

## What Makes an Ecological Icon?

A symposium organized by Aaron Ellison (Harvard Forest) and Paul Dayton (Scripps), at the 91st ESA Annual Meeting at Memphis, Tennessee, August 2006.

Progress in science occurs as new theories are developed and subsequently revised in light of empirical data that challenge hypotheses derived from the theories. Scientific theories and hypotheses are developed, and data are collected, *by individuals* (and collaborative groups); their ideas and results are disseminated to the broader community in publications, both technical and non-technical. Some of these individuals become icons; their work is well known and they achieve recognition for their substantive contributions through extensive citation of their published work. Others are cited rarely, if ever, and they fade into obscurity. At a time when the availability of academic jobs continues to decline, while the number of new Ph.Ds in ecology continues to increase and the Annual Meetings of the Ecological Society of America (ESA) take on the aura of a job fair *cum* meat market, it seemed timely to ask why some ecologists achieve iconic status for their work, but others are quickly forgotten, even if the latter published the same ideas or data before the former. Further, losing the historical context for our work, and the disappearance from contemporary literature of carefully garnered data and results, can lead to unnecessary repetition of research, slowing progress in the field and wasting scarce resources.

In the symposium, “What makes an ecological icon?” a group of seven ecologists and historians discussed individuals—some well known, some forgotten—who made substantive contributions to the development of fundamental ideas in ecology, including the following: the concept of food webs; invasive species and community assembly; the ecosystem concept; nonequilibrium dynamics; and the



Charles Elton setting mouse traps in Bagley Wood, near Oxford, in 1926.

Fig. 1. Charles Elton (1926). Photo used with permission.

value of conservation and preservation. Both during their formal presentations and in the lengthy discussion following the symposium, the speakers also addressed how current norms of scholarship and publication, and mechanics of web-based literature searches and journal-imposed rules for citations inadvertently encourage contemporary researchers to ignore historical antecedents and duplicate past work.

Food webs and invasive species are central topics around which much of contemporary community ecology revolves. Models of how complex networks are structured have reinvigorated theoretical investigations of food web structure (e.g., Pascual and Dunne 2006), and the increasing rates of spread of nonindigenous species provide unfortunate opportunities to empirically test these models as food webs are restructured following novel introductions. If asked, most ecologists would trace the origin of food web theory and studies of invasive species to Charles Elton (Fig. 1). His “food cycle” of Bear Island (Summerhays and Elton 1923: Fig. 2) was reprinted in his 1927

text *Animal Ecology*. It was subsequently reproduced widely and is often held up as the first food web, although it is pre-dated by similarly illustrative diagrams published by Pierce et al. (1912) and Shelford (1913), among others. Elton's other influential book, *The Ecology of Invasions by Animals and Plants* (Elton 1958) is generally considered to ground most contemporary research into the causes of successful species introductions and the impacts of invasive species. But both food web ecology and invasion biology have deeper roots.

Frank Egerton (Fig. 3), a historian of science whose articles on the History of Ecology have been appearing in nearly every issue of the *ESA Bulletin* since 2001, traced the development of the food web concept back to the early 18th century and the writing of naturalist Richard Bradley (1718, Part 3:60-61)

... Insects which prey upon others are not without some others of lesser Rank to feed upon them likewise, and so to Infinity; [that] there are Beings subsisting which are not commonly visible may be easily demonstrated...in a Microscope.

This concept was popularized by Jonathan Swift (1733: lines 341-344):

So, Nat'ralists observe, a Flea  
Hath smaller Fleas that on him prey,  
And these have smaller yet to bite 'em,  
And so proceed *ad infinitum*.

