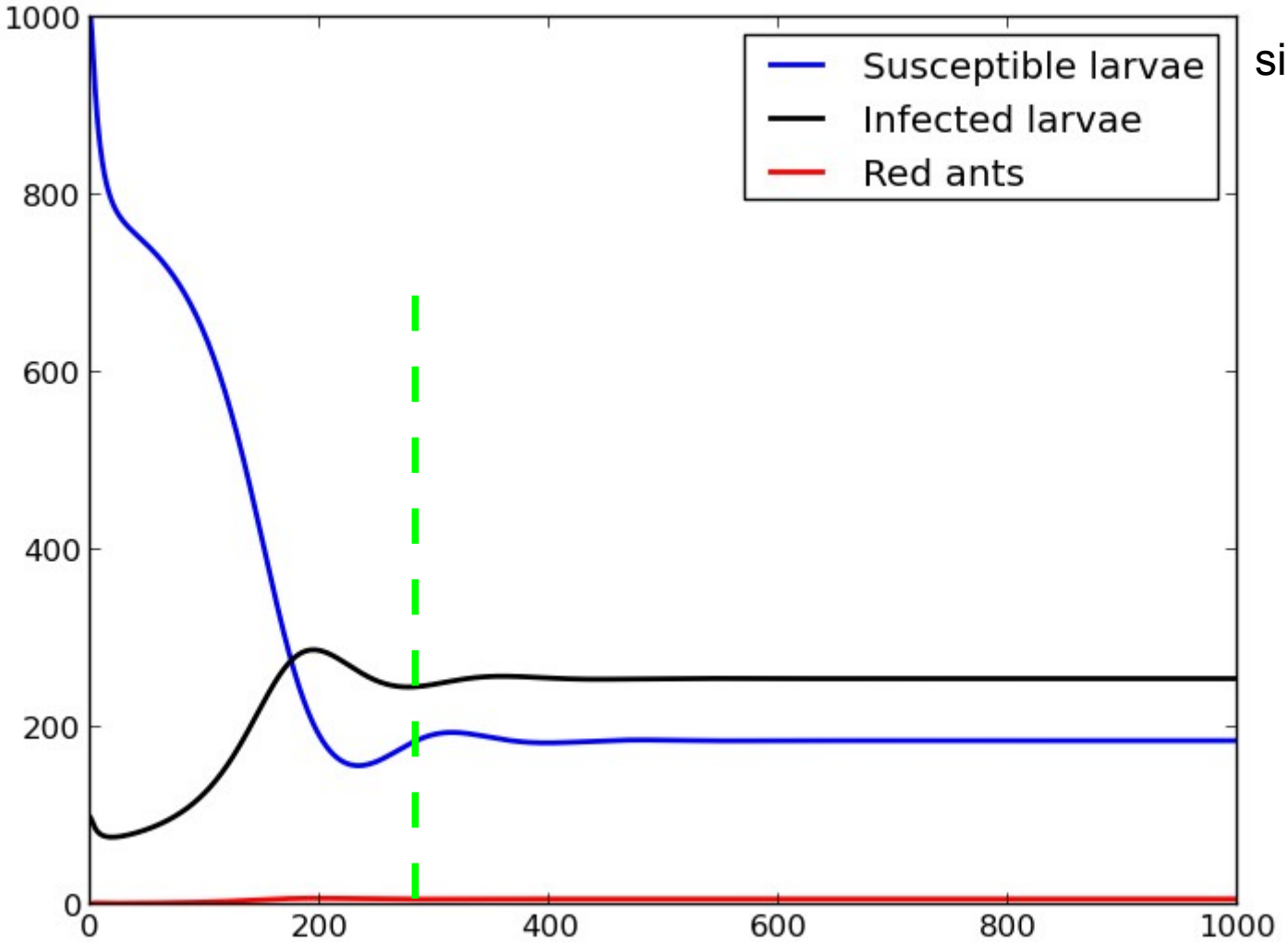


sim#': 271

α = 0.01
Π = 0.38
δ = 0.025

μ: 0.025
K = 1000
r = 0.11

Ls = 1000
Li = 98
R = 0



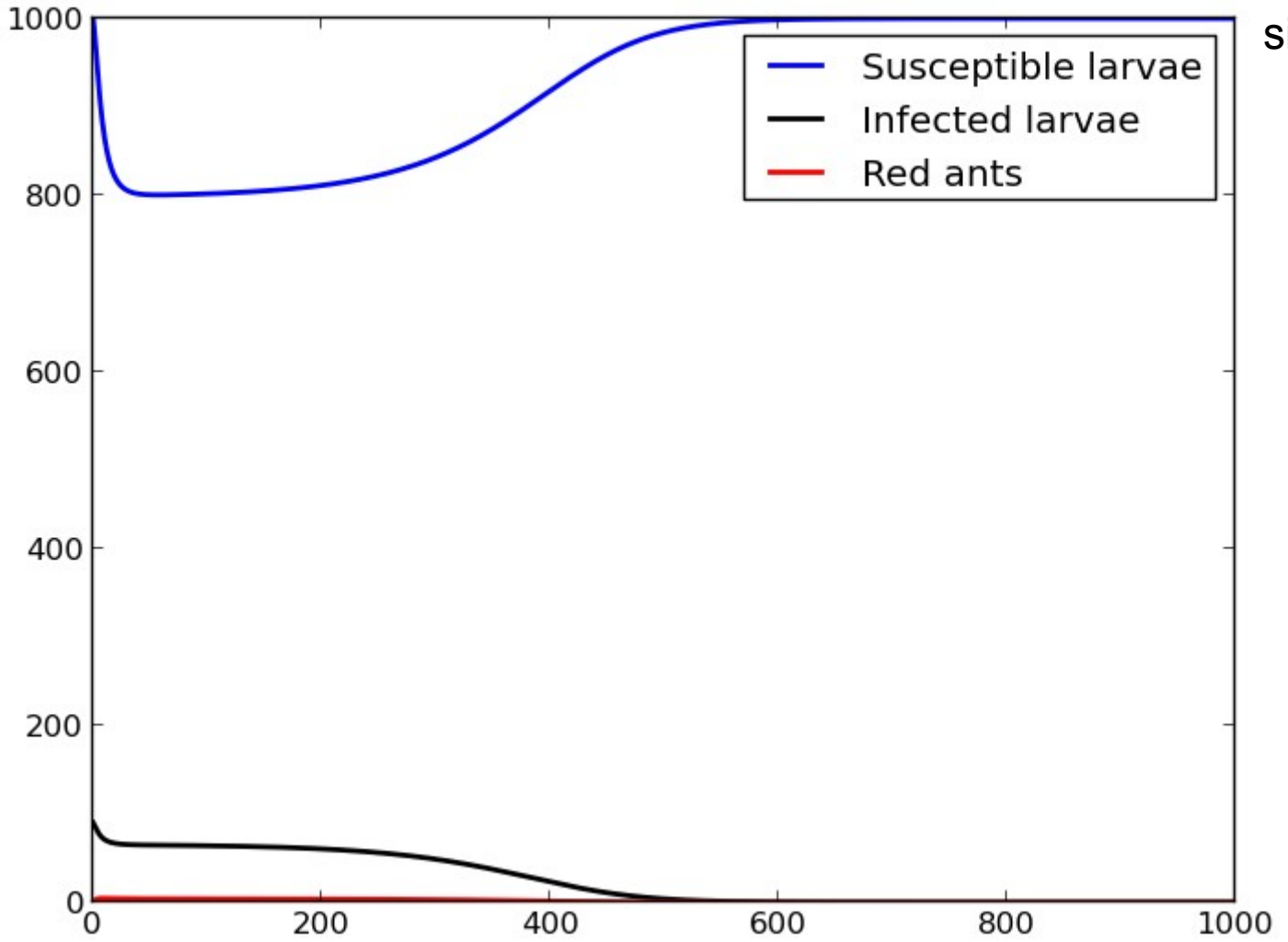
sim#: 274

α = 0.01
Π = 0.9
δ = 0.025

μ: 0.025
K = 1000
r = 0.11

Ls = 1000
Li = 98
R = 0

What predation rate can maintain the parasite in the colony?

