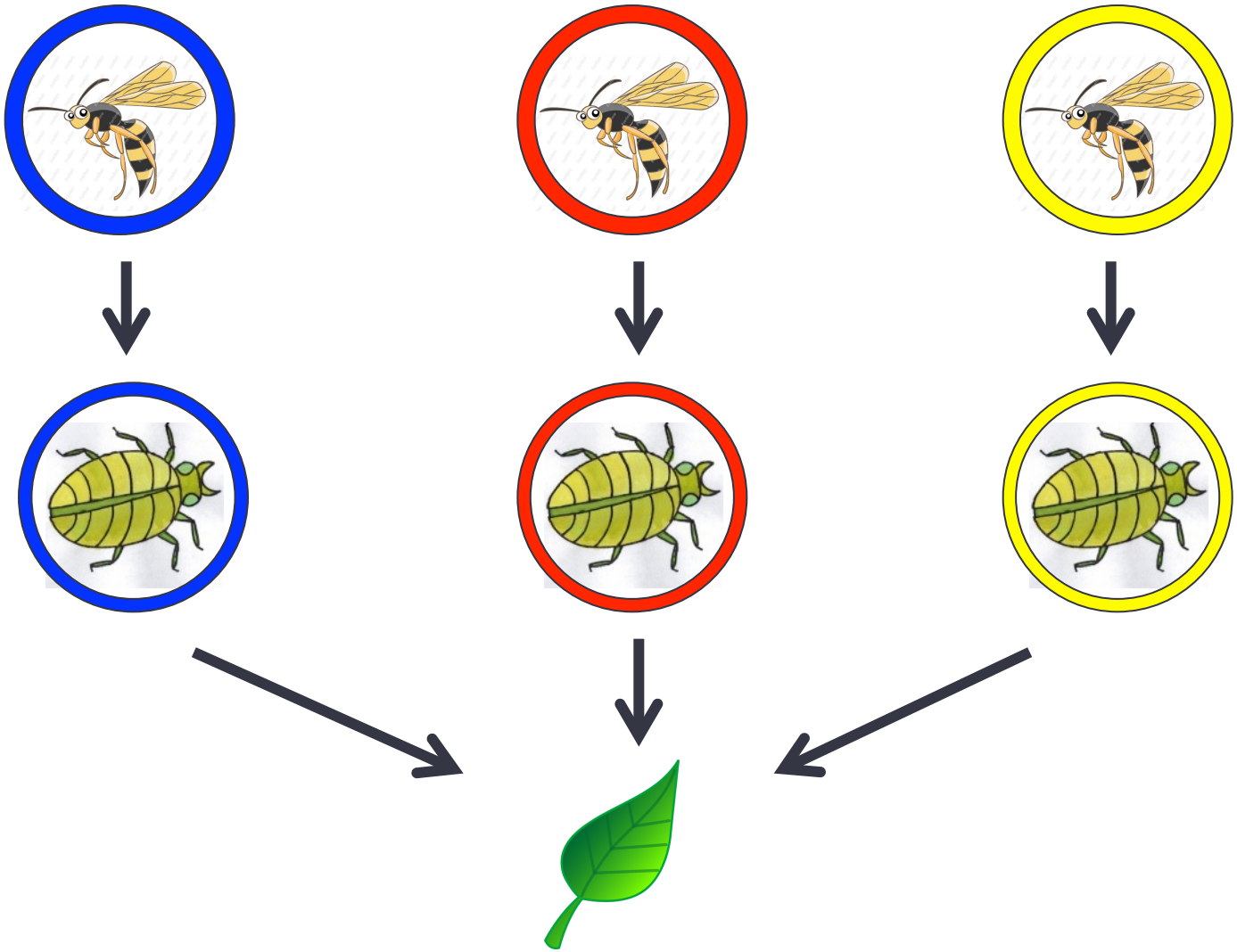
Horizontal trophic cascades

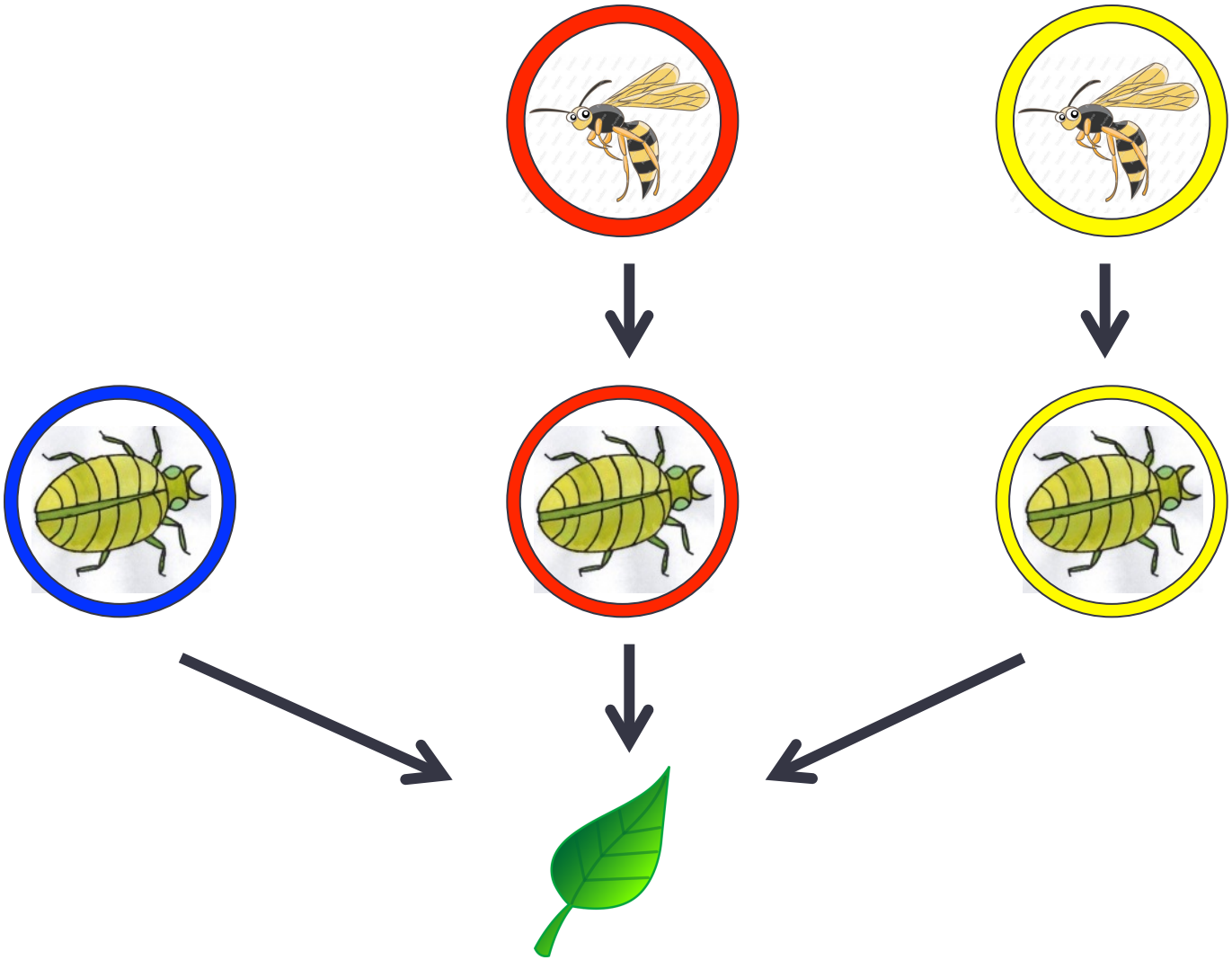
Group 8

2014

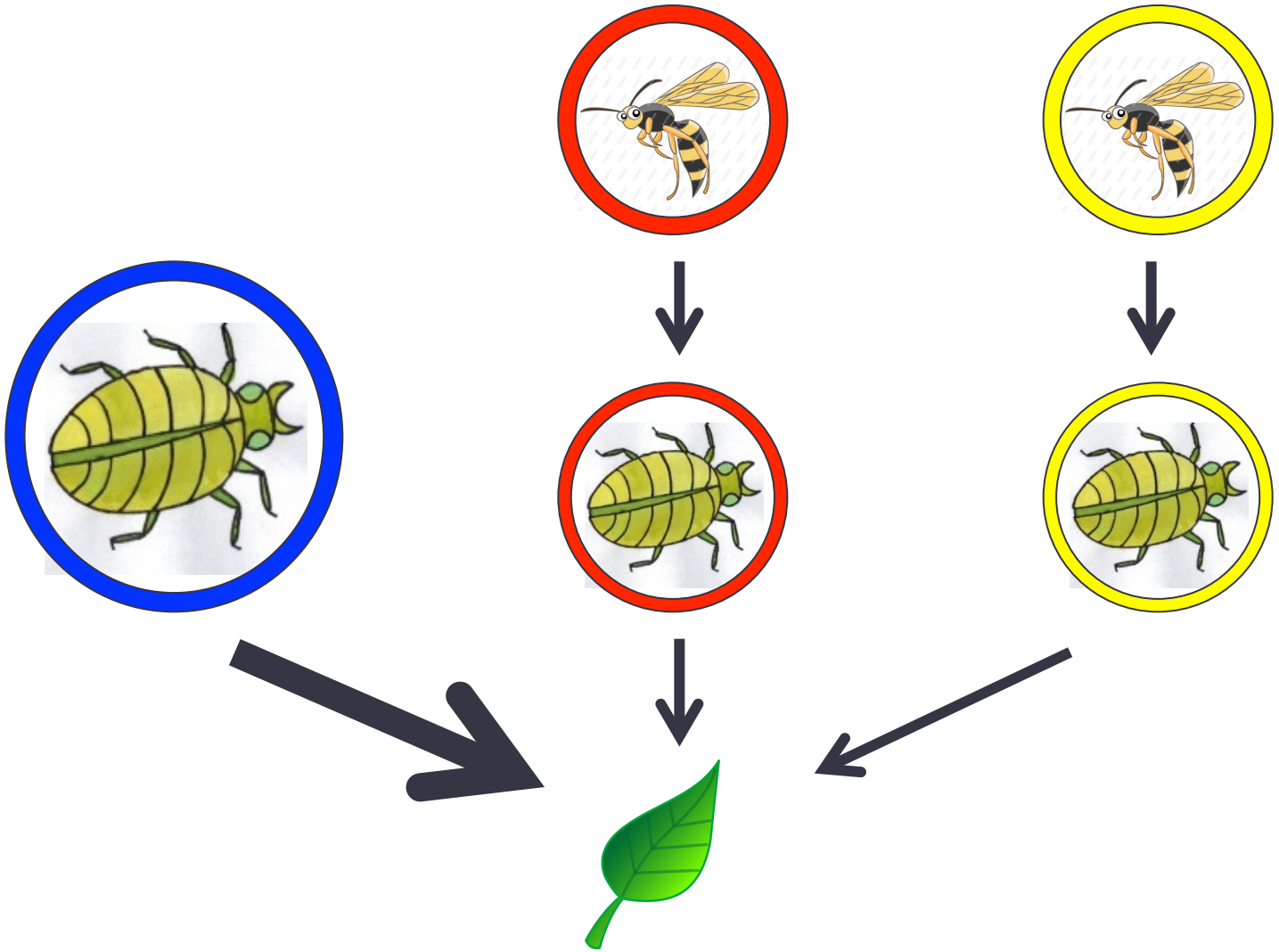
Food webs



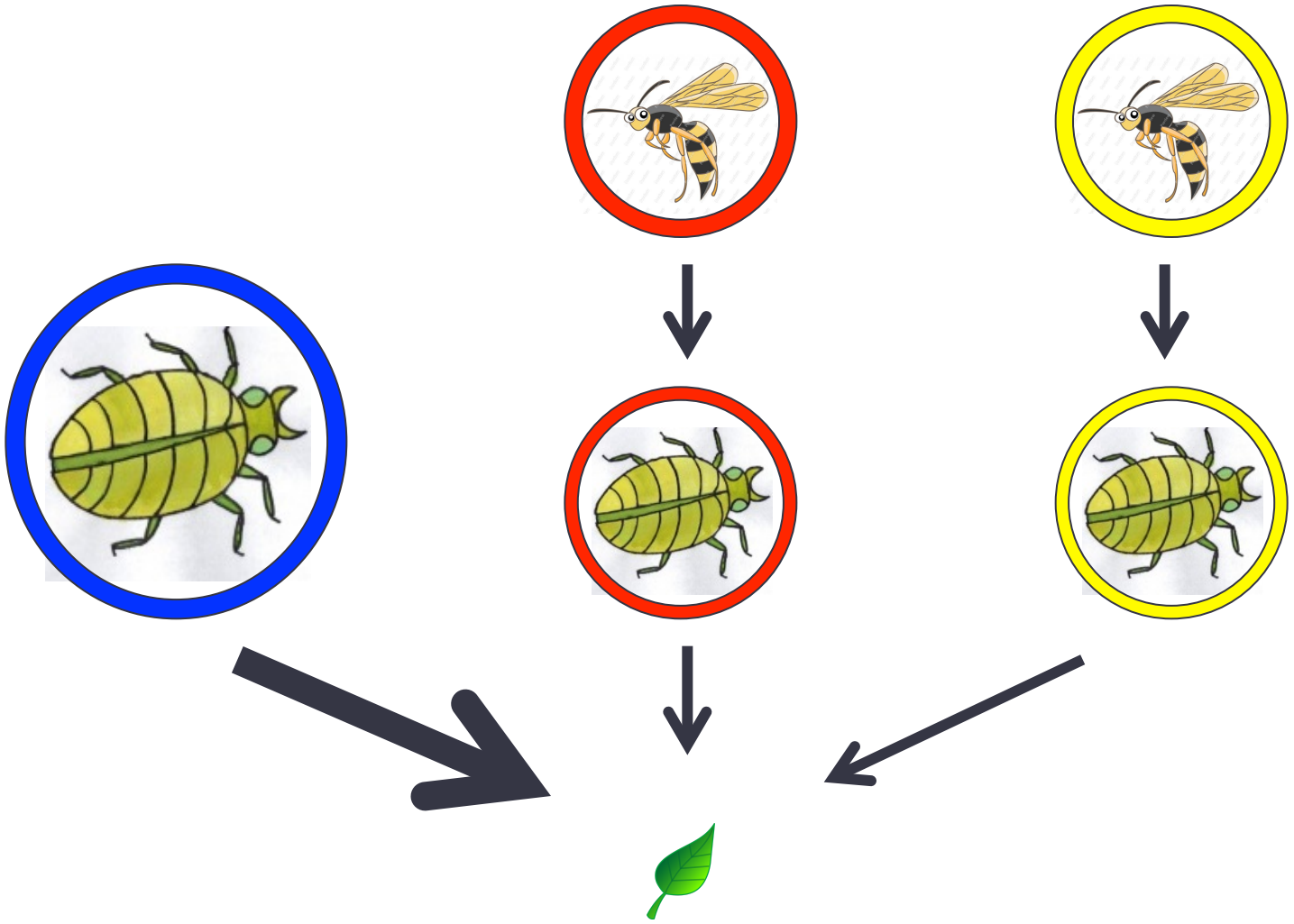
Trophic cascade



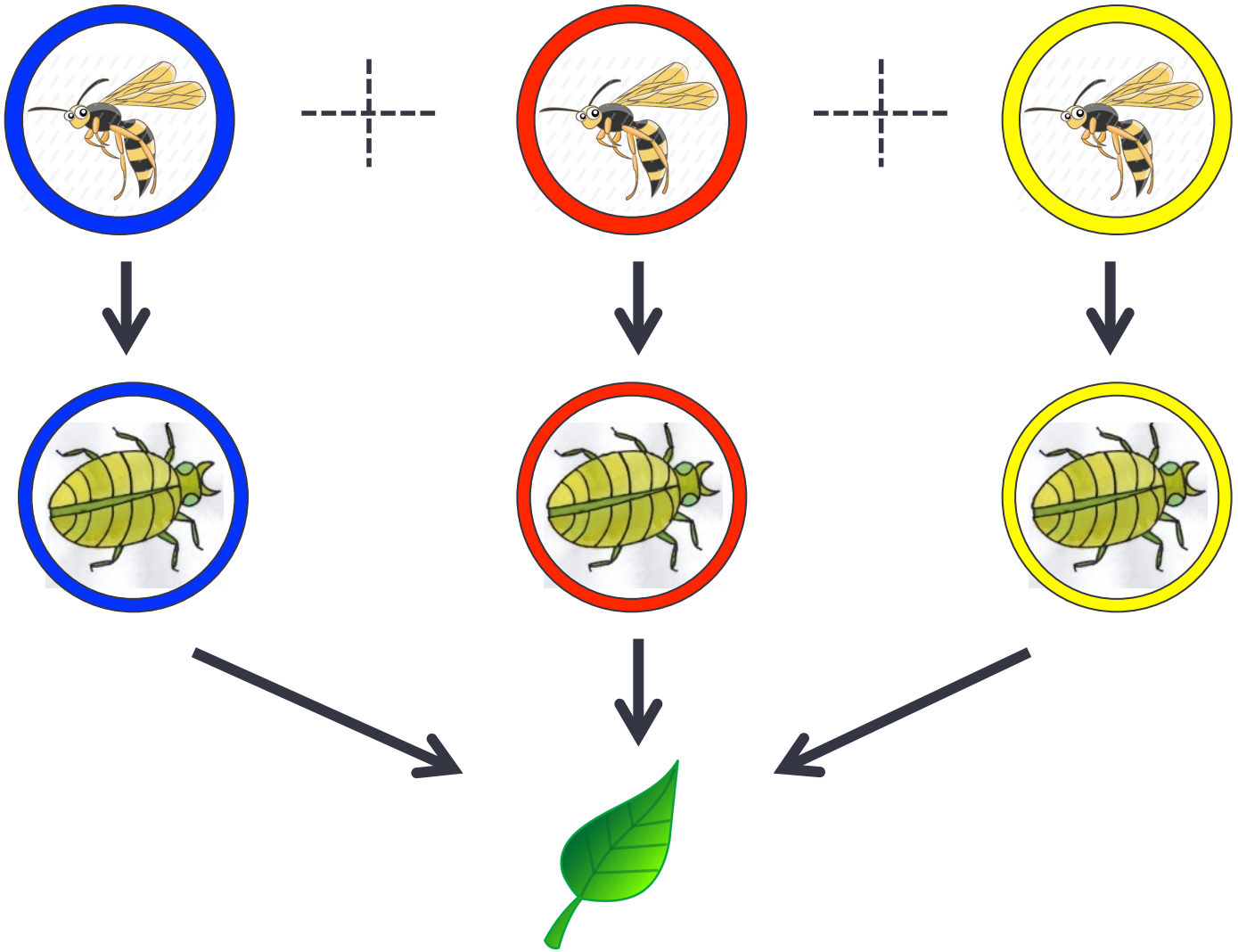
Trophic cascade



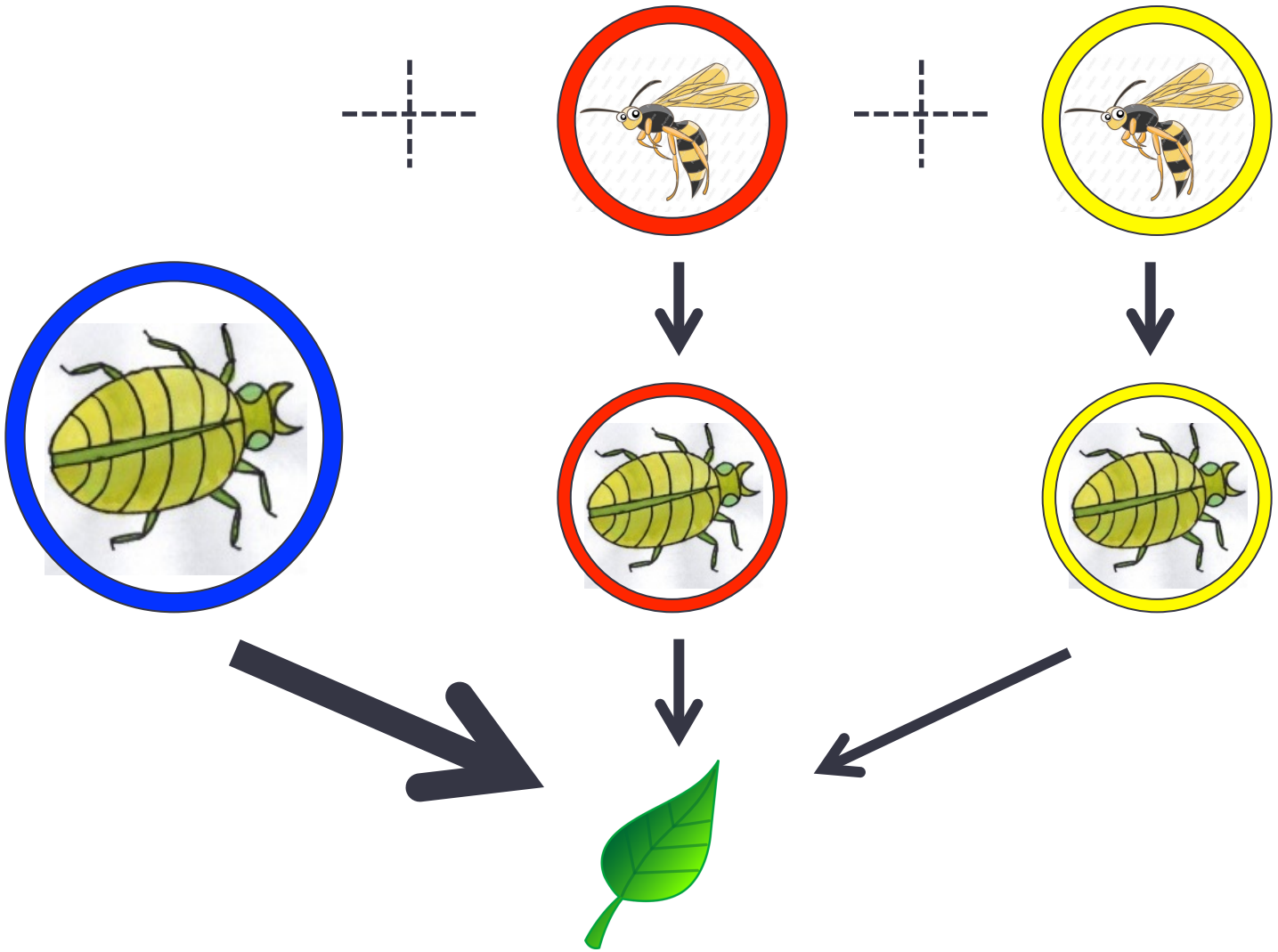
Trophic cascade



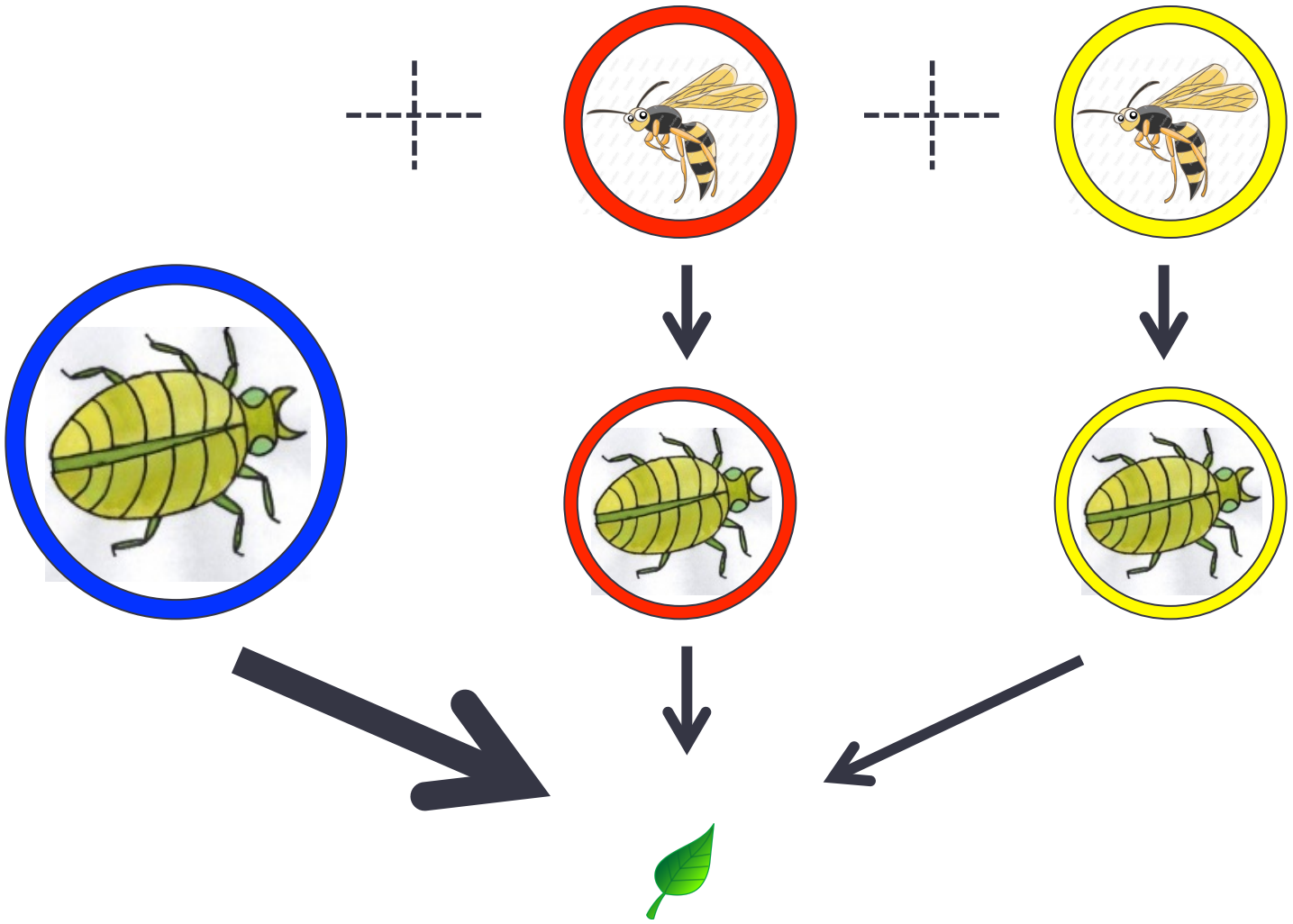
Horizontal trophic cascade



