CHAPTER 22

Implications of Sanitation, Vectors, and Plant Susceptibility for Epidemic Development

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Preparation

These exercises can be performed individually or in small groups and can be completed within two to four hours. The main aim of the chapter is to help develop insights into disease progress curves by sketching freehand graphs to explore the effects of various factors on epidemic development. The spreadsheet program in Chapter 4 (Bowen) may be used; alternatively, a modelling package such as STELLA or SB ModelMaker may be used to supplement or extend the scope of this chapter.

Introduction

The exercises are intended to show how a simple epidemic model can be used to reason through the consequences of changes in a pathosystem. Three examples of practical importance are used: sanitation (without subsequent introduction of inoculum from outside); plant susceptibility to infection which varies over time; and disease vector populations which also vary through time.

Chapters 4 (Bowen), 6 (Nutter and Parker) and 7 (Neher et al.) describe various population growth models used to illustrate disease progress. Two of the simplest of these models are used here: monomolecular and logistic. Both incorporate a rate parameter to describe how fast disease increases per unit time. The focus of the exercises in this chapter is to link this description of disease progress to the biology of particular pathosystems.

Sanitation. One of the aims of sanitation is to reduce or eliminate initial inoculum from which epidemics start (Vanderplank, 1963). Its usefulness as a management technique depends on the type and rate of epidemic development, and the proportion of inoculum that can be eliminated. We shall mention in changes in the rate parameter of a model describing disease progress. If the main spread by vectors is from plant to plant within the field, insight can be gained from the logistic model; if inoculum is entirely [redacted]

what time of the season does $r = 1$ per month?] Now, using this experience, consider the situation for maize sown at the start of the wet season. Sketch the graph expected from linearly increasing vector activity, starting from zero ($r = t/6$ per month). As with many systemic viruses, the maize streak virus reduces maize yield greatly if it infects early, but scarcely at all if it infects late. With the assumptions made, what sowing date will minimize damage from the virus?

3. **Host susceptibility to infection.** Consider the same epidemic as in the previous section and the scenario in Fig. 22.4, with constant vector populations. Sketch what happens if host susceptibility were decreasing linearly through time ($r = 2 - t/3$). [Hint: What happens if vector numbers decrease linearly with time?!] Now sketch an expectation if susceptibility were decreasing exponentially over the season with $r = 2\exp(-t/3)$. [Hint: First calculate or sketch this pattern. When is r greater than in the reference case with constant r, and when is it less? Now sketch the disease progress curve.] Now, sketch an expectation if susceptibility decreased much faster, so $r = 2\exp(-2t)$. What model is a curve of this shape normally associated with?

Further Reading

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