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Why celebrate the death of Primitive Economic Man?: Human nutritional ecology in the 21st century

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ABSTRACT

Primitive Economic Man (PEM) paradigms have been popularly applied in economics, nutrition science, sociology, psychology, and anthropology to explain human behavior for two centuries. PEM contains two general assumptions: (1) that most humans make cost-benefit decisions to further their own personal economic or political condition; and (2) Darwinian selection favors these types of cost-benefit trade-offs; in other words, the children of selfish, cost-benefit oriented individuals differentially survive in greater frequencies through time. Regarding subsistence practices, the application of PEM paradigms has led to the development of a host of models to test whether Darwinian selection has acted upon human behavioral choices to favor those that lead to the maximum caloric intake possible relative to work effort. These models remain popular in archeology despite the fact that nutrition science falsified this assumption a century ago in 1915. This paper explores more specifically why PEM deserves a proper burial if we ever hope to fully understand and appreciate diachronic trends in human subsistence practices. At the same time, there are components to PEM paradigms that should become important pieces to broader, more holistically-based models of human dietary choices through time.

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> *The popular term "forager" is not only etymologically inappropriate, it calls up a model inconsistent with ethnographic data…, malapropos to a historical science of human behavior…, and inadequate even to describe the deer for which it was originally developed.*
>
> [Kehoe (1993)]

1. Introduction

Who was Primitive Economic Man, and why celebrate the 100th anniversary of his death? Answering these questions formed the basis for bringing together a diverse group of scholars during the 80th annual meeting of the Society for American Archaeology, held in 2015 in San Francisco. I recently traced the roots of the Primitive Economic Man interpretive framework from Antiquity to 1950 (Hockett, 2012). In that book chapter, I noted that there was a parallel in the development of the hypotheses that the efficient use of energy alone could serve as a primary proxy for explaining matters concerning human health and nutrition, as well as broader issues of decision-making by individuals in human societies. At least that was the case prior to the early 20th century. The nutrition sciences broke from this methodological perspective to explain human health and nutrition after falsifying the premise during the 2nd decade of the 20th century (e.g., McCollum and Davis, 1915), about the same time as many anthropologists (e.g., Kroeber, 1917; Malinowski, 1922) were also falsifying the premise as a primary explanation of decision-making in human societies. Interestingly, while the nutrition sciences abandoned the reductionism inherent in the Primitive Economic Man framework, and continued to develop new perspectives and ground-breaking research on human health and nutrition over the past century, other disciplines including archeology (e.g., White, 1959) and biology (e.g., Emlen, 1966; McArthur and Pianka, 1966) reverted back to reductionism and the Primitive Economic Man framework beginning in the 1950's. This pattern of relying on energy flow as the primary explanatory framework to interpret differences seen in the various archeological records of North America continues to the present day in some circles, despite an attempt in the 1970's to integrate new research on the importance of both macronutrients and micronutrients to human health and longevity with broader anthropologically-oriented questions of human decision-making (Underwood, 1975; Little and Morren, 1976). It is within this context that a number of researchers have suggested that studies of human behavior would benefit from new and innovative methods currently being developed under the general interpretive framework called nutritional ecology (Hockett and Haws, 2003, 2005; Raubenheimer and Simpson, 1997; Raubenheimer et al., 2009). The papers published in this *Special Issue* offer a variety of perspectives on interpreting human health and

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nutrition in human evolution and past societies, and how these studies may be applied to explaining diachronic trends in human decision-making.

2. Who was Primitive Economic Man?

Economic Man was a selfish, self-interested individual popularized in 1776 by Adam Smith as a means to showcase how economies could operate at an efficient and effective manner. According to Smith (1776/1963), individuals are better off in the long term if they seek to optimize their personal wealth in the most efficient manner possible without regard for the "public good". Societies at large, however, were also seen as the benefactors of selfish individualistic behavior by default, an unforeseen positive consequence guided by Smith's famous "invisible hand."

