1 About This Book

Plant–animal interactions have become a major focus of ecological research during recent years. One field of major interest in this connection is the process of herbivory. Interactions between plants and herbivorous insects constitute an important component of almost any ecosystem. These interactions occur at low trophic levels and as a result often influence food webs. They play a crucial role in the recycling of matter and, hence, energy and nutrient flows. Last, but not least, these interactions evolve and coevolve, and are considered to be one of the processes and driving forces which organize ecosystems (Crawley 1983; Zwölfer 1987). Generally, insect herbivory has been shown to be one of the disturbance effects which can positively influence secondary plant succession, and thus, species diversity (McBrien et al. 1983; Brown and Gange 1990, 1992; Pacala and Crawley 1992; Davidson 1993; Vasconcelos and Cherret 1997; see Chap. 15).

Due to their immense importance as pests (see below), leaf-cutting ants are probably the most studied tropical insects (Weber 1972a,b; Hölldobler and Wilson 1990; Fowler et al. 1990). Cherrett and Cherrett (1975) compiled 1020 references and this number has continuously increased since then. Naturally, the bulk of work on leaf-cutting ants has been devoted to research on pest control (for review see Vander Meer et al. 1990) and to related topics such as the selection of host plants (Cherrett 1968; Rockwood 1975; for review see Vasconcelos and Fowler 1990), including the elucidation of the chemical and physical aspects of the preferred host plants (e.g., Hubbell et al. 1984; Howard 1988; Howard et al. 1989; Nichols-Orions 1991a–c). Further, the phenomenon that leaf-cutting ants distribute their foraging activities over a large area, instead of using the vegetation immediately around their nest site, has provoked a long-lasting discussion on foraging strategies (Cherrett 1968; Fowler and Styles 1980; Rockwood and Hubbell 1987; Shepherd 1982). From the ecological viewpoint, the most striking aspect of leaf-cutting ants in the rainforest ecosystem is their importance as generalist herbivores (see Chap. 15). Of all herbivore groups of comparable taxonomic diversity, the leaf-cutting ants of the genera *Atta* and *Acromyrmex* are the most dominant herbivores in the tropics of the New World (Wilson 1986). Wint (1983), for example, estimated

that *Atta* species were responsible for some 80 % of visible leaf damage found in Panamanian rainforests (but see also Cherrett 1989 and Chap. 11, this Vol.). The ecological and economic impact of the symbiosis between leaf-cutting ants and their plant-consuming mutualist fungus is strikingly revealed by the fact that the two genera *Atta* and *Acromyrmex* are the most serious agricultural pests of tropical and subtropical America, causing enormous economic damage (several thousand million dollars annually) to the neotropic agricultural industry (cf. Cherrett 1986).

Despite considerable research efforts, there are still major aspects of the biology and ecology of leaf-cutting ants that have received little attention and hence have been rarely addressed in the extensive review literature. For instance, there is minimal information about the origin, maintenance and persistence of foraging trails and their spatial and temporal variability (Shepherd 1985; Farji Brener and Sierra 1993; Howard 2001). Also, virtually nothing is known about the survival rates of colonies or their maximum ages under field conditions (Autuori 1941; Fowler et al. 1986b). While the rate of colony turnover is critical for assessing the importance of leaf-cutting ants in rainforest ecosystems, our knowledge of the temporal variation of populations of colonies is correspondingly limited (Perfecto and Vandermeer 1993). Finally, and most surprisingly, detailed studies on the impact of these polyphagous herbivores on rainforest plants and community dynamics are very scarce (but see Vasconcelos 1997, 1999; Vasconcelos and Cherrett 1996; Rao et al. 2001). Although various attempts have been made to estimate the amounts of vegetation carried into the nests of leaf-cutting ants (Hodgson 1955; Cherrett 1968; Rockwood 1975; Blanton and Ewel 1985; Haines 1978; Lugo et al. 1973), no simultaneous estimates have been made of the production of the forest area impacted or the affected standing leaf crop. Little has been done to ascertain the consequences of the foliage loss in these canopies. Most importantly, long-term studies of the quantitative and qualitative effects of the leaf-cutting ant harvesting activities are completely lacking. The case study presented in this volume was undertaken to address most of these open questions.

Starting with a general description of the natural history of leaf-cutting ants in Chapter 2, we subsequently present the results of a 5-year-long case study carried out from 1993 to 1998 in a semideciduous tropical rainforest in Panama. Chapters 3–6 focus on the habitat characteristics of the ants by first describing the study area (Chap. 3) and the floristic composition of the forest (Chap. 4), followed by detailed analyses of the forest light regime (Chap. 5) and the canopy structure (Chap. 6). In the following chapters, the ants and their activities are the center of interest. Information is given on the spatial and temporal colony distribution (Chap. 7), the short-term and long-term harvest dynamics (Chap. 8), the trail system and the foraging area of the colonies (Chap. 9) and the characteristics of their host plant selection (Chap. 10). Subsequently, we analyze the impact of the ants on the rainforest ecosystem starting with the calculation of herbivory rates at several scales

(Chap. 11) and following up with an analysis of the effects on the light climate in various parts of the canopy (Chap. 12). The next two chapters discuss the importance of the ants as seed dispersers (Chap. 13), and assess the role of the ants in nutrient cycling and the water relations of harvested plants (Chap. 14). Integrating the information gained from this study, we finally discuss the role of leaf-cutting ants as a mechanism which may help to maintain ecosystem biodiversity (Chap. 15).

This compilation of leaf-cutting ant activity and interactions with the rainforest vegetation on Barro Colorado Island (see Plate 1) represents an appropriate model for summarizing and extending knowledge about herbivorous insect-plant relationships, and assessing the resulting consequences on structural and functional attributes of tropical ecosystems. To the knowledge of the authors, a study of similar breadth and duration on this subject has not been published. Therefore, we hope that this synthesis volume on the effects of leaf-cutting ant herbivory at multiple scales will act as a reference for researchers and land managers working in the fields of plant-animal interaction, herbivory, community ecology and biodiversity.