

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

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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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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

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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 **Forests and Insects** Allan D. Watt, Nigel E. Stork, Mark D. Hunter, 1997-09-30 This book covers the full breadth of forest entomology It combines the work of forest entomologists working on the impact and management of forest pests with those involved in diversity assessment and conservation of insects in forests Forests and Insects demonstrates that both these disciplines demand an understanding of population and community biology The book covers such topics as colonization of trees by insects population dynamics of forest insects insect natural enemies the effects of climate change and pollution on forest pests spatial variation in the abundance of insects the mineralization of carbon by termites the impact of herbivorous insects and the conservation of forest insect diversity including the effects of forest fragmentation and deforestation This Royal Entomological Society Symposium volume will be of great interest to all agricultural and forest entomologists population and community biologists pest management specialists and anyone concerned with the conservation of forest biodiversity

Forest Insect Population Dynamics, Outbreaks, And Global Warming Effects A. S. Isaev, Vladislav G. Soukhovolsky, O. V. Tarasova, E. N. Palnikova, A. V. Kovalev, 2017-03-16 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 entomologist s and forest engineer s library *Forest Insect Population Dynamics* , 1969 **Forest Insects** Alan A. Berryman, 2012-12-06 This book is intended as a general text for undergraduates studying the manage ment of forest insect pests It is divided into four parts insects ecology manage ment

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

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Forest Insect Population Dynamics United States Agriculture Forest 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 information 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 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

Population Dynamics of Forest Insects at Low Levels Fred Paul Hain,1979* Tropical Forest Insect Pests K. S. S. Nair,2007-05-10 Tropical Forest Insect Pests first published in 2007 promotes a better theoretical understanding of pest population dynamics and causes of forest insect outbreaks in the tropics Covering pests of both natural forests and plantations it examines the diversity of tropical forest insects their ecological functions the concept of pests and the incidence of pests in natural forests plantations and stored timber General issues on which foresters and forest entomologists

hold strong traditional views such as the severity of pest incidence in plantations vs natural forests in plantations of exotics vs indigenous tree species and in monocultures vs mixed plantations are discussed The final section looks in detail at specific insect pests of the common plantation tree species across the tropics with recommendations for their control This is a comprehensive resource suitable for graduate students and researchers in forestry and tropical forest entomology and for forest plantation managers in the tropics The role of the host in the population dynamics of forest insects ,1985

Population Dynamics of Agricultural and Forest Insect Pests Anonymous,2021-09-09 This work has been selected by scholars as being culturally important and is part of the knowledge base of civilization as we know it This work is in the public domain in the United States of America and possibly other nations Within the United States you may freely copy and distribute this work as no entity individual or corporate has a copyright on the body of the work Scholars believe and we concur that this work is important enough to be preserved reproduced and made generally available to the public To ensure a quality reading experience this work has been proofread and republished using a format that seamlessly blends the original graphical elements with text in an easy to read typeface We appreciate your support of the preservation process and thank you for being an important part of keeping this knowledge alive and relevant **Principles of Population Dynamics and Their Application** Alan A. Berryman,2020-11-25 This book provides an introduction to population dynamics exploring rules that govern change in any dynamic system and applying these general principles to populations of living organisms Principles of Population Dynamics and their Application is aimed at applied ecologists resource managers and pest managers It is also aimed at undergraduate students taking courses in forestry fisheries wildlife and pest management **Forest Entomology** William Ciesla,2011-03-08 Insects are the most abundant and diverse organisms that inhabit our planet and are found in all the world s forest ecosystems Many feed and or breed on parts of trees Some perform important functions such as pollination or break down of dead vegetation Others weaken deform or kill trees and compete with humans for the many goods and services that trees and forests provide Forest Entomology A Global Perspective examines forest insects in a global context and reviews their dynamics interactions with humans and methods for monitoring and management of species that damage forests Also provided are 235 profiles of forest insects worldwide A series of tables provides summaries of the distribution and hosts of many more species Included are those that damage forests others that are simply curiosities and some that are beneficial This book is designed as a reference for students practicing foresters and forest health specialists especially for those who work internationally or are concerned with species that have the potential to expand their ranges via international trade travel or environmental changes **Effects of Resource Distribution on Animal Plant Interactions** Mark D. Hunter,Takayuki Ohgushi,Peter W. Price,2012-12-02 Aimed primarily at advanced graduate students and professional biologists this book explores the degree to which animal b1plant interactions are determined by plant and animal variability Many of the patterns seen in natural communities appear to result from cascading effects up as well as down the trophic

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