VIERENVEERTIGSTE KROON-VOORDRACHT

JOHN D. SPETH

ARCHAEOLOGY, ETHNOHISTORY, EARLY HOMININS, AND SOME CHERISHED SCIENTIFIC MYTHS

GERRIT HEINRICH KROON
(1868-1945)

ARCHAEOLOGY, ETHNOHISTORY, EARLY HOMININS, AND SOME CHERISHED SCIENTIFIC MYTHS

VIERENVEERTIGSTE KROON-VOORDRACHT

GEHOUDEN VOOR DE

STICHTING NEDERLANDS MUSEUM

VOOR ANTHROPOLOGIE EN PRAEHISTORIE

TE AMSTERDAM OP 25 NOVEMBER 2022

DOOR

PROFESSOR JOHN D. SPETH

DEPARTMENT OF ANTHROPOLOGY

UNIVERSITY OF MICHIGAN ANN ARBOR,

MICHIGAN, USA

“Herd of reindeer” rendered by AI in “Franz Marc style” using Midjourney (https://www.midjourney.com/) via Discord (https://discord.gg/midjourney) (courtesy of Larrea Young, 05 September 2022).

INTRODUCTION: THE LIVING WORLD OF HUNTERS AND GATHERERS

For years and with great passion archaeologists have debated with each other about the nature of explanation, and especially about the role that our knowledge of the living world should play as a point of departure for developing explanations of the past. Are we unavoidably dependent on such knowledge; or, if by using it, do we instead condemn ourselves to creating visions of the past that are little more than mirror images of the present? In short, how can we understand behaviors and ways of living that no longer exist today if our models and theories are constructed from, and therefore constrained by, what we know and see around us in the present world?

While the intensity of this debate waxes and wanes much like fashion styles, the issue remains a contentious one and far from any sort of consensus. And, no doubt to the relief of my readers, it is well beyond the scope of the present endeavor to review the library's worth of literature that already exists on the topic. Such a review probably isn't necessary anyway, since most archaeologists take the easy way out – they simply ignore the debate altogether, content to let those few who relish wading into the theoretical quagmire do the debating. The result is that much of the day-to-day practice of archaeology relies heavily on understandings provided by a handful of scholars and, for the most part, work in the archaeological profession proceeds as though such "esoteric" debates aren't really all that important, or have already been more than adequately dealt with.

In the realm of Paleolithic archaeology, my principal focus here, the leading thinker of the past four decades, hands down in my opinion, was Lewis R. Binford (Meltzer 2011). A towering but also cantankerous and divisive figure, Binford had a larger-than-life impact on the field. One need only look at the topics that dominate research today to see the breadth and depth of that impact. Almost everyone nowadays deals with logistical and residential mobility, embedded lithic raw material procurement, expedient and curated stone tool technologies, hunting versus scavenging, and utility indices, to name but a few. All of these concepts, and many others, came largely from Binford's fertile mind, whether he is explicitly credited for them or not.

I can see many of my European colleagues shaking their heads in disagreement, no doubt thinking that Binford and the acrimonious furor of the *New Archaeology* were largely an American phenomenon (or aberration if you prefer). European archaeologists largely (and wisely) stayed out of the fray. And they definitely cite Binford's work far less religiously than their American counterparts do. Nevertheless, they zero in on the very same concepts, use much the same terminology, and rely on many of the same underlying assumptions. Binford's influence on hunter–gatherer archaeology in Europe is very evident.

CONSTRUCTING FRAMES OF REFERENCE

There is no doubt where Binford stood in the debate about the use of the living world as a source of insight for understanding lifeways in the past (e.g., Binford 1980, 1981:21–30). Nothing illustrates this more clearly than the very title he chose for his last major book—*Constructing Frames of Reference: An Analytical Method for Archaeological Theory Building Using Hunter–Gatherer and Environmental Data Sets* (Binford 2001). In fact, 65% (n = 887) of the 1,361 references in that book deal to varying degrees with direct observations made by Europeans and others of living hunters and gatherers. In short, Binford's ideas about mobility, settlement systems, site function, stone tool technology, and many other aspects of forager behavior came almost directly from his intimate knowledge of the living world of hunting peoples. Most of the other references cited in the book are also concerned with the observable world, though with topics other than foragers, such as regional and global climates and environments, evolutionary theory, theoretical ecology, wildlife biology, demography, and human behavioral ecology. In *Constructing Frames of Reference* archaeology is the target of explanation, not its source.

My own view on the role of the living world as the primary source of insight for explaining the past is quite similar to Binford's, though I give less weight to the deterministic role of climate and environment, and I credit humans with more non-rational (i.e., non-optimizing or non-maximizing) behavior than Binford does (see Thaler 2015). As I see it, none of the entities that Paleolithic archaeologists routinely deal with—hunting, butchering, transport, mobility, seasonality, settlement patterns, site function, stone-tool technology—actually exist in the archaeological record. In fact, there are no stone tools, just weirdly shaped "grey things." There are no bones, just equally curious "brown things." There is no mobility (nothing wanders around in the archaeological record); there is no hunting (those "grey things" don't suddenly become animated, fly through the air, and kill something); no butchering (the "brown things" just sit there next to the "grey things" and do nothing); no scavenging; no transport; no curation; no embedded procurement; no caching; no sharing; no exchange; no trash middens; no activity areas; no division of labor; no status or prestige; no egalitarianism; no group size; no resource stress; in fact, no hunters and gatherers…none of those things. Just "stuff," some of it grey, some of it brown, all just sitting there doing nothing, and all monumentally boring. We only know that entities such as hunting or mobility or division of labor exist in the realm of human behavior because of our knowledge of the living world. What Paleolithic archaeologists actually produce are a lot of strangely shaped "grey things" and "brown things," together with information about their distribution in three-dimensional space (and a lot of dirt). Everything beyond that is based on how we interpret that "stuff," and such attempts at interpretation proceed hand-in-hand with inferences we draw directly from our understanding of the world of the living and how we think it works. Without that connection to the living, observable, interpretable world around us, we have nothing but "stuff."

Binford, by drawing deeply from his intimate knowledge of the ethnographic record, made many important and highly influential contributions to our understanding of past hunter–gatherer adaptations and lifeways, both empirically and at the level of theory. But precisely because he mastered the forager literature to a degree that few other archaeologists ever had, and used those insights to generate compelling frames of reference that archaeologists could use to interpret the prehistoric record, the great appeal of his insights soon turned them from ideas and hypotheses into virtually unassailable "truths," a kind of "gospel according to St. Binford." Archaeologists nowadays seldom question them; the name of the game today is to develop ever better methods and techniques to help us "see" them in the Paleolithic record.

It is important to recognize that, although Binford continued to write about hunter–gatherers throughout his long and productive career, his most impactful ideas about foragers were already published in the 1970s and 1980s, some 40 years ago, give or take a few years (e.g., Binford 1973, 1977, 1978a, 1978b, 1979, 1980, 1981, 1983; Binford and Binford 1966). One would expect that over such a long period of time archaeologists would have made many serious attempts to re-evaluate his core assumptions. Tellingly, however, that has not been the case. Forty years, nearly half a century! That's a very long time in any scientific discipline for ideas of such import to go with so little real challenge or rethinking. For sure, there have been plenty of tweaks, clarifications, refinements, and lots of new jargon, but very few major rebuilds of the basic concepts from the ground up.

I hasten to point out that the real issue here isn't whether Binford was right or wrong in his conception of mobility or in his other ideas about how hunter–gatherer subsistence–settlement systems were organized and functioned. Forty years ago they were brilliant, pathbreaking, and compelling. The real problem lies in the fact that four decades later much of the profession remains wedded to his original conceptions, seemingly with barely a whimper's worth of serious questioning or doubt. In Alison Wylie's (1985) terms, Paleolithic archaeologists today pay far too little attention to the "source side" of the scientific enterprise, the place where the underlying assumptions come from. Instead, they put the lion's share of their effort into finding more scientifically rigorous and methodologically sophisticated ways of "seeing" and "testing" Binford's ideas in the archaeological record—Wylie's "subject side" of the scientific enterprise. We have made huge strides at the technical end of things—sampling, use-wear, 3-D morphological scanning, dating, taphonomy, lithic sourcing, isotopic and trace element studies, micromorphology, and on and on, but frustratingly little progress when it comes to advancing our understanding of Binford's original underlying assumptions. That does not bode well for a field that prides itself on being a science...

So, if our explanations of hunter–gatherer behavior in the past have to be informed by our understanding of foraging behavior in the living world, our most productive source of insight is obviously going to be the written record from the period that anthropologists generally refer to as the "ethnographic present." Though scholars use the term in a variety of different ways, I use it here simply to refer to that period of time for which there are written descriptions. In many parts of the world such records begin already in the 1500s during the early stages of European exploration, conquest, and colonization. Obviously, in very remote areas of the globe first contact may not have occurred until later, although indirect impacts, such as the spread of measles, smallpox, and other European diseases, as well as European-induced market opportunities and pressures, may have altered local communities, in many cases quite drastically, well before the inhabitants of such isolated communities had any face-to-face interaction with foreigners. Yet, despite the availability of these early ethnohistoric accounts, most contemporary archaeologists with an interest in hunters and gatherers draw their information and insights primarily from ethnographies written by trained observers, usually scholars with at least some formal background in anthropology. However, by making that choice, whether consciously or by default, their information base becomes restricted almost entirely to the 20th and 21st century, with at best barely a smattering of older reports, most dating to the last decade or two of the 19th century.

And that highly restricted subset of the "ethnographic present" is precisely where Binford turned for the data he used in *Constructing Frames of Reference*. He did include a few 19th-century reports, but they formed only a tiny fraction of the total. The distribution of publication dates of the works he cited shows quite clearly the high degree of selectivity he exercised in his research (see Figure 1). Fully 60% (n = 532) of the 887 hunter–gatherer references post-date 1960. In other words, much of his work relies on studies that were published less than 40 years before his own book came out. And almost 90% of his references post-date 1920 (87%). Only 6% (n = 55) pre-date 1900, but just barely so, and only 1% (n = 10) pre-date 1860. None were published prior to the 19th century. Admittedly, some 19th-century reports, after going out of print, got reissued many decades later and can therefore bias the overall distribution of publication dates toward the younger end. Although I did not actually tabulate how many

---

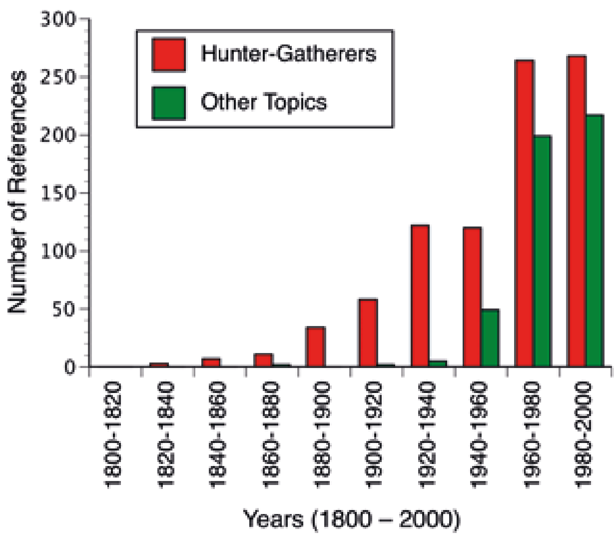

Figure 1. Frequency distribution of publication dates for references used in ***Constructing Frames of Reference*** *(Binford 2001:493-534). References that involved direct or indirect observations of living hunter–gatherers are shown in red, those that dealt with other topics are shown in green.*

such cases are included in Binford's bibliography, having looked at each individual citation I can confidently say that the number of such cases is very small. For the most part, Binford's citations of 19th-century reports are to the original or at least an early edition, not a much later reissue.

Why would such a distribution of publication dates pose a problem? After all, the vast majority of Binford's forager-related sources were written by anthropologists and should therefore be reasonably objective and reliable. There are actually a number of reasons to be concerned. First, the choice of references creates the misleading impression that very little of any worth was known about hunters and gatherers prior to about 1960, a marked inflection point in Figure 1. In fact, one could interpret the overall distribution as evidence that virtually nothing was known about hunter–gatherers throughout the entirety of the colonial period, an absurdity if one thinks about it.

Or one might draw the equally erroneous conclusion that colonial officials, missionaries, explorers, Euroamerican big-game hunters, fur-traders, whalers, military personnel, geologists, health officers, and others were so ignorant, arrogant, racist, or just plain uninterested in their surroundings that they had absolutely nothing relevant to say about the foragers they did in fact encounter, traded with, fought with, were held captive by, were guided by, allied with, learned the language of, became adopted by, missionized, painted or photographed, and not uncommonly married.

Perhaps of most importance, Binford's selection of references implies, even if unintentionally, that forager lifeways across the globe somehow, miraculously, managed to remain intact and unchanged through some four or five centuries of direct and indirect exposure to, and interaction with Europeans. In other words, it treats hunter–gatherers as though their cultures somehow became magically frozen in time, largely unaffected and unaltered despite centuries of European and American empire-building; missionizing; racism; slaving; population displacement; extinction of human and animal populations; expropriation of lands and resources; loss of languages, religions, and entire cultures; virulent new diseases; new weapons and other technologies; endemic warfare; new foods and foodways; and incorporation of local communities into global market economies.

In essence, what the analysis of Binford's bibliography reveals is that his "ethnographic present" constituted only a tiny fraction of the actual ethnographic present that is available to us in the extant ethnohistoric literature. That Binford's database was temporally restricted, of course, does not necessarily mean that the ideas he drew from it were wrong. But it does indicate that his sample of hunter–gatherer references, regardless of its impressive size (N = 887), is biased, probably severely so, and therefore is unlikely to adequately take into account many of the fundamental changes wrought upon Indigenous societies following initial Contact. And if Binford's database is biased, we need to know how such bias may alter or reduce the utility of his frames of reference as tools for interpreting the archaeological record.

ETHNOGRAPHY AND ETHNOHISTORY

Before taking a closer look at some of Binford's classic ideas—"Binfordisms" as I like to call them—I should take a moment to explain why and how I actually use the ethnohistoric record. As already noted in the Introduction, it would be naive to assume that the ethnographic information upon which Binford relied, most of which was generated in the latter half of the 20th century, could possibly provide us with an adequate basis for understanding how forager subsistence-settlement systems were structured, functioned, and changed during the earlier stages of European exploration, conquest, and colonial rule. For our frames of reference to be firmly grounded in reality, we must draw from the entire record available to us, not just the "salvage ethnography" conducted during the last waning twilight hours of the hunting way of life. And as I will show in what follows, some very interesting surprises emerge in so doing, and many more undoubtedly await the enterprising scholar willing to take the deep dive into the ethnohistoric record.

Many would question the utility of these early accounts because they were recorded by people with no formal training in how to conduct ethnographic field work, and their observations often oozed with cultural biases and racism. Nothing illustrates this better than the frequency with which many early observers penned the word "disgusting" in its many different forms, synonyms, and translations (i.e., in English, French, German, Spanish, Portuguese, Italian, or Dutch). The same is true for their rampant use of pejorative epithets like "savage," "heathen," "idolator," "beast," "child-like," "ignorant," "primitive," "filthy," "lazy," and so on. But, despite the patronizing, demeaning and often ugly verbiage, for the most part it is much easier to recognize such blatant prejudice and racism than it is to ferret out the far more subtle prejudice and bias deeply embedded within our own scientific thinking and writing. In fact, it usually takes the passage of many years and the benefit of hindsight for us to recognize our own biases. Later I will discuss a striking example of such deep-seated bias in contemporary scientific thinking; namely, the widely held view that the sight and smell of rotten meat and maggots are universal elicitors of disgust in humans honed by evolution to protect us from ingesting harmful pathogens. The pre-WWI ethnohistoric record from across the globe shows just how wrong and ethnocentric this view really is.

The way archaeologists and paleoanthropologists deal with gender provides another example of such bias hidden in plain sight in scientific writing. In the preface to his popular book on the hunter–gatherer way of life, Elman Service (1966:10) famously explained how he settled on *The Hunters* as the book's title: "'The Hunters' was suggested as the title for this book simply because it sounds more interesting than 'Woman's Work,' 'The Gleaners,' or 'The Foragers.'" Pretty blatant bias! But how about the justly famous volume edited by Lee and DeVore (1968) entitled *Man the Hunter*? Any possible bias embedded in that title? One of Lee's (1968) most noteworthy contributions in the book was a chapter showing that outside of the arctic the bulk of most forager diets came, not from men's hunting, but from women's gathering. So where did that title come from?

Let's bring the issue of bias closer to our front door. How about Lieberman et al.'s (2009:88–89) influential article entitled "Brains, Brawn, and the Evolution of Human Endurance Running Capabilities." In it the authors conclude that:

> ...for most of the history of the genus *Homo*, it appears that hominins have been able to kill large, prime age, adult prey that would have posed serious risks to any hunter armed solely with an untipped spear. ER [endurance running], however, would have changed that equation by allowing hunters in the hot, arid and open habitats that have existed in Africa since at least 1.9 Ma, to run their prey into exhaustion, thereby disadvantaging them sufficiently to be slain with minimal risk and a high probability of success.

Have these authors really gained new insights into the evolution of human subsistence, or have they too fallen victim to much the same gender bias that is so obvious in the way Service chose the title for his book, or in the way Lee and DeVore chose theirs, or in 18th-century ethnohistoric accounts that dismiss women's work as drudgery and focus instead on the prowess, keen eyesight, and sure hand of the intrepid male warrior and hunter? Bias of this sort can be so much harder to recognize in a carefully crafted scientific argument such as Lieberman et al.'s (2009). In short, when used critically and with caution, there are five centuries' worth of valuable and irreplaceable information tucked away in these early accounts, information that is essential for evaluating and rebuilding some of Binford's most influential Binfordisms.

In fairness to Binford, in the 1970s and 1980s when he compiled most of his hunter-gatherer data, undertaking a deep dive into the ethnohistoric record would have been a daunting undertaking, in fact one that would have bordered on the impossible unless he was willing to devote the better part of his career to it. A truly deep dive into these early accounts has really only become practicable with the onset of the digital age. I can only stand in awe of historians and other scholars who, even just a few years ago, attempted to cull information in any systematic fashion from the ethnohistoric literature without the aid of the computer, the Internet, pdfs, and optical character recognition (OCR). Today, one can plow through hundreds of books and articles in a matter of seconds to ferret out the things of interest to one's research.

To be successful, the process itself often amounts to a creative game of keyword searching. Once a particular research question has been articulated, the next step is to zero in on the right keywords and combinations of keywords, first using contemporary spellings, then repeated using 19th-century spellings, then 18th-century spellings, and so on. Take "pemmican" as an example. There are many descriptions in the early accounts of how to make pemmican, and what the proper ratio of fat to lean should be, but finding them is not as straightforward as one might at first assume. While "pemmican" is the way most of us spell the word today, lots of earlier accounts spell (or misspell) it as pemican, pemicon, pimican, pimikan, pemikan, and pemekan. The same is true for Inuit or Eskimo. Older spellings include Eskimau, Eskimaux, Esquimaux, Esquimeaux, and several other variants. Fetus often is foetus; carcass is carcase; caribou may be cariboo or rein-deer, or simply deer or deere, and in some early accounts it is occasionally misspelled as deare; elk is sometimes wapiti but in most earlier accounts it is referred to as red deer; and so forth.

One can take advantage of consistent prejudices in the earlier accounts to find specific sorts of information. For example, if one is interested in women's activities, transport loads, or other issues related to gender during, say, the early Contact period, two of the most effective keywords, aside from "women," are "drudge" and "drudgery."

Tribal names have undergone countless changes in the past several centuries, and in many cases the older names bear little or no obvious resemblance to the names that are commonplace today (e.g., Kutchin and Gwich'in; Naudowessie and Dakota; or Gros Ventre and Atsina). The same is true of the names given to features of the landscape such as rivers, lakes, and mountains, as well as local and regional political units, and even nation states. Wikipedia can be a godsend in sorting through the history of these name changes.

With the Internet, one can easily become overwhelmed in a matter of seconds with information and, not surprisingly, that's where the real work begins. One not only has to read through it all to decide what information is relevant and what isn't, but it becomes really critical to evaluate the context in which the observations were made and, to the extent possible, the particular biases and prejudices of the observer. But this really isn't all that different from what one has to do when dealing with recent ethnographies.

