

## Population dynamics of forest-defoliating insects

Andrew Liebhold · Naoto Kamata

### INTRODUCTION

## Are population cycles and spatial synchrony a universal characteristic of forest insect populations?

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**Abstract** Foliage-feeding forest insects have served as model systems in the study of animal populations for more than 50 years. Early studies emphasized identification of “key” mortality agents or density-dependent sources of mortality. However, these efforts became burdened by rhetorical ambiguity, and population ecologists are increasingly focusing on characterizing population behavior and identifying the processes that generate that behavior. Two types of behavior seem to be common in forest insect populations: periodic oscillations (“population cycles”) and spatial synchrony (synchronous fluctuations over large geographic areas). Several population processes (e.g., host–pathogen interactions) have been demonstrated to be capable of producing periodic oscillations, but the precise identity of these processes remains uncertain for most forest insects and presents a challenge to future research. As part of these efforts, a greater emphasis is needed on the use of statistical methods for detecting periodic behavior and for identifying other types of population behavior (e.g., equilibrium dynamics, limit cycles, transient dynamics). Spatial synchrony appears to be even more ubiquitous in forest insect populations. Dispersal and regional stochasticity (“Moran effect”) have been shown to be capable of producing synchrony, but again more research is needed to determine the relative contribution of these processes to synchrony observed in natural populations. In addition, there is a need to search for other types of time–space patterns (e.g., traveling waves, spiral waves) in forest insect populations and to determine their causes.

**Key words** Population dynamics · Periodic oscillations · Outbreak · Nonlinear dynamics

### Introduction

Royama (1992) states that the ultimate question in population dynamics is “Why do animal populations fluctuate as they do?” Throughout the twentieth century, foliage-feeding forest insects have served well as model systems for answering this question. Most of these insects exist in habitats that are relatively free of anthropogenic disturbance and thus lend themselves as suitable subjects for long-term studies. Long-time series are the “bread and butter” in the field of population dynamics because many dynamic patterns only become evident after 20 or more years of data collection. Foliage-feeding forest insects are also valuable model systems because they are relatively easy to sample and the habitat is rarely destroyed by their feeding, even during outbreaks.

The seven papers in this special feature present syntheses of the current knowledge on the population dynamics of some of the most widely studied foliage-feeding insects. If these papers are contrasted with earlier studies of forest insect dynamics over the past several decades, it becomes clear that during this period there has been an evolution of approaches to the field of animal population ecology. The objective has always been to elucidate the mechanisms behind the dynamics of selected species, but the specific questions have varied.

Early scientists (e.g., Varley and Gradwell 1960; Morris 1963) focused on identifying the most “important” factors responsible for changes in population density. The approach most commonly taken was to collect life table data and apply specialized statistical procedures (e.g., “key-factor analysis”; Varley and Gradwell 1960) to identify specific causes of mortality that explained the largest portion of variation in change in density. Although great advances were made by this work, this approach is rarely applied in contemporary studies because of the ultimately nebulous definition of what makes a certain type of mortality “important” (Royama 1996).

As these efforts tapered off, an increasing emphasis was placed on identifying the existence and causes of population

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# Population Dynamics Of Forest Insects

**Alan A. Berryman**



## **Population Dynamics Of Forest Insects:**

Dynamics of Forest Insect Populations Alan A. Berryman, 2013-06-29 Insects multiply Destruction reigns There is dismay followed by outcry and demands to Authority Authority remembers its experts or appoints some they ought to know The experts advise a Cure The Cure can be almost anything holy water from Mecca a Government Commission a culture of bacteria poison prayers denunciatory or tactful a new god a trap a Pied Piper The Cures have only one thing in common with a little patience they always work They have never been known entirely to fail Likewise they have never been known to prevent the next outbreak For the cycle of abundance and scarcity has a rhythm of its own and the Cures are applied just when the plague of insects is going to abate through its own loss of momentum Abridged with insects in place of voles from C Elton 1924 Voles Mice and Lemmings with permission of Oxford University Press This book is an enquiry into the natural rhythms of insect abundance in forested ecosystems and into the forces that give rise to these rhythms Forests form unique environments for such studies because one can find them growing under relatively natural premeval conditions as well as under the domination of human actions Also the slow growth and turnover rates of forested ecosystems enable us to investigate insect population dynamics in a plant environment that remains relatively constant or changes only slowly this in contrast to agricultural systems where change is often drastic and frequent Forest Insect Population Dynamics, Outbreaks, And Global Warming Effects A. S. Isaev, Vladislav G. Soukhovolsky, O. V. Tarasova, E. N. Palnikova, A. V. Kovalev, 2017-03-21 This new approach to insect modeling discusses population dynamics regularities control theory theory of transitions and describes methods of population dynamics and outbreaks modeling for forest phyllophagous insects and their effects on global climate change Research in insect population dynamics is important for more reasons than just protecting forest communities Insect populations are among the main ecological units included in the analysis of stability of ecological systems Moreover it is convenient to test new methods of analyzing population and community stability on the insect related data as by now ecologists and entomologists have accumulated large amounts of such data In this book the authors analyze population dynamics of quite a narrow group of insects forest defoliators It is hoped that the methods proposed herein for the analysis of population dynamics of these species may be useful and effective for analyzing population dynamics of other animal species and their effects and role in global warming What can insects tell us about our environment and our ever changing climate It is through studies like this one that these important answers can be obtained along with data on the insects and their behaviors themselves The authors present new theories on modeling and data accumulation using cutting edge processes never before published for such a wide audience This volume presents the state of the art in the science and it is an essential piece of any entomologists and forest engineers library *Forest Insects* Alan A. Berryman, 2012-12-06 This book is intended as a general text for undergraduates studying the management of forest insect pests It is divided into four parts insects ecology management and practice Part I Insects contains two chapters The first is

