AGING AND FERMENTATION AS ADAPTIVE FOOD MANAGEMENT STRATEGIES IN THE ARCTIC

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Abstract

This dissertation is composed of three papers: one published article, one article under review for publication, and one published commentary. Chapter 1 provides an introduction to the dissertation as a whole – a work that investigates food aging and fermentation techniques in an indigenous Yup'ik Alaskan community, proposes an adaptive explanation for these strategies in the circumpolar north, and explores the potential importance of them cross-culturally and evolutionarily. Chapter 2 is a paper that describes the seal poke storage system – an indigenous food preservation and storage technique that Yup'ik Alaskans used to manage food security up until approximately one generation ago. Chapter 3 is a detailed study of *ninamayuk* – an indigenous Yup'ik food that involves processing and preservation techniques that are exemplary of the strategy adopted throughout the North American and Eurasian arctic and subarctic to ensure annual food security. Chapter 4 briefly summarizes an article published in *Current Anthropology* on indigenous aged and fermented foods in the Bering Strait region to which the published commentary (Chapter 5) is in response. Chapter 6 elaborates on the main points made in the commentary. Chapter 7 links the previous chapters to the findings in the papers of Chapter 2 and, particularly, Chapter 3 with its broader implications for understanding the evolution of the human diet. Chapter 8 discusses the implications of this research for the direction of future work in the field of Anthropology; specifically, the importance of continued ethnographic work and experimental archaeology with contemporary indigenous communities and the potential contribution of this for developing theories about prehistoric human dietary practices and modern-day diet-related health problems.

Dedication

This work is dedicated to my mother, Lynn Giordano, who always managed to keep food on the table for our big family (and anyone else who happened to stop by), despite limited time and resources. "Questionable" meat leftovers (as my sisters and I called them) were revamped into delicious casseroles, tuna salad or fried tomatoes could be tactfully plated to look like a main dish, old mashed potatoes became fried potato cakes for breakfast, and instead of processing the much more affordable skin-on bone-in chicken cuts, the whole lot was thrown in a pot with a bottle or two of beer for an hour resulting in surprisingly tasty chicken that just slides off the bone. Any leftovers, of course, perfectly suited for a chicken stock later used to make soup for lunch the next day. It is my Mom who gave me the skill of turning not much into something in the kitchen – a skill which now benefits my own family. Her creativity and expertise made something really difficult (preparing three meals a day for a large family with limited resources) seem simple. Perhaps it is because Moms make things in the kitchen look so "simple" that we assume the skills, knowledge of foods, day-to-day decision making, and future planning needed for the task are also simple. This work is the culmination of ideas over the years inspired by my realization that we may be missing important aspects of the evolution of the human diet by taking these things for granted.

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Chapter 1: Introduction

Chapter 2 is an article (published in *Food and Foodways*) that describes the seal poke storage system – an indigenous food preservation and storage technique that Yup'ik Alaskans used to manage food security up until approximately one generation ago. The research for this paper was conducted during a series of field trips to the study region of Tununak, Alaska (a village on Nelson Island adjacent to the southwest coast of Alaska) and included experimental archaeology (reconstruction of the seal poke), participant observation, informal interviews, and the collection of semi-quantitative surveys (on memories of seal pokes and seal oil consumption habits). The purpose of this study was to document and understand this, as yet, underexplored food processing and storage strategy that was important for food security in the study region and is similar to other strategies frequently noted, but not systematically investigated, in the ethnographic record of indigenous populations throughout the circumpolar north. This paper also discusses the prevalence of these "soft technology" food storage containers cross-culturally.

Chapter 3 is a detailed study of *ninamayuk* – an indigenous Yup'ik food that involves processing and preservation techniques that are exemplary of the general strategy adopted throughout the North American and Eurasian arctic and subarctic to ensure annual food security. Contrary to assumptions in the field of Anthropology about the management of food security in cold climates during human prehistory, this strategy rarely involves cooking, or, more precisely, the controlled use of fire. The specific adaptive value of these alternative techniques in arctic and subarctic ecological contexts is explored. Nutritional, temperature (of year-round food storage environments and food smoke and melting points), and historic ethnographic data are presented and discussed to support these claims. The broader argument is made that strategies used by modern-day indigenous arctic communities, and/or their recently seasonally-mobile hunter-

gatherer ancestors, provide a more appropriate framework from which to draw inferences about prehistoric human dietary behavior in cold climates than do interpretations which, so far, have been based largely on food management concepts in modern-industrialized contexts.

Following an introduction in Chapter 4, Chapter 5 is an invited commentary (published in *Current Anthropology*) to an article on indigenous aged and fermented foods in the Bering Strait regions of Russia and Alaska. This article by Yamin-Pasternak and colleagues (2014), which drew from long-term research on a municipals water system project with the Chukchi of the autonomous Russian district of Chukotka, was presented to the authors (Frink and Giordano) for review amidst their own long-term research project with the Yup'ik on the Alaska side of the Bering Strait where they were investigating indigenous food processing and storage techniques (of which, aging and fermentation have a central role). Chapter 6 elaborates on the main tenets of the commentary with regard to the stigmatization of aged and fermented foods among the Yup'ik in Alaska – a process slightly different than the one in Chukotka, albeit with some important similarities. Specifically, it addresses the (mis)association of traditional food practices with poor hygiene and food borne illness by state health officials and argues that this would have motivated women to refrain from advertising their subsistence activities to outsiders. During an era of scholarship in anthropology when the focus of ethnographic research was on the subsistence activities and technology of men, this further widened an already large gap in the ethnographic record of subsistence food processing activities in the circumpolar north – a region where women, almost universally, control all aspects of food management (i.e., processing, storage, and distribution).