Amazingly, all of this searching can be done in the comfort of one's own home or office without ever setting foot in a brick-and-mortar library. Just a few decades ago scholars would have had to drive to the library; look for a place to park; thumb through a cumbersome card catalog to find the needed call numbers; go to the appropriate floor of the library, all the while hoping the book or journal hadn't been checked out, misplaced, or lost; if necessary, peruse the reshelving carts; then spend hours squirreled away in a library carrel or rare book room thumbing through piles of ancient tomes to find the hoped for information; and finally stand for hours hunched over a Xerox machine, one that more often than not is busy, hopelessly jammed, or out of paper, in order to have a permanent record of the day's finds. The good old days....

The Internet now coughs up the same information in a matter of seconds! And where the digital scans are old, and searching for specific keywords is not at first possible, OCR works its magic and you are back in business. OCR and keyword searching even work reasonably well on older English orthography, even though "f"s and "s"s can be nearly indistinguishable, such that when searching for "fat" one ends up with a lot of hits on the word "sat" or "flat." And when working in a foreign language, online translators have improved remarkably over the last decade or so, though they can still be pretty "dumb" when it comes to deciding which meaning of a word to choose for the particular text it is translating. Translators are still largely blind to subject or context. Thus, the output can be pretty amusing at times, and almost always in need of some reworking, but at the mere push of a button one can usually get a pretty good idea what a particular section of text is talking about.

It therefore seems appropriate, if perhaps a bit unorthodox in a study of this sort, to acknowledge, not the usual cast of characters—the internal and external funding agencies—but the real he-

roes of such research—Google Scholar, Internet Archive (Archive.org), HathiTrust Digital Library, JSTOR, ProQuest Dissertations and Theses, Gallica, Project Muse, numerous online translators, digital library catalogs, Academia.edu, ResearchGate, Wikipedia, the pdfs obtained directly from authors or through digital interlibrary loan (ILL), and the OCR capacities of Adobe Acrobat Pro.

In sum, the ethnohistoric record is so much more than just a collection of antiquated trivia recorded by Europeans and Americans who were hopelessly blinded by their own cultural biases, prejudices, and racism. The potential of the record is truly staggering, a potential that wasn't even scratched by Binford's *Constructing Frames of Reference*. As just one striking example of the rich record that awaits the curious Paleolithic archaeologist, The Hudson's Bay Company Archives (HBCA), based in Manitoba, Canada, "...has digitized 1052 reels of microfilm, encompassing over 10,000 volumes of the pre-1870 records kept at almost five hundred Hudson's Bay Company posts. The digitized records include post journals, incoming and outgoing correspondence and accounts kept at individual posts" (https://www.gov.mb.ca/chc/archives/hbca/hbca_microfilm_digitization.html). And there is so much more beyond the HBCA's already massive holdings. Those just dealt with Binford's home turf, the North American arctic and subarctic. The global ethnohistoric record contains literally thousands of day-by-day diaries of expeditions that reveal an unbelievable wealth of information about the Indigenous peoples they encountered and interacted with along the way, often providing details about seasonal movements, group sizes, division of labor, technology, hunting strategies, diet and foodways, village layouts and organization, alliances and enemies, trade, kinship, and religious beliefs. These early accounts aren't just curiosities; they are an essential part of the overall information base that we must incorporate if we are to develop really robust frames of reference for interpreting the archaeological record of hunting peoples in the past.

Let us move now from these generalities to some concrete examples of the kinds of insights we can gain by taking a deep dive into the rich ethnohistoric record, beginning with a closer look at one of Binford's classic Binfordisms as a case in point—"logistical mobility."

LOGISTICAL MOBILITY

Binford envisioned hunter–gatherer mobility as a *continuum of organizational variability*, ranging between "foragers" toward one end and "collectors" toward the other. The labels he chose for these concepts, unfortunately, were rather poor ones because, to me at least, they mean more or less the same thing (hunter–gatherers are frequently called foragers and most foragers do a fair amount of collecting). As a result, I can never remember which is which. Although some archaeologists continue to use them, most now talk instead about "*residential mobility*, movements of the co-residential group from one camp to another, and *logistical mobility*, movements of individuals or task-specific groups out from and back to a residential camp" (Kelly 2013:78). Intuitively, these terms, and the ideas behind them, are much easier to remember. Binford envisioned these mobility variants as end points of a continuum, not a polar dichotomy. Most archaeologists today, however, pay no attention to his concern and not only treat them as discrete types, but also invest a great deal of time and effort attempting to plug archaeological assemblages into one or the other of these typological pigeonholes.

Archaeologists most often associate logistical mobility with long-distance big-game hunting forays by men, either operating alone or in small all-male parties. Moreover, they commonly assume that the distances involved in these hunting treks were so great that it would have been impractical for the hunter(s) to return home each night with the day's kill(s). Based on these assumptions, archaeologists expect the sites produced by logistical hunting to be task specific, with a relatively limited range of activities focused mostly on hunting, butchering, maintaining and repairing weapons, and perhaps hide-working, but with little or no evidence for the presence of women and children (see, for example, Binford 1977).

This all sounds very reasonable and plausible, but how well does it fare when stacked up against the early ethnohistoric record? Unfortunately, not very well. Binford seems to have been unaware of just how central women were to northern transport systems, even as recently as the middle decades of the 19th century. That women, not dogs or men, were the primary transporters, becomes crystal clear the moment one dives into the ethnohistoric record pre-dating the 20th century, something that Binford didn't do. Native dog breeds simply weren't up to the task of pulling heavily loaded sleds through deep snow; but women were (Allen 1887:133; Ameen et al. 2019; Anonymous 1710:27–28; Catesby 1754:viii in text; de Laguna 2000:326; Dunn 1844:105; Franklin 1824:143; Friesen 2020; Glover 1962:106, 125–126; Gookin 1792:9 [originally written in 1675]; Grant [1804] 1890:321; Hardisty 1867:312; Hearne 1795:55, 89–90; Heckewelder [1818] 1876:157; Heine et al. 2007:66-67; Josselyn 1674:136-140; Joutel [1687] 1714:173; Kelsey [1691] 1929:11, page 51 of unpaginated volume; Latham 1851:249; Lytwyn 2002:97–98; Mackenzie 1801:261; McCormack 2014; McGhee 2009; Morey and Aaris-Sørensen 2002; Perry 1979:365; Robinson 1879:326–327; Savelle and Dyke 2014; Savishinsky 1975; Sharp 1976:26; Sheppard 2004; Simpson 1843: 311, footnote; Smith 2022:84; Smith [1612] 1969:359; Swaine and Drage 1748:211; Turner 1894:271; Whitridge 2018:24–25).

> While the lineage of these northern dogs is ancient, there were probably few or no sled dogs before Europeans arrived in the

> western Subarctic. While there were always dogs to interact with and assist humans in various ways, they rarely if ever pulled sleds, which were pulled instead mainly by women. And, it seems likely that dogs were both few in number and small. The development of sled dogs/dog sleds implicates the fur trade and an expanding European-dominated capitalist economy in the North. (McCormack 2018:107, emphasis added)

The following quotes are just two examples out of literally hundreds of similar ethnohistoric and ethnographic observations that underscore the pivotal role of women in virtually all phases of traditional Indigenous transport.

> [Chipewyan, Canadian Subarctic] ...not taking any women with us on this journey, was, he said, the principal thing that occasioned all our wants: for, said he, when all the men are heavy laden, they can neither hunt nor travel to any considerable distance; and in case they meet with success in hunting, who is to carry the produce of their labour? Women, added he, were made for labour; one of them can carry, or haul, as much as two men can do. They also pitch our tents, make and mend our clothing, keep us warm at night; and, in fact, there is no such thing as travelling any considerable distance, or for any length of time, in this country, without their assistance. (Hearne 1795:55)

> [Gwich'in or Kutchin, Canadian Subarctic] The men often travelled ahead of the women and children, leaving early in the morning when it was still dark. "At breaking of day, the men were way ahead making trail. After daylight, the women dressed up and went with their belongings in the sled," Julienne Andre remembers. While they were travelling, the men were constantly on the lookout for caribou and moose. The women followed behind with the families' belongings. When the men reached a site where they wanted to camp for the night, they left a mark such as "an axe or a scarf or a

> glove, so the women knew where it was. The men marked out the place for the women to pitch the tent," according to Joan Nazon. The men might then travel on to hunt, and the women would set up the tents as soon as they arrived at the site. If the men returned in time, they helped the women with this work. Families travelling in the mountains had to set up a new camp day after day, until a caribou kill had been made. Then camp was set up in that place, and the women made drymeat. After the men had left camp, the women got ready to follow with the families' belongings. Sometimes, while they took down the tents and packed up the gear, the women would send the children ahead. The children could safely follow the trail broken by the men who were travelling ahead, backed up by the women who were gradually coming up behind, pulling and carrying the family's belongings. The women would catch up with the children after a few hours, and then they would travel along together. In this way the group was able to make good headway while still allowing the children to travel at their own pace most of the time. (Heine et al. 2007:66-67)

Binford originally developed the logistical concept in the context of his work among the Nunamiut, a group of Inuit or Eskimos living in the small community of Anaktuvuk Pass, located north of the Brooks Range in Alaska. At the time he did his field work (1969–1972), the Nunamiut were relying heavily on snowmobiles to get around. Snowmobiles, of course, made it easy for men to travel rapidly over great distances and return with bulky or heavy loads. The common vision of logistical mobility, therefore, probably works reasonably well when applied to the snowmobile era (i.e., from the 1960s onward). But Binford drew upon the memories of his adult informants, which allowed him to reconstruct a picture of Nunamiut mobility strategies during pre-snowmobile days when they still relied heavily on dog sleds for transport. But if women did the vast majority of transport well into the 19th century, as the ethnohistoric record from across the width and breadth of the northern latitudes makes amply clear, Binford's ideas about logistical mobility may really only be applicable to a rather tiny slice of time, perhaps barely a century, the period between roughly 1850 or 1860 and 1960 when snowmobiles began to make their appearance.

Why should women have been so important to transport in the north? First, there is clearly an important element of "culture" involved in this, since prior to the late 19th century women seem to have been the designated transporters, not just in the north, but across the entire North American continent (and beyond) prior to the introduction of the horse. But there was a functional component to this as well. The use of dog sleds for long-distance hunting (and trading) by all-male parties was not simply a product of having sleds, but of having dog breeds large enough to pull heavily laden sleds through deep snow. As noted earlier, native breeds were simply not up to the task. Suitable Old World dog breeds were introduced by the Hudson's Bay Company (HBC) in the 19th century, motivated by their desire to expand the fur trade into more remote areas of the far north. The larger dogs made it possible for distant hunting bands to bring furs to far-flung HBC trading posts. But the newly introduced canines, when hard at work on the job, were extremely expensive, costing almost as much in daily calories as adult hunters (i.e., ca. 4,000–6,000 kcal; Gerth et al. 2010; Olesen 2014:233; Orr 1966; Speth 2017:48). As a consequence, most Indigenous families couldn't afford to maintain viable dog teams until they acquired repeating rifles with which they could reliably kill enough game to keep their ravenous dogs adequately fed.

Binford's conception of the long-distance male-only hunting trek actually makes little sense if the hunter was on foot. If he was far from home, it would benefit him to kill as many animals as he could before making the return trip. But how could he devote sufficient time to tracking game if he also had to butcher the animals; cut the muscle meat into thin, dryable strips and dry them before they became fly-infested or rotted; remain close enough to the drying rack to be able to periodically flip the strips so they would dry thoroughly and evenly; protect the drying meat from morning dew and from sudden rain showers; and keep wolverines and other mammalian and avian predator–scavengers from stealing the meat. In short, drying meat required supervision over the course of the day and, again judging by numerous early accounts, the entire process of drying typically took at least two to three days to complete, regardless of habitat or whether the meat was air-dried or slowly smoked over a fire (see Speth 2018:194–198). The smoking process would also require a steady supply of firewood, another demand of time and labor that a hunter could ill afford. Two to three days would be a lot of time for a hunter on a logistical foray to be away from his primary mission.

The hides presented a similar dilemma. Depending of course on the season and the purpose to which the hides would be put, they would likely rot unless they were treated quickly to preserve them for the trip home. That could involve scraping, washing, pounding, soaking, stretching, and drying, all very time and labor intensive tasks. Packing the hides in tight bundles so that they would not get wet before they reached home was another task that was best done by women in camp while the men were in the bush hunting. And who would carry all this stuff?

Because all of these essential tasks would have directly competed for the hunter's time, the picture one sees over and over again in the early ethnohistoric accounts—in which women were a common if not a normal member of most long-distance hunting forays—makes a great deal of sense. Once rapid means of bulk transport, such as dog sleds pulled by European dog breeds, horses, and snowmobiles, became available, the role of women in these hunting systems may have changed, with logistical mobility taking on a form and geographic scale more reminiscent of what Binford envisioned on the basis of his Nunamiut work. But in the north that may not have occurred until the 19th century; and, for the Paleolithic, Binford's conception may be a very poor frame of reference indeed from which to work. In the absence of dog sleds, the scale of mobility may have been much smaller; women, and likely children as well, may often have been major players in these events; with no dogs to feed, faunal assemblages (and body part valuations) may have been quite different; emergency caching of meat at localities remote from settlements may have been much less frequent because they would not have been as easily visited; settlements may have been smaller and less permanent; and so forth. In other words, the suite of archaeological correlates that one might anticipate on the basis of the early ethnohistoric accounts is likely to be different, perhaps significantly so, from the Binford-derived ones that archaeologists commonly work with today. For example, the assemblage differences between so-called "hunting camps" and "basecamps" may have been far less clearcut than many archaeologists presently assume. We need to find out, but that won't happen if archaeologists continue to accept Binford's original formulations as though they were universal facts.

PUTRID MEAT IN NORTHERN LATITUDE DIETS

Now let us take a look at what the early ethnohistoric record has to say about the role of putrid meat in human diet. These early accounts provide some real surprises about the human capacity to eat thoroughly rotten, often maggot-infested, meat without the slightest qualms about taste, smell, or pathogens. And while not strictly dealing with one of Binford's classic Binfordisms, this issue illustrates the tremendous importance of the ethnohistoric record, and it sheds light on something that Binford had a lot to say about—the hunting-scavenging debate. It also contributes to our understanding of the role of fire and cooking in early hominin evolution.

It is widely known that northern Europeans occasionally include putrid meat and fish in their diet. Thus, for example, Icelanders now and then treat themselves to a meal of fermented shark (hákarl) and Norwegians dine on rakfisk, a form of salted and fermented trout. But I suspect far fewer people realize just how ubiquitous and important such foods were in the diet of traditional arctic and subarctic hunters and gatherers such as the Inuit, northern Athabaskans, northern Algonkians, Siberians, and many others.

Westerners are firmly wedded to the idea that the sight, smell, and taste of thoroughly putrid meat automatically elicit an intense, involuntary disgust response, one which usually involves odd contortions of the nose and face, verbal expressions of disgust, turning away from the offending substance, a gag reflex, and even vomiting. Most scientists assume that such intense aversion to rotten meat is a human universal that evolved to protect us from ingesting foods laced with pathogens (see, for example, Curtis et al. 2004). Yet there is a library's worth of 19th century and earlier ethnohistory that shows this seemingly "intuitively obvious" truism to be patently false. Consider, for example, the following 19th-century quotes (see Speth 2017 for many others):

> Ikwa [an Inuit]... returned in a jubilant frame of mind, and announced his discovery of a cached seal. He asked Mr. Peary if he might bring the seal to Redcliffe in the boat, saying it was the finest kind of eating for himself and family. We could not understand why this particular seal should be so much nicer than those he had at Redcliffe; but as he seemed very eager to have it, we gave him

> the desired permission, and off he started, saying that he would be back very soon. About half an hour later the air became filled with the most horrible stench it has ever been my misfortune to endure, and it grew worse and worse until at last we were forced to make an investigation. Going to the corner of the cliff, we came upon the Eskimo carrying upon his back an immense seal, *which had every appearance of having been buried at least two year*s. Great fat maggots dropped from it at every step that Ikwa made, and the odor was really terrible. Mr. Peary told him that it was out of the question to put that thing in the boat; and, indeed, it was doubtful if we would not be obliged to hang the man himself overboard in order to disinfect and purify him. But this child of nature did not see the point, and was very angry at being obliged to leave his treasure. After he was through pouting, he told us that the more decayed the seal the finer the eating, and he could not understand why we should object. He thought the odor 'pe-uh-di-och-soah' (very good). (Diebitsch-Peary 1894:59–60, emphasis added)

> Right alongside the spot where we pitched our camp we found an old cache of caribou meat—*two years old I was told*. We cleared the stones away and fed the dogs, for it is law in this country that as soon as a cache is more than a winter and a summer old, it falls to the one who has use for it. The meat was green with age, and when we made a cut in it, it was like the bursting of a boil, so full of great white maggots was it. To my horror my companions scooped out handfuls of the crawling things and ate them with evident relish. I criticised their taste, but they laughed at me and said, not illogically: "You yourself like caribou meat, and what are these maggots but live caribou meat? They taste just the same as the meat and are refreshing to the mouth." (Rasmussen 1931:60, emphasis added)

Judging by conventional scientific wisdom, these northern hunters should have died if they consumed meat in that dreadful state of decomposition. Instead, they clearly delighted in its taste

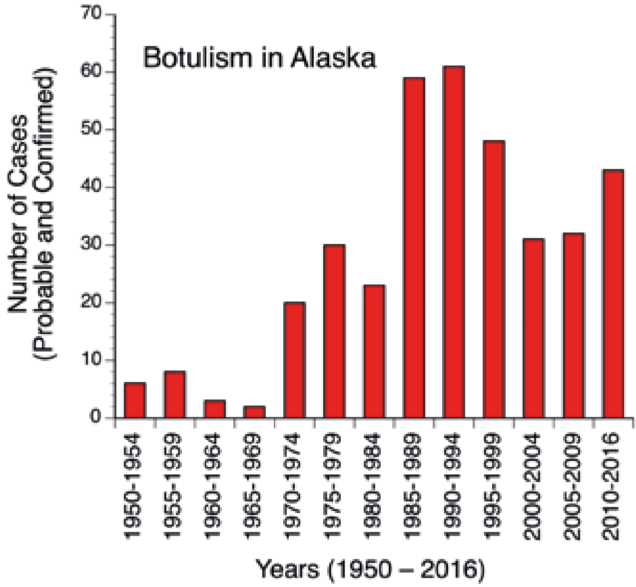

Figure 2. Frequency of confirmed and probable cases of botulism in Alaska between 1950–2016 (redrawn from Department of Health and Social Services 2017:7, their Figure 1).

---

and were either oblivious to the smell or took it as a sign of good food, not spoiled or dangerous food. Moreover, they considered maggots to be equally good as food, and responded to the evident disgust expressed by Europeans by pointing out that maggots ate the same meat they did and hence were simply additional "meat."

Why weren't these northern foragers immediately incapacitated by botulism *(Clostridium botulinum)* or by other potentially deadly pathogens? Despite their heavy reliance on putrid meat and fish, there is no evidence that Inuit suffered to any major extent from botulism or the toxic metabolites of other pathogens until the 1970s and 1980s (Figure 2; see also Department of

Health and Social Services 2017:7, their Figure 1). That's when well-intentioned Westerners, thinking that Indigenous methods of putrefaction were unsanitary and hence unsafe, introduced sterile plastic and glass containers, and encouraged foragers to shift where they putrefied their meat and fish from what they perceived to be "filthy" and "primitive" below-ground pits and caches to "sanitary" above-ground structures and containers.

Unfortunately, contrary to what the outsiders expected, the results of these supposed "improvements" were disastrous (Burch 2006:214; Chiou et al. 2002; Fagan et al. 2011; Shaffer et al. 1990). Why? Because these Westerners were working with the same underlying assumption that so many biologists, evolutionary psychologists, and food scientists work with—namely that decomposing meat rapidly becomes a hotbed of pathogens that is not only disgusting but dangerous to humans as a food source. But northern hunting peoples have been eating such foods with apparent impunity—and unequivocal expressions of pleasure—for centuries, probably millennia, and they ate much of it without cooking (Speth 2017).