John Stuart Mill (1836, 1848) turned Smith's economic philosophy into a deductive heuristic model in the 4th decade of the 19th century to examine and explain the primary decision-making process of people living in western societies. This formalized a deductive approach to the study of economic activity in western societies that relied on reductionism through heuristic modeling to explore the "fit" between model and observed behavior. Mill believed that such an approach would illuminate the primary, but not sole, driving force behind human decision-making in western societies. Further efforts to create a mathematically-based, scientific approach to the study of economics led to increasingly reductionistic approaches after 1870 (Lodewijks, 2000).

The deductively-based and reductionistic model of Smith and Mill was dubbed "Economic Man" by John Kells Ingram (1888). And although ethnographic studies were conducted prior to the mid-19th century (Hodgen, 1964), anthropology as a science was also born in the 1870's within the throes of the development of "Economic Man" (e.g., Tylor, 1871; Morgan, 1877). In hindsight, it seems inevitable that the deductive, reductionistic, and progressive model that classified all human societies as savage, barbaric, or civilized would be combined with Economic Man modeling to inform how and why 'primitive' peoples behaved, including how and why ancient societies procured food resources. In the mid-19th century, heyday of European imperialism and its destruction of colonized societies, it was clear to many philosophers and scientists alike that many ancient savages and barbarians lived a relatively harsh life, always struggling to find a next meal. In addition, in the 1870's anthropology signed on to the belief that 'natural' and 'cultural' phenomenon could and should be studied by the same methods and models; in other words, the same laws that explained the nonliving world, such as the force of gravity or the attraction of objects to one another, should apply equally well to explaining human behavior (e.g., Helmholz, 1861; Tylor, 1871). It was out of this collective pool of thought that Primitive Economic Man was born within a framework that saw the efficient collection and use of energy, often through technological innovation, as the prime mover and shaker in the development of humanity within the newly formed field of evolutionary studies that highlighted a 'struggle' or 'competition' among individuals (e.g., Powell, 1888). Darwinian selection provided the final piece to the jigsaw puzzle — selection favors those individuals who optimize the efficient capture and use of free energy; in other words, selection favored Primitive Economic Man (see Hockett, 2012 for a review).

3. Primitive Economic Man as a natural law of the universe

Natural philosophers, psychologists, and anthropologists of the early to middle 20th century continued to study Primitive Economic Man as an organic extension of the natural order of the universe, relying on the hypothesis that the efficient capture of free energy, or least effort behaviors, were at the root of evolutionary success stories (e.g., Ostwald, 1910; Lotka, 1922, 1925, 1945; Wheeler, 1929; Gengerelli, 1930; Zipf, 1942, 1949; White, 1949, 1959). It is important to note, however, that other anthropologists of this time, including Alfred Kroeber (1917) and Bronislaw Malinowski (1922) warned against studying human behavior as an extension of physical laws that governed the inorganic world, and that doing so would ensure that an understanding of the social human would never be realized.

It is a rather simple matter to provide the formula that explains all human behavior of any consequence for those who continue to adhere to the tenet that the inorganic and organic worlds may be explained by the same mathematical principles (Fig. 1). Some may recognize this chart as a graphical representation of the Law of the Inverse Square.

$H_{behav} \sim 1/r^2$, where H_{behav} = Human behavior; ~ = proportional to; r = least action or least effort.

The Law of the Inverse Square must hold true because if we look at nonliving phenomena such as the force of gravity or sound intensity, each utilizes the same critical integer that factors into Primitive Economic Man models of dietary choice, namely distance. In archeology, this is translated as distance from food sources, distance from lithic raw material sources, and so forth. Thus, $F_{grav} \sim 1/d^2$ (where d = distance); $S_{inten} \sim 1/d^2$; and $H_{behav} \sim 1/r^2$. Human eating habits should follow this same law that at once explains the inorganic movement of matter, as well as the organic behavior of living beings. And in the case of the living world, Darwinian selection takes the place of quantitative formulae explaining the inorganic world, ensuring that human decision-making unfolds accordingly through time.