Jonathan Fisher, a fifth-year graduate student at the University of Pennsylvania, illustrated more quantitative antecedents to food web research, including an extended discussion of the work of Harold Colton (Fig. 4), a student at Penn in the early 20th century, and a faculty member there until 1926. Colton was a founding member of the ESA (ESA 1972) and authored a paper on competition and predation in the rocky intertidal (Colton 1916) that covers much the same ground

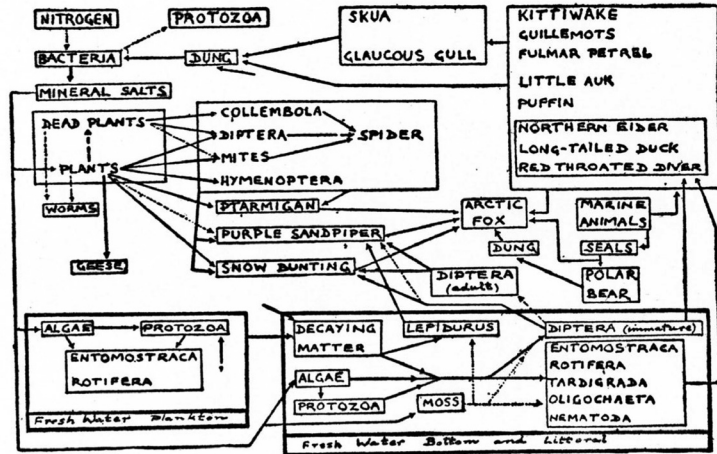


FIG. 4.—Food-cycle among the animals on Bear Island, a barren spot in the arctic zone, south of Spitsbergen. (The dotted lines represent probable food relations not yet proved.) The best way to read the diagram is to start at “marine animals” and follow the arrows. (From Summerhayes and Elton.<sup>21</sup>)

Fig. 2. Elton's “food cycle”. From S.V. Summerhays and C.S. Elton (1923).



Fig. 3. Frank Egerton. Photo by Liana J. Cooper (c) The Journal Times (Racine, WI), and used with permission.



Fig. 4. H. S. Colton (ca. 1916) from the Museum of Northern Arizona collection (No. 7422). Reprinted with permission.

as more well-known icons of the intertidal (e.g., Menge and Sutherland 1976; see the comprehensive review by Fisher 2005). An abstract of Colton's paper was published in *Science* in 1916, and many of his other papers on intertidal biology were widely cited. In modern times, he is better remembered for his archaeological research in the desert southwest (Miller 1991). His work on intertidal food webs, however, is generally forgotten

Colton's work is particularly intriguing because his food web lacks the European green crab, *Carcinus maenas*, which is now an invasive species in Maine where Colton studied (as well as elsewhere in the United States); trawling the historical literature could provide crucial data that can be used to provide baselines from which to assess the impacts of other current invasions. Jim Carlton, Director of the Williams-Mystic Maritime Studies Program (Williams College and Mystic Seaport) discussed how the baseline requirements of successful invasion—including entrainment, transport, and spread of species during emigration; discharge, survivorship, reproduction, and establishment during immigration—the unification of which in “invasion biology” is attributed to Elton (1958), can all be found in earlier books, notably those by Guthrie-Smith (1921), Clark (1949), and Lindroth (1957).

Although Elton's book is generally considered a foundational text, Carlton illustrated that it was really a selective set of case studies (neither Guthrie-Smith's, Clark's, nor Lindroth's work was even cited by Elton). It was well received because unlike the others, it was short, well-written, and appeared at a time when concern about environmental change was taking off. Elton also popularized his work through radio broadcasts, popular writings, and public lectures. While our results and theories will be more accessible and widely read if our papers are written clearly and concisely, an unfortunate lesson of Carlton's talk is that selective citation and incessant self-promotion can lead to iconic status, whether or not it is well deserved.

