Spread of virus infections

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We propose a new reaction-diffusion set of equations to explain the spread of viruses on bacterial populations. Although the process

$$V + B \xrightarrow{k_1} I \xrightarrow{k_2} Y \cdot V, \tag{1}$$

was first described years ago [1] and several modifications have been proposed since then [2-5], in this new model we introduce improvements. The two main features of the model are: (i) the second-order correction in time that takes care of the time delay due to the fact that viruses spend a time τ inside the cells before the new generation disperses away [4, 5], and (ii) a new mathematical formulation for the death of infected cells, also dependent on the time delay τ, and which is biologically more reasonable than other approaches using a logistic equation [4, 5].

We apply our model to experimental data for the front propagation speed of several T7 virus strains [6], calculating the necessary parameters from independent experiments (as opposed to other authors [2, 3, 7, 8]). We find good agreement between the model and experimental data. We compare our results to a classical model with no time delay by Yin and McCaskill [2], as well as to two models that describe the death process similarly to our approach but without the including the diffusive delay [7, 8]. All the other models overestimate the measured speed, therefore showing that our improvements are not only biologically sound, but also necessary to properly describe the processes of virus infection.

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