Chapter 7 draws out the major points of the previous chapters and situates them in a broader cross-cultural and evolutionary framework. Aging and fermentation techniques make

adaptive sense in circumpolar ecological contexts. The many advantages they offer over other food preparation and preservation techniques are particularly prominent in northern latitudes for the various reasons outlined in Chapter 3. However, these advantages are not confined to northern contexts. Indeed, the ubiquity of food aging and fermentation practices – often used for processing staple food resources and weaning foods – among local subsistence-based, non-industrialized populations throughout the world suggests that these techniques may have been more important during human evolution than has been previously recognized. Potential implications of this for contributing to current scholarly research on the evolution of the human diet and its relevance for understanding modern-day diet-related health outcomes are presented and discussed.

In conclusion, Chapter 8 discusses the implications of this research for the direction of future work in the field of Anthropology; namely, the importance of continued ethnographic work and experimental archaeology with contemporary indigenous communities. Nuanced methodologies are suggested. A closer look at the work of indigenous women, in particular, is underscored because of the prominent role that this social group plays in the management of day-to-day food security by way of numerous strategies that may be taken-for-granted in modern industrialized contexts.

Chapter 2: Women and Subsistence Food Technology: The arctic seal poke storage system

By

Liam Frink

Celeste Giordano

Preface and Author Contributions

This is a published article (Frink, Liam and Celeste Giordano. 2015. "Women and Subsistence Food Technology: The arctic seal poke storage system." *Food and Foodways* no. 23 (4): 251-272) based on research conducted by Frink and Giordano in Tununak, Alaska between the Summers of 2013 and 2014, which was funded by a National Science Foundation, Office of Polar Programs grant (#1106362), for which Frink was the Principal Investigator and Giordano the research assistant. The authors contributed equally to this article: both participated in the grant writing, fund administration, fieldwork, research, conceptualization, and writing to produce this article.

Abstract

This study focuses on the pan-arctic seal poke storage system—an innovative and effective food storage and preservation system that was likely used for thousands of years but today is rarely seen. Women expertly processed the skin of a whole seal into a leak proof pliable container. The result was a technology that provided the safe storage and transport of rendered seal oil—a highly prized food and fuel source—and the preservation and taste and texture enhancement of other foods submerged in the oil. Sea mammal oil was (and remains largely so) unequivocally one of the most critical subsistence resources in the arctic. Here we draw from the

ethnographic record and our own field observations in Alaska to discuss the seal poke storage system and implications of women's fundamental role in complex food storage technologies.

Introduction

Arctic hunter-gatherers are a unique class of pre-agriculturalists who store foods (Testart 1982). They are distinctive because the types of subsistence foods stored were primarily of animal origin, and yet food preparation and preservation rarely involved cooking. The thick layer of permafrost that lies about a foot below the surface of the ground throughout much of the arctic appears to have been a ready freezer for foragers of the circumpolar north, but proper food storage was more involved than digging a hole. Indigenous northern women not only used a vast array of pre-processing techniques, but they had specific kinds of storage applications to accommodate the seasonal harvesting rounds and extreme climates of the arctic environment. Despite the importance of food storage as a critical adaptive strategy in the north and its uniqueness in utilizing less understood "wet preservation" (D'Anglure 1984: 491) techniques, it has received little systematic study. This is surprising because the processes and decisions involved in different food storage strategies and how or why they may change over time provides insight into many aspects of human health and behavior of interest to anthropologists.

Northern indigenous groups used a range of storing approaches, including surface, above-surface, and below-surface storage facilities (Park 1999; Stopp 2002). These continue to be used by contemporary descendants; for instance, Inupiaq people use subsurface stone-lined caches and ice cellars in northwest Alaska. In many regions, foods were stored in above-ground, house-like caches, on stilts or in trees, on porch entryways, and frozen under stacked rocks. Although these structures were straightforward in design and might be used for several years, a substantial

amount of work was dedicated to making the "wet preservation" containers year in and year out, which would eventually be stored in these areas. Examples are fish skin bags, organ bags (such as the stomachs of caribou), and the all-important seal skin "poke" bag. Successful storage also depended on the right pre-processing technique: foods often had to be air dried, smoked, salted, frozen, boiled, fermented, or a combination of these before being put in containers and finally into the appropriate storage area. The complex nature of several of these techniques is well captured by ethnographer Bernard Saladin D'Anglure (1984):

> Food preparation, rudimentary as it may seem, was nevertheless subtle and required detailed knowledge in order to prepare meat properly depending on the part of the animal, the age and sex of the game and the circumstances of its killing, the season, whether consumption was to be immediate or deferred, the preservation technique, and incidentally, the tastes of the consumer. The meat of any game species could be aged (slightly, fully, or to the point of decomposition), slightly or fully boiled, uncooked, frozen, dried, or smoked. Drying served in the summer for filleted Arctic char; loins and ribs of ringed seals, belugas, and caribous; the entrails of ringed seals and braided small intestines of ringed and bearded seals; and pieces of skin and cut up flippers of belugas. Wet preservation, in skin or beluga stomach containers, served for beluga skin and fat, cuts of walrus meat and fat, and the oil of various sea mammals. In the autumn it sufficed to place sections of game or whole game animals under piles of stones, where later freezing preserved them through the winter (491).