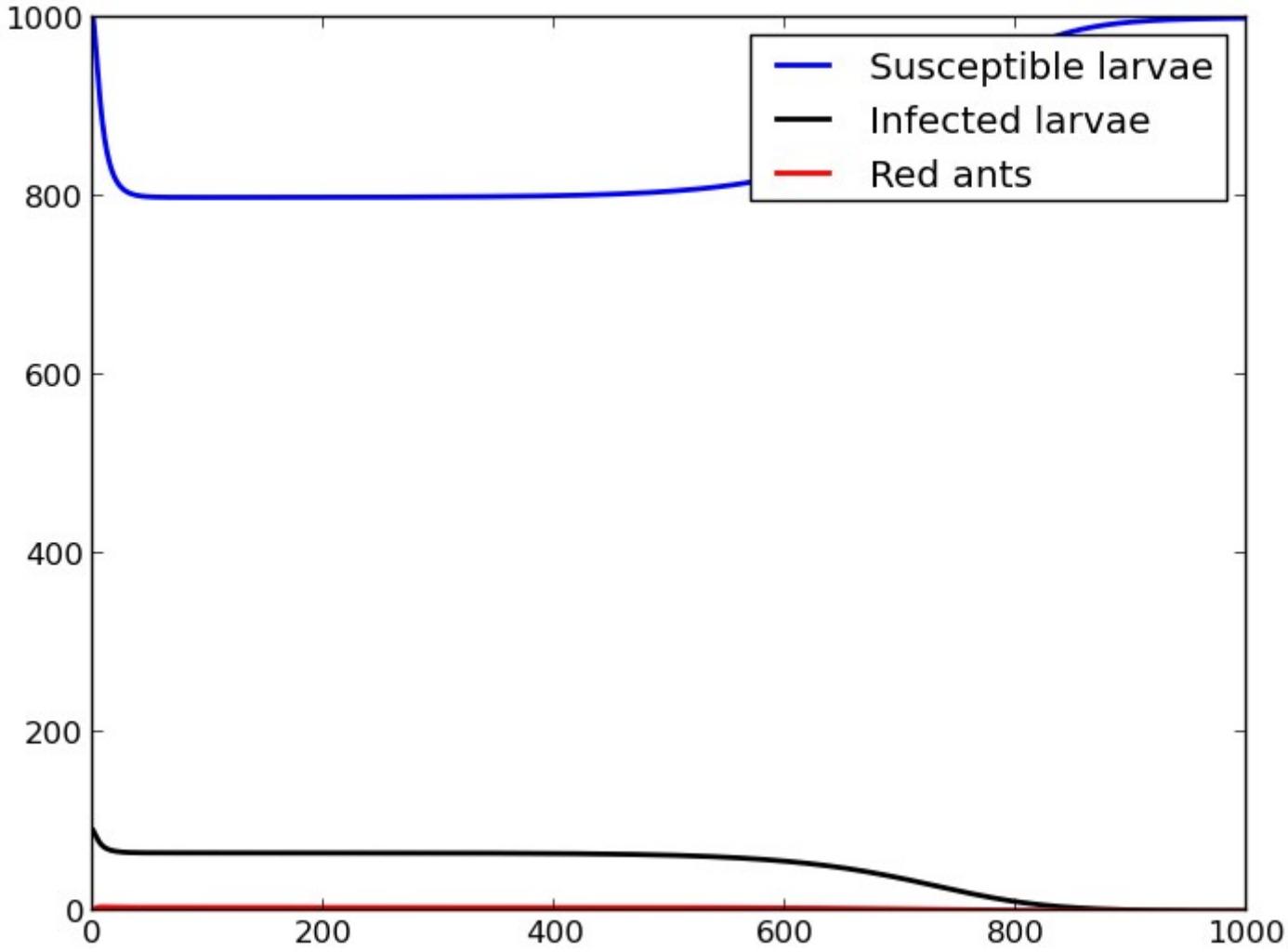


sim#: 267

α = 0.01
Π = 0.37
δ = 0.025

μ: 0.025
K = 1000
r = 0.11

Ls = 1000
Li = 90
R = 0