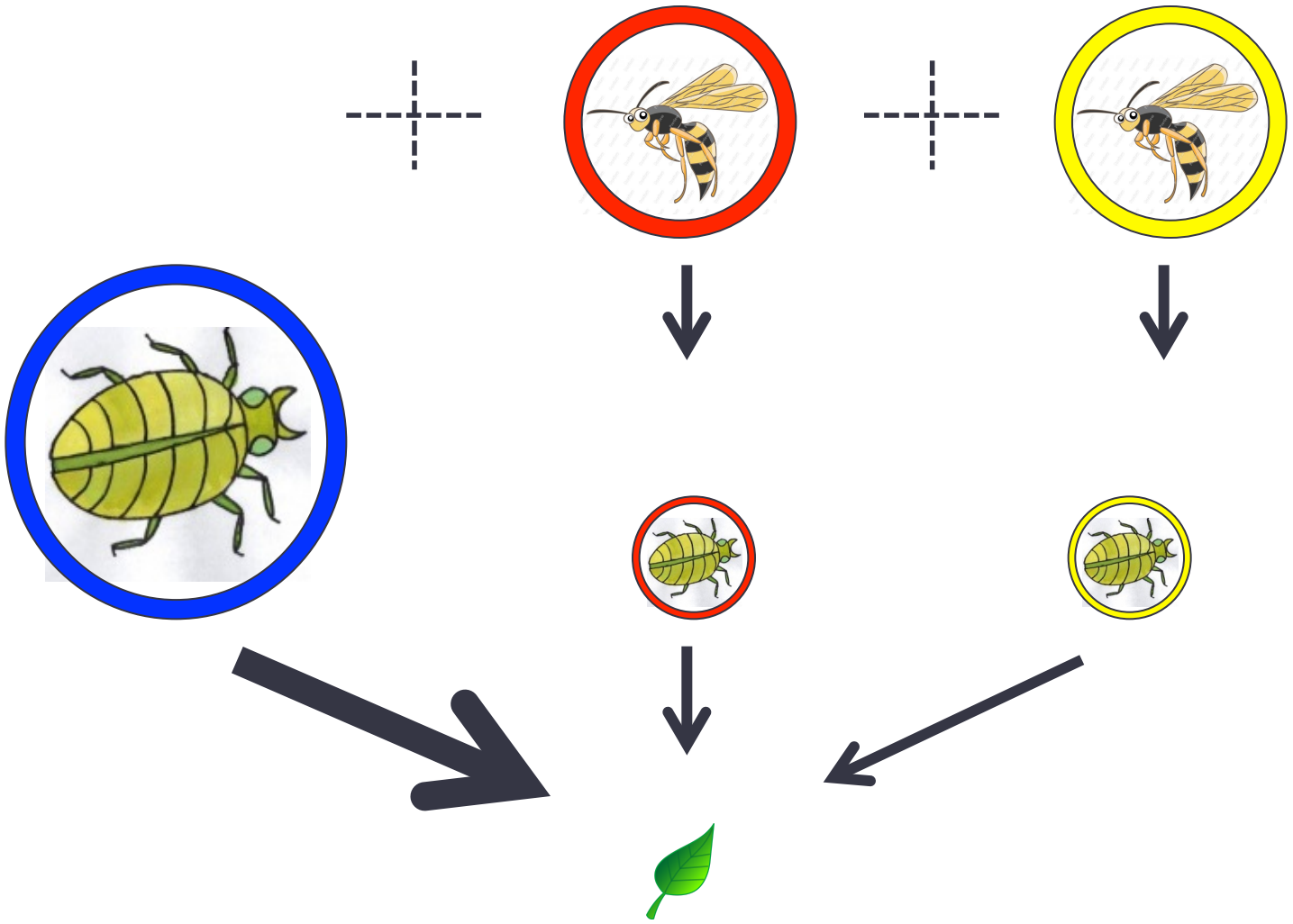
Horizontal trophic cascade



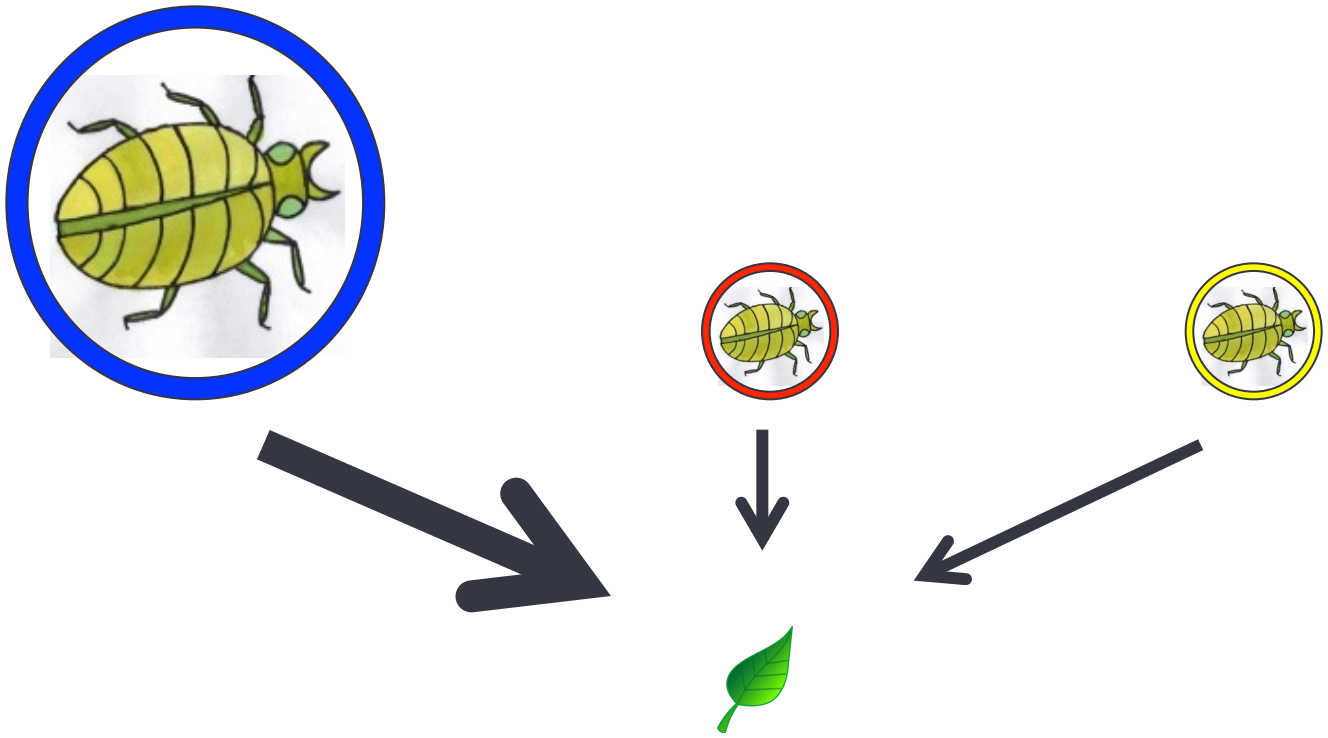
Horizontal trophic cascade



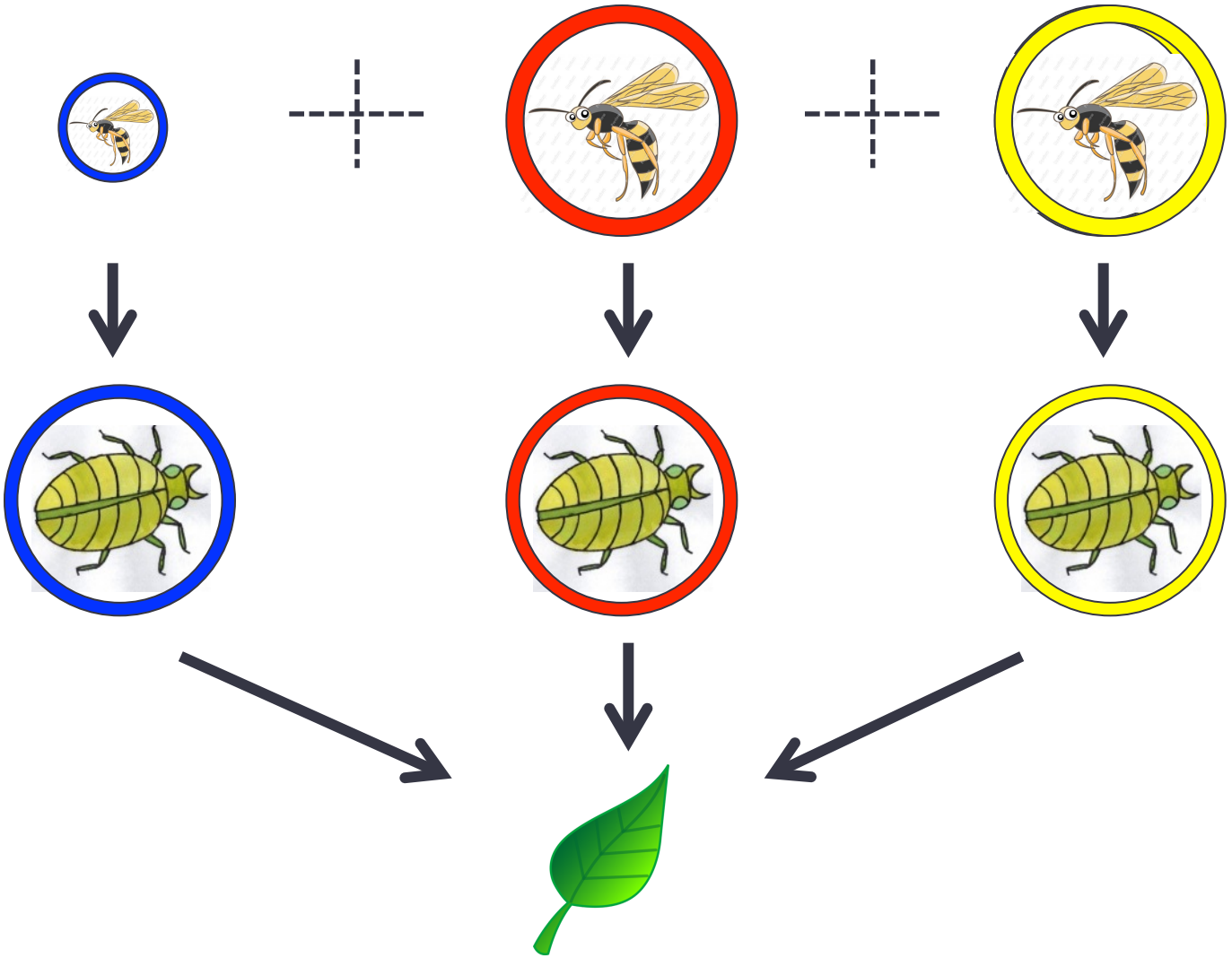
Horizontal trophic cascade



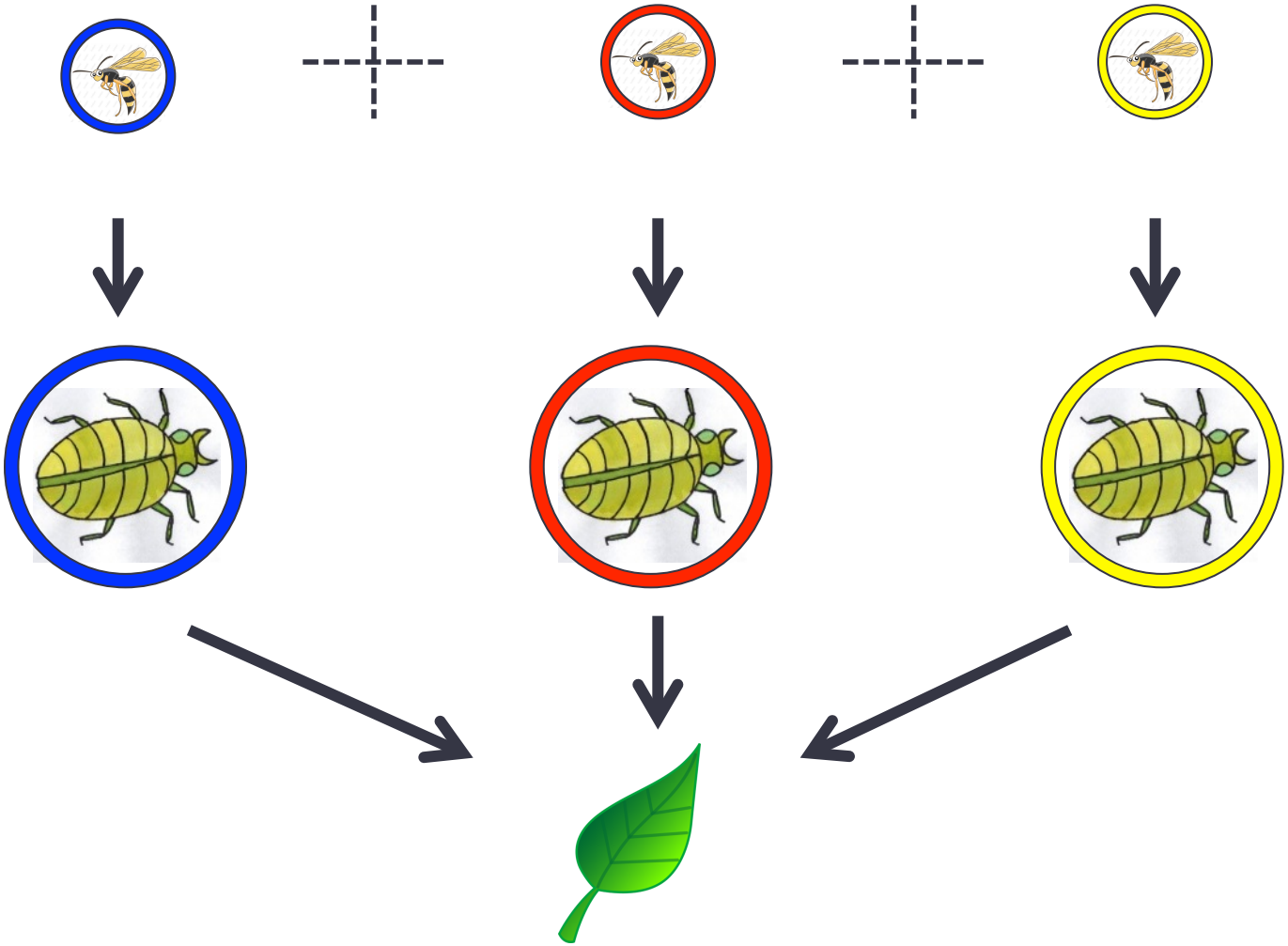
Horizontal trophic cascade



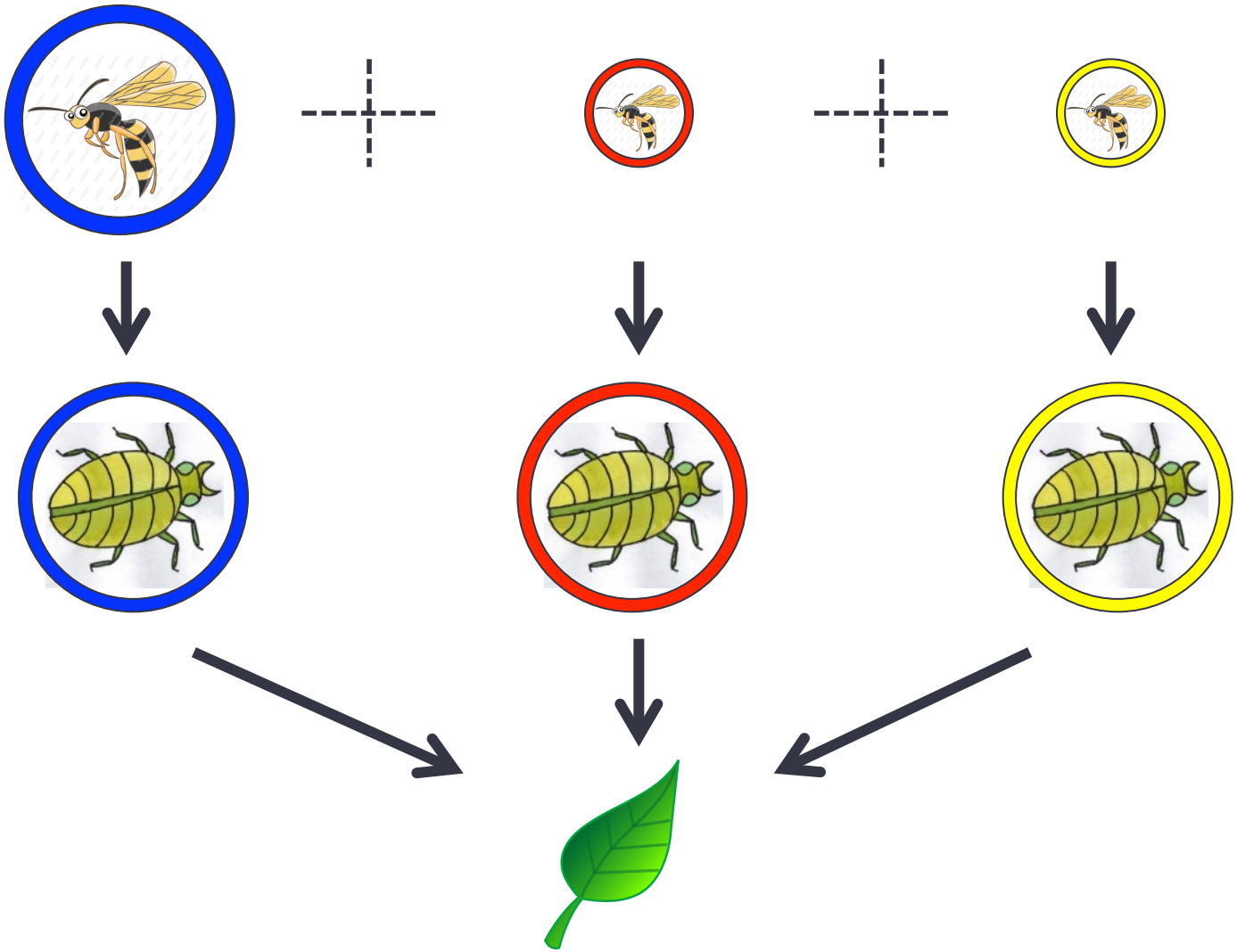
Horizontal trophic cascade



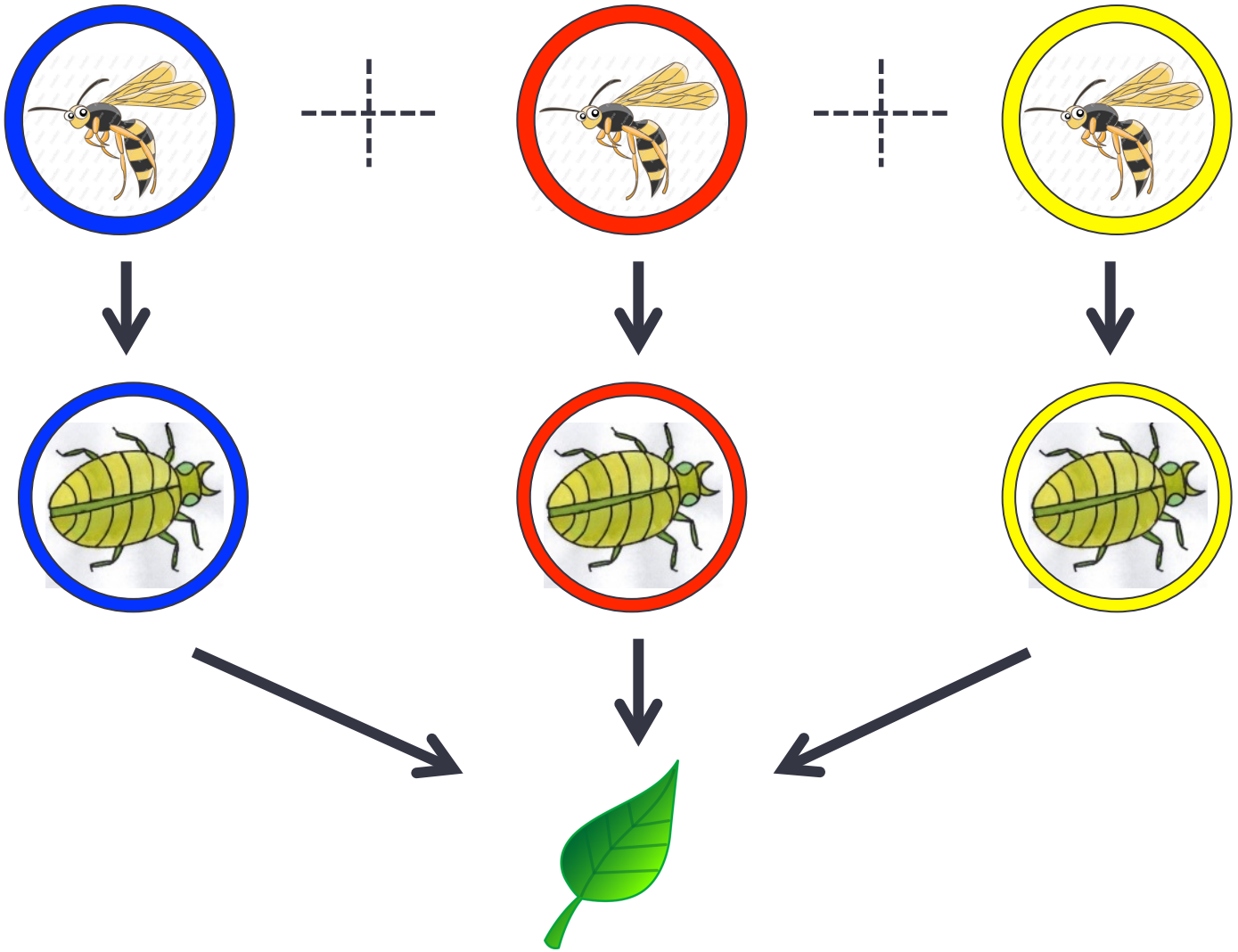
Horizontal trophic cascade