4. A Primitive Economic Straw Man?

Does the discussion above simply create a Primitive Economic Straw Man? After all, no archeologist really believes in such an overarching law…do they? No archeologist really believes that natural selection favors hunter-gatherers who search and procure food with the mindset of obtaining the greatest calories for the least work effort…do they? Primitive Economic Man, we are told, is nothing more than a heuristic device to study human behavior utilizing a quantitatively-based scientific methodology.

Kelly (2013:76) provided a recent summary of the goals of optimal foraging models and described them thusly (italics mine):

> Foraging models do not claim to duplicate reality; instead they claim to model reality at some level of specificity if hunter-gatherers are behaving according to a model's set of goals and conditions.

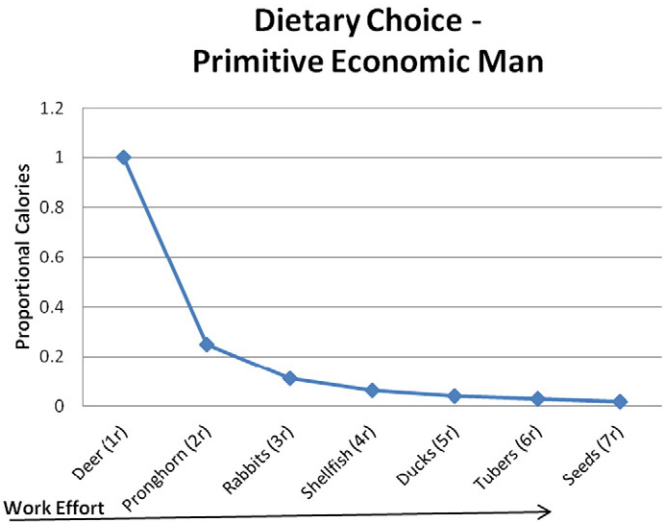

Fig. 1. Graphic representation of the primary dietary decisions made by humans operating as Primitive Economic Man. The mathematical formula that explains human dietary choice would be.

> Optimization models are heuristics; they do not provide a priori answers and explanations… Thus, *a foraging model helps point to which resources are or are not taken for nonsubsistence reasons. Some thirty years after they were first introduced to anthropology, optimal-foraging models provide the best way to understand variation in hunter-gatherer diet.*

The statements shown in the italics above can be challenged on a number of grounds, and principal among them are these three points:

(1) The assertion that Primitive Economic Man can inform which subsistence choices were made for strictly nutritional concerns and which were culturally-based misses one of the primary tenets of nutritional ecology: we should not be separating the two phenomena in the first place because dietary choices are intertwined in the broader social structures that ultimately lead to human behavioral decisions. Feasting and communal social activities (e.g., Hockett, 1998; Jackson and Scott, 2003; Hockett et al., 2013; Kassabaum, 2014) provide examples of how broader-scale models can illuminate sociopolitical phenomena with greater richness compared to reductionistic Primitive Economic Man models. The fact is that humans choose to consume or not consume a variety of resources for a variety of reasons that run the gamut from nutritional needs to taste preferences to culturally ingrained social customs to medicinal concerns. And all of these are packaged together within a society's daily activities. We should not assume that a resource at one point in time was being consumed for strictly subsistence reasons simply because a heuristic model based on energy capture indicates that it might have been relatively easy to procure. Since artiodactyls rank the highest in terms of caloric return rates in Primitive Economic Man models, should archeologists ignore questions related to a broader understanding of culture and society when we find abundant artiodactyl bones in an archeological site? If artiodactyls rank the highest, then they must have been taken for strictly subsistence reasons whenever their bones are found in archeological sites under energy-based reductionistic models. Asking this question brings the tautological underpinnings of these heuristic models into sharper focus. After all, if optimality models inform on which subsistence behaviors were made for reasons other than efficient calorie consumption, then surely the highest ranked prey, when taken, were always eaten for strictly dietary/caloric concerns. As a result, the only time archeologists need to invoke aspects of culture and human interaction to explain the patterns we see in the archeological record is when lower ranked resources such as seeds were eaten, because all things being equal, people would not be eating seeds in the first place unless something was preventing them from eating more artiodactyls or other higher ranked food items. Recent research on large-scale artiodactyl trap features in the Great Basin (Hockett, 2005; Hockett and Murphy, 2009; Hockett et al., 2013) and communal feasts in the Mississippi Valley (Kassabaum, 2014) demonstrate the faulty logic of this reasoning, as Great Basin and lower Mississippian peoples alike came together in large, communal gatherings to mass capture artiodactyls and other food items, and in all likelihood it was the social benefits of these communal gatherings that were the driving force behind large-scale trap construction, not the desire to efficiently procure and consume calories.

