RTM course - Ecological Rate Laws

Karline Soetaert and Lubos Polerecky
June 2021

Ecological interactions: virus infection

In a population comprising individuals that are *susceptible* to a virus and *infected* by a virus, infection can be modelled as a process similar to an elementary chemical reaction: a susceptible person can become infected if he/she "collides" with an infected person. Suppose that the *probability* that a susceptible person meets an infected person, whereby this encounter leads to the susceptible person becoming infected, is described by a parameter b (in units of $ind^{-1}\,d^{-1}$). The amounts of susceptible and infected individuals in the population are denoted by S and I, respectively.

What is a suitable expression for the infection rate?

- ☐ $InfectionRate = b \times (S + I)$
- ☐ $InfectionRate = b \times S$
- ☐ $InfectionRate = b \times I$
- ☑ $InfectionRate = b \times S \times I$
- ☐ $InfectionRate = S \times \frac{I}{I+b}$
- ☐ $InfectionRate = b \times I^2 \times S$

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[Previous Topic] [Next Topic]

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What is a suitable expression for the infection rate?

- ☐ $InfectionRate = b \times (S + I)$ ✗
- ☐ $InfectionRate = b \times S$ ✗
- ☐ $InfectionRate = b \times I$ ✗
- ☑ $InfectionRate = b \times S \times I$ ✓
- ☐ $InfectionRate = S \times \frac{I}{I+b}$ ✗
- ☐ $InfectionRate = b \times I^2 \times S$ ✗

> To become infected, a susceptible person needs to 'collide' with *one* infected person. Therefore, the infection rate is *first-order* with respect to the infected and susceptible persons, i.e., $InfectionRate = b \times S \times I$. The proportionality constant, b, describes the probability (expressed per individual per day) that a susceptible person meets an infected person and their encounter results in the susceptible person becoming infected.

[Previous Topic] [Next Topic]

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More exercises

To learn more about modelling of ecological interactions, solve additional exercises available in the R-package RTM. To display these exercises, type one of the following commands in the R-console:

```
require(RTM)
RTMexercise("detritus")
RTMexercise("COVID")
RTMexercise("npzd")
RTMexercise("crops_weeds")
```

[Previous Topic] [Next Topic]