intended to provide an overview of the general attributes of insects Recognizing that it is impossible to adequately treat such a diverse and complex group of organisms in such a short space I have attempted to highlight those insectan characteristics that make them difficult animals to combat I have also tried to expose the insects weak points those attributes that make them vulnerable to manipulation by human actions Even so this first chapter will seem inadequate and sketchy to many of my colleagues Ideally this book should be used in conjunction with a laboratory manual covering insect anatomy physiology biology behavior and classification in much greater depth in fact this is how I organize my forest entomology course It is hoped that this first chapter will provide nonentomologists with a general feel for the insects and with a broad understanding of their strengths and weaknesses while Chapter 2 will provide a brief overview of the diverse insect fauna that attacks the various parts of forest trees and their products **Forest Insect Population Dynamics** ,1969 Forest Insect Population

Dynamics ,1969 S2The purpose of the Forest Insect Population Dynamics Workshop was to permit some probing in depth of forest insect populations systems and to provide an opportunity for the exchange of ideas and information in this subject Organized and developed primarily for Forest Service personnel interested or involve in quantitative population studies of forest insects the Workshop was augmented by outside scientists especially knowledgeable and experienced in pertinent facets of population dynamics The program was oriented to the researcher with emphasis on approaches and methods of analysis but with due consideration of output and applications S3 **Forest Insect Population Dynamics** ,1969

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Moreover it is convenient to test new methods of analyzing population and community stability on the insect related data as by now ecologists and entomologists have accumulated large amounts of such data In this book the authors analyze population dynamics of quite a narrow group of insects forest defoliators It is hoped that the methods proposed herein for the analysis of population dynamics of these species may be useful and effective for analyzing population dynamics of other animal species and their effects and role in global warming What can insects tell us about our environment and our ever changing climate It is through studies like this one that these important answers can be obtained along with data on the insects and their behaviors themselves The authors present new theories on modeling and data accumulation using cutting edge processes never before published for such a wide audience This volume presents the state of the art in the science and it is an essential piece of any entomologist s and forest engineer s library **Forest Insect Population Dynamics** ,1969

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*Forest Insect Population Dynamics* United States Agriculture Fores Service,2017-11-18 Excerpt from Forest Insect Population Dynamics Proceedings of the Forest Insect Population Dynamics Workshop West Haven Connecticut 23 27 January 1967 The format was simple One day was given to each of four major subject areas The primary presentations which comprise the text of this publication with the exceptions noted below were given in the mornings followed by questions answers and discussion of the subject The presentation of Dr Wyatt W Anderson then with Yale University on the fundamentals of population genetics and its interplay with population ecology is not included in this Proceedings because of the basic nature of the informa tion and its availability in standard texts The paper by Dr Charles L Remington yale University on the genetic consequences of insect population displacement or transport is omitted also because it has been published in Volume 15 1968 of the Annual Review of Entomology Unfortunately the taped recordings of the open discussions could not be transcribed adequately and so this vital portion of the Workshop cannot be included About the Publisher Forgotten Books publishes hundreds of thousands of rare and classic books Find more at [www.forgottenbooks.com](http://www.forgottenbooks.com) This book is a reproduction of an important historical work Forgotten Books uses state of the art technology to digitally reconstruct the work preserving the original format whilst repairing imperfections present in the aged copy In rare cases an imperfection in the original such as a blemish or missing page may be replicated in our edition We do however repair the vast majority of imperfections successfully any imperfections that remain are intentionally left to preserve the state of such historical works

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