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progressively less productive trees and under generally more crowded conditions with a higher incidence of natural enemies, the size and hence the flight propensity of the adults will decline. Owing to the increasing size of the "dead ground" in the interior regions of older and larger infestations, the adults of decreased vitality produced in brood trees located in these regions will face a progressively more difficult task of locating brood trees. Under these conditions, dispersal to and beyond the edges of the infestation or to new host stands is a must for survival and may not be possible through active flight, depending on beetle vigour. However, wind-aided dispersal above the stand canopy may still be quite feasible.

Some of the major problems associated with modeling infestation spread and proliferation of new infestations:

1. Determination of the number of trees to be attacked during the attack period.
2. Average attack density and its distribution among the infested trees.
3. Spatial distribution of attacked trees.
4. Movement of beetles out of infested spots.
5. Decline of infestations.

Regardless of the purpose of modeling, development of rules is required to capture the essential features of these processes in order to derive reasonable inferences/conclusions concerning the nature and effects of beetle-host interaction. Consequently, better quality information is needed through research to address these problems.

SPATIAL SELF-FOCUSING AND SELF-DISSIPATION: STRATEGIES FOR MOUNTAIN PINE BEETLE SURVIVAL

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Spatial dynamics play an important role in ecological systems and can result from both underlying patterns of the physical environment and complex biotic interactions. In fact, the complex spatial patterns of a particular system are often self-generated as a result of feedback between organisms and their abiotic and biotic environment. In particular, spatial complexity can arise from nonlinear self-focusing and self-dissipating. This occurs when a dispersing population is itself responsible for chemical, audible, or other types of cues that lead to aggregation. Self-dissipating forces are also an important ecological adaptation that helps populations avoid dangerous habitats or over-exploitation of a resource. The interplay between self-focusing and self-dissipating forces leads to a complex variety of patterns and spatial dynamics that are important in ecological systems such as *Dendroctonus ponderosae* Hopkins (mountain pine beetle) and pine trees.

Because the mountain pine beetle has both economic and ecological significance, a great deal of monetary and intellectual resources have been invested in understanding outbreak events. Nonetheless, some of the most basic questions regarding mountain pine beetle outbreaks remain unanswered. One important question is 'What are the factor(s) which cause a population to make the transition from an endemic phase to an epidemic phase?' Many hypotheses have been put forth, most of them contradictory, or at least inconsistent. In our opinion, one important reason for the lack of synthesis in outbreak theories is the inadequate treatment of spatial dynamics and population phase dynamics. Our basic thesis is that mountain pine beetle outbreak dynamics are inherently dependant on dispersal behaviour, as well as the local population dynamics, and that dispersal behaviour is inherently dependant on the chemical ecology of the species (e.g., the self-focusing and self-dissipating forces).

In an effort to answer questions that may be physically and logistically impossible to test on the ground, we are developing a mathematical model of mountain pine beetle dispersal, including the chemical ecology and spatial interaction between beetles and host forests. The model is based on a system of spatially explicit nonlinear partial differential equations. We use model simulations to investigate three important ecological issues in mountain pine beetle ecology: (1) the loss of environmental determinism that accompanies successful attacks; (2) the effect of synchrony in adult emergence on the likelihood of successful attack and outbreak potential; and (3) the impact of the spatial proximity of weakened trees to act as foci for an outbreak.

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