

# Resolution of Respect

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## Howard Thomas Odum

(1924–2002)

Atmosphere, Benthos, Canopy, Diversity, Emergy with an “m”: this list could wend through the entire alphabet of ecology and not exhaust the breadth of some 300 publications by Howard Thomas Odum over the past 57 years. How many ecologists have delved substantively into freshwater, marine, and terrestrial environments, publishing landmark papers on each? Although he is known by today’s generation primarily as one profoundly involved in his unique brand of ecological economics, H. T. Odum’s deep roots in ecological science merit examination, revealing his appreciation for organism–environment interactions and the larger systems of which human society is but a part.

His first papers, published before graduate school, dealt with bird migration and navigation (Odum 1947, 1948). World War II interrupted his undergraduate education and he soon gained a solid foundation in abiotic sciences courtesy of the U.S. Army. As a junior officer, he received training in meteorology, which led to presidential recognition when he developed a system for predicting the formation of hurricanes in the Atlantic. After the war, he completed his B.S. in zoology (Phi Beta Kappa, University of North Carolina–Chapel Hill) and moved to Yale for doctoral work under G. Evelyn Hutchinson. His studies in New Haven included a heavy dose of geology and geochemistry, as he unraveled the global strontium cycle. His dissertation was something of a harbinger, involving details of strontium uptake and kinetics at the organism level, as well as a global perspective: strontium-containing sediments were compressed, subsided, and churned into the crust, eventually to reappear upon uplift and volcanism (Odum 1951). He had a trait common to many Hutchinson students of being able to focus simultaneously on the fine detail and the big picture, both temporally and spatially, without losing sight of either.



H. T. Odum’s first faculty position was at the University of Florida, where he received a grant of \$20,000 for a four-year study of energy and material flows. This was in the early 1950s, and an ecosystem perspective was just beginning to trickle into ecology. He chose freshwater springs as his study system, and the choice proved sound: relatively constant oxygen, geochemistry, temperature, and clarity; readily measured flow rates; rooted, therefore easy to census, producers; easily identified boundaries and inputs; relatively large and taxonomically known consumers; and biogeochemically important microorganisms that formed stationary, identifiable mats. The results of his monograph on Silver Springs (Odum 1957) are still widely cited in textbooks to illustrate energy and material flows in an ecosystem.

Another hallmark of his early appointment at Florida was the work that he and his brother Eugene P. Odum conducted on Enewetak Atoll, in the Marshall Islands (Odum and Odum 1955). That study of reef metabolism

led to their joint receipt of the Mercer Award in 1955.

Those early years at Florida were spent doing more than fieldwork. It was here that H. T. Odum collaborated with an engineer, Richard Pinkerton (whose own career was shortened by an early death). Together they wrote the paper that became one of Odum’s greatest legacies: more than any other theme, the theory of maximum power (Odum and Pinkerton 1955), remained central to his thinking throughout his career. Although he invariably shared credit for the theory with Pinkerton, Alfred Lotka, and Ludwig von Bertalanffy, a careful reading of the literature reveals that the contribution was quintessential H. T. Odum.

After that initial stint in Florida, H. T. Odum’s academic odyssey took him to Duke University (1955–1957), where he continued his research on aquatic ecosystems, perfecting approaches for estimating whole-system photosynthesis and respiration using microcosms, mesocosms, small streams, ponds, and estuarine embayments. From there he

moved to the University of Texas (in 1957) as director of its Institute of Marine Sciences at Port Aransas. Capitalizing on the metabolic work on flowing waters that he had conducted in Florida, North Carolina, and the Pacific, he continued to focus on whole systems, this time in the Gulf of Mexico. By now well known for his willingness to tackle large-scale ecological assessments, it was here that he enticed the military to provide a helicopter to deploy a huge drop net over the Gulf, a fish-censusing feat that has never been repeated (Jones et al. 1963). Many of his most important contributions during this period were published in the *Proceedings of the Institute of Marine Sciences*, including studies of bay metabolism (e.g., Odum and Hoskin 1958, Odum et al. 1963) as well as innovative perspectives on the relationships among light intensity, productivity, and chlorophyll density (Odum et al. 1958).

From Texas he migrated in 1963 to the University of Puerto Rico and the Puerto Rico Nuclear Center. The draw was funding for an unprecedented study of a tropical rain forest, ostensibly to assess the consequences of exposing a complex ecosystem to a stress (in this case, radiation from a cesium source), but more importantly, the unparalleled opportunity to know a rain forest structurally and functionally to a level of detail never before attempted. Marshaling dozens of collaborators, over the next four years he and his co-workers looked at nearly every ecological variable in that rain forest. It is not surprising that large-scale ecosystem metabolism was again part of the plan; this time he constructed a giant, open-topped cylinder to enclose a sizable chunk of rain forest. Participants had to agree to withhold publication for a summary volume (Odum and Pigeon 1970). Thirty-two years later, that award-winning tome, weighing in at 4.6 kg and some 1660 pages, is still the authoritative reference on the world's best studied rain forest.