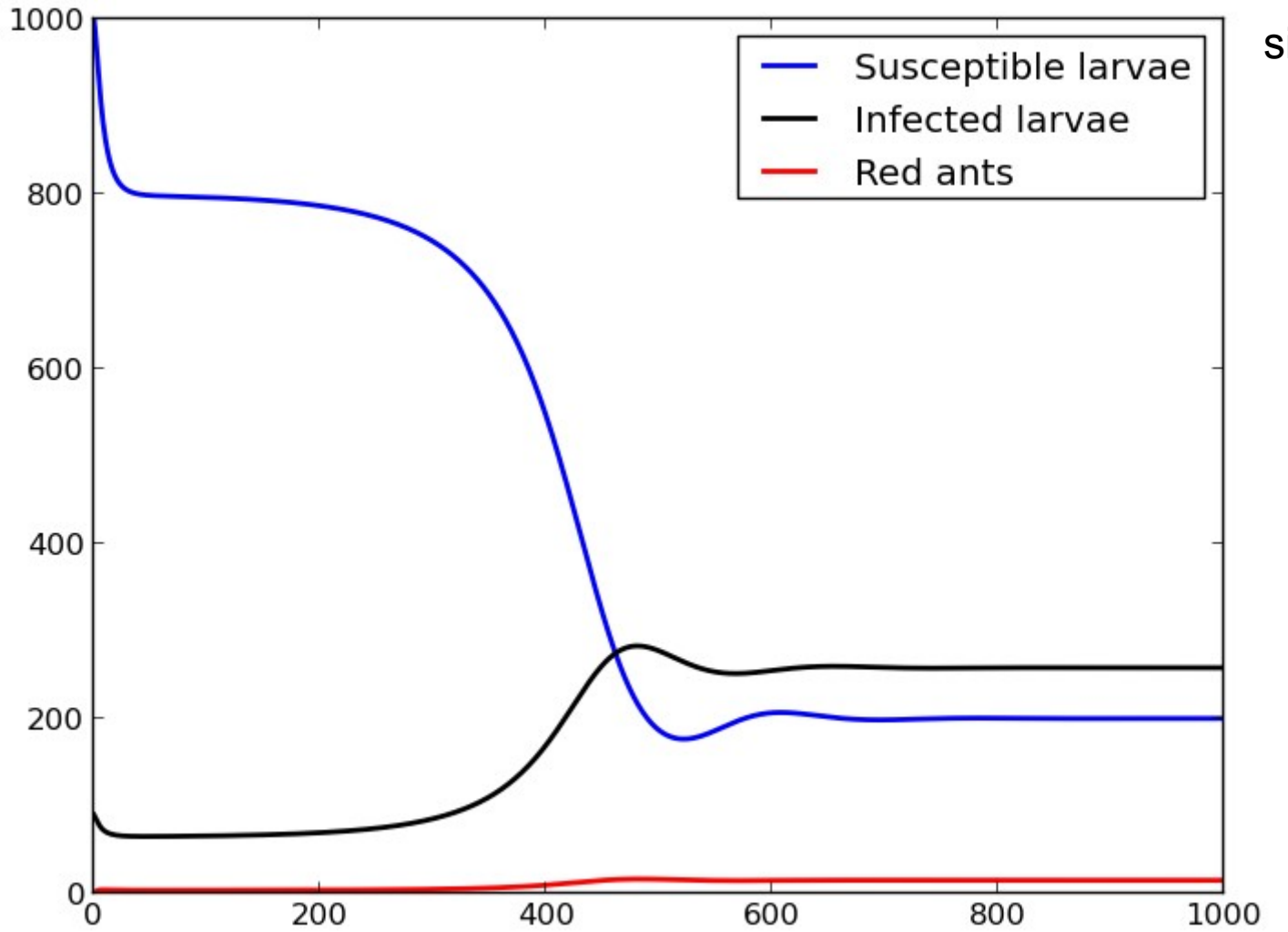


sim#: 268

α = 0.01
Π = 0.38
δ = 0.025

μ: 0.025
K = 1000
r = 0.11

Ls = 1000
Li = 90
R = 0



