

**The effect of searching efficiency on  
predator-prey dynamics: empirical  
and theoretical study of the  
omnivorous bug *Orius laevigatus* and  
its prey.**

**Thesis**

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# Abstract

The functional response of a predator to its prey has a decisive effect on the population dynamics of the predator/prey system. Many studies have assessed the dynamics of systems characterized by type I and II functional responses; simulations have demonstrated that the type I response does not contribute to the stability of ecosystems. Most studies of omnivores, which utilize food sources from several trophic levels, have involved unstable systems, leading to the widespread assumption that omnivory is rare in nature. More recent studies have shown that omnivory is, in fact, common in many ecosystems and in a variety of taxa. Recent models of omnivory in a tri-trophic system characterized by a type II functional response indicate that omnivory can contribute to the stability of such systems.

Few studies have examined the influence of the type III functional response on ecosystem stability. Existing studies assess situations in which the omnivore chooses among food items according to optimal foraging considerations. These considerations are irrelevant where the organism feeds on food items differing in composition that cannot be easily compared, as in true omnivory where both plants and animals are consumed. The research presented here studies the effect of a type III functional response on omnivore population dynamics when the searching efficiency is dependent upon prey population density. In addition, the study addresses the influence of sexual dimorphism in functional response on the stability of the omnivore/prey system.

The omnivorous bug *Orius laevigatus* feeds on pollen, small arthropods and insect eggs. Its functional response on *Helicoverpa armigera* eggs was determined in the laboratory in the presence of pollen, in which case the bug behaves as an omnivore, and in the absence of pollen, where it acts as a predator. Four cases were examined: the number of eggs predated in 24 hours by male and by female *Orius* in the presence of pollen (henceforth "omnivory"), and in its absence (henceforth "carnivory").

## II

Polynomials were used to describe searching efficiency (parameter "a" of the type II functional response) as a function of prey density. These expressions provide a good fit to the data describing the daily consumption of eggs by *Orius*. When searching efficiency is density-dependent, the various functional responses observed are of type III and express decision-making by the bug as to prey searching behavior, both in the case of omnivory and in the case of carnivory. The decision-making process is measured empirically, excluding theoretical assumptions such as optimal foraging. The various functional responses were placed in equations describing the population dynamics of the predator/omnivore (the bug) and the prey (eggs). Plant dynamics were not studied, as the model assumed an unlimited supply.

The type III functional response was found to give a good representation of experimental data for both carnivory and omnivory. It was found that:

1. The type III response that fits the empirical data is not unique: there are several functions that represent different polynomial orders of searching efficiency ("a") with changes in prey density. The optimal solution can be reached only by obtaining additional empirical or theoretical data on the nature of the change in searching behavior. Among females in the carnivore setting, first, second and third order polynomials were found to represent the empirical data well, while in the omnivore setting only the third order polynomial provided a good fit.
2. The particular nature of the fitted functions (polynomials of different orders) has an important effect on the dynamics of the bug and its prey. This effect determines both the value of the equilibrium points and the stability of the system.
3. In the carnivore setting, the system proved stable in the first order polynomial of searching efficiency, while showing bounded periodic oscillations for second order, and instability for third order. In the omnivore state, there were no equilibrium points at all, and the system
- 4.

### III

5. was unstable. When the oscillating populations approach zero, the predator will reach extinction before its prey in the carnivore state. The opposite is true in the omnivore state.
6. The functional response displayed sexual dimorphism in both omnivore and carnivore states. The sexes differed not only in the number of eggs consumed, but in the shape of the functions caused by polynomial fits of searching efficiency, as well. These differences may improve stability in the omnivore state. Oscillations in sex ratio measured in the field were usually found to enhance the instability of the system.