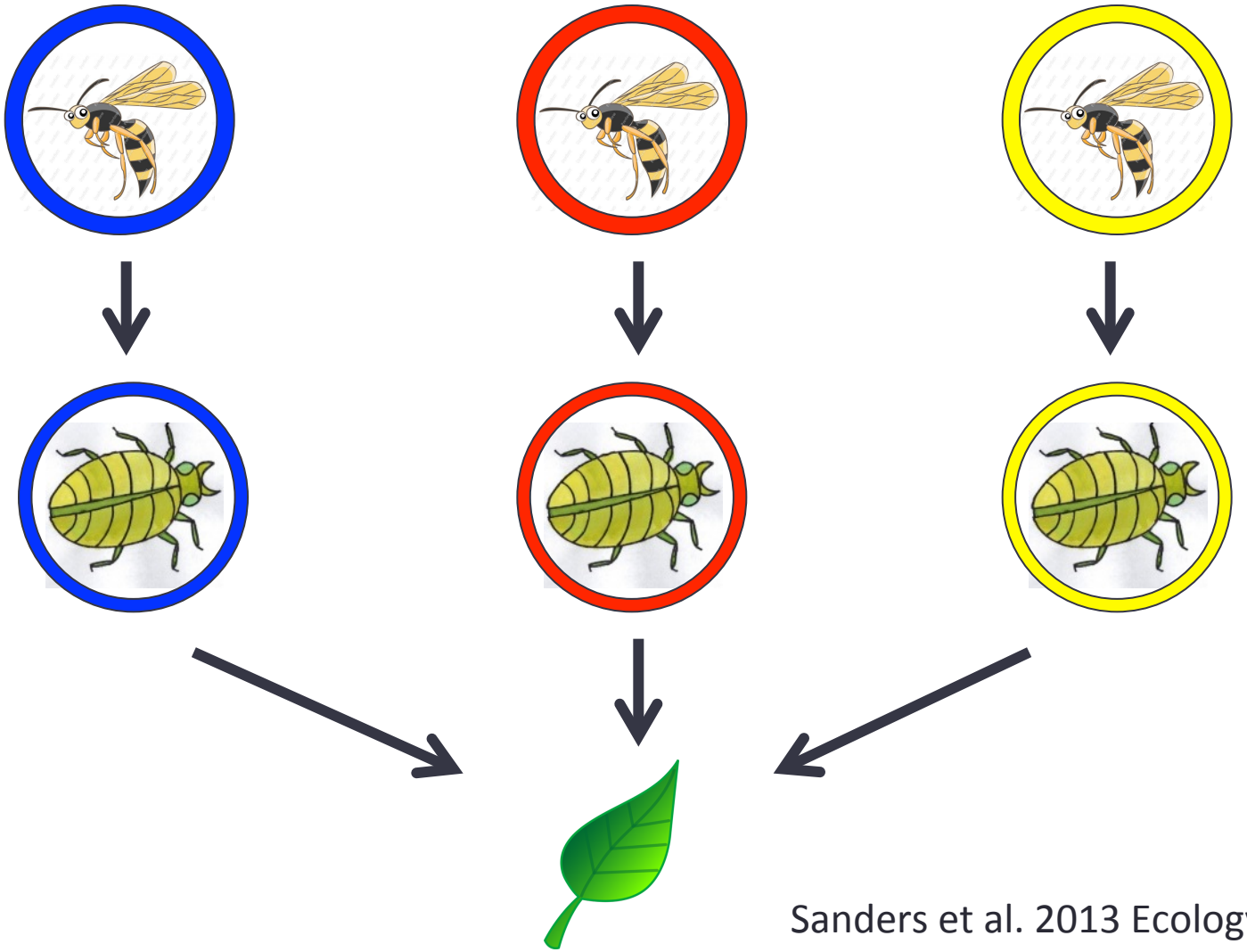
Horizontal trophic cascade



Horizontal trophic cascade



Our system



Sanders et al. 2013 Ecology Letters

Our system

Paper goal:

To test the existence of

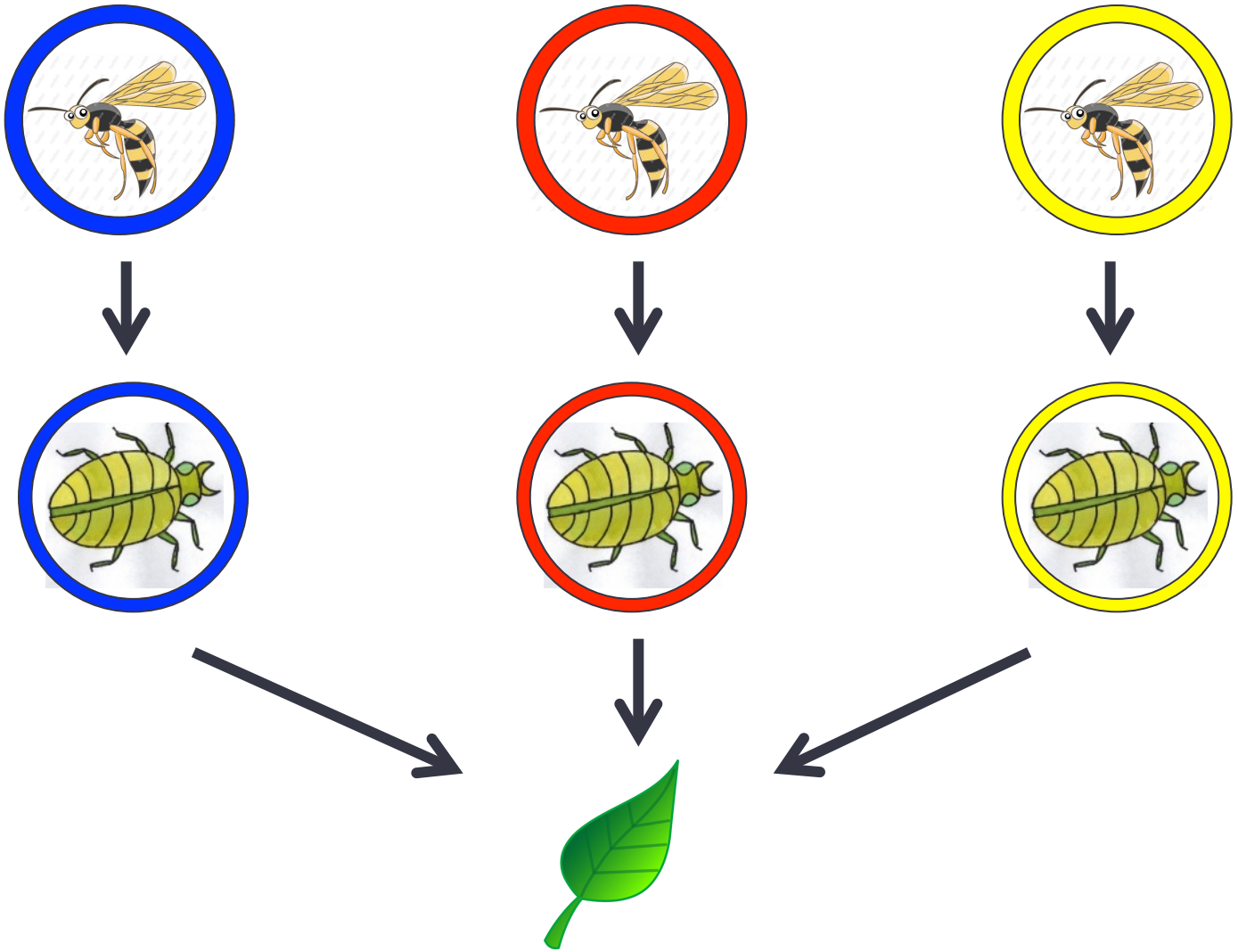
horizontal trophic cascades

Sanders et al. 2013 Ecology Letters

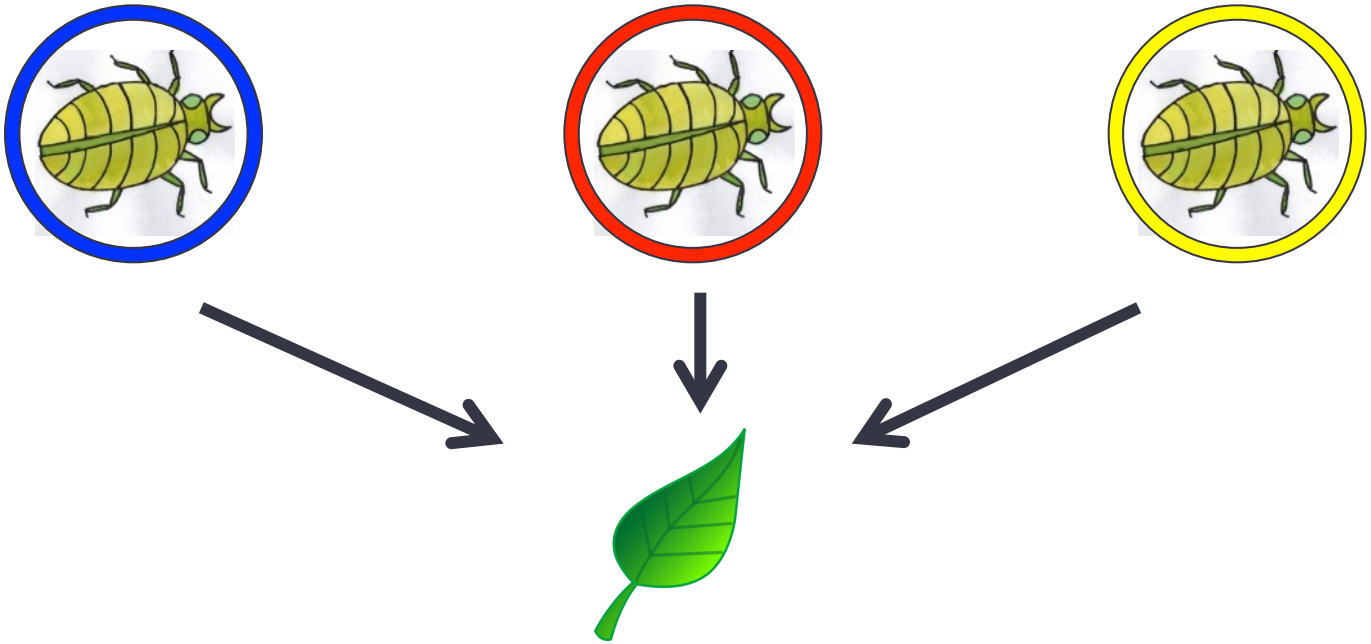
Our Goal

To model the system in order to uncover which mechanisms are compatible with the results.