Earlier I noted that it can be very difficult to recognize bias built into the assumptions that underlie our modern-day "objective" or "scientific" thinking. Well, this is an example of just such bias, one that is so firmly woven into the fabric of Western culture that few scientists, regardless of discipline, recognize it as such. To illustrate, here are a few statements taken directly from mainstream bioscience literature: "because *humans* have a distaste for rotting carcasses..." (Shivik 2006:816, emphasis added); or "the obvious reason for the historical lack of scavenging studies is human aversion to decomposing matter" (DeVault 2003:226, emphasis added); or "in warm climates, [a piece of meat] is unacceptable *to just about all* within a few hours to days, *except those who specialize in eating meat in the later stages of decomposition*"

(Janzen 1977:703, emphasis added); or, finally, "the microbiota of vertebrates rapidly begin to decompose their hosts after death. During the subsequent breakdown of tissue, these microorganisms excrete toxic metabolites, rapidly rendering the carcass a hazardous food source *for most carnivorous and omnivorous animals*" (Roggenbuck et al. 2014:1).

Contrast these sweeping scientific assertions with the ethnohistoric observations quoted earlier. There is obviously a huge disjunct between what contemporary Western science tell us and what northern foragers did less than a century ago (and many still do). Unfortunately, such deep-seated cultural bias is reinforced by the siloed nature of our academic disciplines. After all, how many students of biology, medicine, or food science are expected as part of their normal academic curriculum to read 18^{th}- or 19^{th}-century explorer accounts that describe the food habits of Indigenous northern hunting peoples? Unfortunately, without such exposure it becomes an easy matter for scientists to draw the erroneous conclusion that a widely shared behavior in their own Western or "Westernized" culture, one that also seems to "make sense" scientifically, must therefore be a human universal. And the risk of such confusion has been steadily growing over the last century or so with the spread of Western value systems, foods, sanitary practices, and antibiotics, as well as urbanization, industrialization, the impact of global market economies, movies, TV, advertising, smartphones, and the Internet.

Up to this point I have left unanswered what is undoubtedly the most critical question. What, in fact, did protect traditional northern foragers up until about 1970 from deadly pathogens like botulism. Sadly, Western science has yet to come up with a convincing explanation. Some scientists point to the low average annual temperatures in the north as the key. However, the neurotoxins of *C. botulinum* are not neutralized or destroyed by freezing (Archer 2004:129; James 1933:241; Siegel 1993:339), nor are *Listeria and Salmonella* (Archer 2004:131; Golden et al. 1988:17, 22–23). Moreover, judging from the ethnohistoric record, northern foragers seem to have had no qualms about eating rotten meat, not just in winter, but throughout the warm months of the year as well. And there are a fair number of reports, including those quoted earlier, of eating meat that had been slowly putrefying for up to two years or longer.

Others note that human gastric pH (~1.5) is very low and quite similar to that of vultures and other predator–scavengers (typically between 1 and 2). Such low pH values might therefore have given humans a significant degree of protection against the harmful effects of ingested pathogens (Beasley, Koltz et al. 2015:5–6; Beasley, Olson et al. 2015:115). However, Graves (2017:467) has questioned the supposed link between low pH and protection against pathogens, noting that "...the stomach and intestines of New World vultures appear to be no more acidic than those reported for domestic fowl and non-scavenging birds that consume large animal prey."

In any case, neither cold temperatures nor low gastric pH would explain why botulism posed little threat to the Inuit and other northern foragers until the 1970s, but then suddenly burst upon the scene just as Westerners altered the way these northern hunter–gatherers putrefied their meat and fish (see Figure 2). Stomach pH didn't change. And while the temperature regime in sterile containers placed above-ground might have differed somewhat from the ones to which the foods were exposed using traditional methods, this hardly seems like an adequate explanation for the sudden outbreak of botulism. Likewise, the partial loss of traditional knowledge about methods of meat preparation falls short as well, since many elders in Indigenous communities today continue to carefully preserve the necessary traditional knowledge (e.g., Campbell et al. 2022; Frink and Giordano 2015; Shaffer et al. 1990; Spray 2002).

PUTRID MEAT BEYOND THE NORTHERN LATITUDES

So what protected northern foragers from the potentially deadly effects of food-borne pathogens like *C. botulinum*? Was there something unique about their genetics, or did their immunity stem from interactions with their environment (*sensu lato*; i.e., diet, childhood exposure to pathogens, gut flora, and so on)? Once again, the ethnohistoric record may help point us in the right direction (see Speth and Morin 2022).

Conventional wisdom would tell us that the last place on the globe where we would expect people to be able to safely consume putrid meat is in the sweltering, humid, low-lying tropics. Why? Because in such environments animal carcasses decompose far more rapidly than in the north, usually within a matter of a few hours, and the meat quickly becomes laced with high levels of deadly pathogens (Beasley et al. 2015b; DeVault et al. 2003; Roggenbuck et al. 2014:1). However, conventional wisdom notwithstanding, a quick glance at the ethnohistoric record immediately shows that even this seemingly commonsense notion falls apart. Indigenous peoples throughout the equatorial regions seem to have had no qualms about eating thoroughly rotten meat, and they often did so by choice and with obvious pleasure.

> [Ghana] They use altogether raw and strange kind of meates… […] Dogs, Cats, and filthy stinking Elephants, and Buffoloes flesh, wherein there is a thousand Maggets, and many times stinkes like carrion, in such sort that you cannot indure the smel thereof… (Purchas 1625:935)

> [Democratic Republic of the Congo] I was travelling with a group of natives in a canoe going to Mbala from Lotumbe, once, and we came upon a big dead fish floating in the river. They let out a shout of joy and headed for it. [...] The fish was so rotten that they had to lift it out of the water with a mat to keep it from entirely disintegrating. They took it tenderly aboard and at the first beach we came to they warmed it up a little over a fire and ate it with gusto. Because of climatic conditions meat spoils so rapidly that by the time it has reached the village from the forest it is frequently quite ripe. But nothing ever deters the native from satisfying his desire for it. The odour is never too overpowering; the maggots are never too thick, the state of decomposition is never too complete. Their cast-iron constitutions seem to be able to withstand even the most violent gastronomic insults without being too seriously affected. (Davis 1941:259)

> [Democratic Republic of the Congo] The climate in the Congo is very bad for all kinds of food. Antelope, killed in the early morning, is often rotten by the evening, and thus the difficulty of obtaining fresh food is greatly increased. [...] One day a carcase of a wild pig in a highly decomposed condition was picked up by one of the paddlers on the Ubangi. This was cut up and shared among the canoes and part of it fell to my crew. Next day a most unpleasant smell accompanied us all the forenoon and no one could detect the cause, in fact, none of the natives noticed it. At lunch time however, the polemen produced a basket full of rotten flesh which they had stored in the front part of the canoe and thus given me the full benefit of it. *As they commenced eating it raw*, it was rather too much and I promptly ordered them to the other end of the boat where I could neither see nor smell them. (Dorman 1905:176–177, emphasis added)

Such accounts are nearly ubiquitous throughout the tropics and subtropics, both among traditional hunters and gatherers and among small-scale rural farming–hunting peoples. In fact, they are commonplace among Indigenous peoples almost everywhere on the globe, regardless of latitude or environment. Moreover, contrary to what many might assume, the consumption of putrid meat remained a widespread practice the world over among Indigenous peoples living outside of major colonial centers well into the early decades of the 20th century (see the many examples in Speth and Morin 2022, their Tables 1 and 2).

The pan-global distribution of putrid meat-eating among Indigenous peoples strongly supports the notion that this remarkable immunity to food-borne pathogens derived mainly from environmental sources, not genes (Speth and Morin 2022). Priming of gut floras and immune systems through early childhood exposure to pathogens may have played a critical role in the development of such protection. This conclusion fits well with findings from recent microbiome research, including comparisons of the immune resistance of carrion-eating animals like hyenas living in the wild versus their cousins kept in zoos, and from studies of the gut floras of monozygotic twins living in the same household versus those living separately (Blum et al. 2019; Gilbert et al. 2018:393; Grieneisen et al. 2019; Rothschild et al. 2018:212-214; Yatsunenko et al. 2012).

The widespread practice of alloparenting (care provided by individuals other than the parents) and allonursing (nursing of infants by both lactating and sometimes non-lactating women that are not the infant's own birth mother) documented among hunter–gatherers, especially among those living in the tropics, as well as among many small-scale rural farming–hunting peoples, may prove to be another important mechanism by which an infant's immune system becomes primed right from the start to cope with the full array of local pathogens that the child is likely to encounter throughout its lifetime (e.g., Atyeo and Alter 2021; Henry and Morelli 2022; Hewlett and Winn 2014; Lyons et al.

2020; Martin and Sela 2013; Pannaraj et al. 2017; Stinson et al. 2021; Tronick et al. 1987).

Unfortunately, despite a veritable explosion of research on the human microbiome and related fields, we still remain largely in the dark about the nature and composition of the bacterial assemblages that developed in traditional northern foods such as seals, walruses, caribou/reindeer, elk, muskoxen, polar bears, moose, arctic hares, and ptarmigans as they underwent putrefaction. We also know regrettably little about the gut flora of northern hunting peoples, not just those who still subsist at least partly on "country" (i.e., traditional) foods, *but those who still make regular use of country foods prepared in traditional ways and using non-Western canons of hygiene* (see Campbell et al. 2022; Dubois et al. 2017; Girard et al. 2017; Hauptmann et al. 2020a, 2020b).

WHY DO WESTERNERS FIND PUTRID MEAT DISGUSTING?

The ethnohistoric record makes it clear that the revulsion that Westerners and "Westernized" peoples feel toward putrid meat and maggots is not hardwired in our genome, but instead is a cultural phenomenon, probably learned in very early childhood and that very likely has little or nothing to do with protecting us from ingesting potentially harmful pathogens (Liberman et al. 2016). In fact, early exposure to pathogens is very likely what gave Indigenous peoples their remarkable resistance to such diseases.

When trying to understand the origins of a deeply ingrained cultural tradition, one must be careful not to conflate the desire for achieving a state of holiness and purity in the eyes of God with concerns about food safety and pathogens. This distinction is not trivial, as the following quotes clearly illustrate. The first one, taken from the Qur'an, forbids the eating of carrion, not for reasons of health, but because an animal that has not been ritually slaughtered is not acceptable in the eyes of God (*halal vs. haram*). The second, a quote from an early 20th-century ethnohistoric account, makes it clear that, if meat was derived from an animal that had been ritually slaughtered and bled in the manner prescribed by the Qur'an, and over which the appropriate prayers had been offered, the fact that the meat might be putrid was of no concern (the meat was still accepted as halal). In other words, the issue was not whether the meat was fresh or decomposing, but how the animal from which it was procured had died.

> Forbidden to you is that which dies of itself, and blood, and flesh of swine, and that on which any other name than that of Allah has been invoked, and the strangled (animal) and that beaten to death, and that killed by a fall and that killed by being smitten with the horn, and that which wild beast have eaten, except what you slaughter, and what is sacrificed on stones set up (for idols) and that you divide by the arrows; that is a transgression. (Surah al-Ma'idah or 5th chapter of the Qur'an)

> [Algeria] It had been the intention to keep the ram for a long time, but it became so restless that Ferreg and Maatallah, who shared in the purchase, suggested killing it immediately. We left them to carry out the unpleasant Muslim rites, and went on ahead, and halted at some pasturage. [...] After one meal off the ram the carcase began to putrefy, although neither Tuareg nor Arabs appear to mind eating green, rotten meat. (Pearn and Donkin 1934:403–403)

Religious proscriptions directed against the consumption of carrion are common in the Hebrew Bible and Old Testament (e.g., Deuteronomy 14:21 [KJV]; Ezekiel 4:14 [KJV]; Leviticus 17:10–14 [KJV]), New Testament (e.g., Acts 15:28–29 [KJV]), and continue in later Christian, Jewish, and Muslim texts. Throughout this long religious tradition, theologians over and over again drew direct connections between rot, stench, and filth with unholiness in the eyes of God, spiritual depravity, and sin (e.g., Brown 2009:15).

Some European theologians took these beliefs to the extreme. Thus, if God created heaven and earth, and one can assume that Creation was perfect, then God must have blessed the earth with a perfect climate and environment. Not surprisingly, the place so blessed just happened to be Europe. From that blatantly ethnocentric and racist vantage point, those environments on the globe most alien to Europeans—the hot, steamy, tropical lowlands of equatorial Africa and south and southeast Asia—were seen as hotbeds of rot, stench and, of course, human depravity (Markley 2010:108; Ray 1691:64–65). The fact that Indigenous peoples in those unholy places just happened to eat rotten meat and maggots made the environments and their inhabitants all the more disgusting to the European eye.

Such deep-seated cultural values and traditions, though now far less overtly religious, persist even to the present day (e.g., the oft heard expression "cleanliness is next to godliness"), and are perhaps best epitomized by our revulsion at the sight and smell, not just of decomposing flesh, but of virtually all bodily effluvia, not to mention our ceaseless Herculean efforts to sanitize, freshen, and deodorize our breath, every nook and cranny of our bodies, our clothing, our food, and practically everything else around us. We have transformed long-held Judeo–Christian concerns about religious purity and spiritual contamination into a multi-billion dollar industry!

HUNTING VS. SCAVENGING AND THE ORIGINS OF COOKING

The putrefaction of meat and fat accomplishes outside of the body much of what would normally happen to these foods inside the body if ingested in their fresh state (Kozlov and Zdor 2003). Moreover, in the tropics putrefaction happens rapidly and with little or no investment of time or energy by the consumer. In other words, in many respects putrefaction, through the combined postmortem proteolytic effects of endogenous enzymes in the carcass and the products of both endogenous and exogenous bacterial action, becomes a powerful and very low-cost way of "pre-digesting" meat, softening the flesh significantly, and breaking down the proteins into peptides and amino acids (Amato et al. 2021; Fadda et al. 2002; Forbes et al. 2017; Ordóñez and de la Hoz 2007; Petäjä-Kanninen and Puolanne 2007). The same endogenous and exogenous processes also contribute to the breakdown or lipolysis of fats in the food, liberating a range of nutritionally beneficial free fatty acids (Forbes et al. 2017; Vasundhara et al. 1983). In fact, putrefaction produces many of the same benefits that cooking does but more or less automatically and at far less cost.

If this conclusion is correct, it implies that early hominins could have scavenged meat from decomposing carcasses and consumed it safely without having to cook it first. In fact, I suspect there would have been little incentive to cook meat until hominins began to acquire greater proportions of fresh meat from animals they had killed themselves. Whatever the case, I hasten to point out that I do not see this suggestion as a counterargument to Wrangham's (2009) "cooking hypothesis" popularized in his well-known book *Catching Fire: How Cooking Made Us Human*. In the opinion of many archaeologists and paleoanthropologists, one with which I concur, meat—whether hunted or scavenged—

probably provided only a small and unreliable component of early hominin diet, with the bulk of energy and nutrients coming instead from plant foods (Barr et al. 2022; O'Connell et al. 2002). It is conceivable, therefore, that cooking's most important nutritional contribution to early hominin diet lay in the botanical domain, by making starchy and oily plant foods softer, easier to peel and process, and more readily chewable and digestible (e.g., Groopman et al. 2015; Schnorr et al. 2016; Wrangham 2009). Cooking may also have helped to neutralize or eliminate harmful or irritating phytochemicals (Palermo et al. 2014). And, of course, at some as yet unknown point in the human story the use of fire added all sorts of social and symbolic dimensions to human foodways and ways of life.

PROBLEMS WITH UTILITY INDICES IN NORTHERN LATITUDES AND THEIR PLEISTOCENE ANALOGS

One of Binford's (1978b) most important and influential contributions, based on several years of field work in Alaska among the Nunamiut and published in detail in *Nunamiut Ethnoarchaeology*, was his development of utility indices—rankings of ungulate body parts according to their yields of meat, marrow, and grease. While he generated a variety of different indices (e.g., meat, marrow, grease, drying), each suited for a somewhat different purpose, perhaps the most widely used is the Modified General Utility Index or MGUI (Binford 1978b:74; see Table 1). Using two representative ungulates (caribou and sheep), this index combined individual measures of the amount of meat, marrow, and bone grease for each major skeletal element into a single composite value for each part. He then standardized these values (i.e., converted them to percentages) relative to the element with the highest value (generally the femur). He then modified this composite index—the General Utility Index or GUI—to form the MGUI by adjusting the values assigned to certain individual elements that had no intrinsic food value on their own, but were often transported away from kills as "riders" attached to other, more valuable elements (e.g., small carpals and tarsals). In both the MGUI and its simplified derivative, the Food Utility Index or FUI (Metcalfe and Jones 1988), the femur is the highest ranking element, with a standardized value of 100%. The implication is that the thighs (a.k.a. hams or haunches) are uniquely valuable portions of an ungulate carcass, ones that hunters should almost always save and transport away from kills.

Table 1. Binford's (1978b:74) Modified General Utility Index or MGUI for caribou (standardized values presented in rank order).

Skeletal Element	MGUI[1]
Proximal femur	100.00
Distal femur	100.00
Proximal tibia	64.73
Sternum	64.13
Ribs	49.77
Pelvis	47.89
Distal tibia	47.09
Thoracic vertebrae	45.53
Scapula	43.47
Proximal humerus	43.47
Distal humerus	36.52
Cervical vertebrae	35.71
Lumbar vertebrae	32.05
Astragalus	31.66
Calcaneus	31.66

Skeletal Element	MGUI[1]
Mandible with tongue	30.26
Proximal metatarsal	29.93
Proximal radius-ulna	26.64
Distal metatarsal	23.93
Distal radius-ulna	22.23
Skull	17.49
Mandible w/o tongue	13.89
Phalanges	13.72
Proximal metacarpal	12.18
Distal metacarpal	10.50
Atlas-axis	9.79

[1]Standardized MGUI values for caribou (*Rangifer tarandus*) skeletal elements (expressed as percentage of value for element with highest MGUI value [femur] and listed in descending rank order).

Binford's immediate objective in creating these indices was to model the butchering, processing, and transport decisions made by Nunamiut caribou hunters in northern Alaska. Ultimately, his goal was much broader—to use these models as a means to better understand the way Eurasian Middle and Upper Paleolithic hunters dealt with reindeer, caribou's Old World cousin. The development of these indices is a classic example of the way Binford used insights from the living world of hunters and gatherers to generate frames of reference for understanding behavior in the past.

Binford's original models were quite complex, and subsequent studies have simplified several of them. While these modifications have made the derivation of the indices more transparent and straightforward, the improvements, with few exceptions (e.g., Morin 2007), mostly address technical and methodological issues, and miss some fundamental interpretive problems. At the heart of the issue are the assumptions Binford made about the value of muscle meat. Both the MGUI and FUI place the upper fore- and hindlimbs among the highest-ranking anatomical units in an ungulate carcass in large part because of the masses of muscle tissue associated with these areas of the body. In the American meat industry, the former is commonly referred to as the "chuck," the latter as the "round" (Figure 3). The femurs, in fact, invariably take first place because the thighs or hams account for some two-thirds of the total muscle in the legs of most ungulates (Brink 2001:256).

Intuitively, the MGUI and FUI seem to be doing their job, and doing it well, because they assign the highest values to precisely the same parts that we would normally select at the local grocery store—the meaty roasts and steaks of the upper limbs. But that's where the ethnohistoric record becomes a vital check on our frames of reference. These accounts make it absolutely clear that the parts we most esteem, and that the MGUI and FUI single

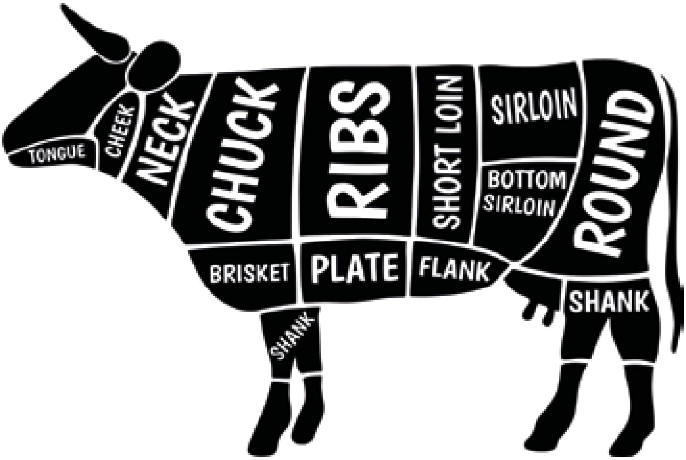

Figure 3. Terms commonly used by the American meat industry for the major meat cuts of a large ungulate. The upper forelimb is called the "chuck," the upper hindlimb the "round." These are the meatiest portions of the carcass and among the most highly ranked parts according to Binford's MGUI (Freepik stock image; https://www.freepik.com/premium-vector/butcher-cow-map_801921.htm).