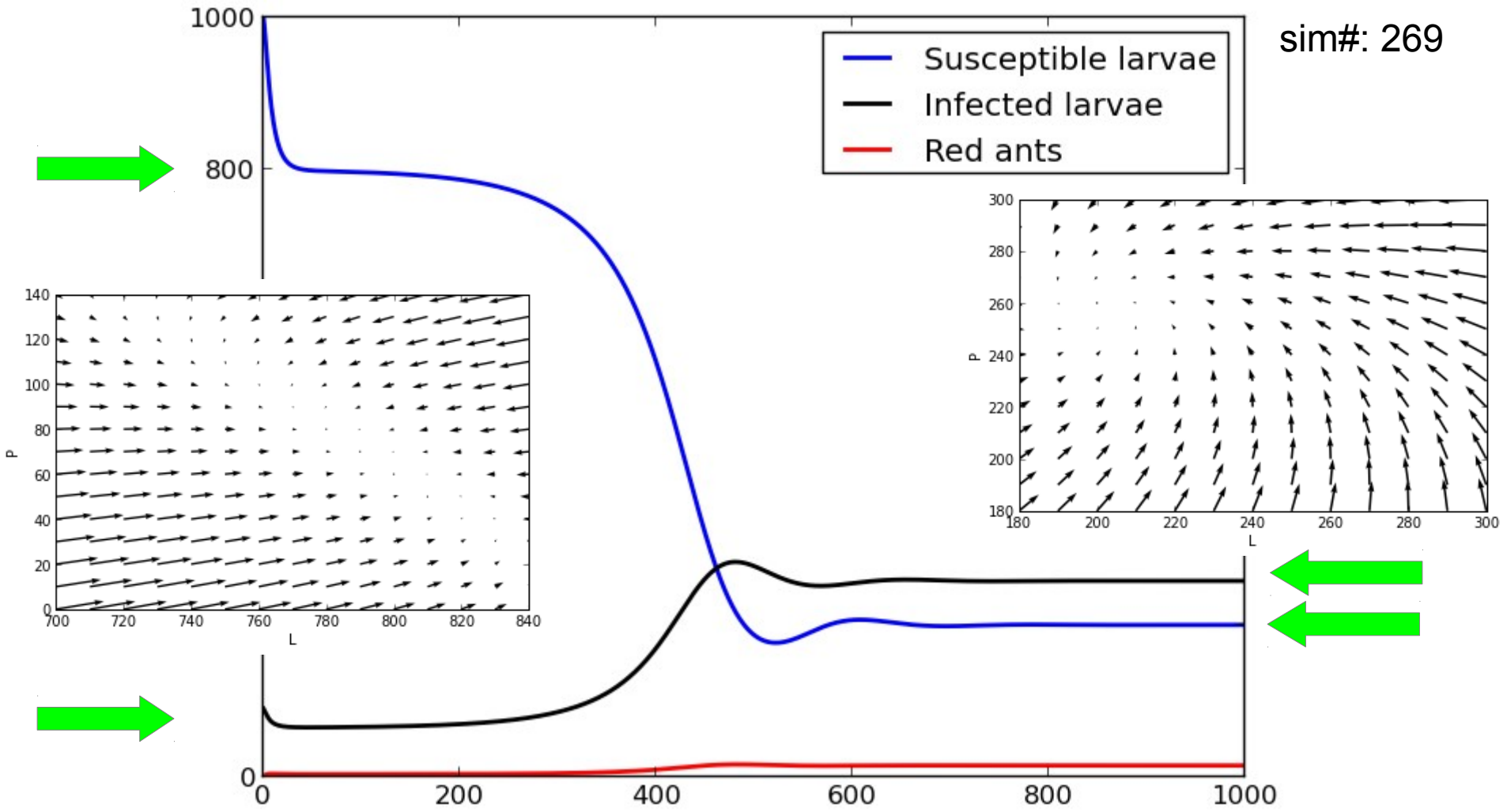
sim#: 269

α = 0.01
Π = 0.39
δ = 0.025

μ: 0.025
K = 1000
r = 0.11

Ls = 1000
Li = 90
R = 0

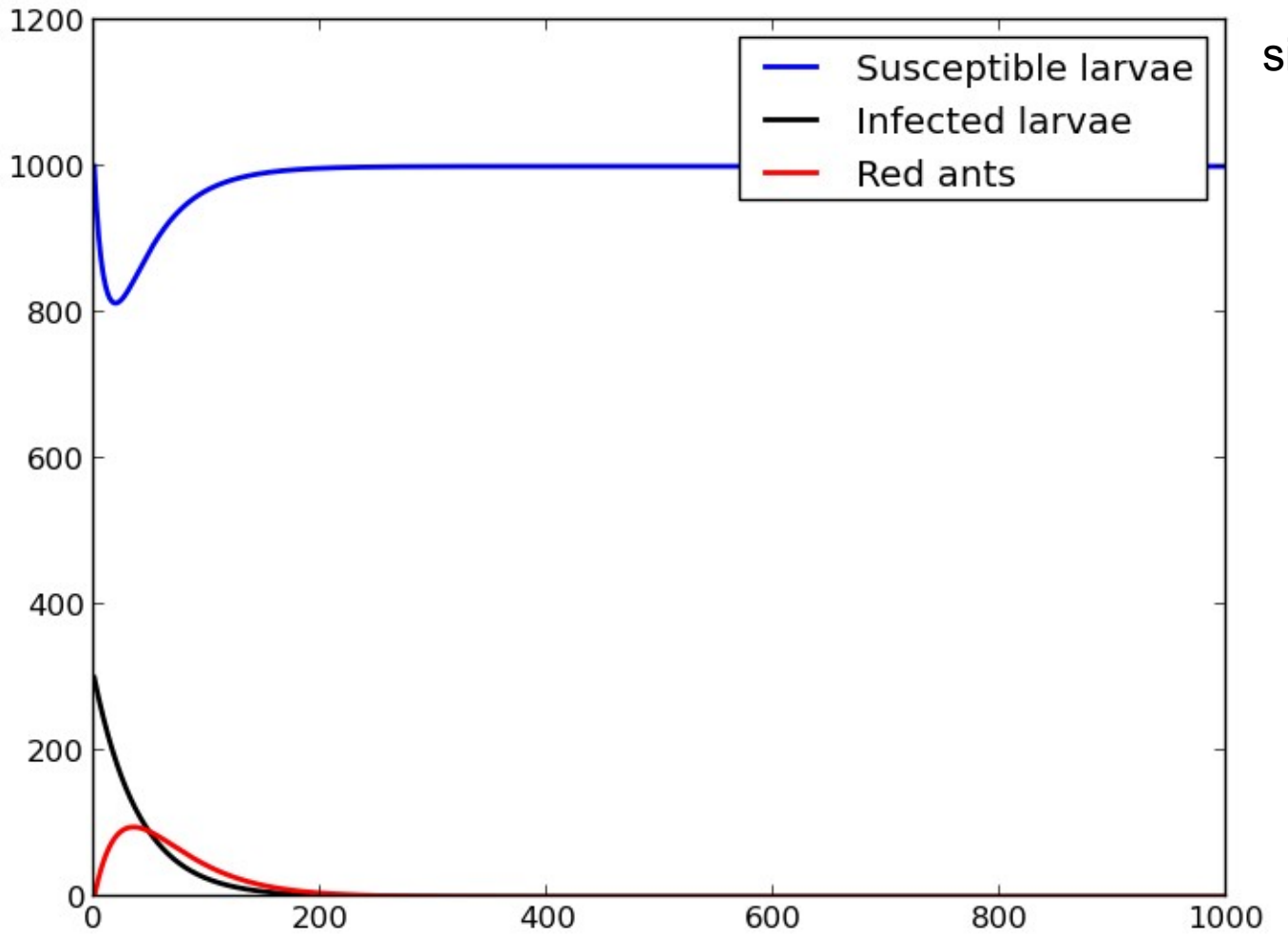