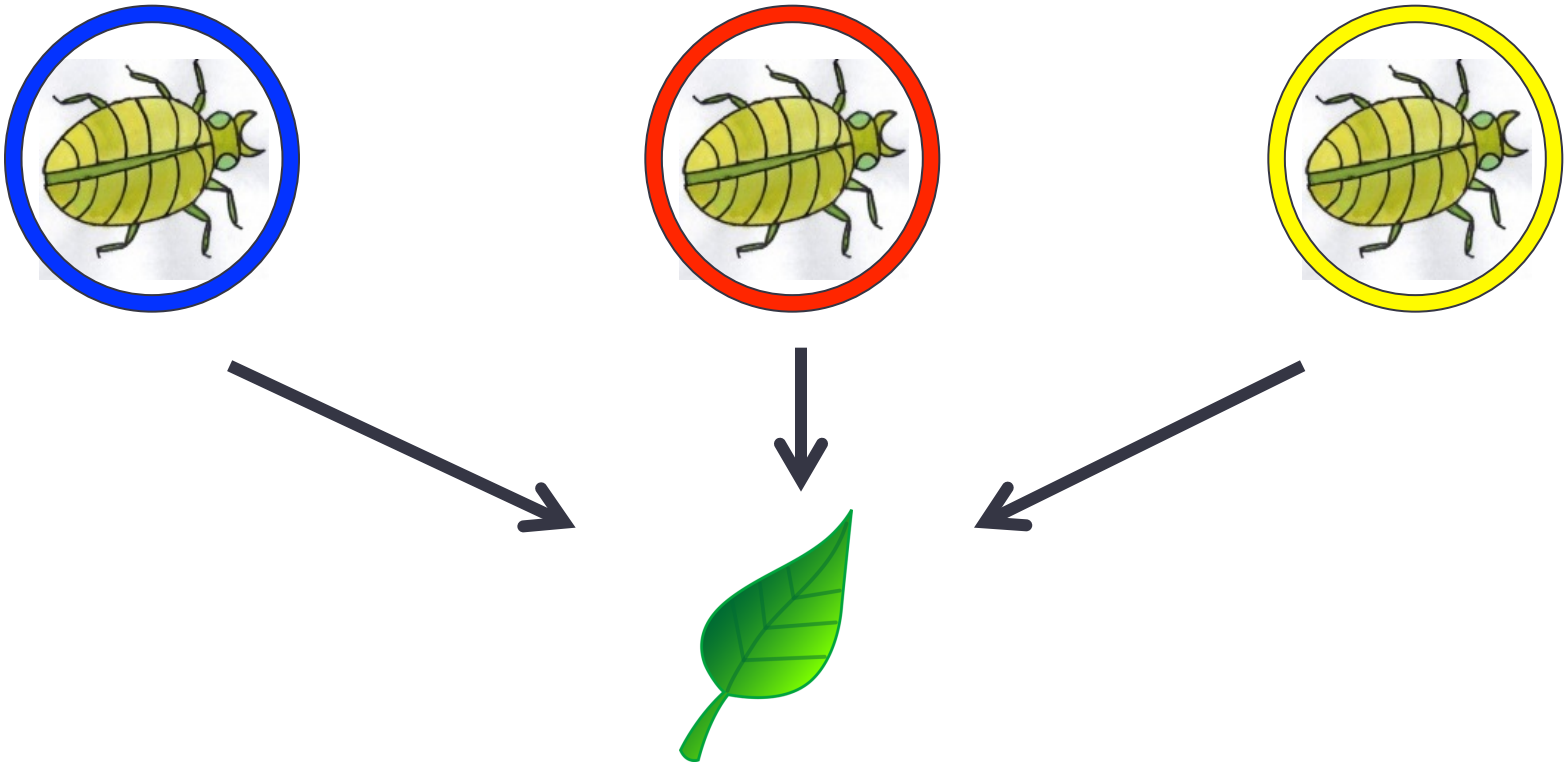
Focusing on competition



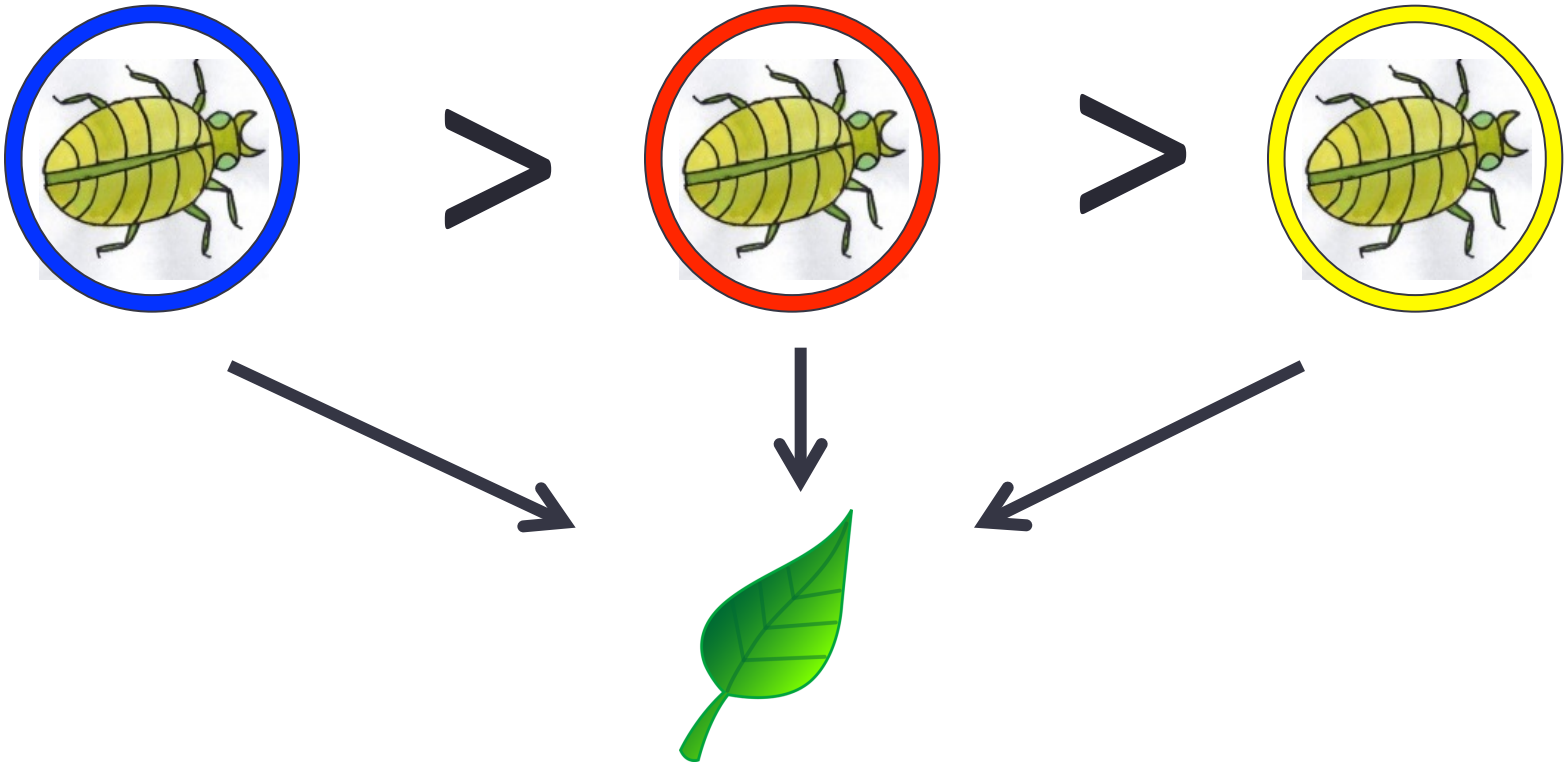
Focusing on competition



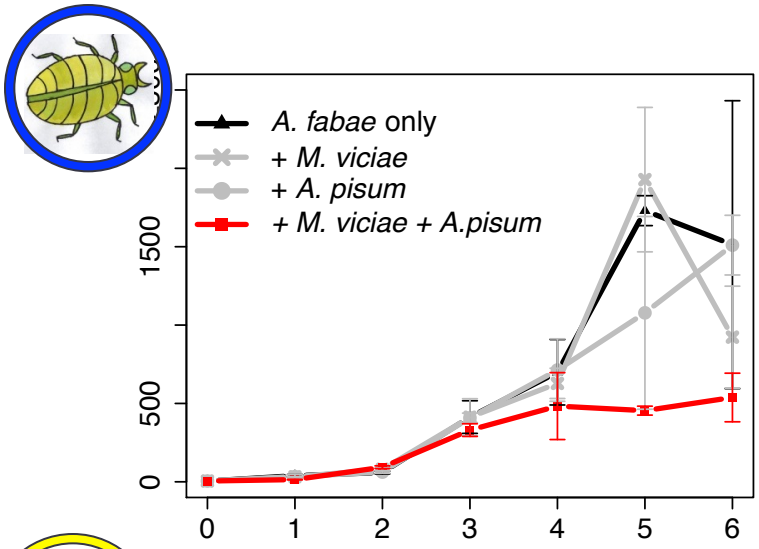
Focusing on competition - experiment

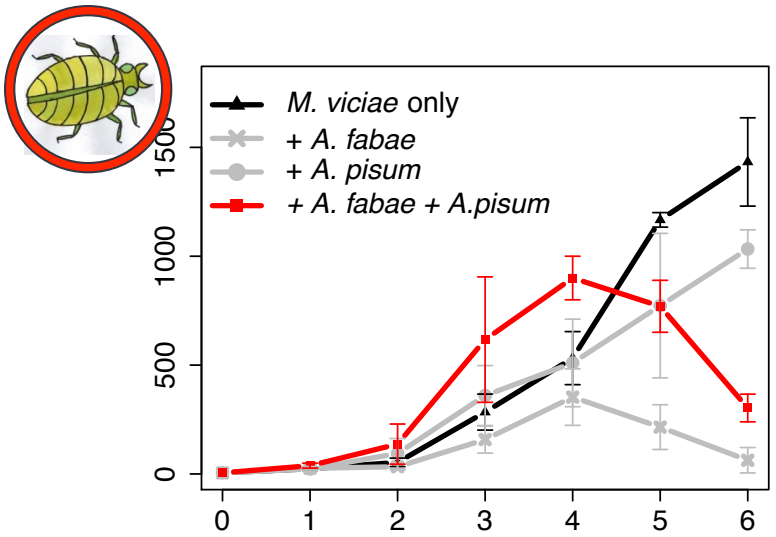


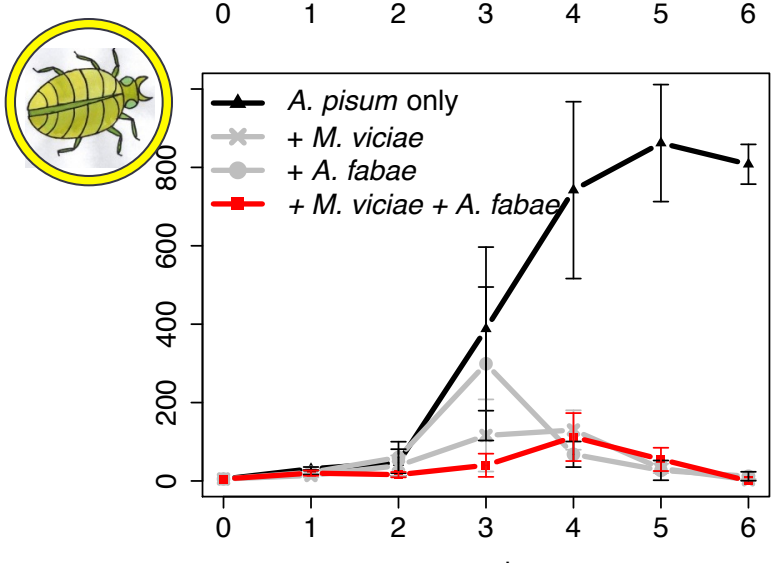
Focusing on competition - experiment



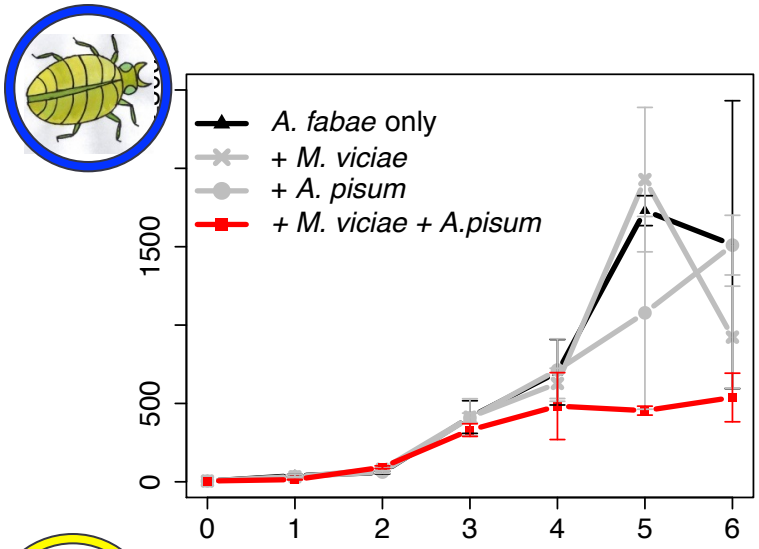
Focusing on competition – experiment results

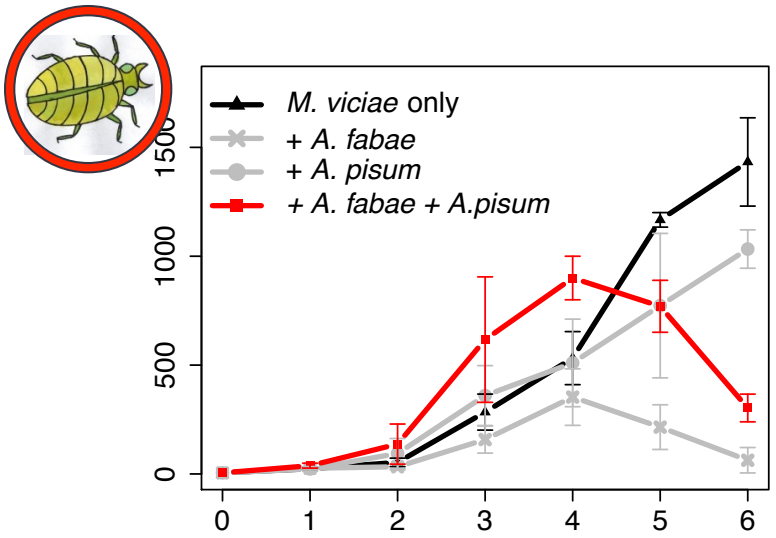


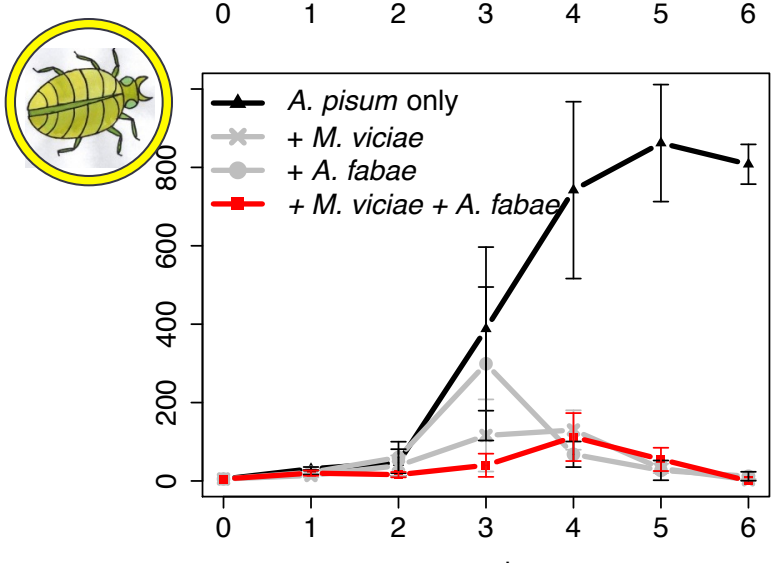




Focusing on competition – experiment results







Focusing on competition - MODEL

$$\frac{dA_1}{dt} = r_1 A_1 - \frac{r_1 A_1^2}{K_1} - \alpha_{12} A_2 A_1 - \alpha_{13} A_3 A_1$$

$$\frac{dA_2}{dt} = r_2 A_2 - \frac{r_2 A_2^2}{K_2} - \alpha_{21} A_1 A_2 - \alpha_{23} A_3 A_2$$

$$\frac{dA_3}{dt} = r_3 A_3 - \frac{r_3 A_3^2}{K_3} - \alpha_{31} A_1 A_3 - \alpha_{32} A_2 A_3$$