(2) Primitive Economic Man models such as optimal foraging essentially state that hunter-gatherers will universally collect easy to procure resources before difficult to procure resources. This proposition is not particularly interesting or unexpected, and is akin to stating that bifaces become smaller as they are reworked away from the original quarry source. Either of these propositions makes sense, and someone had to hypothesize and confirm these propositions through the scientific method. In places such as the Great Basin of North America where there is a wealth of ethnographic data available on pre-contact aboriginal societies, it is well documented that people usually did not move family camps to places that had limited food resources; rather they moved to places to take advantage of specific food resources that typically became abundant in specific places during a specific season, as well as available water. Much effort continues to be spent demonstrating that ancient peoples moved campsites where food and water were available in the archeological studies of regions such as the Great Basin. It is time to move forward with more complex questioning that takes into account human culture and modern principles of nutrition science.

(3) As detailed below and in previous publications (Hockett and Haws, 2003, 2005; Hockett, 2012), the Primitive Economic Man heuristic model was falsified 100 years ago. The falsified tenets of the Primitive Economic Man heuristic model include self-interest, as detailed in Henrich et al. (2001) and Henrich et al. (2005), cost-benefit optimization, as recently described by Krupenye et al. (2015), and, most significantly, the nutritional assumption that least cost behaviors in the procurement of calories would provide people with a selective advantage (McCollum and Davis, 1915; see also Hockett, 2012 for a review).

So it is not straw man building to keep asking: "How can a model [Primitive Economic Man] falsified 100 years ago provide the best way to understand hunter-gatherer diet?" The answer is that it cannot, and we must seek alternatives.

5. Human nutritional ecology for the 21st century

McCollum and Davis' (1915) "The Nature of the Dietary Deficiencies of Rice" demonstrated that non-energy producing micronutrients were fundamental to understanding mortality and fertility trends in the living world, and this helped usher a new era in the scientific study of human nutrition. The ramifications of McCullum and Davis' study are vast, the most important of which for our purposes is the fact that humans did not physiologically evolve to maximize energy intake with the least expenditure of energy. In short, hunter-gatherers who behaved like Primitive Economic Man in the long-term would not be favored by Darwinian selection.

It was with these understandings that 12 years ago Jonathan Haws and I (Hockett and Haws, 2003) published our first manuscript on nutritional ecology in the journal *Evolutionary Anthropology* as an alternative to Primitive Economic Man. Nutritional ecology sets the nutritional foundations under which populations may grow or decline based on current research within the human nutritional sciences. It is inherently holistic, recognizing from the beginning that many different factors may be at play in shaping culture change (see Hockett and Haws, 2005).

Before describing some of the fundamental facts of human nutrition that must be taken into account in any model that attempts to describe or explain human dietary practices in the past, it is important to explore further why nutritional ecology must remain holistic in nature rather than the current standard practice of using or developing reductionistic heuristic models. This exploration will also further clarify the Primitive Economic Man model, both past and present.

