PREFACE

The concept for this book grew during the late 1990s from efforts to educate my insect ecology students on the broad perspective of insect ecology that derives from a synthesis of evolutionary and ecosystem approaches. The traditional evolutionary approach has demonstrated the importance of insect adaptations to environmental conditions for individual fitness, population dynamics and community interactions, whereas the more recent ecosystem approach has shown how insects modify their environment through their effects on primary production, vegetation dynamics, soil development and biogeochemistry, as these regulate global carbon fluxes and climate. Insect evolution represents feedback from ways in which insect phenotypes affect their environment, in the same way that plant adaptations can be seen as feedback from their effects on soil development, carbon and nutrient fluxes and climate.

This third edition provides an updated and expanded synthesis of the feedbacks and interactions between insects and their environment, and adds a new chapter on applications, based on reader feedback. Some of the most exciting recent advances are 1) the identification of gene expression that controls biochemical interactions among insects and other organisms, 2) the identification of specific genes that have been selected by feedback between insect phenotype and environmental conditions, and 3) broadened scope of insect effects on, and responses to, environmental changes. The new Chapter 16 describes the application of insect ecology to various social and environmental issues, including ecosystem services (such as pollination, food and fiber supply, water yield and quality, primary production and soil formation) and pest management.

Ecology, especially ecosystem ecology, necessarily requires a multidisciplinary approach, that involves not only biological disciplines, including molecular biology, but also chemists, geologists, climatologists, hydrologists, soil scientists, geographers, and mathematicians, in order to fully understand and manage the complexity of interactions among organisms and their environment. Despite their small size, insects have demonstrated a

capacity to regulate ecosystem processes that control local-to-global environment. Furthermore, much of what we know about insect ecology has been contributed by studies with an applied orientation, e.g., investigation of factors affecting population dynamics (including insect–plant and predator–prey interactions) to provide tools for managing insect populations.

This text provides the data base for predicting and managing insect effects on ecosystem services, including global carbon fluxes and climate. As we become increasingly aware that global changes must be addressed from a global (rather than local) perspective, we need models with greater integration of ecological processes at various levels of resolution and across regional landscapes. Insect population structure, insect interactions with other species and their effects on ecosystem processes are integral to explaining and mitigating global changes. Furthermore, the increasing recognition that insects have various short and long-term effects on multiple ecosystem services requires a shift in approach, from traditional crop "protection" to integration of compensatory benefits for sustained yield of ecosystem services. Integrated pest management (IPM) is founded on such ecological principles.

A hierarchical model is used in this text to highlight the interactions and feedbacks among individual, population, community, and ecosystem components. This model also contributes to the integration of evolutionary and ecosystem approaches, by illustrating how conditions at higher levels of resolution (e.g., the community or ecosystem) contribute to the environment perceived at lower levels (e.g., populations and individuals), and how responses at lower levels contribute to conditions at higher levels of this hierarchy. Some overlap among sections and chapters is necessary to emphasize linkages among levels. Where possible, overlap is minimized through cross-referencing.

An alternative model would be organization by major topics of current concern, such as evolution, biodiversity, omnivory, biological control, and climate change. However, this topical organization has limited potential for integration and emphasis of the fundamental feedbacks that control many of these processes.

A useful textbook must balance coverage with brevity. A guiding principle for this book has been its emphasis on insect responses to, and effects on, ecosystem structure and function. Evolution is emphasized in the earlier chapters that deal with individual and population responses to environmental conditions, with cross-referencing to later chapters that show how insects affect the ecosystem conditions to which they also respond.

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