

Waldbauer G P. The consumption and utilization of food by insects.  
*Advan. Insect Physiol.* 5:229-88, 1968.  
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This paper reviewed quantitative studies of the consumption, assimilation, and conversion to body mass of food by insects; presented a critical discussion of methods; and suggested a coherent and physiologically appropriate terminology for expressing measures of food utilization. [The SCI® indicates that this paper has been cited over 205 times since 1968.]

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"The dissertation that I did at the University of Illinois with Gottfried Fraenkel led to my interest in quantitative nutrition. In a famous paper,<sup>1</sup> a foundation of current co-evolutionary theory, Fraenkel had shown that the food plant range of insects is determined by taxonomically restricted, non-nutrient, plant chemicals. He had also proposed that an insect would grow equally well on any plant species if it could only be induced to feed sufficiently. In retrospect, this is an overstatement, but it seemed reasonable then, and we decided to test it. I eventually found that tobacco hornworms will, after the excision of certain chemosensilla, eat some plants that they normally reject.<sup>2</sup> They grew well on some of these plants but not on others. We thought that the latter plants might simply contain more indigestible cellulose. This led to a quanti-

tative study of food consumption, assimilation, and conversion to body mass.

"At that time, most work on insect nutrition was quantitative only in that the composition of defined diets was known and survival and growth rates were measured. Intake and output were seldom measured.<sup>3</sup> The methodology for quantitative studies with insects was in disarray; a physiologically inappropriate terminology had been borrowed from mammalian nutrition. I kept what was useful and devised a few new methods and terms, using the resulting system to show that differences in food plant quality are not always due to differences in digestibility.

"The review on quantitative insect nutrition was written a few years later. I appraised the sparse literature, presented a lengthy and highly critical discussion of methods, and suggested a coherent terminology. These 'terms' are really indices that express the rates of feeding and growth and the proportions of consumed food that are assimilated and converted to body mass. The abbreviations for these indices, intended as mnemonics, have been criticized, apparently because they don't look very mathematical. However, they have been widely adopted and adapted, no doubt because I am not the only one who has trouble remembering arbitrary symbols.

"My review has been cited as a compilation of data and, occasionally, as the source of an idea, but it is most often cited for methods and terminology. It has been useful to agricultural entomologists and some insect nutritionists. However, as is apparent from the recent review by Scriber and Slansky,<sup>4</sup> it is most often used by ecologists who are interested in the co-evolutionary relationships of plants and insects."

1. Fraenkel G. The raison d'être of secondary plant substances. *Science* 129:1466-70, 1959.
2. Waldbauer G P & Fraenkel G. Feeding on normally rejected plants by maxillectomized larvae of the tobacco hornworm, *Protoparce sexta* (Lepidoptera: Sphingidae). *Ann. Entomol. Soc. Amer.* 54:477-85, 1961.
3. Gordon H T. Minimal nutritional requirements of the German roach, *Blattella germanica* L. *Ann. NY Acad. Sci.* 77:290-351, 1959.
4. Scriber J M & Slansky F, Jr. The nutritional ecology of immature insects. *Annu. Rev. Entomol.* 26:183-211, 1981.