Focusing on competition - MODEL

$$\frac{dA_1}{dt} = r_1 A_1 - \frac{r_1 A_1^2}{K_1} - \alpha_{12} A_2 A_1 - \alpha_{13} A_3 A_1$$

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$$\frac{dA_3}{dt} = r_3 A_3 - \frac{r_3 A_3^2}{K_3} - \alpha_{31} A_1 A_3 - \alpha_{32} A_2 A_3$$

Intrinsic growth term

Focusing on competition - MODEL

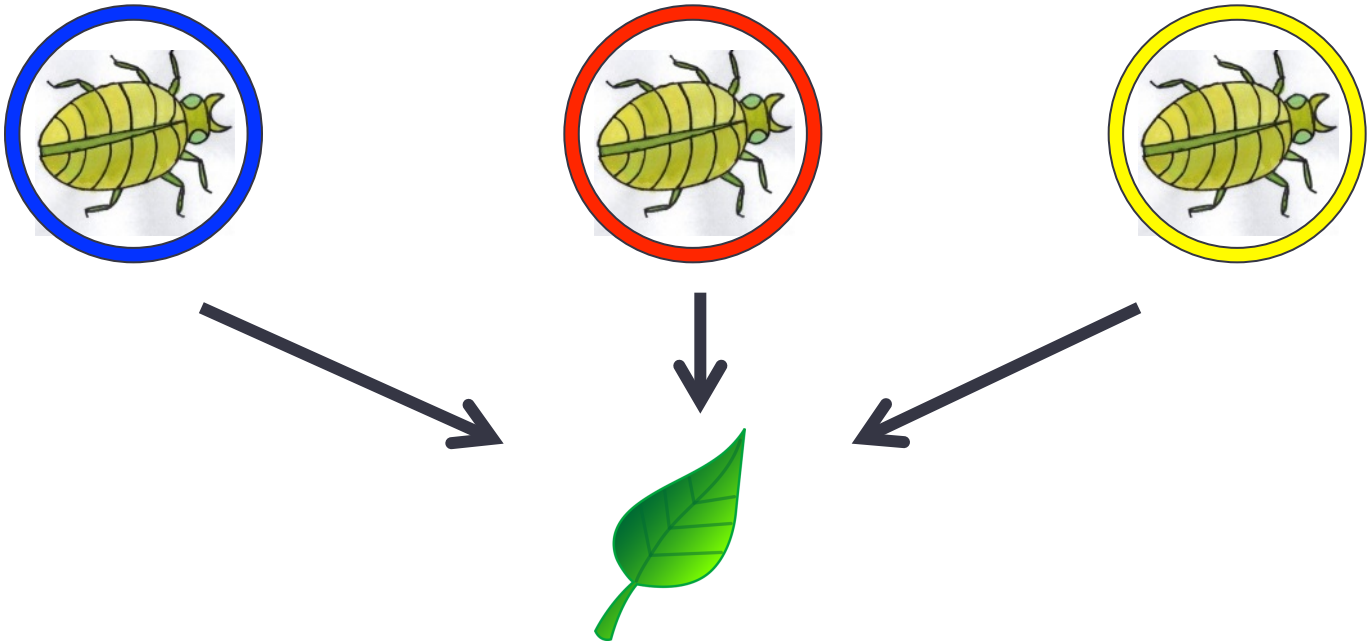
$$\frac{dA_1}{dt} = r_1 A_1 - \frac{r_1 A_1^2}{K_1} - \alpha_{12} A_2 A_1 - \alpha_{13} A_3 A_1$$

$$\frac{dA_2}{dt} = r_2 A_2 - \frac{r_2 A_2^2}{K_2} - \alpha_{21} A_1 A_2 - \alpha_{23} A_3 A_2$$

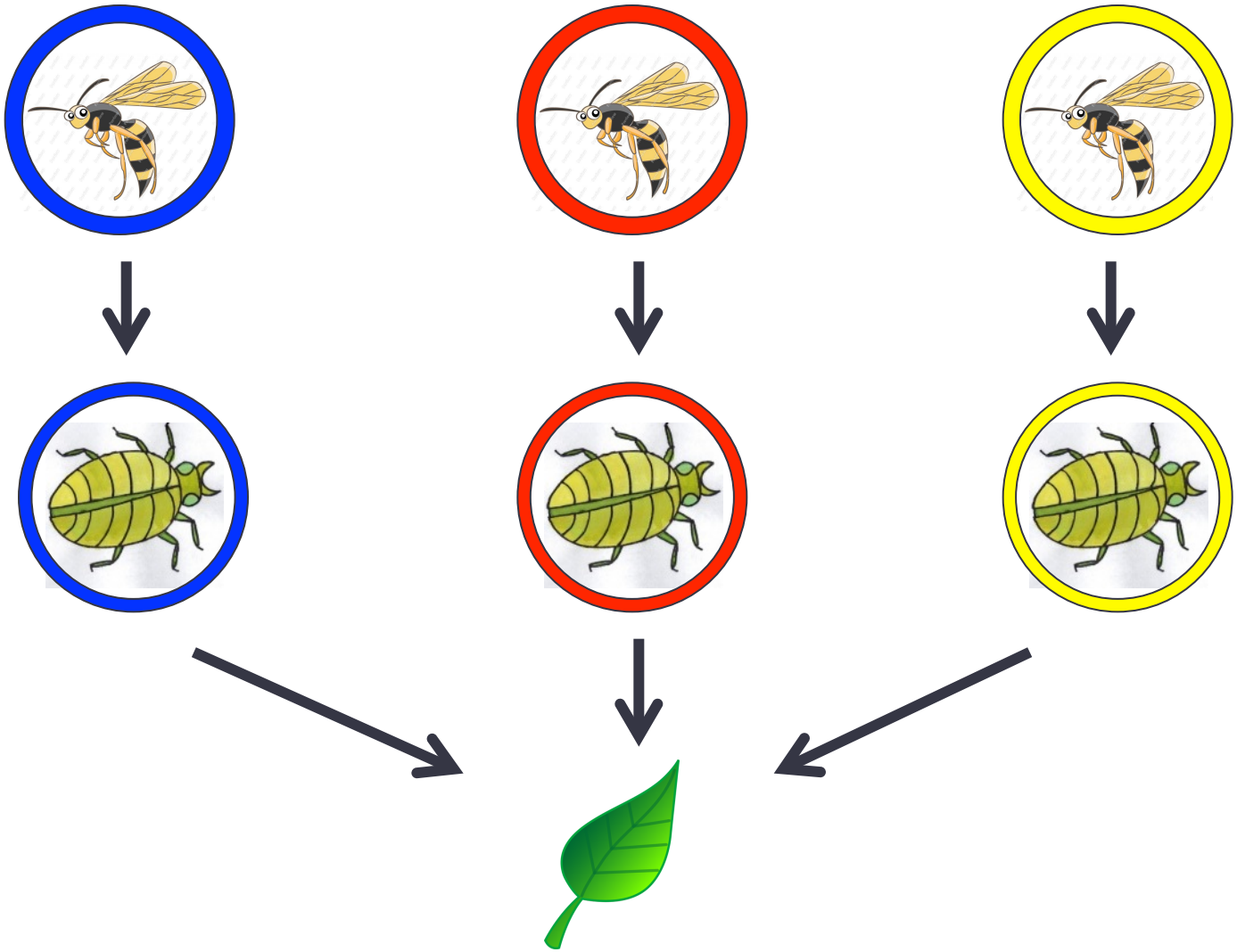
$$\frac{dA_3}{dt} = r_3 A_3 - \frac{r_3 A_3^2}{K_3} - \alpha_{31} A_1 A_3 - \alpha_{32} A_2 A_3$$

Competition terms

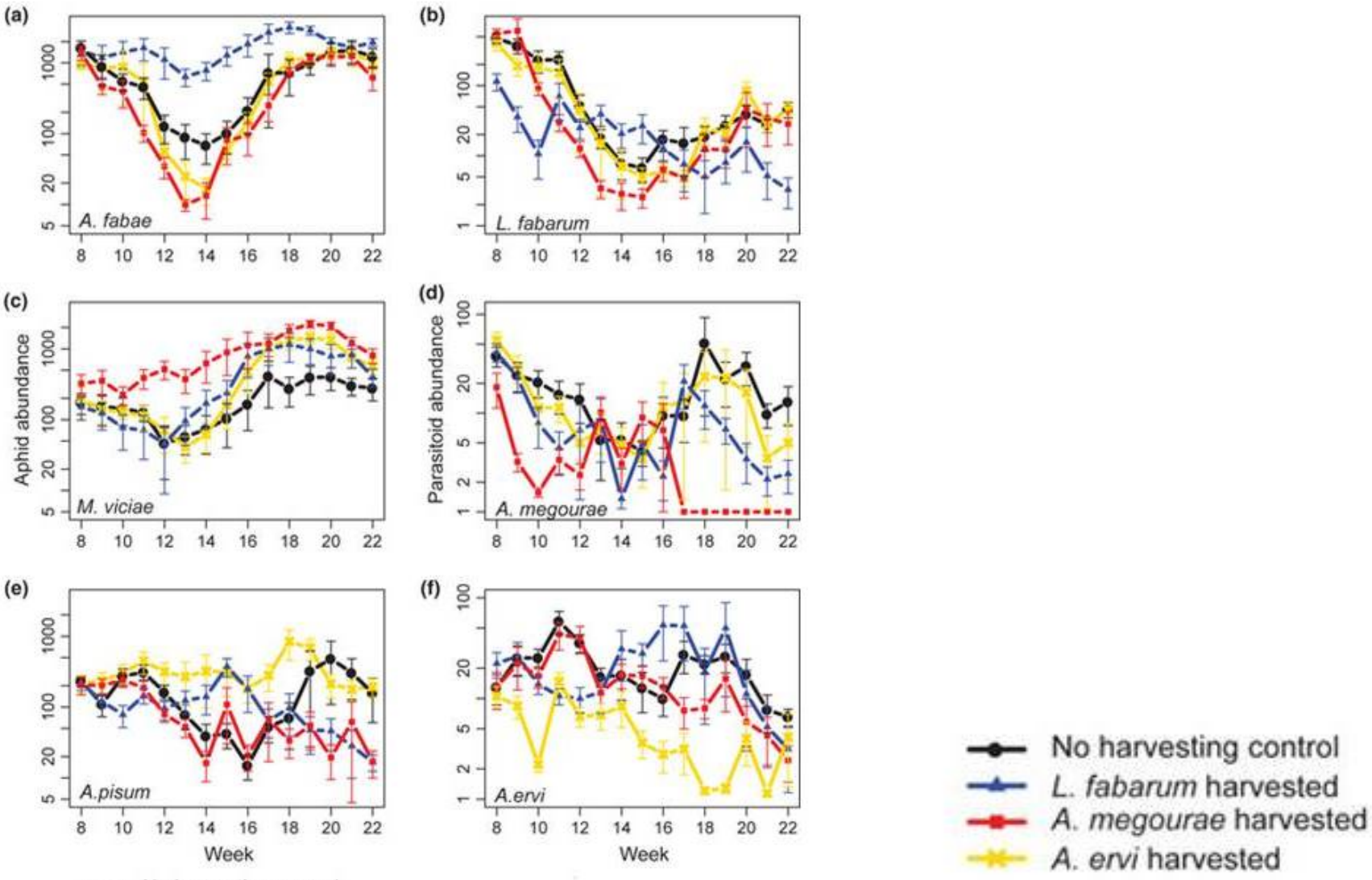
Adding predation



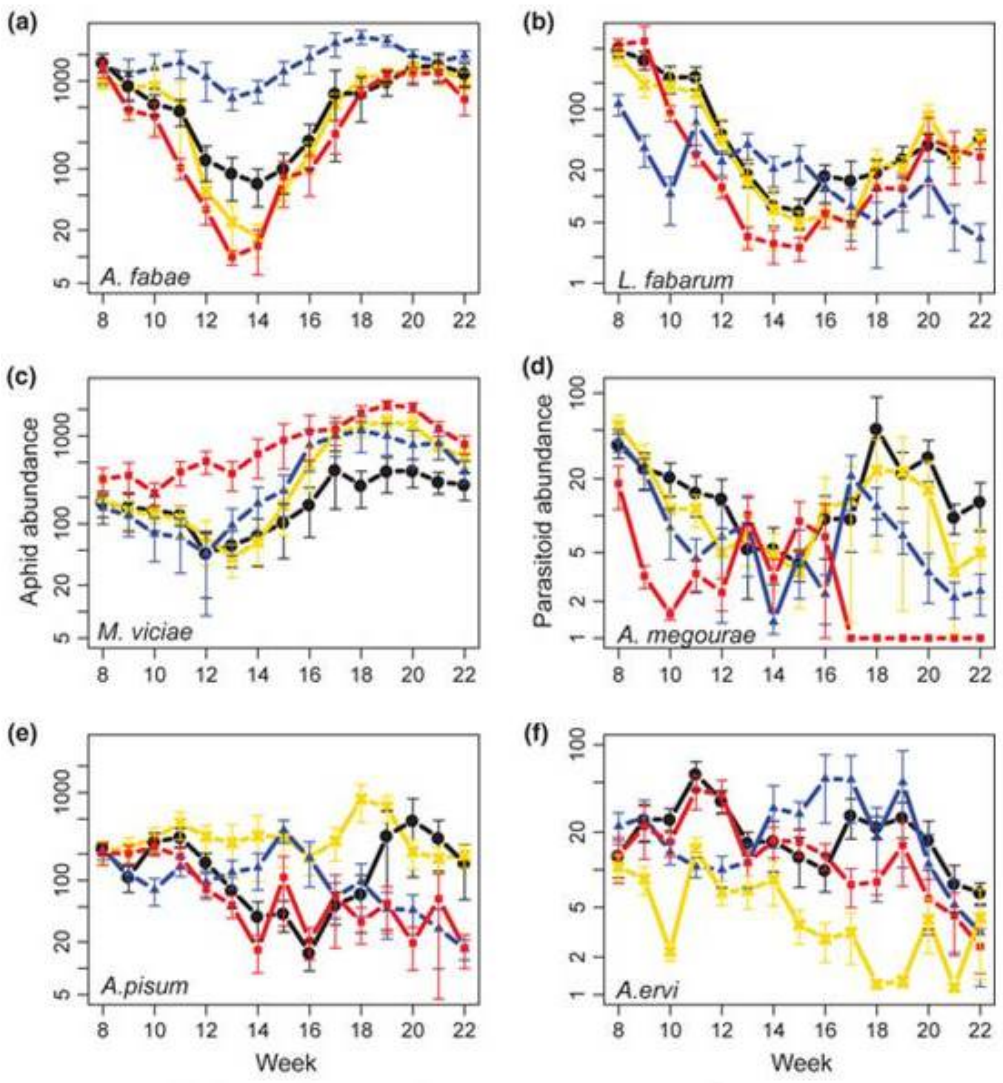
Adding predation

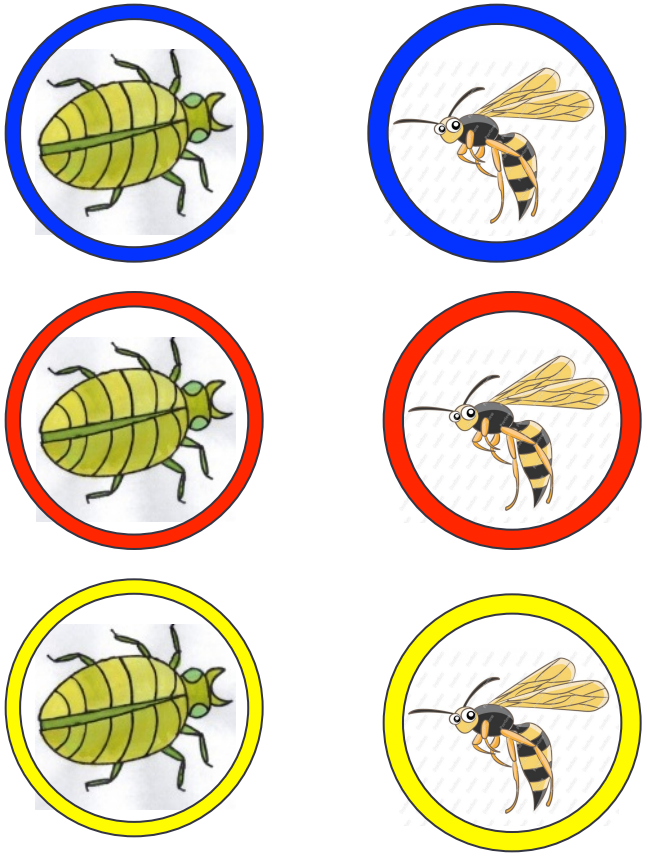


Adding predation



Adding predation





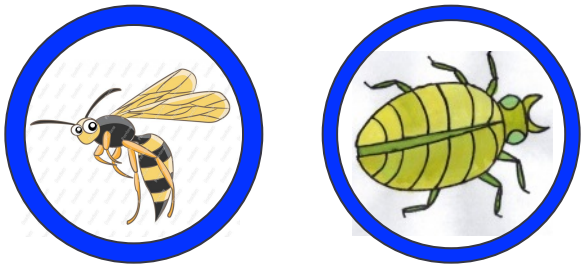
No harvesting control
L. fabarum harvested
A. megourae harvested
A. ervi harvested

Adding predation - MODEL

$$\frac{dA_1}{dt} = r_1 A_1 - \frac{r_1 A_1^2}{K_1} - \alpha_{12} A_2 A_1 - \alpha_{13} A_3 A_1 - \beta_1 A_1 W_1$$

$$\frac{dW_1}{dt} = -d_1 W_1 + \rho \beta_1 A_1 W_1$$

Predation terms



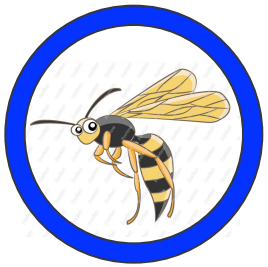
Adding predation - MODEL

$$\frac{dA_1}{dt} = r_1 A_1 - \frac{r_1 A_1^2}{K_1} - \alpha_{12} A_2 A_1 - \alpha_{13} A_3 A_1 - \beta_1 A_1 W_1$$