Although much of the ethnographic data on subsistence-based societies that relied on animal-source food storage and preservation without the advantage of modern containers

and electric cooling or drying appliances comes from the arctic (Eidlitz 1969), such practices are not limited to this region. Indeed, the practice of storing and preserving animal-source foods in animal skin or organ (stomach, bladder, intestine) bags can be found around the world. Pemmican, which is dried meat, pounded down into a meal, mixed with lard or oil and/or berries, and stored in an animal skin or organ bag, was widespread among subarctic North American Indian tribes such as the Dene (Jarvenpa and Brumbach 1995), the Ojibwa (Holzkamm, Lytwyn, and Waisberg 1988), the Crow (Murdock 1934), the Navajo (Kluckhohn, Hill, and Kluckhohn 1971), and the Northern Paiute (Kelly 1932). Pemmican was a nutrient dense, light-weight, transportable food with a long shelf-life, the trade for which early white explorers to North America often depended on for survival (Colpitts 2012; Schillat 2007). Gariss is another nutrient dense, transportable food found in Sudan that is made by fermenting milk in a skin bag (Dirar 1992). Gohomo is a popular food among the Teda of Central Africa, which consists of dried antelope or cow meat that is cut into strips, flattened, dried, and stored in un-tanned antelope skin (LeCoeur and Schütze 1981). In the Middle East, the Pashtun people knead fresh butter and store it in lamb skin bags for up to three months (Glatzer and Schutze 1977), and Tulum cheese is a popular food in Turkey that is made by ripening raw ewe’s milk in goat skin bags (tulums) for three months (Hayaloglu et al. 2007). The Ainu (Ohnuki-Tierney 1974) and Chukchee (Bogoras 1975) in East and North Asia, respectively, both make use of seal skin and seal stomachs for the storage of meat. Finally, in Europe, the Sami of Scandinavia have a festival dish called a “blood stomach,” which is a reindeer stomach that is turned inside-out, cleaned, and then filled with blood and stored in the snow or dried on a raised stand (Itkonen and Minn 1948).

Despite the widespread use of animal skins and organs as food storage and preservation vessels, there is scant systematic information on the details of their design, the people who make them, and the reasons that they are so useful. An ideal region to study hunter-gatherer subsistence storing technologies and techniques and women's contribution is the circumpolar north (Jarvenpa and Brumbach 2006). Indigenous northern women continue to make and use a range of storage containers, and arctic scholars have detailed the value and expertise of women's and men's perishable technologies, materials, and techniques (Gilligan 2010).

This work contributes to this literature by describing the general features of the seal poke storage system, followed by an examination of its importance in an Alaskan coastal village. The seal poke was an ingenious wet technology that preserved sea mammal oil over long periods of time by accommodating extreme temperatures and small harvesting windows with large catches—in both the quantity of fish and the sheer size of sea mammals. Prior to the arrival of European whalers, blubber was not commonly rendered and fish and meat were not commonly prepared with heat by northern indigenous groups. A critical feature of the seal poke system was that it permitted the preservation of blubber as it rendered into oil and the safe storage of dried fish and meat without the need for external fuel sources, which are limited in the region. The seal poke storage system is an apt cross-cultural example of the complexities and subtleties of managing surplus food production among arctic hunter-gatherers and the pivotal position of indigenous women in expert subsistence technologies and techniques.

Overview of Research Area

The Yukon-Kuskokwim Delta is a complex coastal maritime environment. The alluvial fan is demarcated by the Yukon and Kuskokwim Rivers. The region is over 78% water with rivers, sloughs, ponds, and poorly drained marshy areas and temperatures can be extreme ranging from -40 to 80° F. Working in this region demands that one grasp the relative abundance of the short spring, summer, and fall, and the extraordinary challenges of the frigid and windy winter months—and thus a keen appreciation for storage and preservation innovation, expertise, and technologies.

For some of the year sedges, grasses, and other hardy short plants create a carpet of lush tundra. The quantity, quality, and kinds of resources depend on the season (Lantis 1946). Just before salmon and herring begin their seasonal runs, migrating birds flock to the tundra in the spring only to leave in the fall, also the time for picking a variety of coveted berries. Animals, birds, and fish are relatively less available during the winter months (freeze-up typically occurs around October or November and break-up in late April or May), but blackfish (*Dallia pectoralis*) and the tundra hare (*Lepus othus*) remain for the arctic winter. Sea mammals roam the Bering Sea and river courses during the spring, summer, and fall. The most critical sea mammals in the Yukon Kuskokwim Delta are seals: Northern (*Callorhinusursinus*), ringed (*Phocahispida*), harbor (*P. vitulina*), spotted (*P. largha*), ribbon (*P. fasciata*), and bearded (*Erignathus barbatus*) seals.

Evidence from the site of Old Tununak (located adjacent to the contemporary village of Tununak) suggests that people of the Norton Tradition lived on the coast at least 3000 years ago. The Norton period is a time of florescence of people from northwestern Alaska to the Alaska Peninsula. They relied heavily on maritime resources and expanded into the interior rivers around 2,000 to 1,500 years ago. Following Norton were the Thule, the

contemporary descendent populations from Alaska to Greenland and thought to enter the American arctic around A.D. 1000 (Dumond 1977).