As noted above, Primitive Economic Man is an economic/energy-based cost-benefit paradigm. The two most commonly used step-down models are referred to as either prey choice or patch choice models, and all of these have been subsumed under the more general theoretical framework referred to as Human Behavioral Ecology (HBE). Researchers who work under the HBE framework appear to be split into two general theoretical camps. One camp seeks to explain changes in the archeological record in cost-benefit terms through the concept of *adaptiveness*, and more specifically phenotypic adaptiveness

that leads to nearly optimal solutions to ecological problem-solving (see Laland and Brown, 2012 for a review). These researchers do not study human adaptations per se. An *adaptation* is a behavioral, physiological, or anatomical feature or trait produced by natural selection to serve a particular purpose or function at the time of its development. Adaptations increase fitness, which means they afford reproductive advantages in individuals expressing the trait. The adaptiveness program within HBE takes as a given that the primary ancient adaptation guiding human behavior is flexibility or broad adaptiveness. These models then assume that the human adaptive machine is run by a cost-benefit system that leads to nearly optimal solutions to functional problems (Laland and Brown, 2012). Models, therefore, are primarily confined to deciphering or describing which type of cost-benefit phenotypic behavior (e.g., maximizing caloric intake relative to work effort) stands behind the facts observable in the archeological record. Note that this goal stands in contrast to Kelly's (2013) description above which suggested that optimization models do not provide a priori explanations and answers. In essence these models do just that. The higher order "answer" is already known in these models, namely the facts observable in the archeological record were fixed by Darwinian selection in our ancient ancestors because they led to greater reproductive success in those individuals who expressed broad-scale adaptiveness. The goal of archeology, then, is not to explain higher order behavior, but merely to describe the cost-benefit trait or currency that led to the archeological patterns we observe. This is important because according to adaptiveness models within HBE, human behavior has already been selected to optimize reproductive success through behavioral flexibility, so the cognitive viewpoints of individual human actors, or historically contingent behaviors, are largely unimportant to a scientific study of human behavior unless they specifically are a part of the cost-benefit optimization trait being tracked.

The second camp within HBE constructs models that are more explicit in their reference to adaptations, and are thus more "Darwinian" in nature. These models specifically tie cost-benefit optimization behaviors to adaptations (e.g., males who demonstrate they are better hunters of large game than rival males will mate with females with the best child-rearing skills, which in turn increases reproductive fitness along these familial lineages). These are the 'costly-signaling' models (e.g., Smith et al., 2003).

These subtle differences aside, the common ground of each camp rests on reductionism and tracking currencies (optimized behaviors).

> Human behavioural ecology starts with the notion that human behavioural strategies have been shaped by selection to optimize reproductive success in particular environments: the actual data from human populations are then compared with predictions made from theoretical models. Where the data do not fit the model, there are two obvious explanations. First, the assumptions about the behavioural strategies being optimized, or the estimates of the costs and benefits of particular strategies may be incorrect, or the model may not have incorporated the appropriate trade-offs. Second, human beings may not be behaving optimally. However, it frequently appears to the outsider that human behavioural ecologists are reluctant to draw this second conclusion…Given the recursive nature of the human behavioural ecology approach, it is understandable that these researchers should not want to admit defeat and conclude that behavior is suboptimal prematurely and might be tempted to try one further attempt at model fitting …The rarity with which human behavioural ecologists admit to a case of suboptimal behavior has been further fuel to their critics.
>
> [Laland and Brown (2012:99–100)]

> There are several theoretical grounds on which to suspect that human behavior may sometimes be suboptimal. Evolutionary psychologists stress how modern situations are vastly different from past selective environments, frequently rendering our adaptations obsolete…Although human behavioural ecologists claim that humans exhibit little adaptive lag, it is noticeable that their research rarely attends to the behaviour of westernized populations.
>
> [Leland and Brown (2012:100)]

On one side of this nutritional ecology — Primitive Economic Man discussion lies an approach (nutritional ecology) which suggests that (1) historical contingencies matter in explaining culture change and human decision-making, regardless of whether that society is described as "hunter-gatherer", "horticulturalist", "agriculturalist", or whatever westernized terminology is applied to them; (2) these behaviors often do not lead to optimization, regardless of the definition of "optimal" that is used; (3) importantly, the notion that energetic efficiency alone, and particularly the cost-benefit assumption that the consumption of calories relative to work effort increases reproductive fitness in humans was falsified a century ago. This latter fact is one in which I first expounded upon several years ago (Hockett, 2012), and used as the starting point for organizing the 2015 SAA session and this *Special Issue*. It also leads me to conclude that holistic paradigms are required to explain dietary choices in the past.