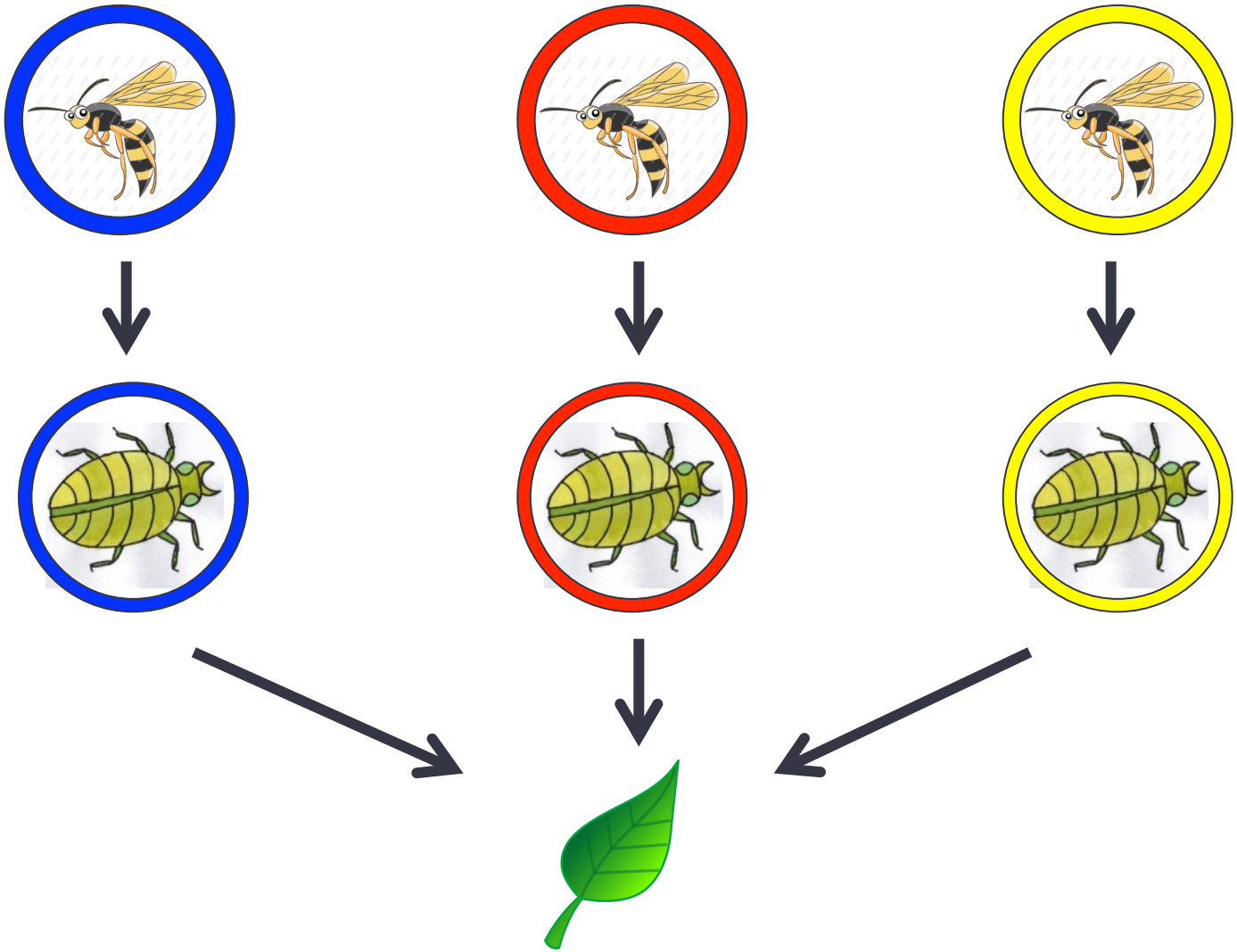
$$\frac{dW_1}{dt} = -d_1 W_1 + \rho \beta_1 A_1 W_1$$

