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This Week's Citation Classic™

Golley F B. Energy values of ecological materials. *Ecology* **42**:581-4, 1961.
[AEC, Savannah River Project, Univ. Georgia, Athens, GA]

An analysis of the energy content of a variety of plant and animal tissues demonstrated that the caloric value of a taxon was not constant but rather was strongly affected by environmental conditions. [The *SCI*® indicates that this paper has been cited in over 180 publications since 1961.]

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"In the late 1950s and early 1960s, ecological energetics became popular, although the initial studies had appeared much earlier (for example, Juday[1]). The basic idea was to measure the energy input, storage, and output of populations and communities, which, according to thermodynamic law, should balance. Inequalities revealed error or inadequate analysis. While these ideas seem deceptively simple now, at the time they were exceedingly stimulating because they allowed ecology to be more predictive.

"I had the opportunity to contribute to ecological energetics as a graduate student with D.W. Hayne at Michigan State University. One step in research on a grass-mouse-weasel food chain was to determine the energy content in the different materials. I was fortunate to have the use of an adiabatic oxygen bomb calorimeter in the human nutrition laboratory of the School of Home Economics for these determinations. At the same time, the group with E.P. Odum at the University of Georgia was also measuring energy in materials using similar techniques. L. Slobodkin, in contrast, was operating a specially constructed machine at the University of Michigan. Calorimetry at that time was a rather unconventional technique for ecologists. It was expensive, laborious, and time-consuming, and therefore, it was a limiting factor in the growth of energy flow studies.

"These experiences led me to the idea that a summary table of energy contents might allow ecologists to make energy analyses without doing calorimetry. I compiled and distributed a list of energy values based on several hundred plant and animal samples.[2] Cummins and Wuycheck[3] have since expanded this list.

"The data set contained some surprisingly large variations in energy level of tissues and organisms and I was motivated to look for patterns which would be useful to field ecologists. After all, the really difficult task in energy analysis was to monitor individuals through different weather conditions, seasons, and years in the field. From this perspective, I used the list of energy values to establish general values for ecological materials and then tested the effect of season, plant part, and taxon on energy content and published the results in the paper cited here.

"My paper and that of Slobodkin[4] showed that the energy value of an organism is a variable and that ecologists have to directly measure energy content if they want to understand the interaction of the organism and the environment through energy flow analysis. I'm not sure what impact these papers had, but calorimeters eventually became a common ecological tool. I suspect that the frequency of citation of this paper reflects a need other than the scientific finding it reported. Many ecologists concerned with theoretical questions require general energy values. For example, in the study of foraging strategy it might be necessary to know the energy value of seeds and insects. For these studies, general values serve a legitimate purpose and are widely used. Many authors citing my paper have used it as a source of such values."

1. **Juday C.** The annual energy budget of an inland lake. *Ecology* **21**:438-50, 1940.
2. **Golley F B.** *Table of caloric equivalents.* Athens, GA: Department of Zoology, University of Georgia, 1959. 7 p.
3. **Cummins K W & Wuycheck J C.** Caloric equivalents for investigations in ecological energetics. *Mitt. Int. Ver. Theor. Angew. Limnol.* **18**:1-158, 1971. (Cited 215 times.)
4. **Slobodkin L B.** Preliminary ideas for a predictive theory of ecology. *Amer. Naturalist* **95**:147-53, 1961. (Cited 15 times.)