On the other side lies the HBE approach, including modern versions of a broader 20th century extension of Primitive Economic Man, which suggests that (1) historical contingencies largely do not matter; (2) the only behaviors that matter are those that lead to "optimization", often defined as 'rational behavior' in westernized terms; and (3) thus, reductionism is required to maintain focus on the key explanation of dietary choices in the past.

The general idea that anthropology and the study of human behavior, including subsistence practices must remain holistic in nature is not new. It is what Charles Hockett (1973:277) meant when he said "*People don't live by logic*; *they live by analogy*" more than 40 years ago. And HBE itself recognized and embraced its reductionistic nature early in its development (E. A. Smith, 2000). The papers in this *Special Issue* of *Journal of Archaeological Science*: *Reports* demonstrate the importance of holistic approaches to the study of ancient human diets and nutrition. Combined with an understanding of modern principles of human nutrition, nutritional ecology may be a powerful paradigm to study past dietary practices and how those choices impacted human use of the landscape, human social interactions within and between groups, and how and why changes are seen in the archeological record through time.

6. Concluding remarks: building paradigms based on facts

As noted several times in this short essay, unlike Primitive Economic Man, nutritional ecology is based on empirical facts in the human nutritional sciences, as well as general anthropology and ethnology. Basic nutritional tenets that human nutritional ecology is founded upon include these four simple facts:

- The human brain and muscles primarily use carbohydrates for energy. The body's 2nd energy source is fat. Protein is by-and-large used for energy in emergency situations brought on by chronic energy deficiency. Stating these principles chemically, the human brain and muscles run on carbohydrates, and in order to utilize fat or protein as an energy source, the body must first break down and convert fats and proteins into carbohydrates, which is a far more costly and expensive way to fuel the brain and muscles than consuming carbohydrates directly from food sources. The raw meats of ungulates such as caribou (*Rangifer tarandus*) contain glycogen, so consuming raw meats may provide for direct carbohydrate consumption; even so, peoples occupying Arctic environments incorporated methods of food acquisition and preparation in order to consume carbohydrates directly, including the consumption of marine plants such as seaweed, as well as fermenting marine mammal parts and birds that resulted in the production of carbohydrates through the fermentation process.

- To prevent the human body from breaking down proteins for use as energy to fuel the brain and muscles, and to prevent long-term ketosis that may have deleterious health consequences, humans must consume 50–100 g, or about 1/5–1/4 lb of carbohydrates per day. Most societies obtain that requirement through the consumption of foods such as plants, insects, shellfish, raw meats, and, in some cases, the stomach contents of large mammals.
- The human body can make all the fatty acids required except two: Omega-6 and Omega-3 (18-carbon). These fatty acids most notably come from vegetable oils, seeds, nuts, fish, and other seafoods.
- Proteins are the building blocks of our muscles and skin, among others, and are vital to making anti-bodies to combat diseases and infections.

There are obviously many other basic principles of human nutrition that must be applied to any sound model designed to interpret human dietary choice, as well as the consequences of those choices on mortality and fertility rates through time. Yet building models of human dietary choices in the past and their subsequent consequences based on the simple empirical facts noted above, developed in the human nutritional sciences, sets a more solid foundation for our interpretations. The papers presented in this *Special Issue* are steps forward in developing those necessary alternatives to understanding past human societies and the dietary choices they made.

I leave this brief overview to the *Special Issue* with thoughts on the roles of measurability and quantification in the sciences in general, and within human nutritional ecology specifically. 'Quantifiable' means to give a quantity to something, or to express a quantity. 'Measureable' more simply means that something is capable of being measured. In order to test propositions, hypotheses, and theories scientists need *measureable* criteria. Q*uantifiable* criteria are obviously useful, but not required in order to conduct scientific testing. To quantify is one way to measure, but there are other ways to measure phenomena.