Important work by notable ecological icons may also be forgotten. G. Evelyn Hutchinson (Fig. 5) is well known to ecologists; the niche as  $n$ -dimensional hypervolume (Hutchinson 1957) and constant size-ratios among competitors (Hutchinson 1959) laid the foundation for a vast amount of ecological research in the 1960s and 1970s that was focused on equilibrium dynamics (both papers were reprinted in Real and Brown's *Foundations of Ecology* collection [1991]). Saran Twombly, a program director at NSF and Hutchinson's last graduate student, explored in detail the roots of *nonequilibrium* theory in Hutchinson's work (especially Hutchinson 1953). This work is virtually unknown to contemporary ecologists, although tests of Hutchinson's nonequilibrium theories pervade the limnological literature (e.g., Reynolds 1980/1984, Sommer 1985). Hutchinson's relatively obscure style of writing (clearly evident in his 1978 textbook), his uninformative (to search engines) titles (e.g., Hutchinson 1957, 1959), and the tireless promotion by his students of equilibrium theory (e.g., MacArthur and Wilson 1967) together likely led to the disappearance of Hutchinson's nonequilibrium ideas from the general ecological literature.

Another example can be found in the life and work of Victor Shelford (Fig. 6). Shelford, whose early work on food webs (1913) was discussed above, was the Founding President (1916) of the ESA. Less well known among ecologists is his role 30 years later in

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the founding of The Nature Conservancy (TNC), a role that is now recognized by TNC's Victor Shelford Award for Science in Conservation (ironically restricted to past or current TNC employees). Sara Tjossem, a historian of science at Columbia University, reviewed Shelford's career and highlighted the origins of the (still ongoing) tensions within the ESA membership between "basic" ecological science and environmental advocacy. As ESA President, Shelford established (and chaired) a committee on preservation, to carry out an ecological resource inventory of the U.S., and to initiate and carry out action concerned with the preservation of hundreds of natural areas. Part of his motivation was to preserve areas in undisturbed condition as benchmarks for future ecological research. But by the 1930s, the leadership of the ESA had focused the Society's activities on basic research and removed both political and financial support from environmental advocacy and land protection. In response, Shelford founded the Ecologist's Union (1946), which was reorganized and renamed in 1950 as The Nature Conservancy.

One of Shelford's students was Eugene Odum, who along with his younger brother Howard (Tom) Odum (a Hutchinson student) are considered the founders of ecosystem ecology, the roots of which can also be traced to Hutchinson's student Ray Lindeman's (1942) paper on food webs! Historian Joel Hagen (Radford University) delved into the personalities of the Odum brothers, exploring the cultural and scientific context and timeline of their most influential work, which was in many ways a progressive response to the coincident ascendancy of rampant individualism in America (exemplified by the work of Ayn Rand [1965], Barry Commoner [1966] and the presidency of Ronald Reagan) and of reductionism in ecology (e.g., Williams [1966] and Dawkins [1976]). Hagen has explored the conceptual roots of ecosystem ecology elsewhere (Hagen 1992); in his symposium presentation he argued that the Odum brother's broader ideas—of emergy, holism, and social progressivism—have been lost to ecosystems ecology, which focuses more narrowly on cycling of nutrients and energy. Hagen further argued that the ecosystem concept remains marginalized within ecology as a whole. Although many ecologists



Fig. 5. G. Evelyn Hutchinson as a student in 1920 collecting the meadow spittlebug, *Philaenus spumarius*, Cherryhinton Chalk Rt, Cambridge. Both this photo and that of Elton (Fig. 1) attest to the decline in the quality of ecologists' attire since the early 20th century! Photograph from the G. Evelyn Hutchinson Papers, image 6290; Manuscripts and Archives, Yale University Library, used with permission.

may dispute this point, the relatively low number of papers on "ecosystem ecology" published in the ESA journals and the continued split between "population and community" ecology and "ecosystems" ecology by federal funding agencies lend credence to Hagen's argument.

