

This Week's Citation Classic®

Scriber J M & Slansky F, Jr. The nutritional ecology of immature insects. *Annu. Rev. Entomol.* 26:183-211, 1981. [Department of Entomology, University of Wisconsin, Madison, WI]

This review attempts to expand the fields of insect dietetics, physiology, and toxicology to include consideration of numerous additional biotic and abiotic variables affecting the evolution of "life history" patterns among insects. While phytochemicals, temperature, and other factors were assessed, the fundamental importance of nutrients for insect growth performance was conveniently indexed by water and nitrogen content of insect food and held up well for phytophagous insects and most other guilds. [The SC² indicates that this paper has been cited in more than 340 publications.]

Nutritional Ecology and Evolutionary Entomology

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Our graduate student research on the comparative nutritional ecology of various foliage-feeding Lepidoptera led us to hypothesize that the nutritional quality of insects of various taxonomic groups and functional guilds would be of fundamental significance in determining their consumption rates, feeding efficiencies, growth rates, and life history "strategies." When asked to prepare an *Annual Review of Entomology* paper, we therefore took advantage of the opportunity to test some of our hypotheses with the data available from the literature. It soon became evident that, as with the phytophagous Lepidoptera, the peak efficiencies and growth rates of other leaf-feeding insects were also indexed well by the nitrogen and water content of their food. To a large extent this was also true for other guilds (e.g., phloem-feeders, fruit-feeders, wood-borers, detritivores, pollen-feeders, insect parasites, predators, etc.).¹

Our frustration with the 30-page limit led us to publish additional literature summaries in a microfiche supplement and elsewhere.^{1,3}

The relative importance of host plant (or animal) nutritional quality, allelochemicals, degree of feeding specialization, sex, temperature, pho-

toperiod, and other biotic and abiotic factors to the ecology of immature insects has remained central to the fields of insect/plant interactions, chemical ecology, plant breeding for insect resistance and tri-trophic level dynamics, and is of significance in understanding insect adaptations from a behavioral, physiological, toxicological, and genetic perspective. In our opinion, this fundamental position of "nutritional ecology" at the foundation of several fields of research is likely to explain the relatively high level of citation that our paper has received.

While initially viewed as a frustrating source of variation in assessing the genetically based adaptive value of feeding specialization, it is ironic that once again the nutritional value of the host plant itself has come to be the focus of a new concept to help explain host-plant specialization: the voltinism/suitability hypothesis.⁴ This hypothesis is predicated on the assumption that ovipositing adults discriminate between plants of different nutritional suitability and are more specific at choosing the "best" hosts for rapid growth at latitudes/altitudes where seasonal thermal unit accumulations allow completion of the generation only on such hosts. At those key locations, choice of the poor hosts would not permit adequate development before unfavorable weather conditions (i.e., winter or leaf "fall") arrived. Once again life-history adaptations of the insect (host plant specialization and voltinism patterns) appeared to be shaped in a major way by interactions of both biotic (nutritionally variable plant leaves and natural enemies) and abiotic (thermal unit accumulations) environmental factors. This is an example of what we meant when we developed the term "nutritional ecology" for immature insects.⁵

The significance of plant chemistry as a defense against insects has its roots in plant breeding for insect resistance before the field of "chemical ecology" evolved. This combination of basic and applied significance for insect feeding (and nutritional) ecology is reflected by a 10-fold increase in publications dealing with insect/plant interactions from the early 1970s to the present.⁶ We still would greatly benefit from a better synthesis among the actively expanding and yet relatively independent disciplines of entomology, evolutionary ecology, phytochemistry, phytopathology, population dynamics, microbiology, and molecular genetics as they relate to insect nutritional ecology.

1. Slansky F, Jr. & Scriber J M. Food consumption and utilization. (Kerkut G A & Gilbert L I, eds.) *Comprehensive insect physiology, biochemistry, and pharmacology*. Volume 4. Oxford, England: Pergamon Press, 1985. p. 87-163.

2. -----, Selected bibliography and summary of quantitative food utilization by immature insects. *Bull. Entomol. Soc. Amer.* 28:43-55, 1982.

3. Slansky F, Jr. & Rodriguez J G, eds. *Nutritional ecology of insects, mites, spiders and related invertebrates*. New York: Wiley, 1987. 1,016 p.

4. Scriber J M & Lederhouse R C. The thermal environment as a resource dictating geographic patterns of feeding specialization of insect herbivores. (Hunter M R, Ohgushi T & Price P W, eds.) *Effects of resource distribution on animal-plant interactions*. New York: Academic Press, 1992. p. 429-66.

5. Scriber J M & Ayres M P. Leaf chemistry as a defense against insects. *ISI Atlas Sci.—Anim. Plant Sci.* 1:117-23, 1988.

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