Despite the fact that the Primitive Economic Man model was falsified 100 years ago, I suspect that one of its primary "strengths" to its practitioners is that the model develops quantifiable cost-benefit formulae. Quantification, however, does not render a model any more or less useful if the tenets of that model have been falsified. The nutritional ecology approach is inherently scientific as it can and should be based on a host of measurable criteria, some quantifiable and some not, the latter relating to human food choices based on socio-cultural concerns. So the challenge will always remain to develop appropriate measureable criteria to test ideas within a human nutritional ecology framework that take into account the complex interplay between macronutrients, micronutrients, and socio-cultural phenomena.

References

Emlen, J.H., 1966. The role of time and energy in food preference. Am. Nat. 100, 611–617.
Gengerelli, J., 1930. The principle of maxima and minima in animal learning. J. Comp. Psychol. 11, 193–236.
Helmholz, H., 1861. On the application of the law of the conservation of force to organic nature. Proceedings of the Royal Society 3, pp. 347–357.
Henrich, J., Boyd, R., Bowles, S., Camerer, C., Fehr, E., Gintis, H., McElreath, R., 2001. In search of homo economicus: behavioral experiments in 15 small-scale societies. Am. Econ. Rev. 91, 73–78.
Henrich, J., Boyd, R., Bowles, S., Camerer, C., Fehr, E., Gintis, H., McElreath, R., Alvard, M., Barr, A., Ensminger, J., Henrich, N.S., Hill, K., Gil-White, F., Gurven, M., Marlowe, F., Patton, J., Tracer, D., 2005. "Economic Man" in cross-cultural perspective: behavioral experiments in 15 small-scale societies. Behav. Brain Sci. 28, 795–855.
Hockett, B., 1998. Sociopolitical meaning of faunal remains from Baker Village. Am. Antiq. 63, 289–302.
Hockett, B., 2005. Middle and Late Holocene hunting in the Great Basin: a critical review of the debate and future prospects. Am. Antiq. 70, 713–731.
Hockett, B., 2012. Optimizing energy: the epistemology of primitive economic man. In: Ollich-Castanyer, I. (Ed.), Archaeology: New Approaches in Theory and Techniques. InTech, Croatia, pp. 3–40.
Hockett, B., Haws, J., 2003. Nutritional ecology and diachronic trends in Paleolithic diet and health. Evolutionary Anthropology 12, 211–216.
Hockett, B., Haws, J., 2005. Nutritional ecology and the human demography of Neandertal extinction. Quat. Int. 137, 21–34.
Hockett, B., Murphy, T., 2009. Antiquity of communal pronghorn hunting in the north-central Great Basin. Am. Antiq. 74, 708–734.
Hockett, B., Creger, C., Smith, B., Young, C., Carter, J., Dillingham, E., Crews, R., Pellegrini, E., 2013. Large-scale trapping features from the Great Basin, USA: the significance of leadership and communal gatherings in ancient foraging societies. Quat. Int. 297, 64–78.
Hockett, C., 1973. Man's Place in Nature. McGraw Hill, Inc., New York.
Hodgen, M., 1964. Early Anthropology in the Sixteenth and Seventeenth Centuries. University of Pennsylvania Press, Philadelphia.
Ingram, J.K., 1888. A History of Political Economy. Adams and Charles Black, Edinburgh.
Jackson, H.E., Scott, S.L., 2003. Patterns of elite faunal utilization at Moundville, Alabama. Am. Antiq. 68, 552–572.
Kassabaum, M.C., 2014. Feasting and Communal Ritual in the Lower Mississippi Valley, AD 700–1000 (PhD dissertation) University of North Carolina, Chapel Hill.
Kehoe, A., 1993. How the ancient Peigans lived. Res. Econ. Anthropol. 14, 87–105.