x 3

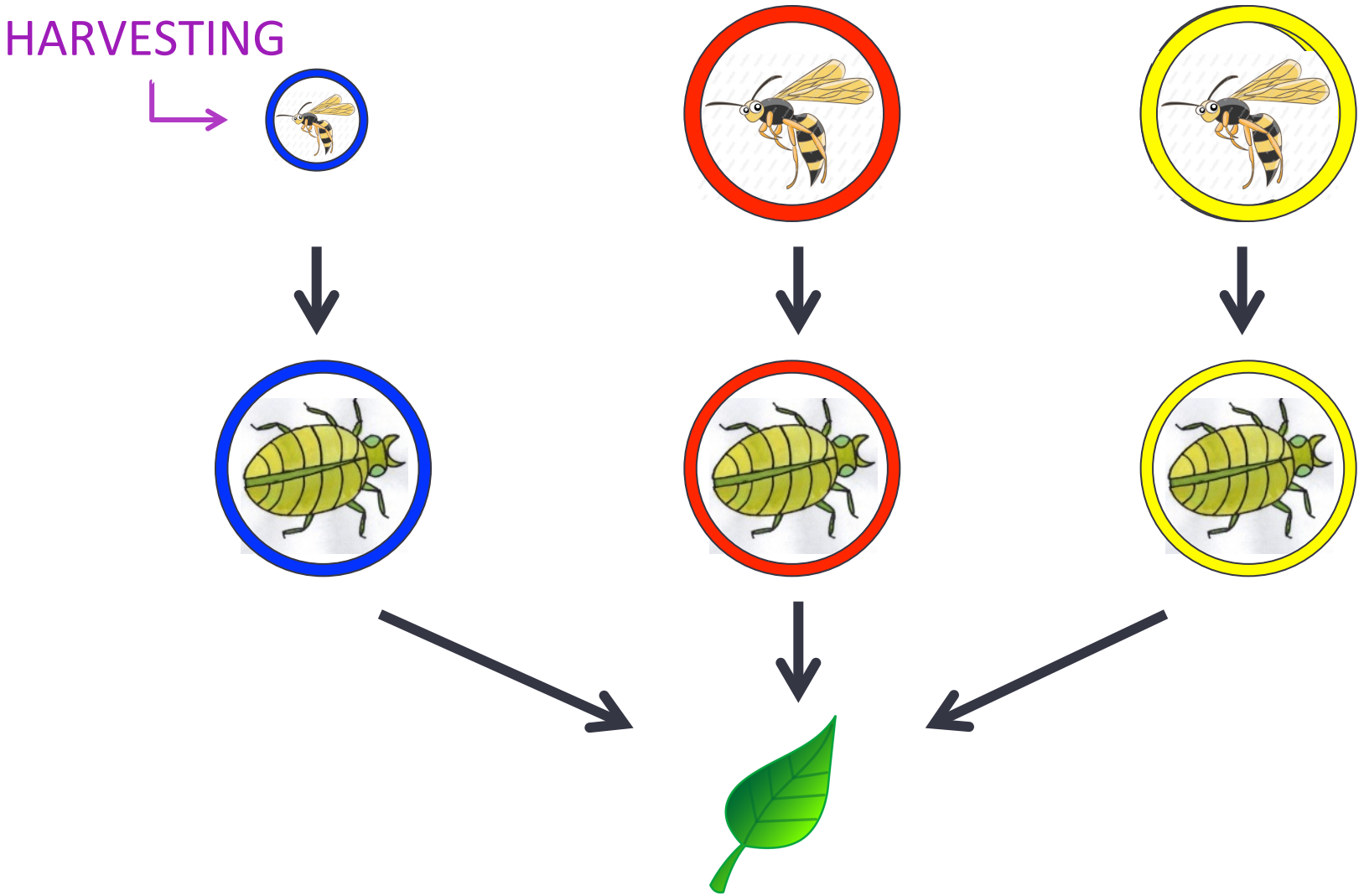
Predation terms



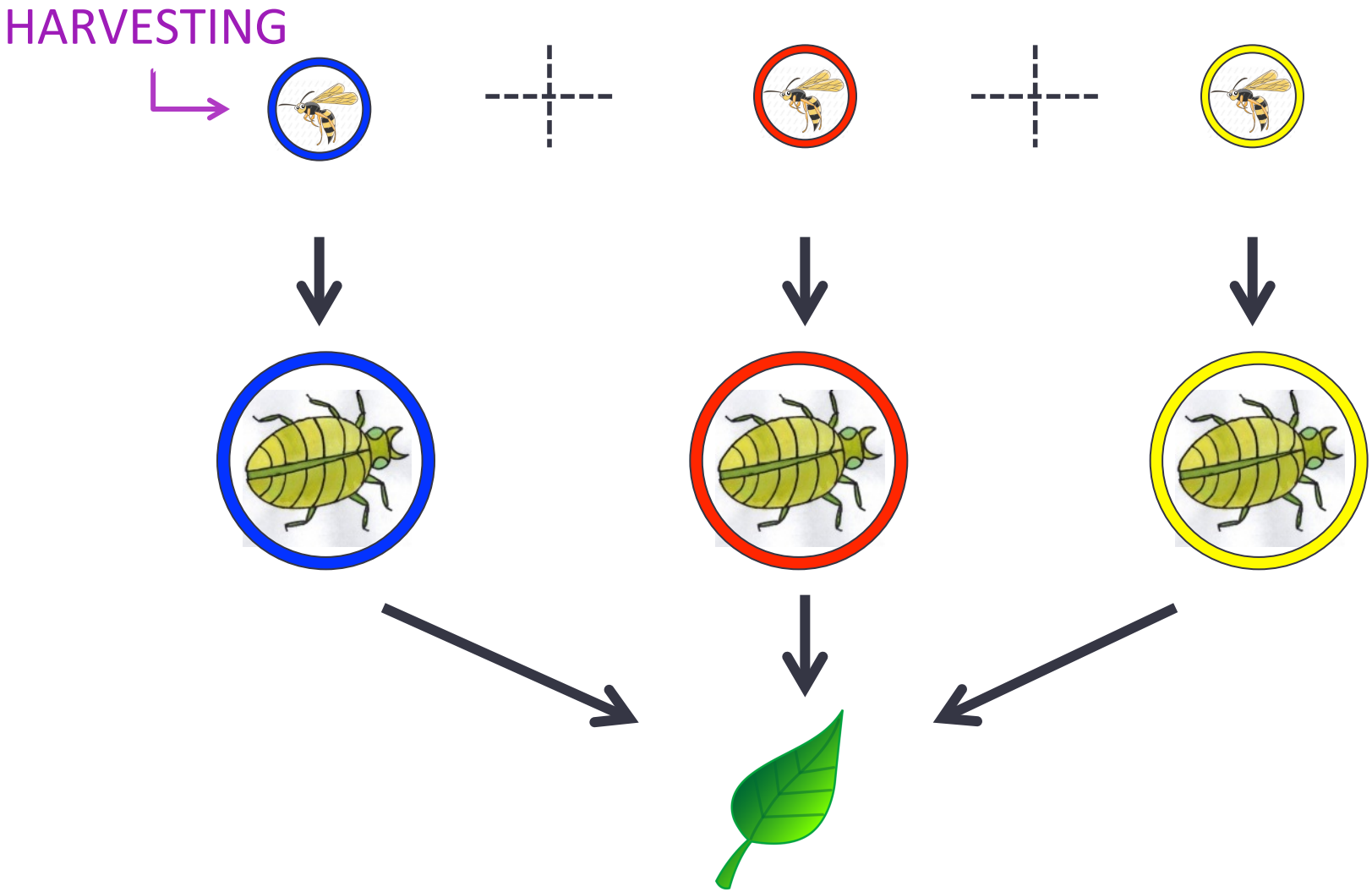
Harvesting - experiment



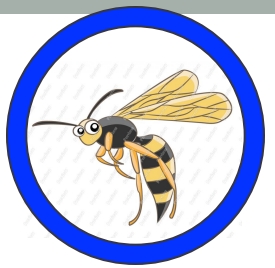
Harvesting - experiment



Harvesting - experiment

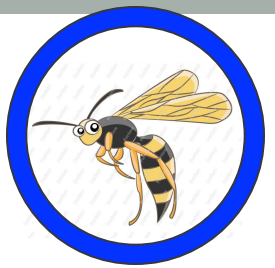


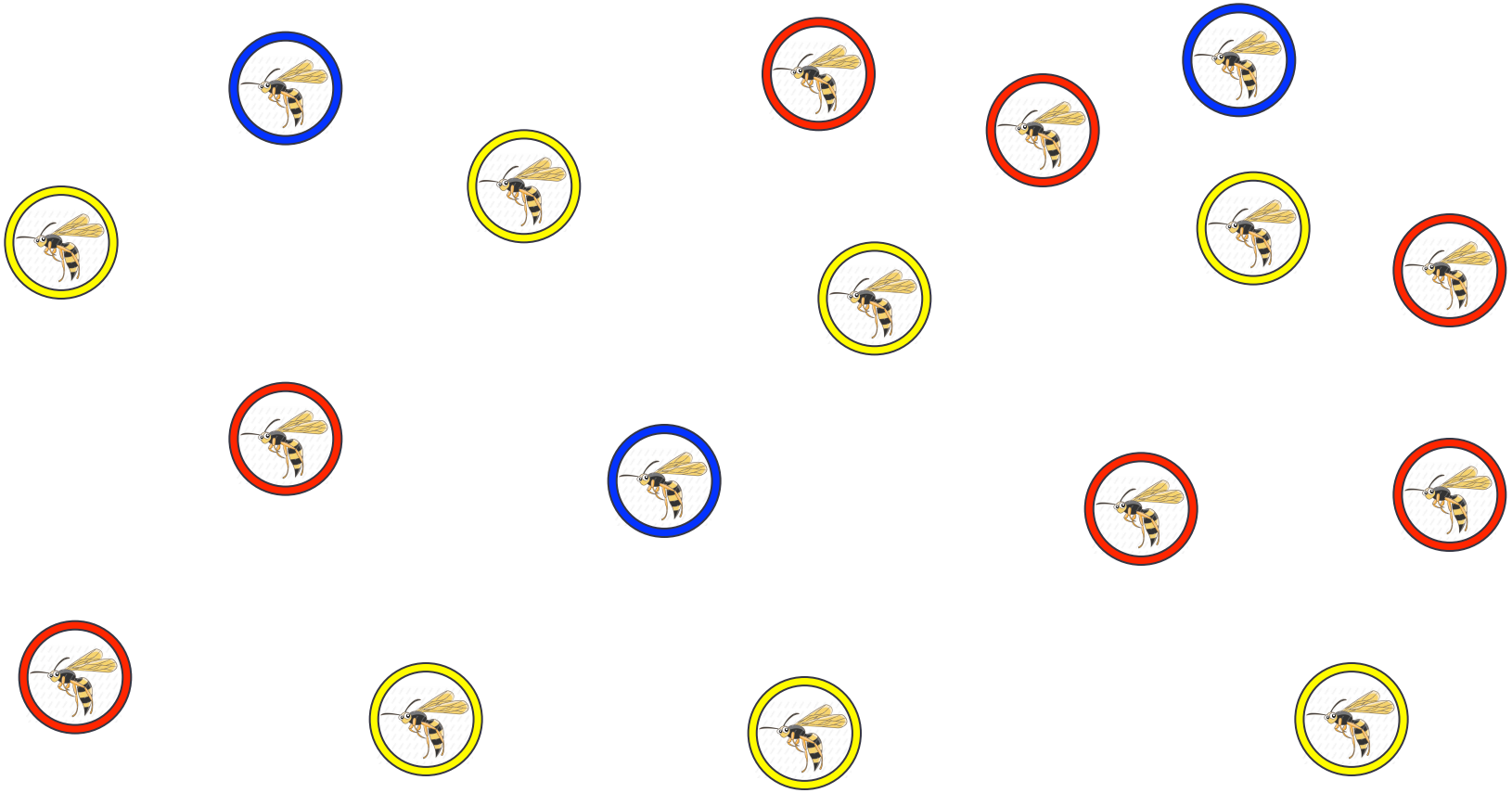
Harvesting experiment



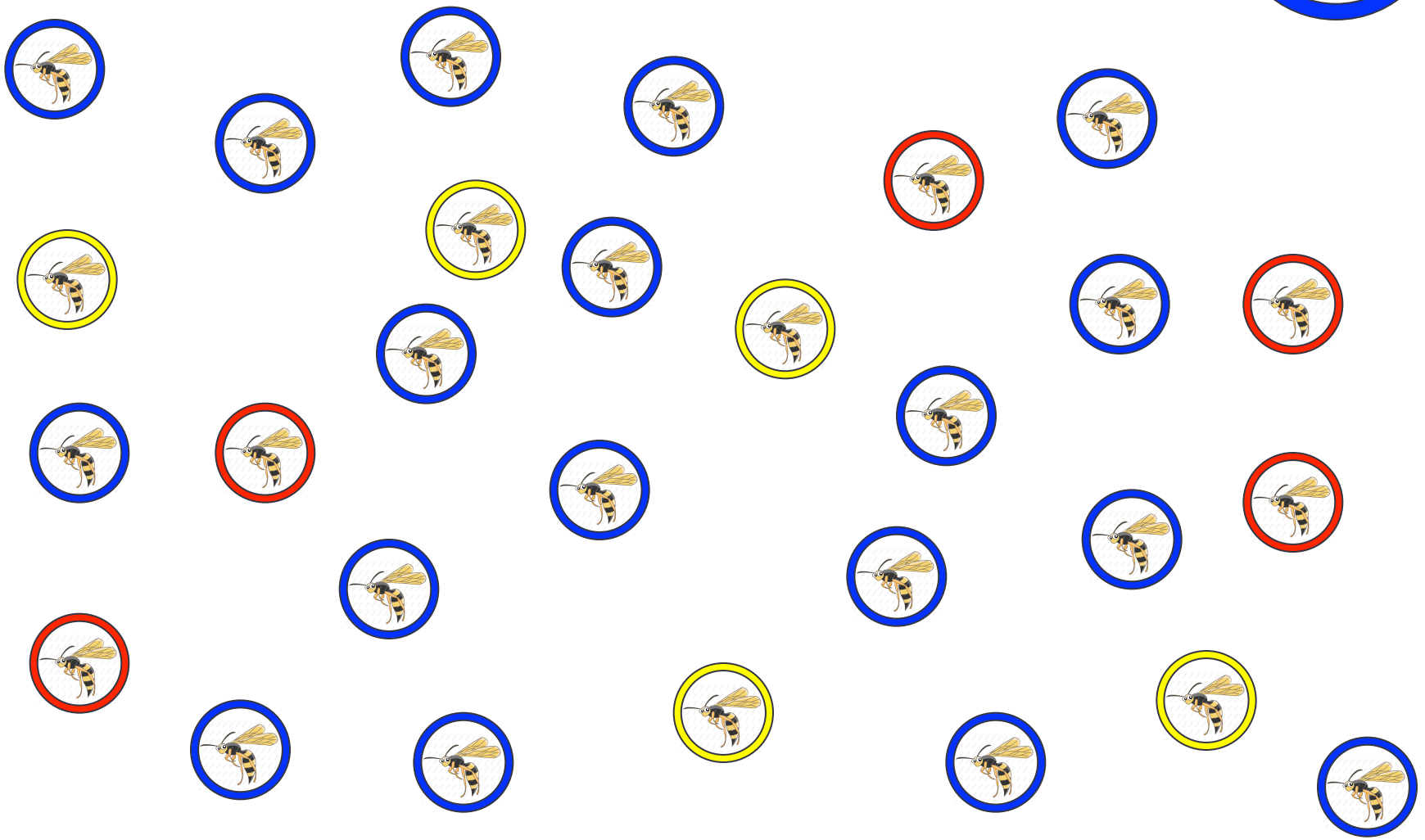
- 15 minutes
- Homogeneous effort

Harvesting experiment

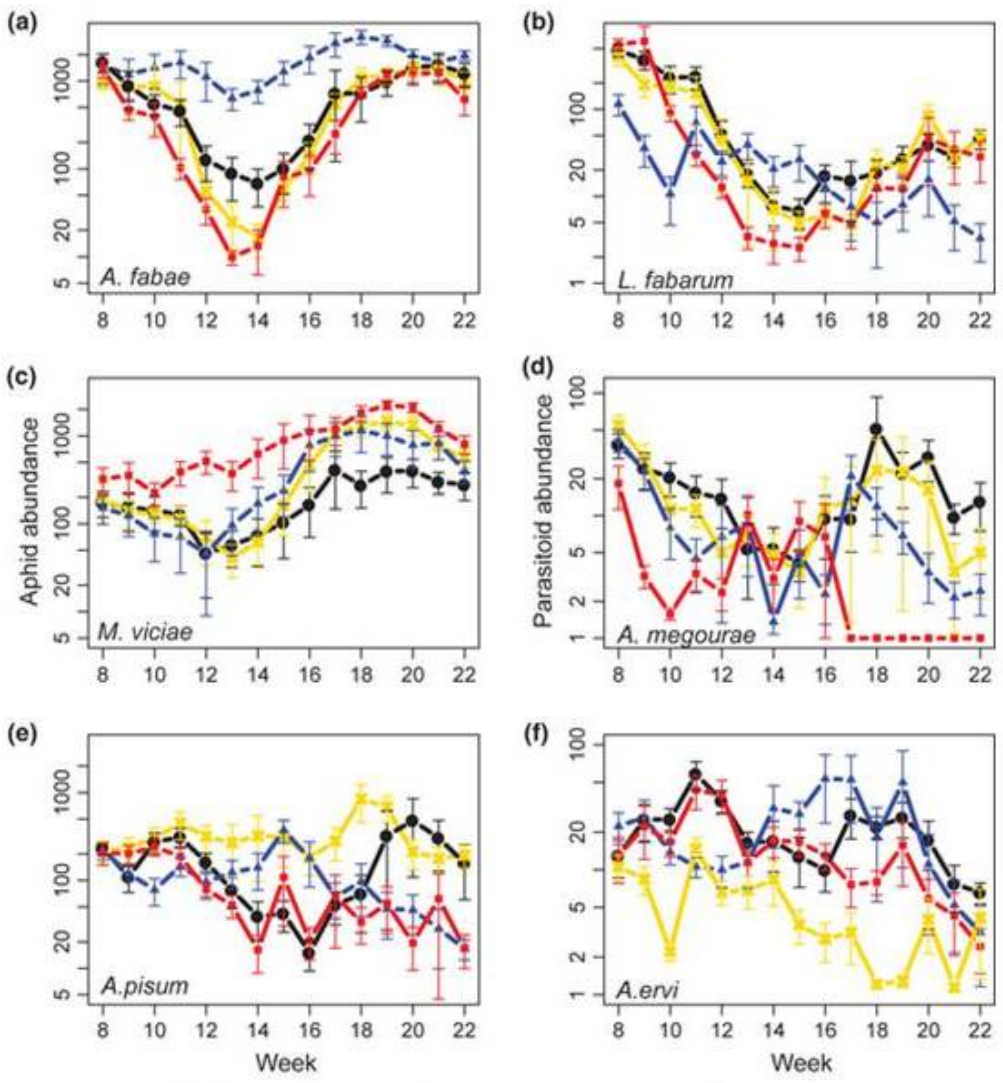


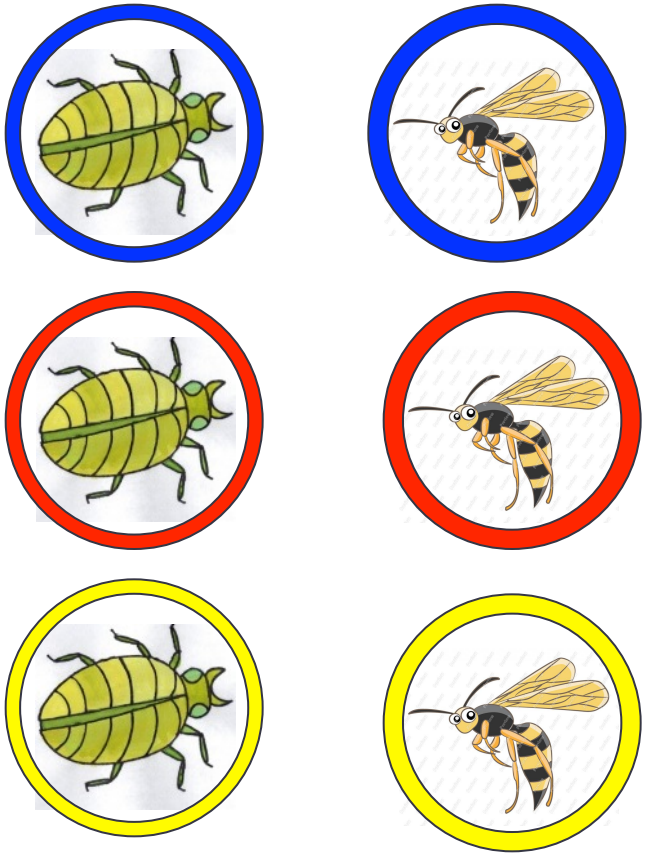


Harvesting experiment



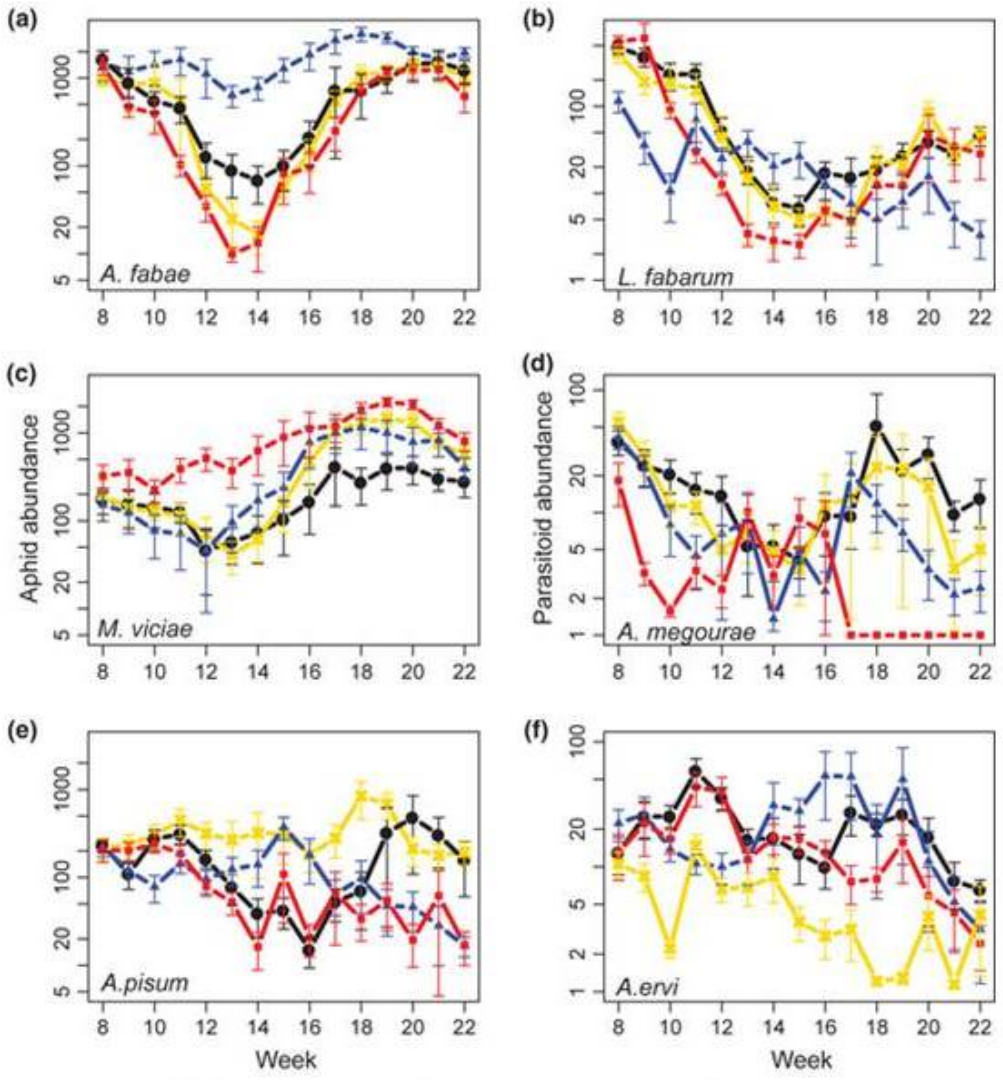
Harvesting

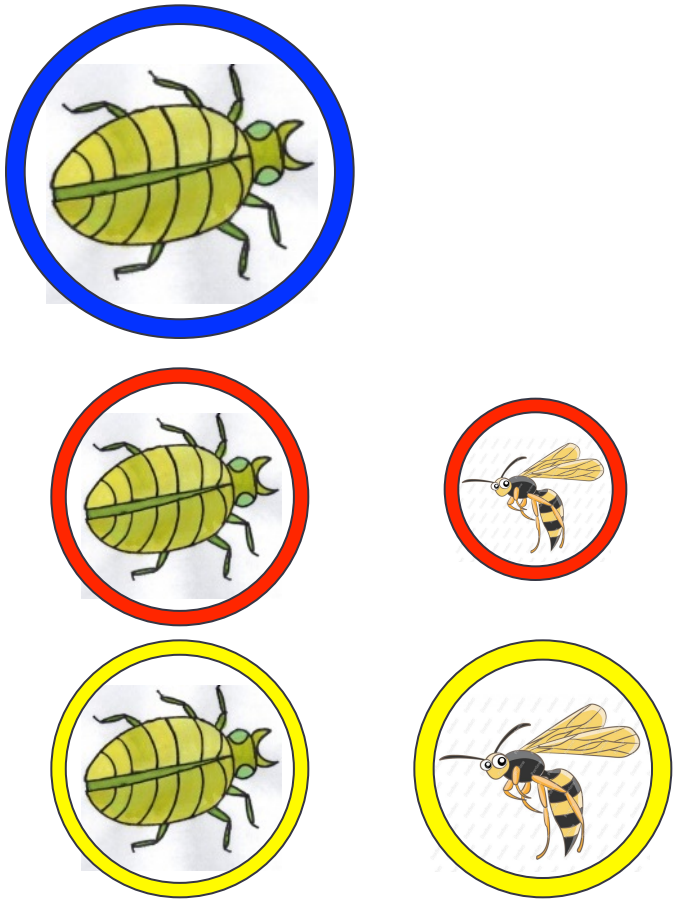




No harvesting control
L. fabarum harvested
A. megourae harvested
A. ervi harvested

Harvesting





No harvesting control
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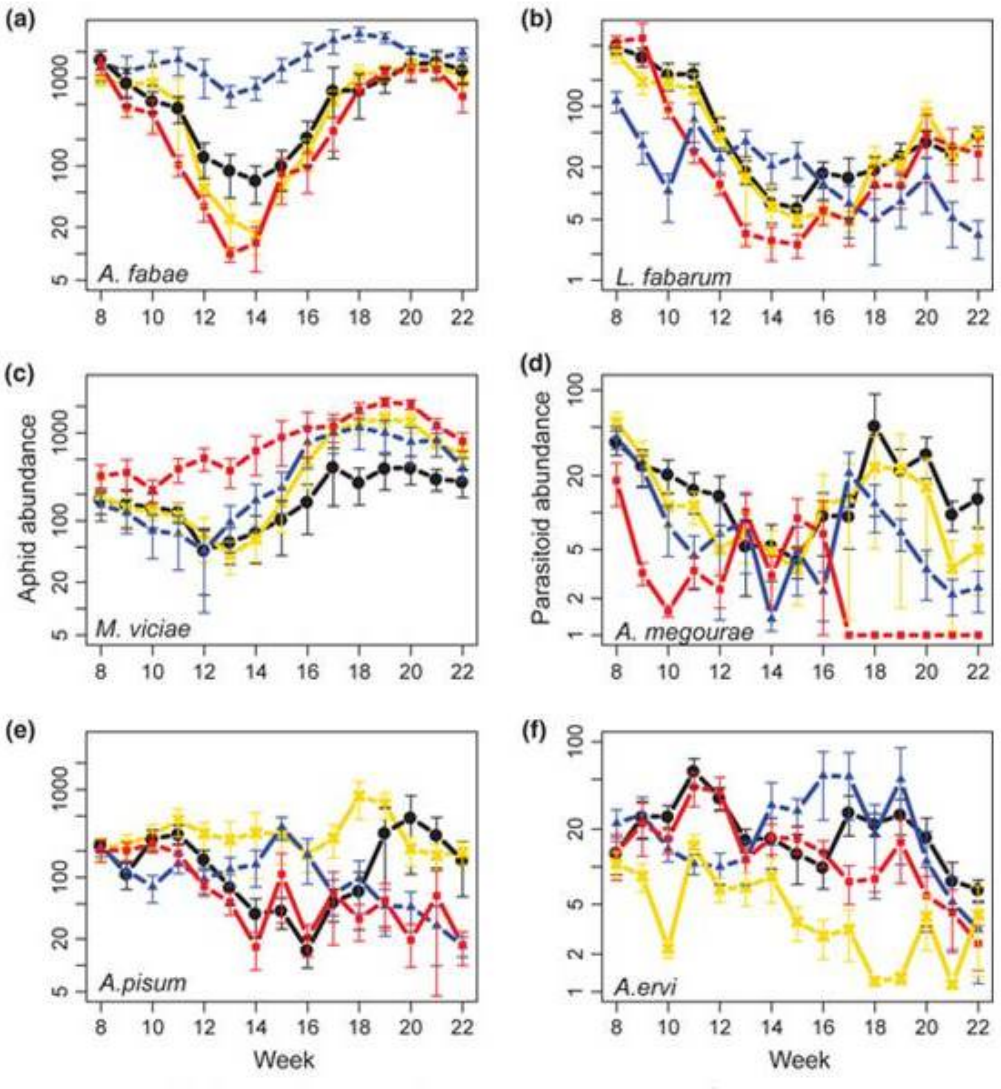
Harvesting



There is horizontal trophic cascade not always related to the decrease in aphid abundance.