---

out as highest ranking, are actually the meat cuts that northern hunter–gatherers most often viewed as dog food or white man's food and frequently discarded. What traditional northern foragers most valued in the limbs was, not the lean muscle, but the fatty marrow content within the bones (Abe 2005:100, footnote; Anderson 1918:61; Banfield 1957:13; Bessels 2016:160; Flook 1952:3; Gaede-Penner 2016:124; Gubser 1965:301; Hadleigh-West 1963:180; Hanson 1973:62–63, 119–121; Harper 1932:30–31; Ingstad 1951:102, 1992:186; Kooyman 1981, 1988; Lawrie 1948: unpaginated, 43rd page of document; Pike 1892:51; Price 1939:260; Russell 1898:90–91; Stefansson 1909:607; 1921:232, 1944:2; Turner 1894:278; United States Army, Chief of the Air Corps 1940:231; Wheeler 1914:58; Whitney 1896:722). The following quotes from the ethnohistoric record strikingly underscore this counterintuitive reality:

> When it is remembered that the ordinary meal for a dog-train—i.e., four dogs, that are travelling thirty or more miles a day—consists of a caribou hind and fore quarter, that we had twenty eight dogs, and that we never got more than a caribou or two at intervals of several days, the reader may understand why the dogs were like wild animals, and why we ate the intestines and grease and saved them the meat. (Whitney 1896:722)

> For themselves, the hams are either fed to the dogs, which must have their share, or cut up for drying. The white man's "choice cuts" are not the Eskimo's or the Indian's favorites, and as a rule are not the first choice of the out-door man who is cooking in the field with primitive appliances. (Anderson 1918:61)

> I found the Indians putting great emphasis upon the eating of the organs of the animals, including the wall of parts of the digestive tract. Much of the muscle meat of the animals was fed to the dogs. (Price 1939:260)

> The coarse meat, which in civilization is used for joints and steaks, is the least popular. In autumn and spring it is used to a certain extent for dried meat, otherwise it is given to the dogs. (Ingstad 1951:102)

The million dollar question, of course, is why traditional northern foragers placed so little value on precisely those cuts of meat we Westerners prize so highly—the steaks? There are two obvious reasons. First and foremost, muscle meat from wild ungulates, regardless of species, sex, or time of year when the animal was killed, has virtually no intramuscular fat (IMF or "marbling") and very little intermuscular fat (Figure 4). What little fat does occur is found in the animal's brain, tongue, under the skin (subcutaneous), in the brisket (sternal or breast area) and intercostal tissue (ribs), around the internal organs or viscera, and in the

Figure 4. Bison meat (range fed, uncooked) showing almost total lack of ***intramuscular fat*** *(IMF) or "marbling" (Dreamstime stock image 205227133).*

Figure 5. Beef (farmed, feedlot finished, uncooked) showing extensive deposits of ***intramuscular fat*** *(IMF) or "marbling" (iStock image 184369737).*

marrow cavities. In striking contrast, meat from domestic animals (e.g., beef) often has substantial quantities of intramuscular fat distributed throughout the muscle tissue (Figure 5). As I will explain shortly, fat was, hands down, the most critical limiting nutrient for hunters in northern latitudes, and muscle meat, because it is one of the leanest parts on the carcass of a wild ungulate, would be anything but highly ranked.

The following quotes show the striking disjunct between the serious nutritional constraints faced by northern hunters subsisting on a diet of lean meat obtained from wild game and the consumer preferences that typify the contemporary Western palate.

> [Traditional northern hunter–gatherer diet] If you are transferred suddenly from a diet normal in fat to one consisting wholly of rabbit you eat bigger and bigger meals for the first few days until at the end of about a week you are eating in pounds three or four times as much as you were at the beginning of the week. By that time you are showing both signs of starvation and of protein poisoning. You eat numerous meals; you feel hungry at the end of each; you are in discomfort through distention of the stomach with much food and you begin to feel a vague restlessness. Diarrhoea will start in from a week to 10 days and will not be relieved unless you secure fat. Death will result after several weeks. (Stefansson 1945:234)

> [Western consumer preferences] Carcass value is influenced by the development of muscle, bone and fat with the most valuable cuts of meat coming from the loin and hindquarters of the carcass. The amount of external, internal and intermuscular fat effects the economic value of carcasses more than any other factor... *as the highest commercial returns are realized from carcasses possessing the highest amount of lean tissue in comparison to bone and fat.* (Renecker et al. 2005:117, emphasis added)

Muscle also has virtually no vitamin C (Speth 2019). In lower latitudes, where foragers had ample access to vitamin C-rich fruits and vegetables, the lack of this micronutrient in meat would have been unimportant. But in northern latitudes, where hunters were often dependent almost entirely on animal foods for months on end, the scarcity of this vitamin could rapidly lead to the onset of scurvy and ultimately death. In ungulates, vitamin C is concentrated in the internal organs and nervous tissues, with by far the highest values in the adrenal glands (Hediger 2002:445). Although northern foragers may have known nothing about vitamin C, they were well aware that consuming an animal's internal organs, and the adrenal glands in particular, offered them the greatest protection against scurvy (see Price 1939:75).

Given the extensive ethnohistoric record explicitly downplaying the value of muscle meat, and especially the thighs, as human food, it is a mystery to me why Binford nonetheless proceeded to assign the highest overall utility value to the femurs. Particularly mysterious is why he ignored Helge Ingstad's (1951) observations (quoted above), the author of the earliest and most important ethnography on the very same Nunamiut community that Binford came to study almost two decades later. Ingstad was crystal clear in stating that the thighs and other muscle meat were generally used as dog food, not human food.

Even more perplexing is the fact that Binford (1978b:41) got the same reaction from his own Nunamiut informants when he asked them to rank caribou body parts strictly on the basis of their perceived meat value. His informants' rankings, shown in Table 2, leave little doubt that they too viewed muscle meat as a poor source of human food. They certainly didn't give the femurs top billing, not even close.

Table 2. Ranking of perceived meat value of major caribou body parts according to Binford's Nunamiut informants. Skeletal elements of the upper fore- and hindlimbs are shown in red capital letters.

Skeletal Element	Rank (mean)
Sternum	1.2
Ribs	1.7
Thoracic vertebrae	3.2
Lumbar vertebrae	3.7
Sacrum-pelvis	5.0
Tongue	6.2
FEMUR	6.7
TIBIA	6.7
Skull	8.0

Skeletal Element	Rank (mean)
SCAPULA	9.0
HUMERUS	9.0
Atlas-axis	10.0
Cervical vertebrae	10.0
Phalanges	10.7
Metatarsal	11.0
Radius-ulna	12.0
Metacarpal	12.0

The striking disjunct between the rankings provided by Binford's heavily meat-based utility indices and the picture that emerges from ethnohistoric and ethnographic sources leaves us with a bothersome interpretive quandary. When archaeologists study a prehistoric faunal assemblage and find a significant correlation between MGUI (or FUI) values and skeletal element frequencies, what do these results really mean? Are we seeing evidence of behavior driven by human food needs, or instead by the needs of the hunters' dogs? What about in earlier times when domestic dogs weren't part of the picture? Do such correlations perhaps reflect hunters' transport decisions based, not on the masses of meat on the limbs, but on their marrow content? In other words, when femurs were brought to a campsite, how many of them arrived fully fleshed, and how many arrived after the meat had already been removed and partially or entirely discarded? In short, the MGUI and FUI may not be telling us what we usually assume they do. This is clearly an issue we need to explore much more fully.

SURPLUS KILLING AND THE IMPORTANCE OF FAT

In this final section, I will turn to the issue of surplus killing. The argument, again based heavily on insights drawn from the ethnohistoric record, holds that families or small parties of northern hunters were frequently unable to obtain enough fat from their ungulate kills to compensate for an almost inevitable caloric deficit that arose because of a physiological limit to the amount of lean meat (i.e., protein) they could safely consume on a daily basis. The result was that the hunters were often compelled to continue hunting long after their protein intake had approached or reached the physiological limit in order to fill the remaining energy deficit with non-protein calories (which in northern latitudes and their Pleistocene analogs had to come mostly from animal fat and fermented stomach contents—see Hearne 1795:316-317).

Let us begin by briefly considering the amount of protein a hunter can actually consume on a daily basis without deleterious health consequences. That amount is often expressed as a percentage of total calories, a figure usually placed somewhere between 25%–35%, although higher percentages are frequently reported in the literature (see Bilsborough and Mann 2006:132–133). Unfortunately, though commonly done, thinking in terms of percentages is misleading, as it gives the mistaken impression that a forager will be fine so long as he or she keeps adding fat or carbohydrate to the diet in order to keep the proportion of protein below the critical threshold. But the limit, whatever the current uncertainties may be about its actual value, *is an absolute, not a relative, amount of protein*, expressed in grams per kilogram body weight, that an individual can safely metabolize within a 24-hour period. Once that amount has been exceeded, and allowing for a certain (but unknown) degree of adaptation, augmenting one's intake of fat or carbohydrate is not likely to result in a significant upward displacement of the protein limit. *In other words, because* *of its protein content, the maximum amount of meat that a forager can safely consume per day is finite, regardless of how much fat the forager can glean from the carcass, or starchy plant foods happen to be at hand in the surrounding landscape or in storage. Once the protein limit is reached, any surplus meat is likely to be discarded.*

Why should there be such a limit? The amino acids from ingested proteins are catabolized (deaminized) in the liver, and the nitrogenous wastes that result from this process are converted to urea and largely excreted in the urine (Morris 1992, 2002; Powers-Lee and Meister 1988; Saheki et al. 1977, 1980). Dimski (1994) provides a concise description of how the urea cycle works; she also outlines the major differences between obligate carnivores, such as cats, and non-carnivorous mammals, such as rats, dogs, and humans, in the way they synthesize urea. According to Rudman et al. (1973) (see also Cordain et al. 2000; Jackson 1999; Mann 2000; Bilsborough and Mann 2006), the ability of the liver to upregulate the enzymes involved in the synthesis of urea is rate limited, such that at protein intakes above the safe upper threshold the liver can no longer effectively deaminize the amino acids, leading to a build-up of ammonia and excess amino acids in the blood (Dimski 1994; Husson et al. 2003; Morris 1992, 2002b; Powers-Lee and Meister 1988; Ratner 1977; Ratner and Petrack 1951). Presumably these are the conditions—exacerbated by low carbohydrate intake, ketosis, and impairment of kidney function (Denke 2001; Cordain et al. 2002)—that Stefansson (1939:233) famously referred to as "rabbit starvation."

What is the actual protein limit for adult hunter–gatherers? The details were worked out many years ago by Rudman et al. (1973). Based on their experiments, the mean maximum rate of urea synthesis is about 65 mg of nitrogen (N) per hour per kg body weight (i.e., 65 mg N h^{-1} BW_{kg}^{-1}), where the value of body weight is the metabolic equivalent ($BW_{kg}^{0.75}$); the range is 55–76 mg N h^{-1} BW_{kg}^{-1}

Table 3. Maximum safe daily intake of protein (g) and meat (kcal) containing different amounts (%) of fat, as well as the expected daily energy deficit (% of total daily energy requirement), calculated for different hunter–gatherer body weight categories (kg).

Body weight[1] (kg)	50	60	70	50–70
Max. protein intake per day[2] (g)	183	210	236	300
Max. meat intake per day[3] (kg)	0.87	1.00	1.12	1.43
Max. energy from meat[4] (0% fat) (kcal)	731	840	944	1200
Daily energy deficit[5] (0% fat)	71%	66%	62%	52%
Max. energy from meat[4] (3% fat) (kcal)	966	1110	1247	1586
Daily energy deficit[5] (3% fat)	61%	56%	50%	37%
Max. energy from meat[4] (7% fat) (kcal)	1279	1470	1652	2100
Daily energy deficit[5] (7% fat)	49%	41%	34%	16%
Max. energy from meat[4] (10% fat) (kcal)	1514	1740	1955	2486
Daily energy deficit[5] (10% fat)	39	30	22	0

[1]Body weights typical of modern hunter–gatherers (Jenike 2001:223, 226).
[2]Maximum amount of protein, for a given body weight, that an individual can safely consume per day without experiencing symptoms of "rabbit starvation"; 300 g/day represents the uppermost limit to prolonged protein intake for the typical range of hunter–gatherer body weights (50–70 kg), above which an individual will very likely begin to experience serious health consequences from "rabbit starvation" (Bilsborough and Mann 2006; Rudman et al. 1973; Speth 2010:76–78).
[3]Assumes meat of both domestic and wild ungulates averages about 21% protein (Bodwell and Anderson 1986; Hoffman and Cawthorn 2012:44; Lee et al. 1995; Purchas et al. 2014; Whitney and Rolfes 2011:9; Williams 2007).
[4]Assumes protein and fat yield 4 kcal/g and 9 kcal/g, respectively (Whitney and Rolfes 2011:9).
[5]Based on a total daily energy requirement of 2500 kcal (see range of modern hunter–gatherer values in Jenike 2001:212).

($BW^{0.75}$). These rates can be used to estimate the approximate upper limit to the amount of protein that individuals of different body weights can safely consume on a daily (i.e., 24-h) basis. Assuming that protein averages about 16% nitrogen, a widely used value to estimate total or "crude" protein (see Conklin-Brittain et al. 1999), a 50 kg (110 lb) adult can safely consume about 183 g of protein per day, while a 70 kg (154 lb) individual can handle up to about 236 g (see Table 3). Nutritionists seem to agree that, regardless of one's body weight, sustained protein intakes that exceed roughly 300 g per day are potentially dangerous and can lead to serious health consequences and even death (Cordain et al. 2000; Mann 2000; Bilsborough and Mann 2006).

Dietary and nutritional data recorded in the first half of the 20th century among traditional coastal-dwelling Inuit in Greenland highlight the reality of the 300 g protein limit. In the earliest of these studies, conducted by August and Marie Krogh (1915; see summary in Rodahl 1954a:71–73), these Inuit consumed about 1.8 kg of meat per day, yielding approximately 280 g of protein and 218 g of fat, the latter coming mostly from marine mammals. Assuming that protein yields 4 kcal per g and fat yields 9 kcal per g (Whitney and Rolfes 2011:9), this group of foragers obtained 1,120 kcal from protein and 1,962 kcal from fat, for a total daily intake of 3,082 kcal, approximately 36% of which came from protein. In another early study, Høygaard (1941:56; see also Mullie et al. 2021) estimated that the Angmagssalik Inuit, also marine mammal hunters in Greenland, consumed about 2,800 kcal per day, with protein contributing 299 g (1,196 kcal or 43% of calories) and fat contributing an additional 169 g (1,521 kcal). Note that Høygaard's percentage figure for average daily protein intake is well above the oft-mentioned 25%–35% range, though it still does not exceed the 300 g ceiling.

To illustrate how this protein threshold works, let us assume we are dealing with a forager who subsists entirely by hunting. We will also assume that the forager, an adult, weighs 60 kg, a reasonable figure given data compiled by Jenike (2001:212). The maximum safe daily protein intake for a forager of that body weight is about 210 g (see Table 3). Muscle meat from wild ungulates typically averages about 21% protein, give or take a few percent; the rest is mostly water and small amounts of fat. With an upper protein limit of 210 g, our hypothetical forager can safely consume only about 1.0 kg of fresh, uncooked meat per day or about 840 kcal's worth of protein. For an adult who burns, say, 2,500 kcal per day (again based on data compiled by Jenike 2001:212), and *assuming for the moment that there is no fat in the meat*, our forager will fall short by nearly two-thirds of his or her total daily energy needs. That would be a staggering deficit to have to face, despite having made a successful kill. Even if the forager pushes his or her intake all the way to the threshold of "rabbit starvation" by consuming 300 g of protein, thereby allowing the forager to consume 1.43 kg of fresh meat, that would still only provide 1,200 kcal from the protein, not even 50% of the forager's daily energy needs. These figures underscore the tremendous importance of fat to northern foragers, and very likely to their ancestors inhabiting analog Pleistocene environments.

So how much fat is there in the carcass of a typical wild ungulate? The answer is not very much, not just in animals living in the north, but globally. Let's put some numbers to this assertion. Because of seasonal fluctuations in food availability (i.e., winter–spring vs. summer–fall, or rainy season vs. dry season), and the demands of the animals' reproductive cycles (pregnancy and lactation in females, rutting in males), most wild ungulates seldom average more than about 10% total body fat when in peak condition, sometimes a few percent higher, but over much of the year their fat levels are lower, typically between about 3% and 7%, and sometimes even less (Speth 2010; Speth 2022; Speth and Spielmann 1983). Caribou/reindeer (*Rangifer tarandus*), arguably the most important terrestrial ungulate in the foodways of interior northern foragers, as well as during much of the Eurasian Late Pleistocene, are no exception (see, for example, Cook et al. 1989; Couturier et al. 2009; Gerhart et al. 1996; Huot 1989; Wiklund et al. 2005; Wiklund et al. 2019).

In Table 3, I have calculated the maximum number of calories that hunters of different average body weights can safely derive from meat obtained from ungulates in peak condition (10% fat), good condition (7% fat), fair condition (3% fat), and lacking fat altogether (0% fat). As a glance at the table shows, hunters will almost always face a caloric deficit unless they routinely consume levels of protein at or near the maximum limit (300 g), while consistently killing only animals in peak body condition, a constraint that will be next to impossible to fulfill over much of the year. The bottom line here is that hunters, when subsisting primarily on hunted foods, will almost always face a caloric deficit of some degree. *Thus, for interior northern hunters relying on terrestrial ungulates, near-continuous hunting or surplus killing was probably the norm, not the exception, with fat (and stomach contents), not lean muscle meat, the principal targets.*

The ethnohistoric record contains countless examples of surplus killing for the express purpose of acquiring fat, many dating prior to the expansion of the fur trade into the particular areas of concern. The following quotes provide vivid depictions of what surplus killing entailed.

> [Louis Hennepin's captivity, Issati and Nadouessans (Dakota), Minnesota, 1680] Sometimes they sent the swiftest amongst them by Land to seek for Prey, who would drive whole Droves of Wild Bulls [bison] before them, and force them to swim the River. Of these

they sometimes kill'd forty or fifty, but took only the Tongues, and some other of the best Pieces: The rest they left, not to burden themselves, that they might make the more haste home. (Hennepin 1698:198–199)

[James Isham, Canadian Arctic, 1743] I have found frequently Indians to Kill some scores of Deer, and take only the tongues or heads, and Let the body or carcass go a Drift with the tide… (Rich and Johnson 1949:81)

[Samuel Hearne, Canadian Arctic, 1770] Having prepared as much dried flesh as we could transport, we proceeded to the Northward; and at our departure left a great quantity of meat behind us, which we could neither eat nor carry away. This was not the first time we had so done; and however wasteful it may appear, it is a practice so common among all the Indian tribes, as to be thought nothing of. On the twenty-second, we met several strangers, whom we joined in pursuit of the deer, &c. which were at this time so plentiful, that we got every day a sufficient number for our support, and indeed too frequently killed several merely for the tongues, marrow, and fat. (Hearne 1795:39)

These and other simmilar accounts also reveal which body parts were the fattiest and most desirable and hence the ones most highly ranked by traditional northern hunters. Not surprisingly, the rankings differ quite markedly from what one would expect on the basis of Binford's MGUI. Most notably, the muscle masses on the upper fore- and hindlimb do not get top billing. Instead, the parts most often and most consistently targeted included the tongue (almost always at or near number 1); backfat (in early accounts often called the fleece or dépouille); fat concentrated around the neck, hump, and on the rump; brisket and ribs; fatty tissue surrounding the intestines and internal organs (kidneys, liver, etc.); and marrow. The brain was sometimes important as a food, but was often slated instead for use in softening and tanning hides. Grease-rendering at times was also important, but the process required a great deal of time and labor and was only done sporadically. One can quickly see from this list that, from the perspective of the ethnohistoric accounts, many of the most highly ranked body parts are ones that, for a variety of taphonomic and other reasons, zooarchaeologists don't routinely monitor (e.g., ribs, brisket), or are ones whose removal by hunters might leave little in the way of cutmarks or other detectable traces (e.g., tongue, backfat, visceral fat). Of this entire list, the extraction of marrow is probably the one activity that not only leaves a clearly visible set of archaeological signatures, but is also one that has received a considerable amount of attention from zooarchaeologists.