Relative to other regions of North and arctic North America, physical Euro-North American contact came later to the western Alaskan shores (VanStone 1984a). There are several reasons for the delay in direct colonial settlement and development. First, access to the coastline was inhibited by the shallow Bering Sea shelf and overland travel throughout the marshy delta was relatively difficult. Second, historic booms in other regions occupied the Russians; first to the south in the Aleutian Archipelago and Kodiak Island, and later in Northwest Alaska (Oswalt 1990). In the latter part of the nineteenth century, Americans hunted baleen whales for export and searched for gold. Like other Alaskan regions, the delta has experienced colonial market booms and busts (for instance, fur and commercial fishing booms) and today the region is enveloped in an escalation of mineral mining. The delta, however, was on the fringe of earlier market booms and the earliest influx of settlers (VanStone 1984a).

Now in settled villages, men continue to fish and hunt sea and land animals. Among a wide range of subsistence pursuits, during the early spring men and women collect and relish bird eggs, and throughout the summer, fish is harvested for year round use. Women are responsible for all of the processing, storage, and distribution of these essential resources. During spring, summer, and fall months, men hunt seal on the Bering Sea as well as up the river courses and women in the coastal villages still butcher, process, and distribute the skin and meat (Lantis 1946).

For this seal poke storage and preservation project, the authors have been working in Tununak (on the northwest coast of Nelson Island; see Figure 1) since 2012 with women who continue to process subsistence foods. This community is ideal to collaborate with when investigating subsistence technologies and practices since many traditional methods and tools continue to be used, and people maintain a keen interest in practicing and preserving their traditional technologies. Like other indigenous North American groups (Ehrhardt 2005), Yup'ik and other arctic groups strategize their incorporation of tools, materials, and ideas and today continue to use many "traditional" technologies and skills. Applications and materials have changed over several thousands of years, but many subsistence activities retain similar fundamental components.

Tununak is a small coastal village of over 300 mostly bilingual (Central Yup'ik and English) Yup'ik Eskimos. Here people have ready access to fishing, sealing, gathering, and terrestrial hunting areas. Direct contact with Anglo-North Americans began in the later 1800s when the Smithsonian Institutions' Edward Nelson traveled through in the winter of 1878 ([1889] 1983). The Jesuit Catholics arrived on Nelson Island in 1889. However, they did not build a mission until the early 1930s (Barker 1993a). Unlike their ancestors into the early twentieth century, the people of Tununak are fairly sedentary. In the late summer, families travel up river to go berry picking, but this is the extent of familial encampment. Most villagers continue to rely heavily on subsistence foods even though there are two small stores. Many of the foods in the stores, such as rice and dry pasta, are used as fillers to extend subsistence or "country" foods (Borre 1991). People are well aware that store stock is not always reliable—a winter storm can delay foods easily for one or two weeks, leaving the shelves vacant.

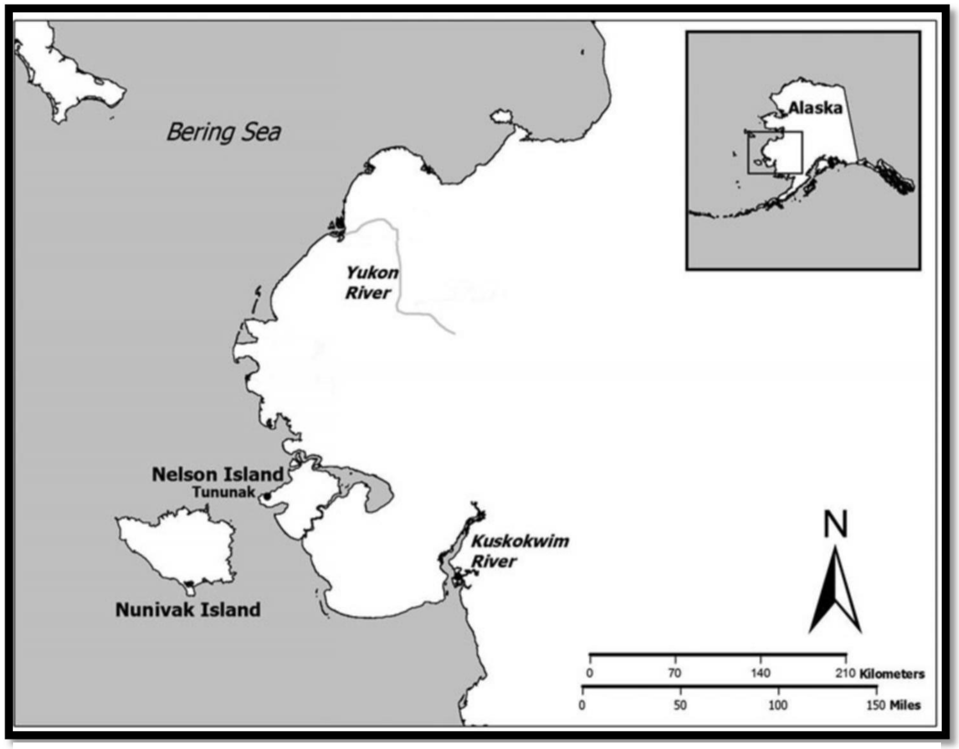

Figure 1. Map of Study Area.