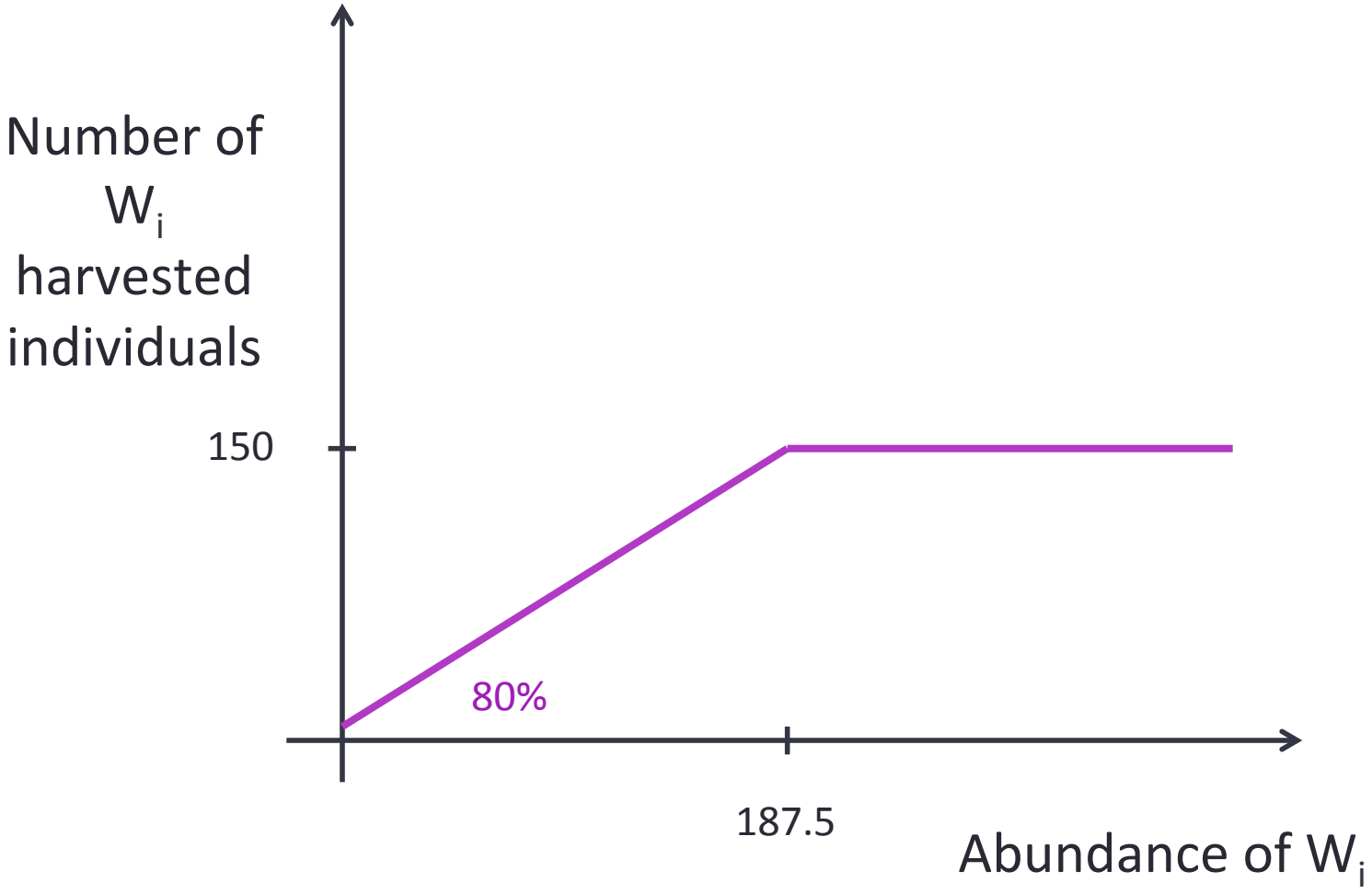
Harvesting - MODEL

$$\frac{dW_1}{dt} = -d_1 W_1 + \rho\beta_1 A_1 W_1 - harvesting$$

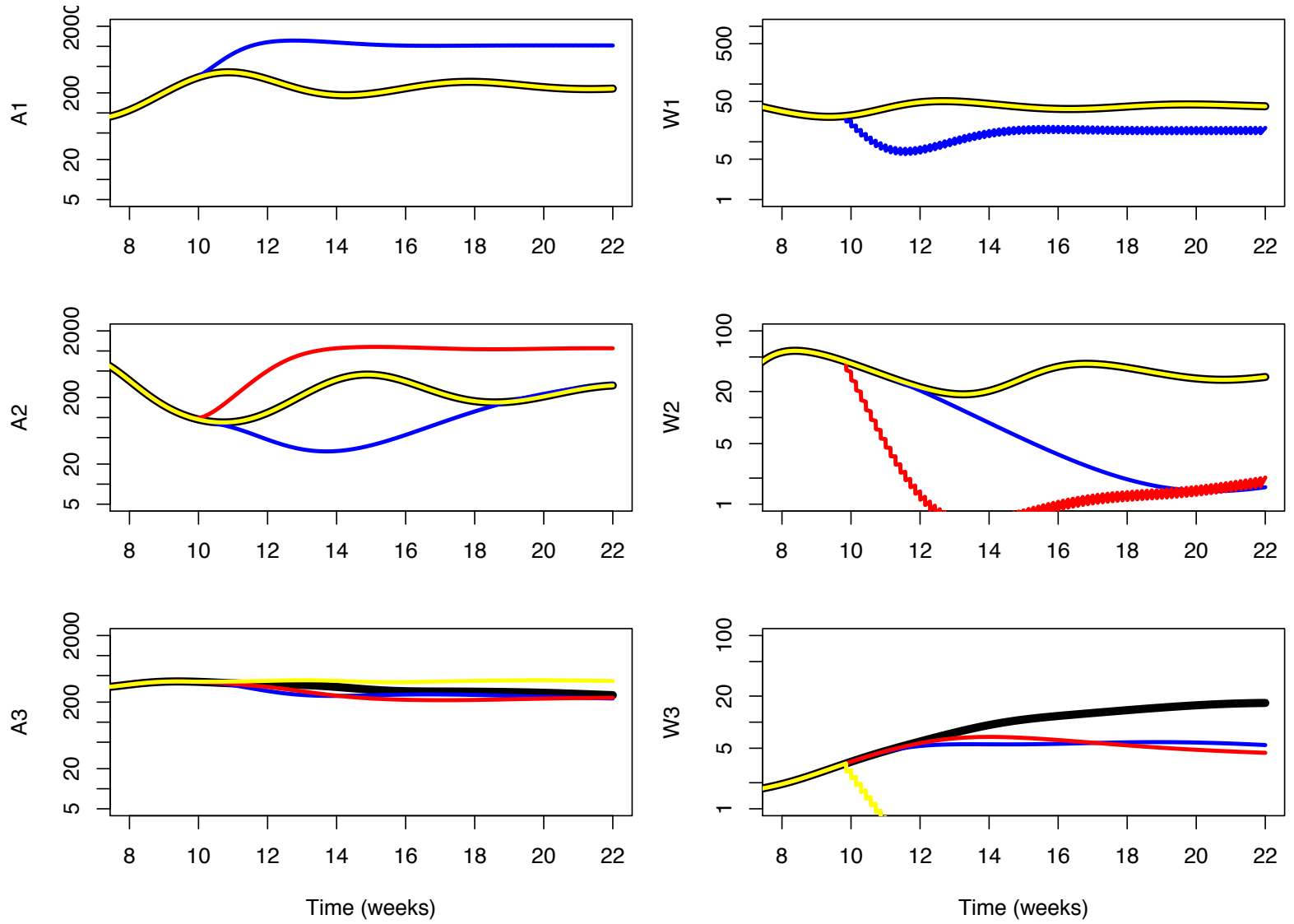
$$\frac{dW_2}{dt} = -d_2 W_2 + \rho\beta_2 A_2 W_2 - harvesting$$

$$\frac{dW_3}{dt} = -d_3 W_3 + \rho\beta_3 W_3 - harvesting$$

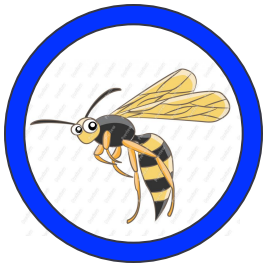
Harvesting

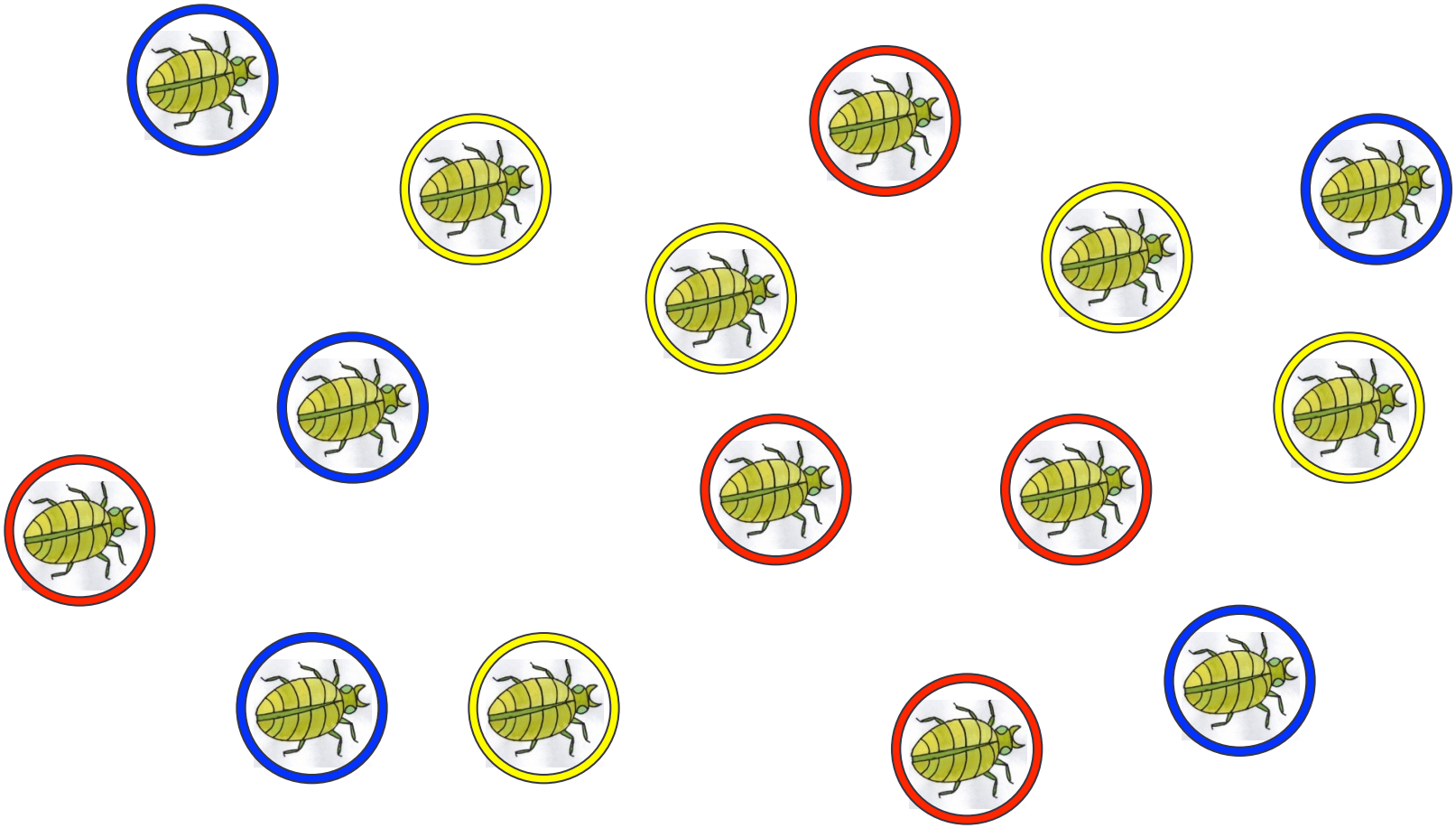

Number of W_i harvested individuals
150
80%
187.5
Abundance of W_i

Harvesting - result

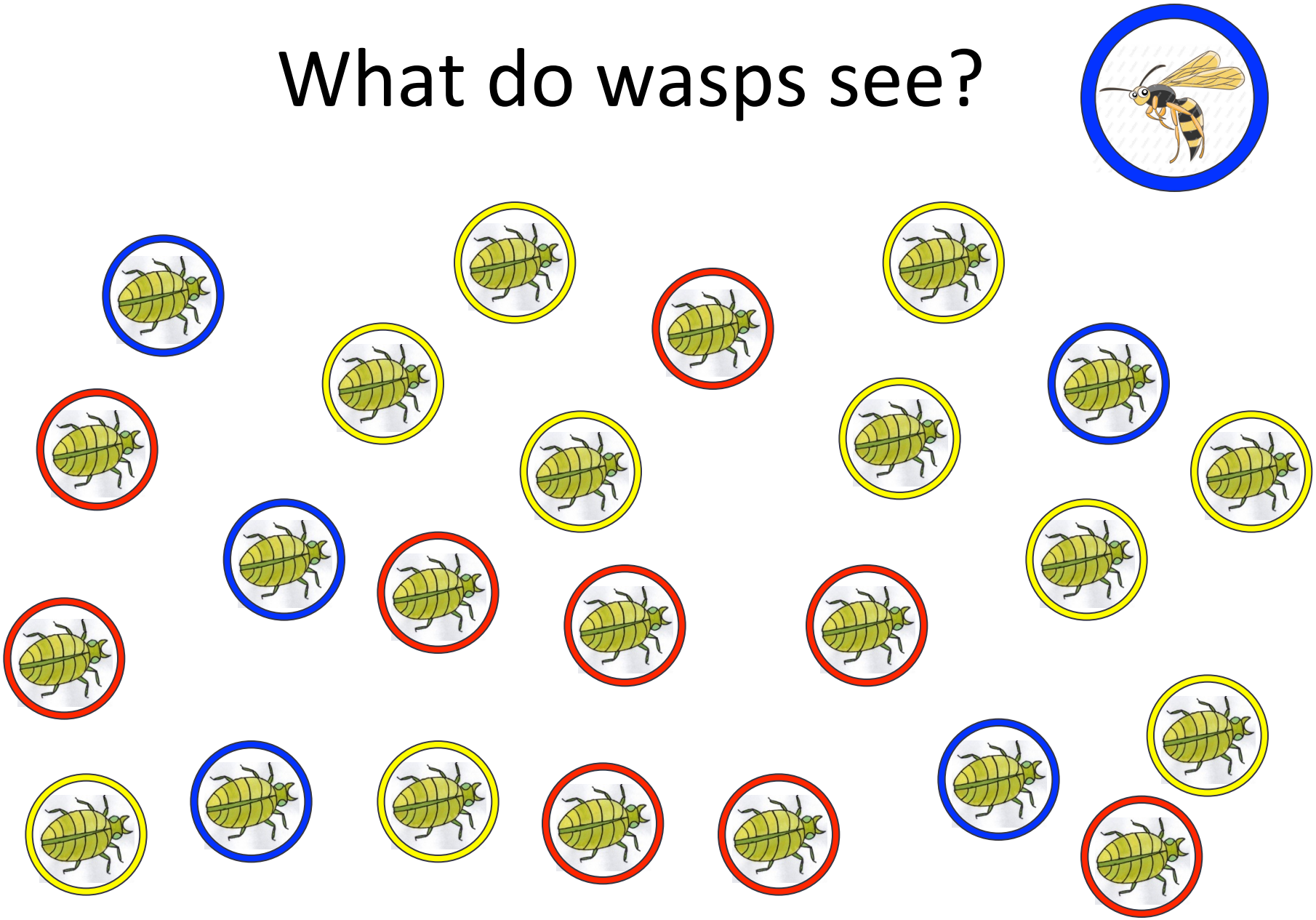


What do wasps see?





What do wasps see?



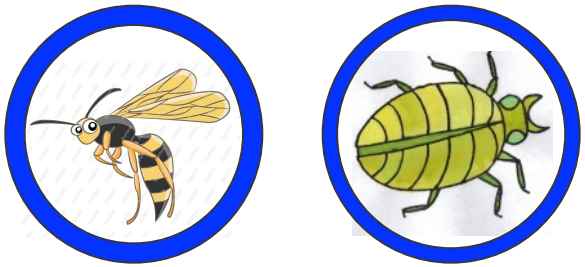
In order to test the
relative abundance effect
on wasp-aphid interactions…

Adding predation – NEW MODEL

$$\frac{dA_1}{dt} = r_1 A_1 - \frac{r_1 A_1^2}{K_1} - \alpha_{12} A_2 A_1 - \alpha_{13} A_3 A_1 - \beta_1 A_1 W_1$$

$$\frac{dW_1}{dt} = -d_1 W_1 + \rho \beta_1 A_1 W_1$$

Predation terms

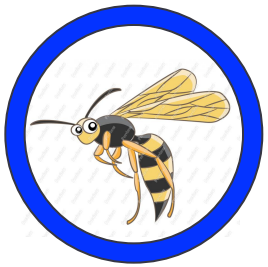


Adding predation – NEW MODEL

$$\frac{dA_1}{dt} = r_1 A_1 - \frac{r_1 A_1^2}{K_1} - \alpha_{12} A_2 A_1 - \alpha_{13} A_3 A_1 - \frac{O_{\max}\left(1 - e^{-\gamma A_T}\right)}{A_T} A_1 W_1$$

$$\frac{dW_1}{dt} = -d_1 W_1 + \rho \frac{\left[O_{\max}\left(1 - e^{-\gamma A_T}\right)\right]}{A_T} A_1 W_1$$

Predation terms (relative abundance)



Prey

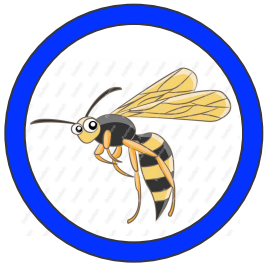
$$-\beta_1 A_1 W_1$$

$$-O_{\max}(1-e^{-\gamma A_t})\frac{A_1}{A_t}W_1$$

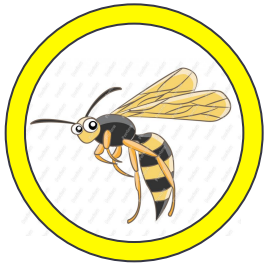
$A_T = A_1 + A_2 + A_3$

Predator

$$+\rho\beta_1 A_1 W_1$$

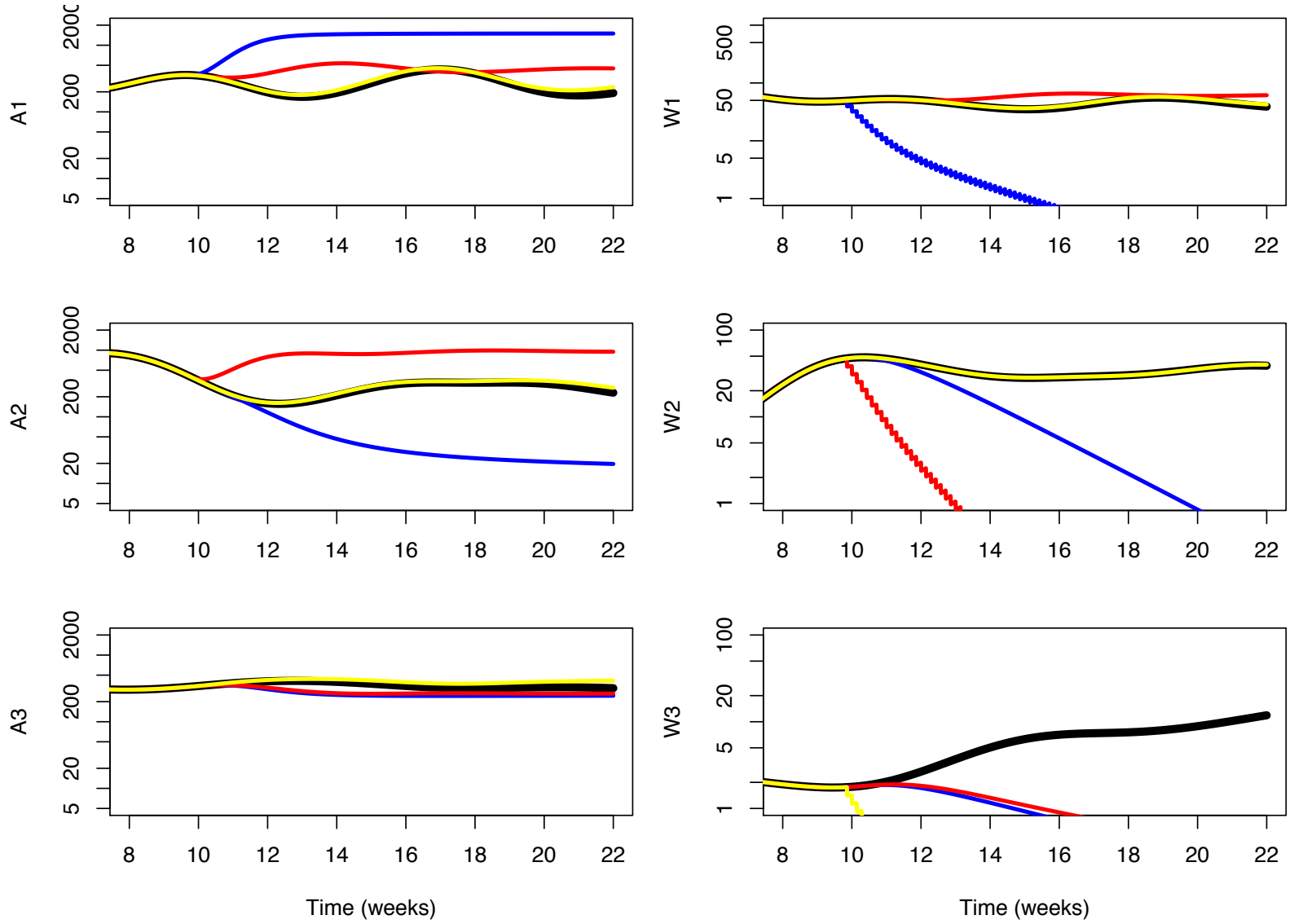


$$+\rho O_{\max}(1-e^{-\gamma A_t})\frac{A_1}{A_t}W_1$$



$A_T = A_1 + A_2 + A_3$

NEW MODEL - result



NEW MODEL

1) Relative abundance is not the mechanism

2) Relative abundance is the mechanism, but the history is not that simple

3) To explore the difference in competition among aphids

Conclusions

- The paper shows the existence of horizontal trophic cascades and suggests a mechanism

- Our model can predict horizontal trophic cascades, but is always related with reduction in aphid abundances

- The addition of relative abundance in our model generates two types of trophic cascades

- The experiment and the model support the existence of horizontal trophic cascades

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