Was surplus killing little more than wasteful behavior on the part of Indigenous hunters? From a Western perspective, especially one which sees game as a "resource" or "commodity" to which a market value can be assigned, "yes." Tellingly, the blueprint for that sort of logic dates back at least to the Bronze Age, as it is already clearly spelled out in the Old Testament's *Book of Genesis, KJV*: "28 And God blessed them, and God said unto them, Be fruitful, and multiply, and replenish the earth, *and subdue it: and have dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth"* (Anonymous 1900:1, emphasis added). But in the world view of most traditional northern hunters the answer is "no." Other sentient beings, from insects to large carnivores, shared the same landscape with them. Humans were not above the others, destined to subdue them as in *Genesis*, but alongside them as spiritual equals. All had important needs that had to be acknowledged, respected, and fulfilled, one of them being basic sustenance. So, what human hunters could not use of their kills was not wasted, it was shared with other kindred beings.

Wolves provide a classic example. These intelligent social carnivores, capable of tolerating much higher protein intakes than humans, often followed northern foragers on their hunting forays. They seldom harassed the hunters, not even unarmed women traveling alone to fetch home a kill, but stayed close by, waiting to claim their share of the bounty once the hunters had taken what they needed. The ethnohistoric record provides ample evidence of the mutual respect that existed between Native hunters and wolves, a bond that not surprisingly unraveled during the 19th century as the rapacious appetite of the global fur trade penetrated the farthest reaches of the northern latitudes.

> [Expedition with Chipewyan to the Coppermine River and the Arctic Sea] They [wolves] always burrow under ground to bring forth their young; and though it is natural to suppose them very fierce at those times, yet I have frequently seen the Indians go to their dens, and take out the young ones and play with them. I never knew a Northern Indian hurt one of them: on the contrary, they always put them carefully into the den again; and I have sometimes seen them paint the faces of the young Wolves with vermillion, or red ochre. (Hearne 1795:362-363)

UTILITY, FAT, AND BODY PART SELECTIVITY

Up to this point I have discussed the fat available from an ungulate as though it were uniformly distributed throughout the entire carcass, such that almost any cut of meat from the animal would yield roughly the same amount of fat as any other. Though seldom explicitly stated, many reconstructions of hunter–gatherer diets, past and present-day, are built upon precisely this assumption. But fat is decidedly not distributed in this manner. As noted previously, meat from domestic animals like cattle, sheep, and pigs is strongly "marbled"—that is, there is a great deal of fat, not just under the skin and between the muscles (*intermuscular fat*), but also dispersed within the muscle tissue itself (*intramuscular fat* or IMF). Not so in wild game (Bartoň et al. 2014; Bureš et al. 2015; Cordain et al. 2002; Crawford et al. 1970; Davidson et al. 2011; Soriano and Sánchez-García 2021). The meat of most wild ungulates has very little IMF. In other words, it is not "marbled" and is therefore far leaner than its domestic counterparts (see Figures 4 and 5 above).

Most meat science **and** wildlife studies that report data on the amount of fat in ungulate muscle tissue generally provide values for just a few muscles, selected because they are assumed to be representative of others in the animal, and because they also happen to be easily accessible for sampling. The muscle complex most commonly reported, in large part because of its ready accessibility, is the *Longissimus dorsi*, a muscle complex comprised of the *L. thoracis* and *L. lumborum*, both of which lie along the spine atop the ribs. In the meat industry these muscles are often referred to as the "backstrap," "loin," or "ribeye" steaks. Though less often reported separately, another important muscle is the Psoas major, the "tenderloin" or "filet mignon." This muscle also lies along the spine but beneath the ribs. Two other muscles commonly analyzed are the *Semimembranosus* ("top round") and *Semitendinosus* ("eye of round"), both very lean muscles of the upper hind leg or thigh. Unfortunately, many studies, especially those most readily available to the general public, simply report a single value under the vague rubric "meat" or "venison" without specifying which muscle or muscles were analyzed.

Table 4 provides data on the IMF content of the uncooked meat (muscle) for a number of different wild ungulates. What is immediately apparent is how little fat there actually is within these tissues. The mean for the entire array is only 1.46% and many of the muscles yielded values below 1%. It is important to keep in mind that these IMF values remain low throughout the year. The values that vary most with season and sex are the intermuscular fat deposits, the fat associated with the viscera, fat within the marrow cavities, and the subcutaneous deposits, but not the IMF values. Earlier I calculated the caloric deficit faced by a 60 kg forager who consumed 300 gram's worth of protein each day in the form of meat, but with no fat in the meat. Now let's repeat the same calculation, but this time assume that the meat has a fat content of 1.46%. Operating at a level of 300 g of protein—in other words, close to the threshold of rabbit starvation—the forager can consume 1.43 kg of fresh meat, which would yield 20.86 g or roughly 188 kcal's worth of fat. That would yield the forager 1,200 $kcal_p$ + 188 $kcal_f$ = 1,388 $kcal_{total}$ or about 56% of his or her daily energy requirements. That still leaves a whopping caloric deficit of 44%! A family or party of foragers, living in the interior with no access to marine mammal blubber, could not survive just on the muscle meat of wild ungulates; additional surplus killing for the express purpose of obtaining fat would be absolutely vital to their survival.

I hasten to point out here that I am NOT suggesting that muscle meat has no food value. It certainly does. But its value is limited by its high protein and low fat content. Once a hunter has consumed about 300 g of protein (roughly 1,200 kcal's worth), he or she cannot simply continue to eat more meat to fulfill their energy needs, at least not on any sort of sustained basis. After a few weeks on a diet of this sort, the result would be rabbit starvation. The remaining energy has to come from fat or from some other source of non-protein calories (e.g., plant carbohydrates or oils). Unfortunately, those are precisely the food sources that are so difficult for archaeologists to see archaeologically, especially in Paleolithic contexts, and which understandably therefore often end up getting little more than lip service. Zooarchaeology definitely has some serious limitations...

Table 4. Average fat content (%) in the uncooked muscle meat of snowshoe hare and various wild ungulates.

Species	Muscle (uncooked)	Fat (%)	Reference
Lepus americanus (snowshoe hare)	Unspecified	0.90	Appavoo et al. (1991:110)
Cervus elaphus (red deer)	Unspecified	0.30	Lorenzo et al. (2019:1563)
Cervus elaphus (male) (red deer)	*Longissimus*	0.42	Soriano et al. (2020:4)
Cervus elaphus (female) (red deer)	*Longissimus*	0.56	Soriano et al. (2020:4)
Dama dama (male) (fallow deer)	Unspecified	0.60	Volpelli et al. (2003:559)
Lama guanicoe (guanaco)	*Semitendinosus*	1.02	González et al. (2004:77, 81)
Bison bison (American bison)	*Longissimus*	1.90	Marchello et al. (1989:178)
Bison bison (American bison)	*Semimembranosus*	1.20	Marchello et al. (1989:178)
Bison bison (American bison)	*Longissimus*	1.90	Janssen et al. (2021:11)
Bison bonasus (European bison)	*Longissimus dorsi*	1.26	Haščík et al. (2011:18)
Bison bonasus (European bison)	*Longissimus dorsi*	2.11	Haščík et al. (2011:18)
Bison bonasus (male) (European bison)	*Semitendinosus*	1.13	Łozicki et al. (2017:121)
Rangifer tarandus (female) (caribou/reindeer)	*Gastrocnemius*	2.32	Adamczewski et al. (1987:370)
Rangifer tarandus (female) (caribou/reindeer)	*Gastrocnemius*	3.90	Chan-McLeod et al. (1995:281)
Rangifer tarandus (caribou/reindeer)	Unspecified	1.90	Appavoo et al. (1991:110)
Rangifer tarandus (caribou/reindeer)	Unspecified	1.50	Appavoo et al. (1991:110)
Rangifer tarandus (caribou/reindeer)	Unspecified	1.70	Farmer et al. (1971:139)
Rangifer tarandus (male) (caribou/reindeer)	Unspecified	2.90	Hoppner et al. (1978:257)

Rangifer tarandus (caribou/reindeer)	Unspecified	1.20	Mann et al. (1962:63, 72)
Rangifer tarandus (caribou/reindeer)	*Longissimus*	1.18	Rincker et al. (2006:72)
Rangifer tarandus (caribou/reindeer)	Unspecified	1.10	Schaefer (1977:24)
Rangifer tarandus (male) (caribou/reindeer)	*Longissimus dorsi*	1.20	Semenova et al. (2019:72-73, 75)
Average		1.46	

THE BODY PARTS THAT TRULY DO RANK HIGHLY

Besides the obvious (e.g., subcutaneous fat, marrow fat, and fat around the intestines, kidneys, and other internal organs), a few body parts do stand out as particularly valued among traditional northern hunting peoples, in large part because of their fat content. Most noteworthy among these are the tongue, brain, ribs, and brisket. For example, Buffalo Bird Woman, an elder of the Northern Plains-dwelling Hidatsa, recalled the special value her people assigned to these particular parts of the bison (while obliquely indicating that her people did not attribute similar importance to the thigh meat, only to the marrow bones contained within):

> When they returned, each hunter packed a load of meat on his back… Only the choice cuts were brought back in this fashion: the tongues, the kidneys, and the ham bones for the marrow; the rest of the meat was left behind on the meat pile. Some of the ribs with the meat clinging to them were also brought in. (Wilson 1924:249–250)

Warburton Pike, a 19th-century English explorer of the Canadian west and arctic, provided an ordering of body parts very similar to Buffalo Bird Woman's ranking:

> Of the external parts the ribs and brisket rank highest, the haunches being generally reserved for dog's food; a roast head is not to be despised, and a well-smoked tongue is beyond all praise. (Pike 1892:51)

Data on the fat content (%) of brain, tongue, ribs, and brisket are summarized in Table 5. A few brief comments on each of these are in order. There is no shortage of information about the fatty acid composition of the brain, particularly since there has been so much interest in recent years in so-called omega-3 fatty acids, and especially in the DHA or docosahexaenoic acid content of human nervous tissue. However, finding data on the brain as a food source is much more difficult. Nevertheless, there are enough data to suggest that values in both wild and domesticated animals typically fall between about 8% and 9% (mean = 8.88), or about six times greater than the average fat content of muscle meat. That's a substantial difference. Also important is the fact that the fat in the brain does not get mobilized and depleted in an animal under stress (McIlwain 1971:33).

The tongue, with an average fat content of about 19% (13 times greater than the average for muscle meat; see Table 5), was often the most highly ranked organ in the ungulate body. Even when most other body parts were left behind at a kill, the tongue was usually either consumed on the spot or taken. Dried and smoked tongues figure prominently in the ethnohistoric literature as gifts and as items of trade. Again, like the brain, the tongue is an organ whose fat content remains stable, even in animals suffering from severe stress. Thus, the tongue provided a reliable source of fat throughout the year and one that could be transported with relative ease. Caribou tongues became one of the principal items that northern foragers brought for exchange to Hudson's Bay Company (HBC) trading posts (a.k.a. factories): "The commercial trade in caribou products began with sales of

Table 5. Average fat content (%) in the uncooked brain, tongue, ribs, and brisket of various domesticated and wild ungulates.

Species	Tissue	Fat (%)	Ref.*
Brain (uncooked)			
Rangifer tarandus (caribou/reindeer)	Brain	9.80	*1*
African ruminants	Brain	9.30	*2*
Domesticated animals (pig)	Brain	9.25	*3*
Domesticated animals (pig)	Brain	9.00	*4*
Domesticated animals (beef)	Brain	8.32	*5*
Domesticated animals (calf)	Brain	8.50	*4*
Domesticated animals (lamb)	Brain	8.00	*4*
Average		8.88	
Tongue (uncooked)			
R*angifer tarandus* (caribou/reindeer)	Tongue	17.00	*1*
Rangifer tarandus (caribou/reindeer)	Tongue	17.00	*1*
Rangifer tarandus (caribou/reindeer)	Tongue	29.20	*6*
Dama dama (fallow deer)	Tongue	15.00	*7*
Dama dama (fallow deer)	Tongue	18.00	*7*
Ovis aires (domesticated sheep)	Tongue	21.70	*8*
Bos taurus (beef)	Tongue	23.00	*9*
Bos taurus (beef)	Tongue	16.93	*5*
Bos taurus (beef)	Tongue	16.10	*10*
Average		19.33	
Ribs (Intercostal) and Brisket (uncooked)			
Rangifer tarandus (female) (caribou/reindeer)	Ribs	7.05	*11*
Rangifer tarandus (caribou/reindeer)	Brisket	5.10	*12*
Bison bonasus (European bison)–cattle hybrid	Brisket	8.50	*13*
Average		6.88	

** References:*
1 Kuhnlein & Soueida (1992:119)
2 Cordain et al. (2001:152)
3 Chanted et al. (2021:5)
4 Ockerman et al. (2017:685)
5 Mustafa (1988:270)
6 Grinkova et al. (2014:13)
7 Stanisz et al. (2015:1061, 1065)
8 Bester et al. (2018:5–6)
9 van Heerden & Morey (2014:249, 253)
10 Jayawardena et al. (2022:334)
11 Adamczewski et al. (1987:370)
12 Rodahl (1954b:34)
13 Szulc et al. (1971:494)

caribou tongues, which were prized year-round because they contained rich reserves of fat when other parts of the caribou were lean" (Lytwyn 2002:150). To get an idea of the magnitude of this trade, in less than 35 years between 1747–1781, York Factory, just one of HBC's network of northern posts, received an astounding 18,456 caribou tongues (Lytwyn 2002:152).

It was difficult to find reliable data on the fat content of the ribs and briskets of wild ungulates. Nevertheless, the small set of values shown in Table 5 suggest an average value of about 6.5%–7%, roughly 4.5 times greater than the fat content of muscle meat. If the ribs were removed as a unit together with the overlying fleece or dépouille, they would be a fatty prize indeed, even in an otherwise lean wild ungulate.

After all is said and done, why do zooarchaeologists nonetheless find significant positive correlations between the MGUI or FUI and skeletal element frequencies, with the upper fore- and hindlimb bones seeming to behave precisely as these indices would lead us to expect them to? I think the answer is fairly straightforward. We assume that these anatomical units were transported especially for their massive meat yield, with their marrow content as an "also ran," albeit an important one. However, in northern latitudes and their Pleistocene analogs, I think the opposite was more often the case. The upper limbs were probably often transported primarily for their marrow content (Morin and Ready 2013), and it was the muscle meat that was the "also ran." Muscle would have been useful to mobile foragers only in limited amount, just up to the point where they had reached the safe protein limit (i.e., less than about 1,200 kcal per day), beyond which the excess meat would likely have been discarded. Unfortunately, cutmark placement and frequency, though almost always carefully documented by zooarchaeologists, may not be very helpful in distinguishing between these two nutritionally quite different scenarios. One obviously has to dismember the limbs and deflesh them in order to get at the marrow. Whether the meat was kept during this process, and if so, how much of it, may be difficult, if not impossible, to determine.

In short, the classic image of the intrepid Ice Age forager hungrily chomping on a hunk of thoroughly roasted lean reindeer or mammoth steak is in large part a Western myth, one that ended up becoming incorporated into the MGUI and FUI. The absence of fat and vitamin C in such "meaty" meals would have been a recipe for disaster for hominins living in the colder reaches of Pleistocene Eurasia—the surest way to guarantee a northern forager's untimely demise from both rabbit starvation and scurvy.

CONCLUDING REMARKS: THE IMPORTANCE OF THE ETHNOHISTORIC RECORD

I was a graduate student at the University of Michigan during the early days of the *New Archaeology*, starting there just four short years after Binford left Michigan for his first academic position at Chicago. My newly minted mentors, fired up by the frenzy gripping the field at the time, drummed into my head that theory was all-important, that data didn't speak for themselves, and that their significance had to be deduced from theoretical understandings of how things worked in the living world. All that seemed fine and good at the time and, for the most part, still does today. But I was also told that the world of data was full of noise, of outliers, of "spoilers" (terms I heard a lot in those days)—bits of data that deviated from the expectations of well-established theory and therefore irrelevant distractions. The "spoilers" were the things we sought to remove from our data so we could see the "true" picture more clearly. Ethnography was full of such noise—

trivia, mistaken or misguided observations, unusual or unique circumstances, and so on. And if conventional ethnography was filled with such noise, the early ethnohistoric record, because of its rampant ethnocentrism and racism, was surely bursting at the seams with noise, so much so that little or nothing of any import would be lost by ignoring it altogether. And that's just what most archaeologists have done, and continue to do, and that is also what is so clearly epitomized by the biased sample of literature that Binford consulted in researching his *magnum opus—Constructing Frames of Reference* (see Figure 1 above).

Now that I have worked much more closely with early ethnohistoric accounts, I have come to a rather different view of things. While some spoilers probably are just that—uninformative noise—many have actually turned out to be much more. When looked at closely and with a comparative eye, they often turn out to be the tips of really interesting theoretical icebergs, revealing insights about the living world of hunters and gatherers that differ, at times markedly so, from the conventional wisdom cobbled together from the very limited snapshots available to us through the salvage ethnographies of the 20th century. I have presented just a few concrete examples of the surprises that await the archaeologist who is willing to take a deep dive into that treasure trove of early material. But there are so many more fascinating issues just waiting to be winnowed out and explored.

Here are just a few additional examples to whet the appetite of the hungry graduate student who may be searching for an interesting research topic. Archaeologists and paleoanthropologists assume that the relationship between humans and carnivores in the Pleistocene was invariably a nasty one, and usually a lopsided one at that, with hominins, particularly pre-modern ones, largely at the mercy of the big predators. The ethnohistoric accounts from both the Old and New World suggest that the picture may have been more complicated, and at times much less adversarial, before the era of the repeating rifle, the unholy alliance between glory-seeking "great white hunters" and the avaricious collecting proclivities of newly emerging natural history museums, the spread of pastoralism, and massive programs of land clearance for commercial crop production (see MacKenzie 1988:25–53). The example quoted earlier of northern hunters fearlessly playing with wolf pups at active dens and painting their faces with red ocher is just one such case. Long-term truces between foragers and lions is another (e.g., Thomas 2003). Many more examples remain buried in the early record.

We often hear that Neanderthals, lacking eyed needles, were handicapped in dealing with extreme Pleistocene climates by their presumed inability to make form-fitting or tailored clothing (Collard et al. 2016; Hoffecker 2011). However, the ethnohistoric record provides tantalizing evidence of northern peoples doing fine sewing without such needles. They did so by drying the end of sinew thread and cutting the tip obliquely to form a sharp point. The sinew itself then served as the needle; no eye was necessary. In some areas eyed needles did not appear until Europeans introduced iron needles, and those were valued especially for attaching tiny decorative glass trade beads to clothing. So maybe Neanderthals did make tailored clothing after all... Without the eyed needle as a proxy, there really is no other evidence to tell us whether Neanderthals could or could not make such clothing. And what about the foragers in Tierra del Fuego? They dealt with some of the harshest climates on the planet and never dressed themselves in such clothing (e.g., Garvey 2021; Lothrop 1928)? Should we treat the ethnohistoric record of the entire southern tip of South America as one giant spoiler? Perhaps the appearance of eyed needles had more to do with an increase in the importance of fancy beadwork and social display than with clothing changes in the face of worsening climates? We have also been told that Neanderthals probably didn't line their hoods with fur ruffs, further reducing their ability to tolerate severe weather (Collard et al. 2016). Again, the ethnohistoric record documents northern foragers who wore hoods and caps with no fur ruffs. And sometimes only men had ruffs, not women. And again the head gear in Tierra del Fuego was altogether different. Simply more spoilers? It seems more likely that the models themselves are flawed, very likely because, like Binford's *Constructing Frames of Reference*, they too have been built from a small and unrepresentative slice of a vastly larger ethnohistoric reality.

The standard view of prosocial behavior among foragers is that men not only hunt big game, but they use the meat as a public good which they share with other men as a form of display, and as a means of establishing trust and cooperation among otherwise unrelated individuals (Bliege Bird and Power 2015; Hawkes and Bliege Bird 2002; Hawkes et al. 2014). However, over and over again in the ethnohistoric record from the North American arctic and subarctic, one finds evidence that after a man killed an animal, the carcass immediately became the property of his wife. She transported it home, she butchered it, and she, not her husband, controlled its distribution, both within the household and more broadly. Are we simply dealing with faulty observations, or instead with fundamental differences in world view between 19th-century Victorian-period observers and modern feminist-minded scholars, or does the northern record perhaps reveal a pattern of prosocial behavior that differed in important ways from conventional wisdom? It would be nice to know...

The early ethnohistoric record suggests that men performed the vast majority of their tool-making and tool-using activities in the outdoors and often well away from home. They also repaired many of their tools, not at home, but close to where they used them. In addition, men spent a lot of their time, when not hunting or away fighting, engaged in ceremonial and political activities, and these usually took place in special men's houses, in public spaces, or in areas to which women were denied access. Most women's work, on the other hand, was carried out within the home. If that was traditionally the case further back in time, whose activities most likely predominate in the tool assemblages we recover from sites we assume to have been Paleolithic basecamps?