So why are some individuals remembered while others are forgotten? Why are some contributions rapidly catapulted into widely cited paradigms while



Fig. 6. Victor Shelford (1940).

others remain buried and unread in the pages of our journals? Should current upstarts aspire to iconic status? In his wide-ranging talk, Paul Dayton explored these central questions of the symposium by peering through the lenses of norms of scholarship, the peer review process, and dynamics of citation. A central nugget, attributable to Lamarck (1984 [1809]:404), is that

Men who strive in their works to push back the limits of human knowledge know well that it is not enough to discover and prove a useful truth previously unknown, but that it is necessary also to be able to propagate it and get it recognized.

This sentiment is encapsulated in the well-known maxim, “publish or perish” (which, given the overwhelming flood of literature, would be more aptly

stated, “keep publishing or vanish”). But as we have seen, publishing is clearly not enough; others must read what we write and cite it. Scholarship demands that the burden of reading the literature is on each scientist, but reading is also not enough. We not only read the literature, but in our choices of citations, we propagate some ideas and prune others. With a metaphor that would be familiar to most ecologists, David Hull (1988:376–377) suggested that

If science is a selection process, transmission is necessary. Disseminators are operative in this process. Perhaps they do not get the ceremonial citations that patron saints do, but they are liable to get much more in the way of substantive citations. . . . To the extent that disseminators substitute their own views for the patron saints whom they cite ceremoniously, they are functioning as germ-line parasites—the cowbirds of science.

(This parasitism process is modeled quantitatively by the economists Myong-Hun Chang and Joseph Harrington [2006], using analysis of social networks that are similar to methods being independently developed and used by food-web ecologists [see papers in Pascual and Dunne 2006]. How can we (or should we) reduce the influence of these cowbirds?)

New articles in ecology are being published at an ever-increasing rate. More and more, we rely on title and keyword searching of electronic indices and tertiary reviews (such as those found in *Trends in Ecology and Evolution* or *Annual Reviews of Ecology, Evolution, and Systematics*) to keep abreast of the literature in our ever-narrowing subdisciplines. Even the most extensive online databases, such as ISI’s Science Citation Index (Web of Science), do not cover all sources or the temporal span of modern ecology. Many journals, including outlets for new findings as well as review journals, limit the number of citations per article, discourage citing articles >10–15 years old, and/or encourage citation of articles published in the journal to which the paper is submitted (a strategy intended to increase a journal’s impact factor). All of these trends should be resisted. Journals that limit the number of

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citations per article usually provide options for on-line appendices, in which more extensive citations can, and should, be placed and discussed. Writers of reviews should make it known to journal editors, and especially our students, that ecology's roots extend back more than a decade. Impact factors are notoriously unreliable (Anonymous 2002), and we should neither concern ourselves with them nor encourage their use in making decisions about publication outlets, much less hiring decisions.

As Jonathan Fisher suggested, we should all try to resurrect unappreciated classics. This can be done by consciously using data from, and appropriately citing, relatively unknown but useful books and papers; try to cite one such paper in each article you write. As Fisher illustrated in his review of rocky intertidal ecology in the early 20th century (see also Fisher 2005), many of these may be in foreign languages, the reading of which poses a problem for students who no longer have to master a second language as part of their graduate education. These can be translated using Google Translate (<http://translate.google.com>), and if they are in the public domain (as most works >50 years old are), posted on the Web. At the same time, we should (re)read, and encourage our students to read, well-known classic papers, such as those in Real and Brown (1991). Ecologists know that current ecological processes and dynamics are controlled or constrained by land-use history and past ecological events (e.g., Foster and Aber 2004). Similarly, contemporary ecological thought is bounded and shaped by the work of individuals who have come before us. Ecologists would do well to remember George Santayana's oft-quoted aphorism, "[t]hose who cannot remember the past are condemned to repeat it" (Santayana 1905–1906:284). In times of rapid ecological and environmental change, we do not have the time or resources to continually repeat the good work that has already been done.

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- Aaron M. Ellison, Organizer  
Harvard University  
Harvard Forest  
Petersham, MA 01366 USA
-