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Modeling the Impact of Plant Toxicity on Plant–Herbivore Dynamics

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Numerous empirical studies over the past two decades have documented substantial effects of plant toxins on diet choice and feeding behavior of herbivores, but analytical models have failed thus far to incorporate toxin-mediated effects of browsing on plant population dynamics. We study a mathematical model that incorporates plant toxicity in the functional response of plant–herbivore interactions. The model also includes a Lotka–Volterra type competition between plants. The model exhibits a rich variety of complex dynamics including Hopf bifurcation and period-doubling bifurcations. Differences in dynamical behavior stem from interspecific differences in plant biology and strategies for growth and defense as well as variation in responses of herbivores to toxins. Analyses suggest that for realistic parameter values, herbivores are capable of promoting coexistence of plant species by ameliorating competitive effects and hence enhancing biodiversity.

KEY WORDS: Mathematical model; bifurcation; plant-herbivore dynamics; functional response; plant toxicity.

1. INTRODUCTION

Three groups of chemicals interact to control mammalian herbivory. They are nutrients (nitrogen, phosphorous, carbohydrates, etc.), digestion inhibitors (fiber, tannins), and toxins [30,31]. Nutrients increase forage intake because they are required by herbivores and often are limiting in the

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