sim#: 269



α = 0.01
Π = 0.39
δ = 0.025

μ: 0.025
K = 1000
r = 0.11

Ls = 1000
Li = 90
R = 0



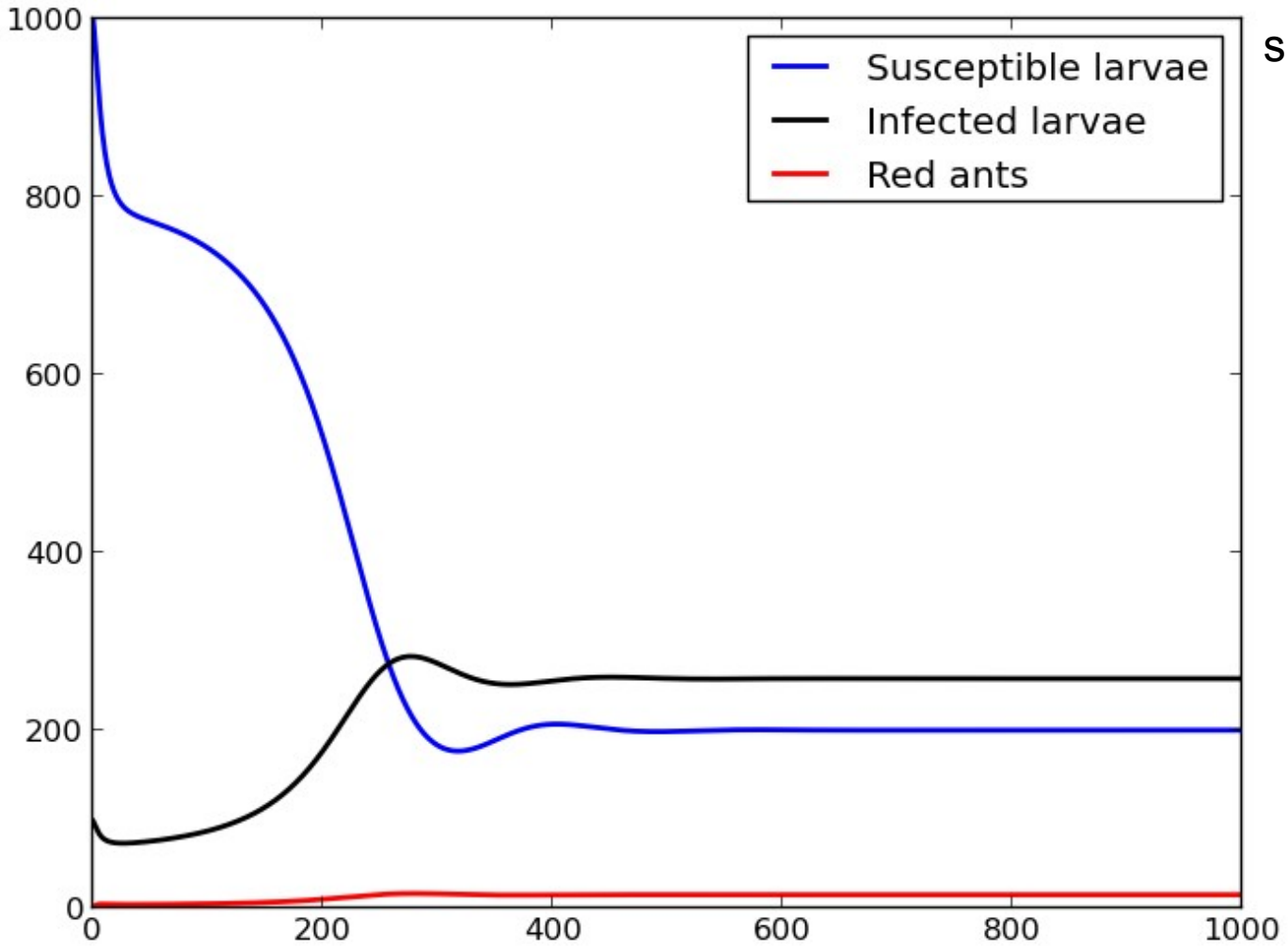
sim#: 281

α = 0.01
Π = 0.0
δ = 0.025

μ: 0.025
K = 1000
r = 0.11

Ls = 1000
Li = 300
R = 0

What infection rate makes the colony collapse?