The brain is a major source of lipids, far richer than most muscle tissues. Moreover, brain lipids are not depleted when an animal is stressed (McIlwain 1971:33). Yet, I have the clear impression from the ethnohistoric record that Indigenous peoples used the brain far more often to soften hides than as a source of food. Is that impression correct and, if so, why, especially given the arguments laid out in this essay about the overwhelming importance of fat in northern forager diets?

There are many such interesting issues that rise to the surface when exploring the rich ethnohistoric record. These aren't trivial "spoilers," they bear directly on major issues of concern to contemporary archaeology. They make it obvious that we need to reexamine many of our conventional understandings of the hunting way of life, and the archaeological expectations we draw from those understandings. To do this effectively, however, we need to work with the entire five-century-long "ethnographic present," not just the momentary glimpses we get from recent ethnographies of cultures on the very brink of extinction.

ACKNOWLEDGMENTS

I am deeply honored and grateful to the Board of the Stichting Nederlands Museum voor Anthropologie en Praehistorie for their kind invitation to deliver the Kroon-Lecture for 2022. I would particularly like to acknowledge the help and encouragement I received from dr. Willy H. Metz and professor Wil Roebroeks in preparing both the lecture and the accompanying monograph. A number of the ideas presented here took shape during several brief but wonderful summer stints as a University of Arizona, School of Anthropology, UIR Resident Scholar. Many thanks to the School of Anthropology and to Diane Austin, Director, for making those wonderful and productive opportunities possible. Many of the ideas discussed in the section on putrid meat in the tropics are the result of a joint effort with Eugène Morin, an archaeologist and anthropologist at Trent University in Peterborough, Ontario (see Speth and Morin 2022). Finally, the computer-generated “Franz Marc style” image of a “herd of reindeer” was produced in about 60 seconds by my daughter, Larrea Young, using her smartphone, while the entire family was relaxing on the porch after staining a cedar fence in our back yard. Having been weaned in the “good old days” on IBM punch cards and Fortran IV, I haven’t yet found my lower jaw! Since a lot of this monograph deals with caribou and reindeer, I couldn’t resist including that amazing image. And as it happens, Franz Marc is also one of my favorite artists.

References Cited

Abe, Y., 2005. Hunting and butchery patterns of the Evenki in northern Transbaikalia, Russia. Ph.D. Dissertation. State University of New York at Stony Brook.

Adamczewski, J.Z., Gates, C.C., Hudson, R.J., 1987. Fat distribution and indices of carcass composition in Coats Island caribou *(Rangifer tarandus groenlandicus)*. Canadian Journal of Zoology 65, 368–374.

Allen, H.T., 1887. Report of an Expedition to the Copper, Tananá, and Kóyukuk Rivers, in the Territory of Alaska in the Year 1885, for the Purpose of Obtaining All Information which Will be Valuable and Important, Especially to the Military Branch of the Government. Made Under the Direction of Nelson A. Miles, Commanding the Department of the Columbia. Government Printing Office, Washington, DC.

Amato, K.R., Mallott, E.K., Maia, P.D.A., Sardaro, M.L.S., 2021. Predigestion as an evolutionary impetus for human use of fermented food. Current Anthropology 62, S207–S219.

Ameen, C., Feuerborn, T.R., Brown, S.K., Linderholm, A., Hulme-Beaman, A., Lebrasseur, O., Sinding, M.-H.S., Lounsberry, Z.T., Appelt, M., Bachmann, L., Betts, M., Britton, K., Darwent, J., Dietz, R., Fredholm, M., Gopalakrishnan, S., Goriunova, O.I., Grønnow, B., Haile, J., Hallsson, J.H., Harrison, R., Heide-Jørgensen, M.P., Knecht, R., Losey, R.J., Masson-MacLean, E., McGovern, T.H., McManus-Fry, E., Meldgaard, M., Midtdal, Å., Moss, M.L., Nikitin, I.G., Nomokonova, T., Pálsdóttir, A.H., Perri, A., Popov, A.N., Rankin, L., Reuther, J.D., Sablin, M., Schmidt, A.L., Shirar, S., Smiarowski, K., Sonne, C., Stiner, M.C., Vasyukov, M., West, C.F., Ween, G.B., Wennerberg, S.E., Wiig, Ø., Woollett, J., Dalén, L., Hansen, A.J., Gilbert, M.T.P., Sacks, B.N., Frantz, L., Larson, G., Dobney, K., Darwent, C.M., Evin, A., 2019. Specialized sledge dogs accompanied Inuit dispersal across the North American arctic. Proceedings of the Royal Society of London, Series B. Biological Sciences 286B, 1–10 (doi:10.1098/rspb.2019.1929).

Anderson, R.M., 1918. Eskimo food—how it tastes to a white man. Ottawa Naturalist 32, 59–65.

Anonymous, 1710. The Four Kings of Canada. Being a Succinct Account of the Four Indian Princes Lately Arriv'd from North America. With a Particular Description of their Country, their Strange and Remarkable Religion, Feasts, Marriages, Burials, Remedies for their Sick, Customs, Manners, Constitution, Habits, Sports, War, Peace, Policy, Hunting, Fishing, Utensils Belonging to the Savages, with Several Other Extraordinary Things Worthy [of] Observation, as to the Natural or Curious Productions, Beauty, or Fertility, of that Part of the World. John Baker, London (Reprinted in 1891 by J. E. Garratt, London).

Anonymous, 1900. Genesis, The Holy Bible, Containing the Old and New Testaments and the Apocrypha (KJV). Cambridge University Press, London, pp. 1–41.

Archer, D.L., 2004. Freezing: an underutilized food safety technology? International Journal of Food Microbiology 90, 127–138.

Atyeo, C., Alter, G., 2021. The multifaceted roles of breast milk antibodies. Cell 184, 1486–1499.

Banfield, A.W.F.F., 1957. The plight of the barren-ground caribou. Oryx 4, 5–20.

Barr, W.A., Pobiner, B., Rowan, J., Dud, A., Faith, J.T., 2022. No sustained increase in zooarchaeological evidence for carnivory after the appearance of Homo Erectus. Proceedings of the National Academy of Sciences 119, 1–6 (doi:10.1073/pnas.2115540119).

Bartoň, L., Bureš, D., Kotrba, R., Sales, J., 2014. Comparison of meat quality between eland (Taurotragus oryx) and cattle (Bos taurus) raised under similar conditions. Meat Science 96, 346–352.

Beasley, D.E., Koltz, A.M., Lambert, J.E., Fierer, N., Dunn, R.R., 2015. The evolution of stomach acidity and its relevance to the human microbiome. PLoS ONE 10, 1–12 (doi:10.1371/journal.pone.0134116).

Beasley, J.C., Olson, Z.H., DeVault, T.L., 2015. Ecological role of vertebrate scavengers. In: Benbow, M.E., Tomberlin, J.K., Tarone, A.M. (Eds.), Carrion Ecology, Evolution, and their Applications. CRC Press, Boca Raton, FL, pp. 107–127.

Bessels, E., 2016. Polaris: the Chief Scientist's Recollections of the American North Pole Expedition, 1871–73. University of Calgary Press, Calgary.

Bester, M., Schönfeldt, H.C., Pretorius, B., Hall, N., 2018. The nutrient content of selected South African lamb and mutton organ meats (offal). Food Chemistry 238, 3–8.

Bilsborough, S., Mann, N., 2006. A review of issues of dietary protein intake in humans. International Journal of Sport Nutrition and Exercise Metabolism 16, 129–152.

Binford, L.R., 1973. Interassemblage variability: the Mousterian and the 'functional' argument. In: Renfrew, C. (Ed.), The Explanation of Culture Change: Models in Prehistory. Duckworth, London, pp. 227–254.

Binford, L.R., 1977. Forty-seven trips: a case study in the character of archaeological formation processes. In: Wright, R.V.S. (Ed.), Stone Tools as Cultural Markers: Change, Evolution, and Complexity. Australian Institute of Aboriginal Studies, Canberra, pp. 24–36.

Binford, L.R., 1978a. Dimensional analysis of behavior and site structure: learning from an Eskimo hunting stand. American Antiquity 43, 330–361.

Binford, L.R., 1978b. Nunamiut Ethnoarchaeology. Academic Press, New York.

Binford, L.R., 1979. Organization and formation processes: looking at curated technologies. Journal of Anthropological Research 35, 255–273.

Binford, L.R., 1980. Willow smoke and dogs' tails: hunter–gatherer settlement systems and archaeological site formation. American Antiquity 45, 4–20.

Binford, L.R., 1981. Bones: Ancient Men and Modern Myths. Academic Press, New York.

Binford, L.R., 1983. Long term land use patterns: some implications for archaeology. In: Dunnell, R.C., Grayson, D.K. (Eds.), Lulu Linear Punctated: Essays in Honor of George Irving Quimby. University of Michigan, Museum of Anthropology, Ann Arbor, pp. 27–53.

Binford, L.R., 2001. Constructing Frames of Reference: An Analytical Method for Archaeological Theory Building Using Hunter–Gatherer and Environmental Data Sets. University of California Press, Berkeley.

Binford, L.R., Binford, S.R., 1966. A preliminary analysis of functional variability in the Mousterian of Levallois facies. American Anthropologist 68, 238–295.

Bliege Bird, R.L., Power, E.A., 2015. Prosocial signaling and cooperation among Martu hunters. Evolution and Human Behavior 36, 389–397.

Blum, W.E.H., Zechmeister-Boltenstern, S., Keiblinger, K.M., 2019. Does soil contribute to the human gut microbiome? Microorganisms 7, 1–16 (doi:10.3390/microorganisms7090287).

Bodwell, C.E., Anderson, B.A., 1986. Nutritional composition and value of meat and meat products. In: Bechtel, P.J. (Ed.), Muscle as Food. Academic Press, Orlando, pp. 321–370.

Brink, J.W., 2001. Carcass utility indices and bison bones from the Wardell kill and butchering sites. In: Gerlach, S.C., Murray, M.S. (Eds.), People and Wildlife in Northern America: Essays in Honor of R. Dale Guthrie. BAR International Series S944. Archaeopress, Oxford, pp. 255–274.

Brown, K.M., 2009. Foul Bodies: Cleanliness in Early America. Yale University Press, New Haven.

Burch, E.S., 2006. Social Life in Northwest Alaska: The Structure of Iñupiaq Eskimo Nations. University of Alaska Press, Fairbanks.

Bureš, D., Bartoň, L., Kotrba, R., Hakl, J., 2015. Quality attributes and composition of meat from red deer (*Cervus elaphus*), fallow deer (*Dama dama*) and Aberdeen Angus and Holstein cattle (*Bos taurus*). Journal of the Science of Food and Agriculture 95, 2299–2306.

Campbell, R., Hauptmann, A., Campbell, K., Fox, S., Marco, M.L., 2022. Better understanding of food and human microbiomes through collaborative research on Inuit fermented foods. Microbiome Research Reports 1, 1–7 (doi:10.20517/mrr.22021.20506).

Catesby, M., 1754. The Natural History of Carolina, Florida, and the Bahama Islands: Containing the Figures of Birds, Beasts, Fishes, Serpents, Insects and Plants: Particularly the Forest-Trees, Shrubs, and Other Plants, Not Hitherto Described, or Very Incorrectly Figured by Authors: Together with their Descriptions in English and French: to which Are Added, Observations on the Air, Soil, and Waters: with Remarks upon Agriculture, Grain, Pulse, Roots, &c.: to the Whole Is Prefixed a New and Correct Map of the Countries Treated of, Vol. 1. Printed for Charles Marsh…, Thomas Wilcox…, and Benjamin Stichall, London.

Chan-McLeod, A.C.A., White, R.G., Russell, D.E., 1995. Body mass and composition indices for female barren-ground caribou. Journal of Wildlife Management 59, 278–291.

Chanted, J., Panpipat, W., Panya, A., Phonsatta, N., Cheong, L.-Z., Chaijan, M., 2021. Compositional features and nutritional value of pig brain: potential and challenges as a sustainable source of nutrients. Foods 10, 1–14 (doi:10.3390/foods10122943).

Chiou, L.A., Hennessy, T.W., Horn, A., Carter, G., Butler, J.C., 2002. Botulism among Alaska natives in the Bristol Bay area of southwest Alaska: a survey of knowledge, attitudes, and practices related to fermented foods known to cause botulism. International Journal of Circumpolar Health 61, 50–60.

Collard, M., Tarle, L., Sandgathe, D., Allan, A., 2016. Faunal evidence for a difference in clothing use between Neanderthals and Early Modern Humans in Europe. Journal of Anthropological Archaeology 44, 235–246.

Conklin-Brittain, N.L., Dierenfeld, E.S., Wrangham, R.W., Norconk, M.A., Silver, S.C., 1999. Chemical protein analysis: a comparison of Kjeldahl crude protein and total ninhydrin protein from wild, tropical vegetation. Journal of Chemical Ecology 25, 2601–2622.

Cook, J.G., Kelly, A.P., Cook, R.C., Culling, B., Diane, C., McLaren, A., Larter, N.C., Watters, M., 1989. Seasonal patterns in nutritional condition of caribou (Rangifer tarandus) in the southern Northwest Territories and northeastern British Columbia, Canada. Canadian Journal of Zoology 67, 103–107.

Cordain, L., Brand Miller, J., Eaton, S.B., Mann, N., Holt, S.H.A., Speth, J.D., 2000. Plant–animal subsistence ratios and macronutrient energy estimations in worldwide hunter–gatherer diets. American Journal of Clinical Nutrition 71, 682–692.

Cordain, L., Eaton, S.B., Brand Miller, J., Mann, N.J., Hill, K., 2002. The paradoxical nature of hunter–gatherer diets: meat-based, yet non-atherogenic. European Journal of Clinical Nutrition 56, S42–S52.

Cordain, L., Watkins, B.A., Mann, N.J., 2001. Fatty acid composition and energy density of foods available to African hominids: evolutionary implications for human brain development. In: Simopoulos, A.P., Pavlou, K.N. (Eds.), Nutrition and Fitness: Metabolic Studies in Health and Disease. World Review of Nutrition and Dietetics 90. Karger, Basel, pp. 144–161.

Couturier, S., Côté, S.D., Huot, J., Otto, R.D., 2009. Body-condition dynamics in a northern ungulate gaining fat in winter. Canadian Journal of Zoology 87, 367–378.

Crawford, M.A., Gale, M.M., Woodford, M.H., Casped, N.M., 1970. Comparative studies on fatty acid composition of wild and domestic meats. International Journal of Biochemistry 1, 295–305.

Curtis, V., Aunger, R., Rabie, T., 2004. Evidence that disgust evolved to protect from risk of disease. Proceedings of the Royal Society of London, Series B. Biological Sciences 271B, S131–S133.

Davidson, B., Maciver, J., Lessard, E., Connors, K., 2011. Meat lipid profiles: a comparison of meat from domesticated and wild southern African animals. In Vivo 25, 197–202.

Davis, W.E., 1941. Congo Doctor. Robert Hale, London.

de Laguna, F., 2000. Travels Among the Dena: Exploring Alaska's Yukon Valley. University of Washington Press, Seattle.

Denke, M.A., 2001. Metabolic effects of high-protein, low-carbohydrate diets. American Journal of Cardiology 88, 59–61.

Department of Health and Social Services (DHSS), 2017. Botulism in Alaska. State of Alaska, Department of Health and Social Services, Division of Public Health, Section of Epidemiology, Anchorage. (http://dhss.alaska.gov/dph/Epi/id/SiteAssets/Pages/botulism/monograph.pdf)

DeVault, T.L., Rhodes, O.E., Shivik, J.A., 2003. Scavenging by vertebrates: behavioral, ecological, and evolutionary perspectives on an important energy transfer pathway in terrestrial ecosystems. Oikos 102, 225–234.

Diebitsch-Peary, J., 1894. My Arctic Journal: A Year Among Ice-Fields and Eskimos. With an Account of the Great White Journey Across Greenland by Robert E. Peary. Longmans, Green, and Company, London.

Dimski, D.S., 1994. Ammonia metabolism and the urea cycle: function and clinical implications. Journal of Veterinary Internal Medicine 8, 73–78.

Dorman, M.R.P., 1905. A Journal of a Tour in the Congo Free State. J. Lebègue, Brussels.

Dubois, G., Girard, C., Lapointe, F.-J., Shapiro, B.J., 2017. The Inuit gut microbiome is dynamic over time and shaped by traditional foods. Microbiome 5, 1–12 (doi:10.1186/s40168-40017-40370-40167).

Dunn, J., 1844. History of the Oregon Territory and British North-American Fur Trade; with an Account of the Habits and Customs of the Principal Native Tribes on the Northern Continent. Edwards and Hughes, London.

Fadda, S., Oliver, G., Vignolo, G., 2002. Protein degradation by *Lactobacillus plantarum* and *Lactobacillus casei* in a sausage model system. Journal of Food Science 67, 1179–1183.

Fagan, R.P., McLaughlin, J.B., Castrodale, L.J., Gessner, B.D., Jenkerson, S.A., Funk, E.A., Hennessy, T.W., Middaugh, J.P., Butler, J.C., 2011. Endemic foodborne botulism among Alaska native persons—Alaska, 1947–2007. Clinical Infectious Diseases 52, 585–592.

Farmer, F.A., Ho, M.L., Neilson, H.R., 1971. Analyses of meats eaten by humans or fed to dogs in the arctic. Journal of the Canadian Dietetic Association 32, 137–141.

Flook, D.R., 1952. Utilization of Caribou in the Rae District. Canadian Wildlife Service, Department of Resources and Development, Ottawa.

Forbes, S.L., Perrault, K.A., Comstock, J.L., 2017. Microscopic post-mortem changes: the chemistry of decomposition. In: Schotsmans, E.M.J., Márquez-Grant, N., Forbes, S.L. (Eds.), Taphonomy of Human Remains: Forensic Analysis of the Dead and the Depositional Environment. John Wiley and Sons, Chichester, pp. 26–38.

Franklin, J., 1824. Narrative of a Journey to the Shores of the Polar Sea, in the Years 1819, 20, 21, & 22. H. C. Carey and I. Lea, Philadelphia.

Friesen, T.M., 2020. Radiocarbon evidence for fourteenth-century Dorset occupation in the eastern North American arctic. American Antiquity 85, 222–240.

Frink, L., Giordano, C., 2015. Women and subsistence food technology: the arctic seal poke storage system. Food and Foodways 23, 251–272.

Gaede-Penner, N., 2016. 'A' Is for Anaktuvuk: Teacher to the Nunamiut Eskimos—The Story of Anna Bortel Church, 2nd ed. Tate Publishing and Enterprises, Mustang, OK.

Garvey, R., 2021. Patagonian Prehistory: Human Ecology and Cultural Evolution in the Land of Giants. University of Utah Press, Salt Lake City.

Gerhart, K.L., White, R.G., Cameron, R.D., Russell, D.E., 1996. Growth and body composition of arctic caribou. In: Haugerud, R.E., Brown, K., Cichowski, D., Edmonds, J., Seip, D., Stevenson, S., Thomas, D., Wood, M. (Eds.), Proceedings of the Sixth North American Caribou Workshop, Prince George, BC, Canada, 1–4 March, 1994, and Proceedings of the George River Caribou Workshop, Labrador City, Labrador, Canada, 27–29 January, 1994. Rangifer, Vol. 16, No. 4, Special Issue 9. Nordisk Organ for Reinforskning (NOR), Tromso, Norway, pp. 393–394.

Gerth, N., Redman, P., Speakman, J., Jackson, S., Starck, J.M., 2010. Energy metabolism of Inuit sled dogs. Journal of Comparative Physiology B 180, 577–589.

Gilbert, J.A., Blaser, M.J., Caporaso, J.G., Jansson, J.K., Lynch, S.V., Knight, R., 2018. Current understanding of the human microbiome. Nature Medicine 24, 392–400.

Girard, C., Tromas, N., Amyot, M., Shapiro, B.J., 2017. Gut microbiome of the Canadian arctic Inuit. mSphere 2, 1–14 (doi:10.1128/mSphere.00297-00216).

Glover, R.G., 1962. David Thompson's Narrative, 1784–1812. Publication 40. The Champlain Society, Toronto.

Golden, D.A., Beuchat, L.R., Brackett, R.E., 1988. Inactivation and injury of *Listeria monocytogenes* as affected by heating and freezing. Food Microbiology 5, 17–23.

