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What Is the Oviposition Decision Rule by Bean Weevil, *Callosobruchus maculatus*?

Shwu-Bin Horng

Department of Plant Pathology and Entomology, National Taiwan University, Taipei, Taiwan 106, R.O.C.

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Shwu-Bin Horng (1994) What is the oviposition decision rule by bean weevil, *Callosobruchus maculatus*? *Zoological Studies* **33**(4): 278-286. The oviposition decision of the female bean weevil is assumed to minimize the effects of larval competition and to maximize her lifetime fitness. A dynamic, stochastic model is proposed for bean weevil oviposition behavior analysis in terms of fitness maximization. The behavioral processes of the optimal females with varied levels of larval competition and females using other strategies (one absolute and two relative rules selected here) were simulated with the Monte Carlo simulation. The accepting probability of beans with varied egg loads, and the cumulative number of eggs laid by females using distinct strategies were compared. Lifetime fitness was used to analyse the effect of natural selection on the oviposition behavior of bean weevil. The real rule used by the bean weevil can be explored by comparing experimental data with this information.

Key words: Dynamic programming, Simulation.

The larvae of many bruchid beetles make no choices; they must feed, grow, and mature in a bean that was selected for them by their mother. If larval survival is affected by the size and quality of beans, selective pressures favor females that discriminate among beans and avoid overloading a bean (Mitchell 1975). For granivorous insects such as the bean weevil, *Callosobruchus maculatus*, a single ovipositing female maximizes her fitness by dispersing her eggs over the available seeds thereby minimizing the effects of larval competition between her offspring.

The oviposition behavior of this insect has been studied extensively; many reports have shown that the female can accurately assess the number of eggs on a seed and use this information to produce a near uniform distribution of egg loads (Utida 1943, Mitchell 1975, Messina and Renwick 1985, Credland et al. 1986, Wilson 1988). Although the cues controlling oviposition decisions include the number of eggs per bean that are discriminated accurately, there are still insufficient data to deduce how such information might be processed.

Mitchell (1975) proposed a simple digital model for release of oviposition behavior if a bean carries fewer eggs than the previous bean encountered. Wilson (1988) distinguished models based on fixed oviposition response (absolute models) from relative models in which cue interpretation based on past experience release oviposition behavior. He also proposed five sub-models. Absolute model A involves digital processing: an egg is added to beans with no eggs and the probability of laying an egg on a bean with eggs is 0.25. The probability of oviposition in Model B is the exponent of the negative number of eggs per bean. His relative models (C-E) call for oviposition decisions to be based on the relations between two of three measures, the measures being the number of beans visited, the number of beans encountered with no eggs on the bean, and the total number of eggs encountered.

There are two criteria according to which we can assess the correctness of these oviposition models. The model must generate egg dispersions resembling the observed dispersion, and the behavior of the beetle must correspond to expectations of the model (Mitchell 1990). Some of Wilson's models do not generate a uniform egg distribution, and as all strains are biased toward