Kelly, R., 2013. The Lifeways of Hunter-Gatherers: The Foraging Spectrum. Cambridge University Press, Cambridge.
Kroeber, A., 1917. The superorganic. Am. Anthropol. 19, 163–214.
Krupenye, C., Rosati, A., Hare, B., 2015. Bonobos and chimpanzees exhibit human-like framing effects. Biol. Lett. 11, 20140527.
Laland, K., Brown, G., 2012. Sense and Nonsense: Evolutionary Perspectives on Human Behavior. Oxford University Press, Oxford.
Little, M., Morren, G., 1976. Ecology, Energetics, and Human Variability. Wm. C. Brown Company, Dubuque.
Lodewijks, J., 2000. Rational economic man and the ignoble savage. History of Political Economy 32, 1027–1032.
Lotka, A., 1922. Contribution to the energetics of evolution. Proceedings of the National Academy of Sciences 8, pp. 147–151.
Lotka, A., 1925. Elements of Physical Biology. Williams & Wilkins Company, Baltimore.
Lotka, A., 1945. The law of evolution as a maximal principle. Hum. Biol. 17, 185.
Malinowski, B., 1922/1932. Argonauts of the Western Pacific: An Account of Native Exterprise and Adventure in the Archipelagoes of Melanesian New Guinea. George Routledge & Sons, Ltd., London.
McArthur, R.H., Pianka, E.R., 1966. On optimal use of a patchy environment. Am. Nat. 100, 603–609.
McCollum, E.V., Davis, M., 1915. The nature of the dietary deficiencies of rice. J. Biol. Chem. 23, 181–230.
Mill, J.S., 1836/1967. On the definition of political economy and on the method of investigation proper to it. In: Robson, J.M. (Ed.), Collected Works of John Stuart Mill, Volume IV. Toronto University Press, Toronto, pp. 309–339.
Mill, J.S., 1848/2004. Principles of Political Economy. Prometheus Books, New York.
Morgan, L.H., 1877. Ancient Society, Or Researches in the Line of Human Progress From Savagery, Through Barbarism, to Civilization. MacMillan & Company, London.
Smith, A., 1776/1963. An Inquiry into the Nature and Causes of the Wealth of Nations. P. F. Collier & Son Corporation, New York.
Smith, E.A., 2000. Three styles in the evolutionary analysis of human behavior. In: Cronk, L., Chagnon, N., Irons, W. (Eds.), Adaptation and Human Behavior: An Anthropological Perspective. Aldine de Gruyer, New York, pp. 27–46.
Smith, E.A., Bird, R.B., Bird, D.W., 2003. The benefits of costly signaling: Meriam turtle hunters. Behav. Ecol. 14, 116–126.
Ostwald, W., 1910. Natural Philosophy. Henry Holt and Company, New York.
Powell, J.W., 1888. Competition as a factor in human evolution. The American Anthropologist 1, 297–323.
Raubenheimer, D., Simpson, S.J., 1997. Integrative models of nutrient balancing: application to insects and vertebrates. Nutr. Res. Rev. 10, 151–179.
Raubenheimer, D., Johnson, S.J., Mayntz, D., 2009. Nutrition, ecology and nutritional ecology: toward an integrated framework. Funct. Ecol. 23, 4–16.
Tylor, E., 1871/1970. The Origins of Culture. Peter Smith, Gloucester.
Underwood, J., 1975. Biocultural Interactions in Human Variation. Wm. C. Brown Company, Dubuque.
Wheeler, R.H., 1929. The Science of Psychology. Crowell, New York.
White, L., 1949. The Science of Culture. Grove Press, Inc., New York.
White, L., 1959. The Evolution of Culture: The Development of Civilization to the Fall of Rome. McGraw-Hill, New York.
Zipf, G., 1942. The unity of nature, least-action, and natural social science. Sociometry 5, 48–62.
Zipf, G., 1949/1965. Human Behavior and the Principle of Least Effort: An Introduction to Human Ecology. Hafner, New York.