González, F., Smulders, F., Paulsen, P., Skewes, O., König, H.-E., 2004. Anatomical investigations on meat cuts of guanacos (*Lama guanicoe*, Müller, 1776) and chemical composition of selected muscles. Wiener Tierärztliche Monatsschrift 91, 77–84.

Gookin, D., 1792. Historical Collections of the Indians in New England. Of Their Several Nations, Numbers, Customs, Manners, Religion and Government, Before the English Planted There… Now First Printed from the Original Manuscript at the Apollo Press in Boston by Belknap and Hall, Boston.

Grant, P., 1890. The Sauteux Indians (about 1804). In: Masson, L.R. (Ed.), Les Bourgeois de la Compagnie du Nord-Ouest: Récits de Voyages, Lettres et Rapports Inédits Relatifs Publiés avec une Esquisse Historique et des Annotations, Tome 2. Imprimerie Générale A. Coté, Québec, pp. 301–366.

Graves, G.R., 2017. Field measurements of gastrointestinal pH of New World vultures in Guyana. Journal of Raptor Research 51, 465–469.

Grieneisen, L.E., Charpentier, M.J.E., Alberts, S.C., Blekhman, R., Bradburd, G., Tung, J., Archie, E.A., 2019. Genes, geology and germs: gut microbiota across a primate hybrid zone are explained by site soil properties, not host species. Proceedings of the Royal Society, Series B. Biological Sciences 286B, 1–9 (doi:10.1098/rspb.2019.0431).

Grinkova, G.V., Marcekha, E.V., Shelepov, V.G., 2014. Description of quality and technological properties of reindeer by-products [in Russian]. Technique and Technology of Food Production [Tekhnika i Tekhnologiya Pishchevykh Proizvodstv] 32, 11–17.

Groopman, E., Carmody, R.N., Wrangham, R.W., 2015. Cooking increases net energy gain from a lipid-rich food. American Journal of Physical Anthropology 156, 11–18.

Gubser, N.J., 1965. The Nunamiut Eskimos: Hunters of Caribou. Yale University Press, New Haven.

Hadleigh-West, F., 1963. The Netsi Kutchin: an essay in human ecology. Ph.D. Dissertation. Louisiana State University and Agricultural and Mechanical College.

Hanson, W.C., 1973. Fallout strontium-90 and cesium-137 in northern Alaskan ecosystems during 1959–1970. Ph.D. Dissertation. Colorado State University.

Hardisty, W.L., 1867. The Loucheux Indians. In: Gibbs, G., Ross, B.R., Hardisty, W.L., Jones, S., Joseph Meredith Toner Collection (Eds.), Notes on the Tinneh or Chepewyan Indians of British and Russian America. Smithsonian Institution, Washington, DC, pp. 311–320.

Harper, F., 1932. Mammals of the Athabaska and Great Slave Lakes region. Journal of Mammalogy 13, 19–36.

Haščík, P., Müller, M., Pavelková, A., Kačániová, M., Čuboň, J., Benczová, E., Habánová, M., Mihok, M., Garlík, J., 2011. Chemical structure of European bison musculus longissimus dorsi at different stages of age. Potravinárstvo (Slovak Journal of Food Sciences) 5, 17–21.

Hauptmann, A.L., Paulová, P., Castro-Mejía, J.L., Hansen, L.H., Sicheritz-Pontén, T., Mulvad, G., Nielsen, D.S., 2020a. The microbial composition of dried fish prepared according to Greenlandic Inuit traditions and industrial counterparts. Food Microbiology 85, 1–11 (doi:10.1016/j.fm.2019.103305).

Hauptmann, A.L., Paulová, P., Hansen, L.H., Sicheritz-Pontén, T., Mulvad, G., Nielsen, D.S., 2020b. Microbiota in foods from Inuit traditional hunting. PLoS ONE 15, 1–15 (doi:10.1371/journal.pone.0227819).

Hawkes, K., Bliege Bird, R., 2002. Showing off, handicap signaling, and the evolution of men's work. Evolutionary Anthropology 11, 58–67.

Hawkes, K., O'Connell, J.F., Blurton Jones, N.G., 2014. More lessons from the Hadza about men's work. Human Nature 25, 596–619.

Hearne, S., 1795. A Journey from Prince of Wales's Fort in Hudson's Bay to the Northern Ocean, Undertaken by Order of the Hudson's Bay Company for the Discovery of Copper Mines, a North-West Passage, &c., in the Years 1769, 1771, and 1772. A. Strahan and T. Cadell, London.

Heckewelder, J.G.E., 1876. History, Manners, and Customs of the Indian Nations: Who Once Inhabited Pennsylvania and the Neighboring States, New and revised ed. Historical Society of Pennsylvania, Philadelphia.

Hediger, M.A., 2002. New view at C. Nature Medicine 8, 445–446.

Heine, M., Andre, A., Kritsch, I., Cardinal, A., the Elders of Tsiigehtshik, 2007. Gwichya Gwich'in Googwandak: The History and Stories of the Gwichya Gwich'in as Told by the Elders of Tsiigehtshik, Revised ed. Gwich'in Social and Cultural Institute, Tsiigehtshik and Fort McPherson, NT.

Hennepin, L., 1698. A New Discovery of a Vast Country in America, Extending Above Four Thousand Miles, Between New France und New Mexico, with a Description of the Great Lakes, Cataracts, Rivers, Plants, and Animals: Also, the Manners, Customs, and Languages of the Several Native Indians; and the Advantage of Commerce with those Different Nations.... M. Bentley, J. Tonson, H. Bonwick, T. Goodwin, and S. Manship, London.

Henry, P.I., Morelli, G.A., 2022. Niche construction in hunter–gatherer infancy: growth and health trade-offs inform social agency. In: Hart, S.L., Bjorklund, D.F. (Eds.), Evolutionary Perspectives on Infancy. Springer, Cham, Switzerland, pp. 213–236.

Hewlett, B.S., Winn, S., 2014. Allomaternal nursing in humans. Current Anthropology 55, 200–229.

Hoffecker, J.F., 2011. The early Upper Paleolithic of eastern Europe reconsidered. Evolutionary Anthropology 20, 24–39.

Hoffman, L.C., Cawthorn, D.-M., 2012. What is the role and contribution of meat from wildlife in providing high quality protein for consumption? Animal Frontiers 2, 40–53.

Hoppner, K., McLaughlan, J.M., Shah, B.G., Thompson, J.N., Beare-Rogers, J.L., Ellestad-Sayad, J., Schaefer, O., 1978. Nutrient levels of some foods of Eskimos from Arctic Bay, N.W.T., Canada. Journal of the American Dietetic Association 73, 257–261.

Høygaard, A., 1941. Studies on the Nutrition and Physio-Pathology of Eskimos, Undertaken at Angmagssalik, East-Greenland, 1936–1937. Norsk Videnskaps–Akademi i Oslo Skrifter 1. Matematisk–Naturvidenskapelig Klasse 1940, No. 9, Oslo.

Huot, J., 1989. Body composition of the George River caribou (*Rangifer tarandus caribou*) in fall and late winter. Canadian Journal of Zoology 67, 103–107.

Husson, A., Brasse-Lagnel, C., Fairand, A., Renouf, S., Lavoinne, A., 2003. Argininosuccinate synthetase from the urea cycle to the citrulline-NO cycle. European Journal of Biochemistry 270, 1887–1899.

Ingstad, H., 1951. Nunamiut: Among Alaska's Inland Eskimos. George Allen and Unwin, London.

Ingstad, H., 1992. Land of Feast and Famine. McGill–Queen's University Press, Montreal.

Jackson, A.A., 1999. Limits of adaptation to high dietary protein intakes. European Journal of Clinical Nutrition 53, S44–S52.

James, L.H., 1933. Effects of freezing on the spores and toxin of *Clostridium botulinum*. Journal of Infectious Diseases 52, 236–241.

Janssen, J., Cammack, K., Legako, J., Cox, R., Grubbs, J.K., Underwood, K., Hansen, J., Kruse, C., Blair, A., 2021. Influence of grain- and grass-finishing systems on carcass characteristics, meat quality, nutritional composition, and consumer sensory attributes of bison. Foods 10, 1–23 (doi:10.3390/foods10051060).

Janzen, D.H., 1977. Why fruits rot, seeds mold, and meat spoils. American Naturalist 111, 691–713.

Jayawardena, R., Morton, J.D., Brennan, C.S., Bhat, Z.F., Bekhit, A.E.-D.A., 2022. Meat co-products. In: Bekhit, A.E.-D.A., Riley, W.W., Hussain, M.A. (Eds.), Alternative Proteins: Safety and Food Security Considerations. CRC Press, Boca Raton, FL, pp. 329–359.

Jenike, M.R., 2001. Nutritional ecology: diet, physical activity and body size. In: Panter-Brick, C., Layton, R.H., Rowley-Conwy, P. (Eds.), Hunter–Gatherers: An Interdisciplinary Perspective. Cambridge University Press, Cambridge, pp. 205–238.

Josselyn, J., 1674. An Account of Two Voyages to New-England. Giles Widdowes, London.

Joutel, H., 1714. A Journal of the Last Voyage Perform'd by Monsr. de La Sale, to the Gulph of Mexico, to Find Out the Mouth of the Missisipi River; Containing, an Account of the Settlements He Endeavour'd to Make on the Coast of the Aforesaid Bay, His Unfortunate Death, and the Travels of His Companions for the Space of Eight Hundred Leagues Across that Inland Country of America, Now Call'd Louisiana (and Given by the King of France to M. Crozat,) Till They Came into Canada. A. Bell, London.

Kelly, R.L., 2013. The Lifeways of Hunter–Gatherers: The Foraging Spectrum. Cambridge University Press, Cambridge.

Kelsey, H., 1929. The Kelsey Papers (Edited by Arthur G. Doughty and Chester Martin). F. A. Acland, Ottawa.

Kooyman, B.P., 1981. Métis faunal remains and variables in archaeological butchering pattern analysis. M.A. Thesis. University of Calgary.

Kooyman, B.P., 1988. Appendix II. Faunal remains at the Buffalo Lake Métis Site. In: Doll, M.F.V., Kidd, R.S., Day, J.P. (Eds.), The Buffalo Lake Métis Site: A Late Nineteenth Century Settlement in the Parkland of Central Alberta. Provincial Museum of Alberta, Edmonton, pp. 341–358.

Kozlov, A.I., Zdor, E.V., 2003. Whaling products as an element of indigenous diet in Chukotka. Anthropology of East Europe Review 17, 127–138.

Krogh, A., Krogh, M., 1915. A study of the diet and metabolism of Eskimos undertaken in 1908 on an expedition to Greenland. Meddelelser om Grønland 51, 1–52.

Kuhnlein, H.V., Soueida, R., 1992. Use and nutrient composition of traditional Baffin Inuit foods. Journal of Food Composition and Analysis 5, 112–126.

Latham, R.G., 1851. The Ethnology of the British Colonies and Dependencies. John Van Voorst, London.

Lawrie, A.H., 1948. Barren-Ground Caribou Survey. Canadian Wildlife Service, Department of Resources and Development, Ottawa.

Lee, R.B., 1968. What hunters do for a living, or, how to make out on scarce resources. In: Lee, R.B., DeVore, I. (Eds.), Man the Hunter. Aldine, Chicago, pp. 30–48.

Lee, R.B., DeVore, I., 1968. Man the Hunter. Aldine, Chicago.

Lee, S.M., Buss, D.H., Holcombe, G.D., Hatton, D., 1995. Nutrient content of retail cuts of beef, pork and lamb: preliminary results. Journal of Human Nutrition and Dietetics 8, 75–80.

Liberman, Z., Woodward, A.L., Sullivan, K.R., Kinzler, K.D., 2016. Early emerging system for reasoning about the social nature of food. Proceedings of the National Academy of Sciences 113, 9480–9485.

Lieberman, D.E., Bramble, D.M., Raichlen, D.A., Shea, J.J., 2009. Brains, brawn, and the evolution of human endurance running capabilities. In: Grine, F.E., Fleagle, J.G., Leakey, R.E.F. (Eds.), The First Humans: Origin and Early Evolution of the Genus *Homo*. Springer, Dordrecht, The Netherlands, pp. 77–92.

Lothrop, S.K., 1928. The Indians of Tierra del Fuego. Museum of the American Indian, Heye Foundation, New York.

Łozicki, A., Olech, W., Dymnicka, M., Florowski, T., Adamczak, L., Arkuszewska, E., Niemiec, T., 2017. Nutritive value and meat quality of domestic cattle (*Bos taurus*), zubron (*Bos taurus* × *Bison bonasus*) and European bison (*Bison bonasus*) meat. Agricultural and Food Science 26, 118–128.

Lyons, K.E., Ryan, C.A., Dempsey, E.M., Ross, R.P., Stanton, C., 2020. Breast milk, a source of beneficial microbes and associated benefits for infant health. Nutrients 12, 1–30 (doi:10.3390/nu12041039).

Lytwyn, V.P., 2002. Muskekowuck Athinuwick: Original People of the Great Swampy Land. University of Manitoba Press, Winnipeg.

Mackenzie, A., 1801. Voyages from Montreal, on the River St. Laurence, Through the Continent of North America, to the Frozen and Pacific Oceans; in the Years 1789 and 1793. With a Preliminary Account of the Rise, Progress, and Present State of the Fur Trade of that Country, Vol. 1. T. Cadell, Jun. and W. Davies, London.

MacKenzie, J.M., 1988. The Empire of Nature: Hunting, Conservation and British Imperialism. Manchester University Press, Manchester.

Mann, G.V., Scott, E.M., Hursch, L.M., Heller, C.A., Youmans, J.B., Consolazio, C.F., Bridgforth, E.B., Russell, A.L., Silverman, M., 1962. The health and nutritional status of Alaskan Eskimos. American Journal of Clinical Nutrition 11, 31–76.

Mann, N., 2000. Dietary lean red meat and human evolution. European Journal of Nutrition 39, 71–79.

Markley, R., 2010. "A putridness in the air": monsoons and mortality in seventeenth-century Bombay. Journal for Early Modern Cultural Studies 10, 105–125.

Martin, M.A., Sela, D.A., 2013. Infant gut microbiota: developmental influences and health outcomes. In: Clancy, K.B.H., Hinde, K., Rutherford, J.N. (Eds.), Building Babies: Primate Development in Proximate and Ultimate Perspective. Springer, New York, pp. 233–256.

McCormack, P.A., 2014. Evolving accommodations: the sled dog in the Canadian fur trade. In: Guizard, F., Beck, C. (Eds.), Une Bête Parmi les Hommes: Le Chien—De la Domestication à l'Anthropomorphisme. Actes des Troisièmes Rencontres Internationales "Des Bêtes et des Hommes," Valenciennes, 5 et 6 Novembre 2009. Encrage Édition, Amiens, France, pp. 130–147.

McGhee, R., 2009. When and why did the Inuit move to the eastern arctic? In: Maschner, H.D.G., Mason, O.K., McGhee, R. (Eds.), The Northern World, AD 900–1400. University of Utah Press, Salt Lake City, pp. 155–163.

McIlwain, H., 1971. Biochemistry and the Central Nervous System, 4th ed. Williams and Wilkins, Baltimore.

Meltzer, D.J., 2011. Lewis Roberts Binford 1931–2011: a biographical memoir. National Academy of Sciences, Washington, DC.

Metcalfe, D., Jones, K.T., 1988. A reconsideration of animal body-part utility indices. American Antiquity 53, 486–504.

Morey, D.F., Aaris-Sørensen, K., 2002. Paleoeskimo dogs of the eastern arctic. Arctic 55, 44–56.

Morin, E., 2007. Fat composition and Nunamiut decision-making: a new look at the marrow and bone grease indices. Journal of Archaeological Science 34, 69–82.

Morin, E., Ready, E., 2013. Foraging goals and transport decisions in western Europe during the Paleolithic and early Holocene. In: Clark, J.L., Speth, J.D. (Eds.), Zooarchaeology and Modern Human Origins: Human Hunting Behavior During the Later Pleistocene. Springer, New York, pp. 227–269.

Morris Jr., S.M., 1992. Regulation of enzymes of urea and arginine synthesis. Annual Review of Nutrition 12, 81–101.

Morris Jr., S.M., 2002. Regulation of enzymes of the urea cycle and arginine metabolism. Annual Review of Nutrition 22, 87–105.

Mullie, P., Deliens, T., Clarys, P., 2021. East-Greenland traditional nutrition: a reanalysis of the Inuit energy balance and the macronutrient consumption from the Høygaard nutritional data (1936–1937). International Journal of Circumpolar Health 80, 1–8å.

Mustafa, F.A., 1988. Moisture, fat and cholesterol content of some raw, barbecued and cooked organ meats of beef and mutton. Journal of Food Science 53, 270–271.

Ockerman, H.W., Basu, L., Toldrá, F., 2017. Edible by-products. In: Toldrá, F. (Ed.), Lawrie's Meat Science, 8th ed. Woodhead Publishing, Duxford, England, pp. 679–696.

O'Connell, J.F., Hawkes, K., Blurton Jones, N., 2002. Meat-eating, grandmothering, and the evolution of early human diets. In: Ungar, P.S., Teaford, M.F. (Eds.), Human Diet: Its Origin and Evolution. Bergin and Garvey, Westport, CT, pp. 49–60.

Olesen, D., 2014. Kinds of Winter: Four Solo Journeys by Dogteam in Canada's Northwest Territories. Wilfrid Laurier University Press, Waterloo, ON.

Ordóñez, J.A., de la Hoz, L., 2007. Mediterranean products. In: Toldrá, F. (Ed.), Handbook of Fermented Meat and Poultry. Blackwell, Oxford, England, pp. 333–347.

Orr, N.W.M., 1966. The feeding of sledge dogs on Antarctic expeditions. British Journal of Nutrition 20, 1–12.

Palermo, M., Pellegrini, N., Fogliano, V., 2014. The effect of cooking on the phytochemical content of vegetables. Journal of the Science of Food and Agriculture 94, 1057–1070.

Pannaraj, P.S., Li, F., Cerini, C., Bender, J.M., Yang, S., Rollie, A., Adisetiyo, H., Zabih, S., Lincez, P.J., Bittinger, K., Bailey, A., Bushman, F.D., Sleasman, J.W., Aldrovandi, G.M., 2017. Association between breast milk bacterial communities and establishment and development of the infant gut microbiome. JAMA Pediatrics 171, 647–654.

Pearn, N., Donkin, W., 1934. A camel journey from Tugurt to Kano. Geographical Journal 83, 399–409.

Perry, R.J., 1979. The fur trade and the status of women in the western subarctic. Ethnohistory 26, 363–375.

Petäjä-Kanninen, E., Puolanne, E., 2007. Principles of meat fermentation. In: Toldrá, F. (Ed.), Handbook of Fermented Meat and Poultry. Blackwell, Oxford, pp. 31–36.

Pike, W.M., 1892. The Barren Ground of Northern Canada. Macmillan, London.

Powers-Lee, S.G., Meister, A., 1988. Urea synthesis and ammonia metabolism. In: Arias, I.M., Jakoby, W.B., Popper, H., Schachter, D., Shafritz, D.A. (Eds.), The Liver: Biology and Pathobiology, 2nd ed. Raven Press, New York, pp. 317-329.

Price, W.A., 1939. Nutrition and Physical Degeneration: A Comparison of Primitive and Modern Diets and their Effects. Paul B. Hoeber, New York.

Purchas, R.W., Wilkinson, B.H.P., Carruthers, F., Jackson, F., 2014. A comparison of the nutrient content of uncooked and cooked lean from New Zealand beef and lamb. Journal of Food Composition and Analysis 35, 75–82.

Purchas, S., 1625. Purchas His Pilgrimes: In Five Bookes. The Second Part. William Stansby for Henrie Fetherstone, London.

Rasmussen, K., 1931. The Netsilik Eskimos: Social Life and Spiritual Culture. Report of the Fifth Thule Expedition, 1921–1924. The Danish Expedition to Arctic North America in Charge of Knud Rasmussen, Vol. 8, No. 1–2 [Translated from the Danish by W. E. Calvert] Gyldendalske Boghandel, Nordisk Forlag, Copenhagen.

Ratner, S., 1977. A long view of nitrogen metabolism. Annual Review of Biochemistry 46, 1–24.

Ratner, S., Petrack, B., 1951. Biosynthesis of urea, III. further studies on arginine synthesis from citrulline. Journal of Biological Chemistry 191, 693–705.