After Puerto Rico, it was back to the mainland (in 1966) and the University of North Carolina—Chapel Hill, his place of birth (in 1924). This was an exciting time for ecology: environmental awareness permeated our society as never before. As part of an interdis-

iplinary group of scholars who ran a graduate program in ecology, H. T. Odum held appointments in three departments: zoology, botany, and environmental sciences and engineering. Two research topics received considerable attention while he was in Chapel Hill. One was ecosystem self-design, a topic he and his students explored using a variety of microcosms and species-enrichment experiments, including a snail-like tank that had flowing water and a nutrient source at its center (thus creating a fertility continuum), and was heavily seeded with all manner of organisms (Beyers and Odum 1993). The other was computer simulation of relatively simple but insight-yielding mini-models, crafted after real-world systems and based upon the energy flow symbol set that he developed and used throughout his career.

Howard T. Odum was a staunch patriot (but never subject to political manipulation), and although he was heavily engaged in teaching, writing, and research during his tenure at UNC and beyond, he also served his country generously. He tried to bring reason and science to some of the emotional debates surrounding the aftermath of the Viet Nam war, for example. As a member of a blue-ribbon team appointed to address the ecological consequences of herbicide use by the military in the mangroves of Viet Nam, he looked forward, focusing on recovery, rather than backward, focusing on damage. He also served proudly as a member of President Lyndon Johnson's Panel on World Food Supply, which led to a long, insightful paper on the energetics of food production systems (Odum 1967).

In 1970, like the migratory birds and the strontium with which he began, H. T. Odum returned to his starting place and accepted a Graduate Research Professorship in the Department of Environmental Engineering Sciences at the University of Florida, thus closing his academic circuit. Having already held five other faculty positions, it seems remarkable that he spent the next 32 years at Florida—longer than the single-institution career of most scholars. Still engaged in ecological research, but increasingly attentive to problems of immediate relevance to society, he assembled a team to examine the use of

cypress swamps as natural treatment plants for sewage (Ewel and Odum 1985). He also headed a major analysis of the South Florida ecological crisis, a quarter of a century before Congress allocated billions in its attempt to remedy the situation. While at Florida, he founded the university's Center for Wetlands and its Center for Environmental Policy.

During the second half of H. T. Odum's career, he devoted an increasing proportion of his efforts to broader issues of society and nature, addressing the topic primarily through his own brand of ecological economics, based upon the true energy costs of policies and practices (e.g., Odum 1988, 1996). Feeling the need to express his ideas fully, he published less in the traditional peer-reviewed journals, while writing more books—some 15 at last count. It was, in part, because of their devotion and contributions to the big issues of society and nature that the brothers H. T. and E. P. Odum shared two major international awards: the Prix de la Vie (in 1976), and the Crafoord Prize (in 1987). The jury is still out on the central concept to which H. T. Odum was most wedded in recent years—his emergy analysis—but whether or not it becomes the standard currency, the amount of creative thought that went into its development must instill admiration in all.

Howard T. Odum was exceptionally fortunate to have been accompanied through his adult life by four tremendously supportive women. Virginia, whom he married in 1947, was a student of English literature and the mother of their two daughters, Anne Odum (of Gainesville) and Mary Logan (of Anchorage, Alaska). Virginia died in 1973. In 1974, Howard T. and Elisabeth C. Odum partnered in marriage and in careers that were to last for the rest of his life, which ended on 11 September 2002, at age 78. Betty, a frequent co-author with H. T., capitalized on her background in education to make ecological systems concepts accessible to a broad audience, including schoolchildren.

In addition to the three awards shared with Gene and mentioned previously, H. T. Odum received formal recognition for distinguished service

from several institutions: University of North Carolina–Chapel Hill, American Institute of Biological Sciences, University of Florida (the Presidential Medallion), and University of Puerto Rico; he was awarded an Honorary Doctorate of Science from Ohio State University. Howard T. Odum was an elected member of the Swedish Royal Academy of Science. He was very proud and extremely respectful of these honors, although he was modest about touting them. Perhaps he would not mind being remembered as well for the fact that he could identify any seashell found on a North American beach, or any songbird spotted in eastern North America; that he was firmly and invariably committed to helping the underdog; and that he never compromised his principles, even when doing so might have led to increased acceptance of his oft-controversial concepts by colleagues. In that regard, he was unwavering.

It might well be said of Howard T. Odum that his ideas suffered inordinately for being far ahead of their time. Today's mainstream paradigm or methodology was often his outrageous suggestion of yesteryear: whole-system metabolism, biodiversity and ecosystem functioning, net energy, ecosystem services, emerging ecosystems, understanding nature through mesocosms and microcosms, carbon sequestration, fossil energy as a driver in international relations, ecosystem self-design, implications of aggregations of organisms and materials, power output, nonindigenous species, steady-state economics, adaptive management...this list could go on and on. His were the kinds of original, prescient thoughts and contributions that someday will capture the attention of a keen historian: "Look at this stuff, written way back in the 20th century!" Some have examined pieces of this complex, kind, original, jigsaw puzzle of a scholar (see a partial list, below *Literature cited*), but the definitive biography has not yet been produced. H. T. Odum changed the world view of many, including hundreds of ecologists. How happy he would be if we heeded his typically optimistic ad-

monishment to follow the prosperous way down (Odum and Odum 2000).

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