Seal hunting was (and remains widely so) a critical part of Yup'ik men's subsistence and status activities (see also Searles 2002). Into the mid-1900s, seals were captured by net, spear, or harpoon jettisoned off an atlatl or a bow and arrow (Lantis 1946). (Today men hunt from their aluminum boats with their ubiquitous .22 caliber rifles.) Margaret Lantis (1946: 173) noted that "even in a poor year" men (26 hunters in a village on Nunivak Island) caught some 500 seals of varying types and, although the number of smaller-sized seals was not noted by the men, "every hunter knew exactly how many adult bearded seals every other hunter had caught, and everyone was rated thereon."

A Yup'ik woman's subsistence production, though entwined with a man's harvest, is her discretionary economic production. For instance, a man will accrue status for his hunting success, but when he transfers the catch to a woman, decisions about processing, storage, and distribution were (and largely still are) directed by her. Robert Spencer (1959: 149) reports for the Inupiaq as well that, "once the hunter had taken the game into the house, or once it was butchered and stored in the cache or ice cellar, it became the property of the woman of the household." A woman's production portfolio is generated by her acquisition and implementation of a broad range of knowledge and skills built over a lifetime, and status is achieved through her skilled management and distribution of foods and their products (Frink et al. 2007; see also De Laguna 1990). Elder Yup'ik women who have attained a significant measure of influence through their mastery of a range of subsistence production and food management skills are known as *pinutaq* (Frink 2009a). Even the seemingly most "simple" applications of subsistence processing for a Yup'ik woman require years of apprenticeship and training (Frink 2009b), and the seal poke storage system is one of the most expert and adaptive examples of this.

Seal Poke Storage System

One of the most important foods women process is seal, a mainstay in Yup'ik economy and ideology. Seal oil served as a primary source of fuel, an essential condiment and marinade, and a common medicinal application (Borre 1991). The meat and some organs were also important sources of food; the bones were used for making various tools, and the blood was used as dye and to flavor/thicken soups and stews. Worked seal skins provided the raw material for boots, parkas, ceremonial drums, kayaks, and more. Finally, the inflated whole seal skin served two other purposes: as a buoy for hunters (also known as a seal float) and as a storage container (known commonly as a seal poke). The seal poke storage system was critical for food security among groups ranging from the Siberian coast to Greenland (D'Anglure 1984) and the details of its production and use were the primary purpose of the current study.

Though found across the circumpolar north, little is known about the origins, making, or performance characteristics of the seal poke. Zona Starks (2007: 43) suggests the use of pokes for food storage among the Inupiat of the northwest coast of Alaska may have been used as far back as 4,000 years ago, citing the prior work of Giddings in the Kotzebue Sound area. Apparently the only "hard" evidence for the use of pokes is identifying the remains of pits in which the seal pokes were reportedly stored (Frink et al. 2007). Other preserved evidence include plugs (ivory, wood) used to seal weapon wounds to prevent blood leakage. Another critical archaeological marker is the *qapiarun* knife (see Figure 2), described to the authors as a specific tool used by women for seal poke skinning (see also Fienup-Riordan 2007).

Figure 2. *Qapiarun* Knife with Seal.

The bulk of what we know about the process of making and using seal pokes in the circumpolar north is from early ethnographic accounts. There appear to have been two primary means by which women made the pokes: either they sliced open the length of the seal along the stomach from neck to anus, removing the inner carcass and stitching the skin back up, or they opened selected areas (such as the neck) and either reached in, sliced the meat from the skin, and pulled the inner carcass out, or peeled the skin down away from it. After women stitched any punctures (such as the kill wound) and tied off any holes (such as the anus) they would inflate the skin bag and allow it to dry before filling.

In his account of the Polar Inuit in Greenland, Peter Freuchen (1962: 96) provides a detailed account of one of these techniques:

> To prepare a giviak [seal poke] one must first catch a seal, which has to be skinned in a special, very intricate manner. One [a woman] starts by cutting away

> at the mouth and carefully sticking the hands along the inside of the skin. The knife must not be too long and it takes some training before one can avoid making holes in the skin with the fingers. At the flippers it may be particularly difficult to find the right joint to cut through. As one progresses, both arms are soon buried inside the seal. Large lumps of blubber often have to be cut free and removed through the mouth to make room. At length, when the knife has gone all the way round and the skin is entirely free from the meat, comes the most tricky part of all: the entire body has to be pulled out through the mouth. As a rule, two men have to pull with all their might to manage this.

Peter Freuchen and Finn Salomonsen (1958: 200) report that the "whole seal must be skinned through the mouth, which is quite difficult. The flippers have to be cut away at the joints and the entire seal loosened from its skin. Then the body is dragged out through the mouth, and of course a thick layer of fat is left sticking to the hide. Thus a good bag contains a considerable amount of blubber, which is just what is needed." And Knud Rasmussen (1938: 19) notes of the eastern Greenlanders that after the insides are peeled away from the skin, the skin is then blown up "like a balloon" and left to dry.

Construction of a Seal Poke in Tununak

The observations of Ann Fienup-Riordan and James Barker offer insight on how the last generation of seal pokes was processed on Nelson Island. According to Fienup-Riordan (1983: 82):

> Cutting the skin free around the seal's mouth, the woman will work her qapiarsuun (flensing knife) under the skin, rolling it back and virtually turning the

> seal inside out to produce a seal skin poke suitable for storing dried fish and/or seal oil…once cut away from the carcass, the skins are washed in Clorox and stretched for tanning. If the skin is to be used as a poke, bullet holes are mended, and it is inflated and set to dry in the house or on the roof of the porch.