Ray, J., 1691. The Wisdom of God Manifested in the Works of the Creation. Being the Substance of Some Common Places Delivered in the Chappel of Trinity–College, in Cambridge. Printed for Samuel Smith, London.

Renecker, T.A., Renecker, L.A., Mallory, F.F., 2005. Relationships between carcass characteristics, meat quality, age and sex of free-ranging Alaskan reindeer: a pilot study. Rangifer 25, 107–121.

Rich, E.E., Johnson, A.M., 1949. James Isham's Observations on Hudsons Bay, 1743 and Notes and Observations on a Book Entitled A Voyage to Hudsons Bay in the Dobbs Galley, 1749. Publication 12. The Champlain Society, Toronto.

Rincker, P.J., Bechtel, P.J., Finstadt, G.L., Van Buuren, R.G.C., Killefer, J., Mckeith, F.K., 2006. Similarities and differences in composition and selected sensory attributes of reindeer, caribou and beef. Journal of Muscle Foods 17, 65–78.

Robinson, H.M., 1879. The Great Fur Land, or, Sketches of Life in the Hudson's Bay Territory. Sampson Low, Marston, Searle, and Rivington, London.

Rodahl, K., 1954a. Eskimo Metabolism: A Study of Racial Factors in Basal Metabolism. Brøggers Boktrykkeris Forlag, Oslo.

Rodahl, K., 1954b. Studies on the Blood and Blood Pressure in the Eskimo and the Significance of Ketosis Under Arctic Conditions. Norsk Polarinstitutt Skrifter 102. Brøggers Boktrykkeris Forlag, Oslo.

Roggenbuck, M., Schnell, I.B., Blom, N., Bælum, J., Bertelsen, M.F., Sicheritz-Pontén, T., Sørensen, S.J., Gilbert, M.T.P., Graves, G.R., Hansen, L.H., 2014. The microbiome of New World vultures. Nature Communications 5, 1–7.

Rothschild, D., Weissbrod, O., Barkan, E., Kurilshikov, A., Korem, T., Zeevi, D., Costea, P.I., Godneva, A., Kalka, I.N., Bar, N., Shilo, S., Lador, D., Vila, A.V., Zmora, N., Pevsner-Fischer, M., Israeli, D., Kosower, N., Malka, G., Wolf, B.C., Avnit-Sagi, T., Lotan-Pompan, M., Weinberger, A., Halpern, Z., Carmi, S., Fu, J., Wijmenga, C., Zhernakova, A., Elinav, E., Segal, E., 2018. Environment dominates over host genetics in shaping human gut microbiota. Nature 555, 210–215.

Rudman, D., DiFulco, T.J., Galambos, J.T., Smith III, R.B., Salam, A.A., Warren, W.D., 1973. Maximal rates of excretion and synthesis of urea in normal and cirrhotic subjects. Journal of Clinical Investigation 52, 2241–2249.

Russell, F., 1898. Explorations in the Far North, Being the Report of an Expedition Under the Auspices of the University of Iowa During the Years 1892, '93, and '94. University of Iowa Press, Iowa City.

Saheki, T., Katsunuma, T., Sase, M., 1977. Regulation of urea synthesis in rat liver: changes of ornithine and acetylglutamate concentrations in the livers of rats subjected to dietary transitions. Journal of Biochemistry 82, 551–558.

Saheki, T., Tsuda, M., Takada, S., Kusumi, K., Katsunuma, T., 1980. Role of argininosuccinate synthetase in the regulation of urea synthesis in the rat and argininosuccinate synthetase-associated metabolic disorder in man. Advances in Enzyme Regulation 18, 221–238.

Savelle, J.M., Dyke, A.S., 2014. Prehistoric Neoeskimo komatiks, Victoria Island, arctic Canada. Arctic 67, 135–142.

Savishinsky, J.S., 1975. The dog and the Hare: Canine culture in an Athapaskan band. In: Clark, A.M. (Ed.), Proceedings: Northern Athapaskan Conference, 1971, Vol. 2. National Museum of Man, Mercury Series, Canadian Ethnology Service Paper 27. National Museums of Canada, Ottawa, pp. 462– 515.

Schaefer, O., 1977. Changing dietary patterns in the Canadian north: health, social and economic consequences. Journal of the Canadian Dietetic Association 38, 17–25.

Schnorr, S.L., Crittenden, A.N., Henry, A.G., 2016. Impact of brief roasting on starch gelatinization in whole foods and implications for plant food nutritional ecology in human evolution. Ethnoarchaeology 8, 30–56.

Semenova, A.A., Derevitskaya, O.K., Dydykin, A.S., Aslanova, M.A., Vostrikova, N.L., Ivankin, A.N., 2019. The distinctive characteristics of the nutrient composition of reindeer meat from the Vorkuta District determined by the conditions of the region of origin [in Russian]. Voprosy Pitaniia [Problems of Nutrition] 88, 72–79 (doi:10.24411/20042-28833-22019-10056).

Service, E.R., 1966. The Hunters. Prentice-Hall, Englewood Cliffs, NJ.

Shaffer, N., Wainwright, R.B., Middaugh, J.P., Tauxe, R.V., 1990. Botulism among Alaska natives: the role of changing food preparation and consumption practices. Western Journal of Medicine 153, 390–393.

Sharp, H.S., 1976. Man: wolf: woman: dog. Arctic Anthropology 13, 25–34.

Sheppard, W.L., 2004. The significance of dog traction for the analysis of prehistoric arctic societies. Alaska Journal of Anthropology 2, 70–82.

Shivik, J.A., 2006. Are vultures birds, and do snakes have venom, because of macro- and microscavenger conflict? BioScience 56, 819–823.

Siegel, L.S., 1993. Destruction of *botulinum* toxins in food and water. In: Hauschild, A.H.W., Dodds, K.L. (Eds.), *Clostridium botulinum* Ecology and Control in Foods. CRC Press, Boca Raton, FL, pp. 323–342.

Simpson, T., 1843. Narrative of the Discoveries on the North Coast of America; Effected by the Officers of the Hudson's Bay Company During the Years 1836–39. Richard Bentley, London.

Smith, G.M., 2022. The Gift of the Middle Tanana Dene: Pre-Colonial History in the Alaskan Interior. Lexington Books, Lanham, MD.

Smith, J., 1969 (1612). A Map of Virginia (Printed at Oxford, 1612). In: Barbour, P.L. (Ed.), The Jamestown Voyages Under the First Charter 1606–1609, Volume II. Documents Relating to the Foundation of Jamestown and the History of the Jamestown Colony Up to the Departure of Captain John Smith, Last President of the Council in Virginia Under the First Charter, Early in October, 1609. Cambridge University Press, London, pp. 327–464.

Soriano, A., Sánchez-García, C., 2021. Nutritional composition of game meat from wild species harvested in Europe. In: Ranabhat, C.L. (Ed.), Meat and Nutrition. IntechOpen, London, pp. 1–23 (doi:10.5772/intechopen.97763).

Speth, J.D., 2010. The Paleoanthropology and Archaeology of Big-Game Hunting: Protein, Fat or Politics? Springer, New York.

Speth, J.D., 2017. Putrid meat and fish in the Eurasian Middle and Upper Paleolithic: are we missing a key part of Neanderthal and Modern Human diet? PaleoAnthropology 2017, 44–72.

Speth, J.D., 2018. A new look at old assumptions: Paleoindian communal bison hunting, mobility, and stone tool technology. In: Carlson, K., Bement, L.C. (Eds.), The Archaeology of Large-Scale Manipulation of Prey: The Economic and Social Dynamics of Mass Hunting. University Press of Colorado, Boulder, pp. 161–285.

Speth, J.D., 2019. Neanderthals, Vitamin C, and scurvy. Quaternary International 500, 172–184.

Speth, J.D., 2022. Rethinking Binford's utility indices: interpretive problems in northern environments and their Pleistocene analogs. PaleoAnthropology 2022, 207–235.

Speth, J.D., Morin, E., 2022. Putrid meat in the tropics: it wasn't just for Inuit. PaleoAnthropology 2022, 297–353.

Speth, J.D., Spielmann, K.A., 1983. Energy source, protein metabolism, and hunter–gatherer subsistence strategies. Journal of Anthropological Archaeology 2, 1–31.

Spray, Z., 2002. Alaska's vanishing Arctic cuisine. Gastronomica 2, 30–40.

Stanisz, M., Ludwiczak, A., Buda, P., Pietrzak, M., Bykowska, M., Kryza, A., Ślósarz, P., 2015. The effect of sex on the dressing percentage, carcass, and organ quality in the fallow deer (Dama dama). Annals of Animal Science 15, 1055–1067.

Stefansson, V., 1909. Northern Alaska in winter. Bulletin of the American Geographical Society 41, 601–610.

Stefansson, V., 1921. The Friendly Arctic: The Story of Five Years in Polar Regions. Macmillan, New York.

Stefansson, V., 1939. Unsolved Mysteries of the Arctic. George G. Harrap and Company, London.

Stefansson, V., 1944. The diets of explorers. Military Surgeon 95, 1–3.

Stefansson, V., 1945. Arctic Manual. Macmillan, New York.

Stinson, L.F., Sindi, A.S.M., Cheema, A.S., Lai, C.T., Mühlhäusler, B.S., Wlodek, M.E., Payne, M.S., Geddes, D.T., 2021. The human milk microbiome: who, what, when, where, why, and how? Nutrition Reviews 79, 529–543.

Swaine, C., Drage, T.S., 1748. An Account of a Voyage for the Discovery of a North-West Passage by Hudson's Streights, to the Western and Southern Ocean of America. Performed in the Year 1746 and 1747, in the Ship California, Capt. Francis Smith, Commander. By the Clerk of the California, Vol. 1. Mr. Jolliffe, London.

Szulc, M., Tropilo, J., Krasinska, M., 1971. Bisoniana XLVII: Dressing percentage and utility value of the meat of European bison and domestic cattle hybrids. Acta Theriologica 16, 483–504.

Thaler, R.H., 2015. Misbehaving: The Making of Behavioral Economics. W. W. Norton, New York.

Thomas, E.M., 2003. The lion/Bushman relationship in Nyae Nyae in the 1950s: a relationship crafted in the old way. Anthropologica 45, 73–78.

Tronick, E.Z., Morelli, G.A., Winn, S., 1987. Multiple caretaking of Efe (Pygmy) infants. American Anthropologist 89, 96–106.

Turner, L.M., 1894. Ethnology of the Ungava District, Hudson Bay Territory. In: Eleventh Annual Report of the Bureau of Ethnology to the Secretary of the Smithsonian Institution, 1889–1890. Government Printing Office, Washington, DC, pp. 159–350.

United States Army Chief of the Air Corps, 1940. Arctic Manual, Vol. 1. Government Printing Office, Washington, DC.

van Heerden, S.M., Morey, L., 2014. Nutrient content of South African C2 beef offal. Food Measure 8, 249–258.

Vasundhara, T.S., Kumudavally, K.V., Sharma, T.R., 1983. Altered free fatty acid levels in fresh or canned mutton as indicators of spoilage. Journal of Food Protection 46, 1050–1054.

Wheeler, D.E., 1914. The Dog-Rib Indian and his home. Bulletin of the Geographical Society of Philadelphia 12, 47–69.

Whitney, C.A., 1896. On snow-shoes to the barren grounds, Part 5. musk-ox and desolation. Harper's New Monthly Magazine 92, 717–732.

Whitney, E., Rolfes, S.R., 2011. Understanding Nutrition, 12th ed. Wadsworth, Cengage Learning, Belmont, CA.

Whitridge, P., 2018. The government of dogs: archaeological (zo)ontologies. In: Baltus, M.R., Baires, S.E. (Eds.), Relational Engagements of the Indigenous Americas: Alterity, Ontology, and Shifting Paradigms. Lexington Books, Lanham, MD, pp. 21–39.

Wiklund, E., Finstad, G., Bechtel, P.J., 2005. Seasonal variation in carcass quality of reindeer (Rangifer tarandus tarandus) from the Seward Peninsula, Alaska. In: Proceedings of the 51st International Congress of Meat Science and Technology, August 7–12, 2005, Baltimore, MD. International Congress of Meat Science and Technology and American Meat Science Association, Baltimore, pp. 1739–1744.

Wiklund, E., Malmfors, G., Finstad, G.L., Åhman, B., Skuterud, L., Adamczewski, J., Garner, K., 2019. Meat quality and meat hygiene. In: Tryland, M., Kutz, S.J. (Eds.), Reindeer and Caribou: Health and Disease. CRC Press, Boca Raton, FL, pp. 353–381.

Williams, P., 2007. Nutritional composition of red meat. Nutrition and Dietetics 64, S113–S119.

Wilson, G.L., 1924. The horse and the dog in Hidatsa culture. Anthropological Papers of the American Museum of Natural History 15, 125–311.

Wrangham, R.W., 2009. Catching Fire: How Cooking Made Us Human. Basic Books, New York.

Wylie, A., 1985. The reaction against analogy. Advances in Archaeological Method and Theory 8, 63–111.

Yatsunenko, T., Rey, F.E., Manary, M.J., Trehan, I., Dominguez-Bello, M.G., Contreras, M., Magris, M., Hidalgo, G., Baldassano, R.N., Anokhin, A.P., Heath, A.C., Warner, B., Reeder, J., Kuczynski, J., Caporaso, J.G., Lozupone, C.A., Lauber, C., Clemente, J.C., Knights, D., Knight, R., Gordon, J.I., 2012. Human gut microbiome viewed across age and geography. Nature 486, 222–227.

© John D. Speth

Department of Anthropology

1085 South University Avenue

University of Michigan

Ann Arbor, Michigan 48109–1107

USA

E-mail: jdspeth@umich.edu

EERSTE KROON-VOORDRACHT (1971)
G. Bosinski, *Die Tierdarstellungen des Magdalénien Fundplatzes Gönnersdorf bei Neuwied*

TWEEDE KROON-VOORDRACHT (1975)
F. Anders, *Kunst und Kunstgewerbe Altmexikos*

DERDE KROON-VOORDRACHT (1977)
C.B.M. McBurney, *Archaeology and the Homo Sapiens Sapiens Problem in Northern Africa*

VIERDE KROON-VOORDRACHT (1978)
Raymond H. Thompson, *Mesoamerica and the Goals of Archaeology*

VIJFDE KROON-VOORDRACHT (1981)
J.K.S. St Joseph, *Air Photography and Archaeology: Achievements and Prospects*

ZESDE KROON-VOORDRACHT (1983)
Glynn Isaac, *Early Stages in the Evolution of Human Behavior: the Adaptive Significance of Stone Tools*

ZEVENDE KROON-VOORDRACHT (1984)
H.T. Waterbolk, *Archeologie en Landschap*

ACHTSTE KROON-VOORDRACHT (1985)
Tim D. White, *Acheulian Man in Ethiopia's Middle Awash Valley: The Implications of Cutmarks on the Bodo Cranium*

NEGENDE KROON-VOORDRACHT (1986)
M. Biddle, *The Thames and the Rhine: urban origins in the Channel-region (paper presented for the Ninth Kroon-Voordracht (1986); manuscript for publication never received)*

TIENDE KROON-VOORDRACHT (1987)
J.D. van der Waals, *De kolonisatie van het terpengebied – een ethno-archeologische benadering*

ELFDE KROON-VOORDRACHT (1988)
Jane E. Buikstra, *The mound-builders of eastern North America – a regional perspective*

TWAALFDE KROON-VOORDRACHT (1990)
David R. Harris, Settling down and breaking ground: *Rethinking the Neolithic Revolution*

DERTIENDE KROON-VOORDRACHT (1991)
W.A. van Es, *Van Maastricht naar Rhenen, een wandeling in de Laat-Romeinse tijd*

VEERTIENDE KROON-VOORDRACHT (1992)
J.D. Lewis-Williams, *Vision, Power and Dance: The Genesis of a Southern African Rock Art Panel*

VIJFTIENDE KROON-VOORDRACHT (1993)
B.W. Cunliffe*, Fertility, Propitiation and the Gods in the British Iron Age*

ZESTIENDE KROON-VOORDRACHT (1994)
J.T. Urtāns*, Latvian Hillforts: the Originality of the Archaeological Reality*

ZEVENTIENDE KROON-VOORDRACHT (1995)
Ph.V. Tobias, *The communication of the dead: earliest vestiges of the origin of articulate language*

ACHTTIENDE KROON-VOORDRACHT (1996)
O. Crumlin-Pedersen*, Archaeology and the sea*

NEGENTIENDE KROON-VOORDRACHT (1997)
George Eogan, *The discovery programme: Initiation, consolidation and development*

TWINTIGSTE KROON-VOORDRACHT (1998)
Leendert P. Louwe Kooijmans, *Between Geleen and Banpo, the Agricultural Transformation of Prehistoric Society, 9000 – 4000 BC*

EENENTWINTIGSTE KROON-VOORDRACHT (1999)
Colin Renfrew, *Loot, Legitimacy and ownership: The ethical crisis in archaeology*

TWEEENTWINTIGSTE KROON-VOORDRACHT (2000)
Erika Hagelberg, *Genetics in the study of human history: problems and opportunities*

DRIEENTWINTIGSTE KROON-VOORDRACHT (2001)
João Zilhão, *Anatomically archaic, behaviorally modern: The last Neanderthals and their destiny*

VIERENTWINTIGSTE KROON-VOORDRACHT (2002)
S. von Schnurbein, *Augustus in Germanien, neue archäologische Forschungen*

VIJFENTWINTIGSTE KROON-VOORDRACHT (2003)
S.W. Hillson, D.R. Brothwell and G.J.R. Maat, *Wealth, health and human remains in archaeology*

ZESENTWINTIGSTE KROON-VOORDRACHT (2004)
Miranda Aldhouse-Green, *Beyond the gods: biographies, values and cosmologies in 'celtic' iconography*

ZEVENENTWINTIGSTE KROON-VOORDRACHT (2005)
Maarten J. Raven, *Architectural principles in theory and practice: The New Kingdom Necropolis at Saqqara (Egypt)*

achtentwintigste kroon-voordracht (2006)
Paul Halstead, *What's ours is mine? Village and household in early farming society in Greece*

negenentwintigste kroon-voordracht (2007)
Peter de Knijff, *Archaeology by means of DNA: hype or here to stay?*

dertigste kroon-voordracht (2008)
Hermann Parzinger e.a., *Der Skythenzeitliche Krieger aus dem Eis: neue Entdeckungen im Mongolischen Altaj*

eenendertigste kroon-voordracht (2009)
Bernard Wood, *The Human Fossil Record: Challenges and Opportunities*

tweeendertigste kroon-voordracht (2010)
Wil Roebroeks, *The Neandertal Experiment*

drieendertigste kroon-voordracht (2011)
Johannes Müller, *Megaliths and Funnel Beakers: societies in change 4100-2700 BC*

vierendertigste kroon-voordracht (2012)
Albert Zink, *From Tutankhamun to Ötzi: the use of modern scientific methods in mummy research*

vijfendertigste kroon-voordracht (2013)
J. Francis Thackeray, *Human evolution from an African perspective: with reference to Charles Darwin palaeoclimate and the problem of defining a species*

zesendertigste kroon-voordracht (2014)
André F.L. van Holk, Jerzy H.G. Gawronsky, Jonathan R. Adams and Henk Dessens, *Maritime Archaeology*

ZEVENENDERTIGSTE KROON-VOORDRACHT (2015)
Lee R. Berger, *Five years after Australopithecus Sediba. New discoveries changing our understanding of human evolution*

ACHTENDERTIGSTE KROON-VOORDRACHT (2016)
Fred Spoor, *Evolving primates: a palaeontologist's view of his tribe*

NEGENENDERTIGSTE KROON-VOORDRACHT (2017)
Graeme Barker, *A tale of three caves: why was our species so successful at colonising new environments*

VEERTIGSTE KROON-VOORDRACHT (2018)
Michael Parker Pearson, *Science and Stonehenge: recent investigations of the world's most famous stone circle*

EENENVEERTIGSTE KROON-VOORDRACHT (2019)
Jean-Jacques Hublin, *The rise and spread of homo sapiens*

TWEEENVEERTIGSTE KROON-VOORDRACHT (2020)
Corrie C. Bakels, *Man: manipulator of his physical environment*

DRIEENVEERTIGSTE KROON-VOORDRACHT (2021)
David R. Fontijn, *'Give Peace a Chance' on Violence and Warfare in Prehistory and Why it Matters*

KROON-VOORDRACHTEN

REDACTIE: WILLY H. METZ

Printed by

DRUKKERIJ J. BOUT & ZN., HUIZEN

ISBN/EAN 978-90-829-481-9-6