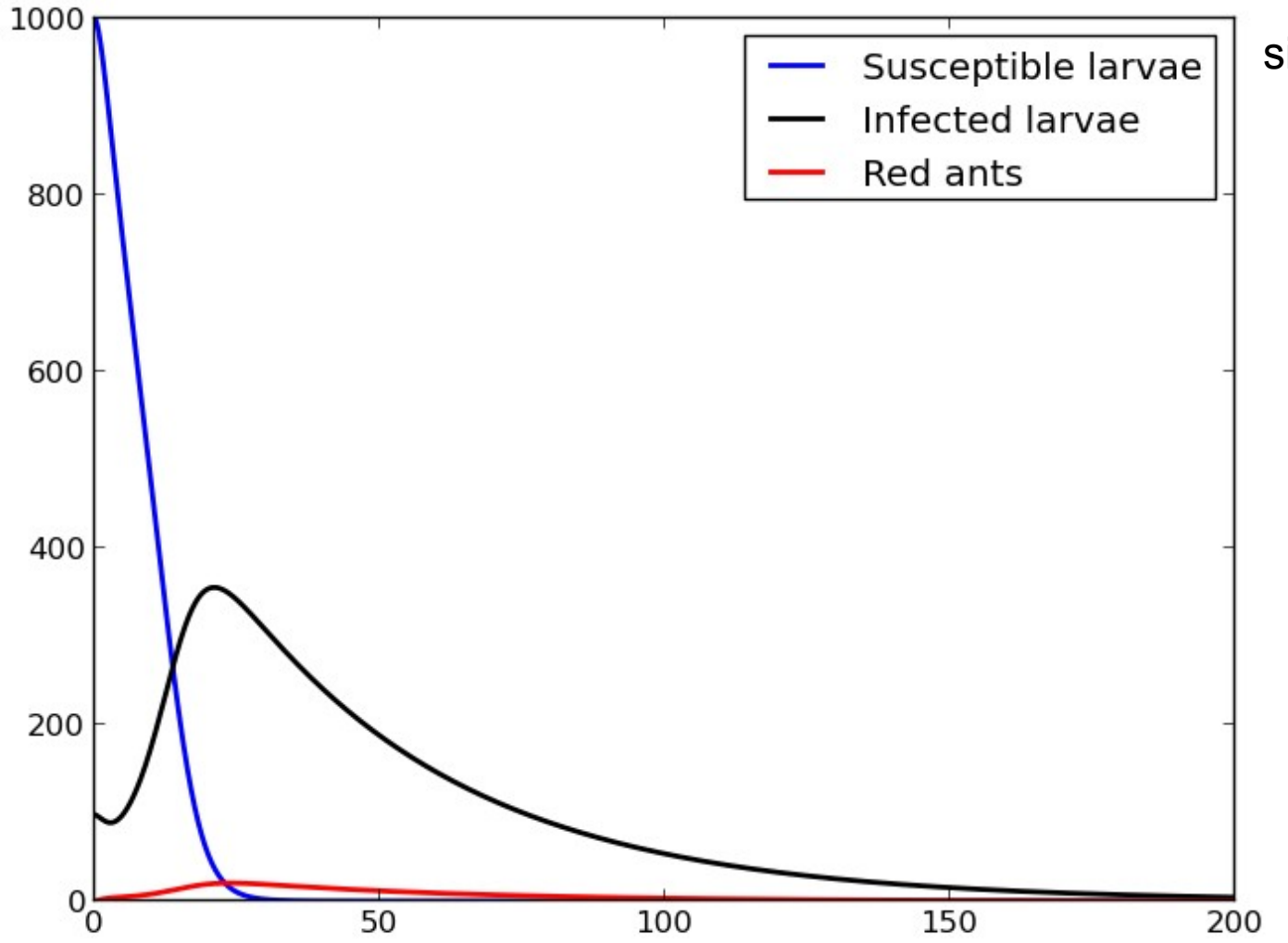


sim#: 378

α = 0.01
Π = 0.39
δ = 0.025

μ: 0.025
K = 1000
r = 0.11

Ls = 1000
Li = 98
R = 0



sim#: 386

α = 0.05
Π = 0.39
δ = 0.025

μ: 0.025
K = 1000
r = 0.11

Ls = 1000
Li = 98
R = 0

CONCLUSIONS

Predation of infected ants and infectivity of the parasite seem to play an important role in the stabilization of the population dynamics of host and parasite.

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Manipulative parasites can drive host population sizes down to levels considerably below the carrying capacity of the host population, and possibly to extinction.

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Depending on the population parameters, the initial infection rate is essential for the establishment of the parasite population in the colony (coexistence).

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Predation of infected ants and infectivity of the parasite seem to play an important role in the stabilization of the population dynamics of host and parasite.

Manipulative parasites can drive host population sizes down to levels considerably below the carrying capacity of the host population, and possibly to extinction.

Depending on the population parameters, the initial infection rate is essential for the establishment of the parasite population in the colony (coexistence).

Collapse	Coexistence	No Infection
↑α		↓α
↑π	> π → < time to equilibrium	↓π
↓r	<r → Ls nearer Li	↑r

LIMITATIONS

Resistance.

Single colony.

Dependence of alpha on R. → $\alpha \leq 1/(\pi * R)$

No spatial structure of populations.

No basal infection rate.

Thank you!