Barker (1993a: 40), underscoring the breadth of women's work for processing a seal even after they have taken care of the butchering and distribution of the seal, adds that:

> "Pokes" are fashioned out of whole skins turned inside out and filled with fat to be rendered. The oil, fresh or fermented, is a favorite additive to many foods. Hides are prepared and bundled away for later when long winter evenings will be spent making boots, parkas, and mitts. Every part of the seal is used.

The authors have heard similar descriptions from residents of Tununak, such as this elder Yup'ik woman's (one of the few women in the village who still make seal pokes) explanation of her technique as she demonstrates using a deflated seal poke she used for food storage the previous season:

> And then when I'm done [with] this part—somewhere here—I reach through, going around. And the seal—when I'm done somewhere, I pull this and push—let the body out—and then when it some way can come out, I pull it [the skin] back again. . .like this [she demonstrates]. Inside I cut—my hands are inside this. I cut it—the blubber—and then go in, take the blubber out—because I did that when I was—when I was small I learned. I did it myself. So somehow I take the blubber out and go like this [she demonstrates]. I cut the inside blubber, I pull the blubber, it [comes] out and then cut it. And do the other one, I guide it. I go without

> looking. So when I pull it out, it comes. The whole body. The head is here. I pull it with the hands [through the neck opening]. Since I learned this, I never make holes, never make holes. I learned myself. (Elder Yup'ik Female Consultant, June, 2013)

During the 2013 field season, the authors worked with a Yup'ik consultant and her family in the village of Tununak to record her making a seal poke. To supplement this, we conducted informal interviews with two elder Yup'ik women—one who still makes seal pokes and one who used to make them in the past—and collected short, semi-quantitative questionnaires (n = 32) from female and male adults about their memories of seal pokes and seal oil consumption habits. To obtain current information on the climate of different storage conditions, we also collected temperature data in an under-ground pit and above-ground storage shed from June 2013 through March 2014 (see Figure 3).

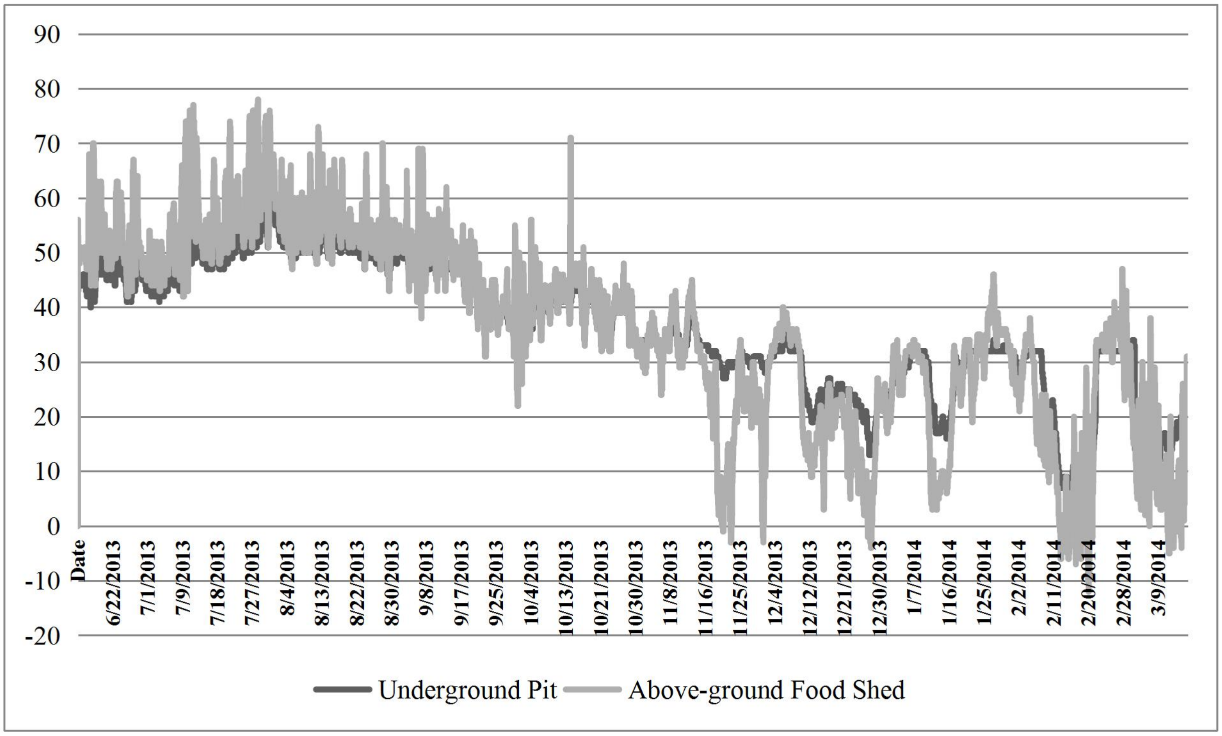

Figure 3. Temperature (°F) Comparison of Undergound Pit and Above-ground Food Shed in Tununak, Alaska June 2013 to March 2014.

The consultant we worked with is in her late 30s and the elder women in her family have a long history of making and using the bags to render the blubber and store the oil and other additive foods. She is one of very few local women who continue to make these bags. During the month of May 2013 her son caught a 68-pound (0.39 cm long) ringed seal in the Bering Sea and it was frozen intact until we arrived for field research in June. After the seal thawed (on cardboard on the house floor), our host began the project of creating the seal bag. Processing of the seal from initial butchering to drying took four days to complete and a total time of 13 hours and 4 minutes (over three hours per day on average). The butchering of the seal was much like

what is described by Freuchen and Salomonsen (1958) and Fienup-Riordan (1983) in the above descriptions.

Children moved in and out of the workspace as she worked on the seal on the floor (on cardboard) in the house. Our consultant first expertly wielded her *kegginaluk* (or ulu, a semi-lunar knife) to cut around the neck of the seal; afterward she took the neck skin and fitted and twisted a piece of wood (like a woodworker's dowel) to create a handle of skin that she used throughout the procedure. She then carefully used her *qapiarun* knife to trim away and separate the blubber from the skin, a demanding task that took skill, strength, and endurance. The most challenging trimming areas are around the seal fins (which remain intact). Pronounced care is taken not to puncture the skin—even the seals' nails are trimmed with a nail cutter so when the seal is later turned inside out the nails do not puncture the skin. Also challenging are areas of thinner skin, especially near the nipples of the seal. At this point our elder host assisted her with suggestions on how to deal with the nipple area without puncturing the skin. This elder has a history of making the bags, but, like other older women in the village, the demands of making them is greater than her body can now manage.

While shaving the connection between blubber and skin, our consultant continued to fold back the skin exposing more blubber to trim. At several points she held the outside of the seal skin, sticking her hand in to trim, feeling where to cut. After trimming down to the base fins, the whole package of blubber and meat is coaxed from the skin. After this, she turned the skin out, so the fur side was once again on the outside, and mended two holes with needle and thread—one made during processing and the other from the hunters' .22. After mending, our host and our entire group walked to the nearby Bering Sea coastline and she washed the fur side of the seal

skin with dish detergent (not Clorox, as cited previously in Fienup-Riordan 1983). The wet skin bag is then hung to dry, right-side-out, until the fur has dried.

The final step in the process of making the bag is to dry it while inflated. The weather was mild (60s and clear with light wind) and the drying sequence was performed outside the family house on a large piece of plywood. First, she turned the inside skin out again, after mending and washing the fur side, and then reused the wooden dowel handle to cinch down and tighten the neck opening. She then wrapped a cord around the neck to ensure the skin was airtight. After ensuring it was secure, she filled the seal skin with air (like blowing up a balloon) and cleverly used a candy pix stick straw to blow air into through the anus—much to the merriment of the crowd gathered outside! During this procedure there was community interest in the seal poke since middle-aged people remember their mothers and grandmothers making the pokes but no longer do they see them do so in the village. Since this was such a new experience for many—especially the children who were gathered around—several people took turns blowing air into the seal skin. One elder Yup'ik participant (for whom a translator was provided) laughed about her memories of a unique way of cleaning the seal pokes from the prior season to prepare them for a second use:

> YUP'IK RESPONDENT 1: (*speaking in Yup'ik)*
>
> TRANSLATOR: Once you take off the fur, because it has turned orange from the oil, they put ash [on it] and then they use it to remove the fur.
>
> INTERVIEWER: After it is used?
>
> TRANSLATOR: After it was used and after it was washed.
>
> YUP'IK RESPONDENT 1: (*speaking in Yup'ik*)

TRANSLATOR: And if they don't want to wash it they get the kids to use it as a sled!

YUP'IK RESPONDENT 2: . . .and they wash it on the snow!

TRANSLATOR: They have the kids help remove that fur then (*speaking in Yup'ik*)

YUP'IK RESPONDENT 1: (*speaking in Yup'ik*)

TRANSLATOR: It would become clean and free of oil after playing.

YUP'IK RESPONDENT 2: We're rich. They didn't have any (*Yup'ik term for modern sled*)

TRANSLATOR: No sleds then.

YUP'IK RESPONDENT 2: Me and her used to—used the skins to—Mama used to tell me—who used this one to sled? We used to sled really fast!

Once filled with air, our consultant secured the inflated seal skin on top of the corrugated tin roof of the family steamhouse where it dried outside for approximately two days. Luckily, the mid-June weather was warm (50s and 60s) and dry with a slight breeze. As the skin increasingly swelled, close attention was paid to the changing color of the blubber that clings to the skin and she periodically and very carefully cleaned some off with her *kegginalek* (ulu knife). She also rotated the poke for even drying of the skin. At the end of the drying period, the poke skin was a light to medium brownish mottled color and drum tight. The drying has at least two purposes—to cure the skin for use and to stretch it out to store more contents. Based solely on former ethnographic accounts of seal poke creation, it is not clear whether or not the pokes are always filled with contents when they are inside-out (fur side in), but this was universally the case for the authors (based on both our observations and what we were told by Yup'ik elders). This may

be an important distinction to make in future research since, unlike in fat tissue, mercury is likely to accumulate in sea mammal fur (Cizdziel and Gerstenberger 2004).

At a later time (after we had left the field), our consultant put chunks of blubber (that were cut during the bag construction) into the bag and placed it in a pit that we had dug near the home for this purpose (see Figure 4). People report storage of the bags in water and ground storage. Unfortunately from this experiment, we were unable to get data from our stored bag since, not long into the experiment, rodents ate the blubber and most of the seal bag. While in the bag, the blubber renders into oil and any additional contents are marinated and stored in the bags.

Figure 4. Filled Seal Poke.

The pokes needed to be kept out of direct sunlight and in a cool place in the summer (in Tununak, temperatures can reach up to 80° F) to prevent the blubber from becoming rancid while it renders and kept above ground during the winter (or in pits lined carefully with grasses) to

prevent the oil from freezing. While blubber can be rendered into oil using a heat source, Yup'ik women today cut the blubber into approximately one to two inch square chunks and then allow it to render on its own in their storage container of choice, usually with the help of an occasional (one to three times daily) gentle stir. Yup'ik women differ slightly in terms of their stirring frequency during the rendering process and some do not stir at all. However, all women stress the importance of keeping the bucket lid off or loose during the rendering process until all of the air bubbles have escaped from the contents—only then can the bucket of oil be sealed tight. The bacteria *Clostridium botulinum* is present in northern regions and, given the right conditions (airtight storage and lack of heating), can metabolize and produce a toxin that leads to the fatal disease botulism (Dolman 1960). Indeed, botulism has taken many lives in Native Alaska since public health reports began documenting the disease in rural communities beginning in 1945 (Wainwright et al. 1988), and the majority of outbreaks have been linked to the consumption of traditional "fermented" marine mammal source foods. Nevertheless, detailed data on the methods of preparation and storage (e.g., traditional or modern containers, airtight or porous, etc.) used to make the foods found to have the toxin present is absent, with the exception of one report linking the introduction of plastic wrapping and containers with the most significant outbreaks in rural communities (Eisenberg and Bender 1976). The health implication of different methods of preserving and storing animal by-products without the use of refrigeration is a fascinating topic demanding future research.

Table 1. Seal Oil Consumption Frequency (n = 32).

	Once a day or more	A few times a week	A few times a month	A few times a year
Females	6	8	6	1
Males	4	5	1	1
Total	10	13	7	2

Table 2. Changes in Seal Oil Consumption (n = 32).

	Same today	Less now	More now	None now	Only recently
Females	12	4	4	0	1
Males	7	2	1	1	0
Total	19	6	5	1	1

From the temperature data we collected every hour from June 2013 to March 2014, it was clear that the underground pit provides a more climatically stable environment than storage in above-ground sheds (see Figure 3). During this time frame that we were able to record, both the above-ground shed and poke pit temperatures averaged the same (at 36°F), but the above-ground shed temperatures had a broader range (92 versus 70° F), a higher maximum (79 versus 63° F), and a lower minimum (-13 versus 7° F) than the underground poke pit. This could be the reason why we were told again and again that, in the past, seal pokes (once full and sealed tight) could

be left virtually alone until they were ready to be opened. As one elder Yup'ik woman jokingly exclaimed, "if that food is in there even for [a] hundred years, it would taste good!" (June, 2013).

Northern coastal groups hung the pokes in "trees beyond reach of predators" (1984: 351), but on Nunivak Island (a Central Yup'ik island approximately 40 miles west of Tununak with a similar climate), the "pokes of blubber were placed in a spring if possible and left for several weeks, the blubber being broken down into oil by the constant gentle movement of the pokes in the running water. This apparently was [sic] the only method for rendering fat" (Lantis 1946: 179).

Another method of cool storage which facilitated the rendering of the fat into oil was by placing the pokes in submerged pits. Men dug pits a meter or so deep into the soils in a marshy area and the breadth of the pit corresponded with the number of seal pokes that would be stored within. At Tununak, there are several of these pits (unused today) near the river's marshy edge. The pokes were placed in the cool water at the bottom of the pit for preservation and then removed prior to freeze-up and reused each season. This technique of keeping the pokes in marshy pits partially submerged in the cool water is an older practice. The pokes can also be stored in dry pits set in the permafrost. The floor of the pit is lined with driftwood and covered in moss and/or grass. Wood (driftwood or a sheet of plywood) is placed on top of the pit, which is then finally covered with sod (according to a few local consultants, part of the reason for this was to keep out prying dogs). The preservation potential of these seal pokes is quite remarkable. Reporting from three elders (independent consults) indicates that the contents can be edible for at least five years, and Starks (2007: 44) reports cases of preservation of up to 25 years! As one female elder describes the methods used in Tununak in the past (June 2013):

YUP'IK RESPONDENT: And long time ago they used to—when they make lots of seal skin with blubber inside, they dig a hole and then put wood or log or something, so it's not on the bottom. Put these kinds there, side by side (*lying down*) so water comes in. And they're really good. I could show you where they used to be. [They keep them in there] all summer, and then when it's going to freeze up, they take them out.

YUP'IK TRANSLATOR: (*translates from Yup'ik*) I guess with different owners, but they would be kept together.

INTERVIEWER: What does the water do to help?

YUP'IK RESPONDENT: Protects the oil, lets them stay in a cold place. I mean (*speaking in Yup'ik*)

YUP'IK TRANSLATOR: (*speaking in Yup'ik*) Oh, ok, they dunked them in the water.

INTERVIEWER: Did you cover it, or was there sun on [it]?

YUP'IK RESPONDENT: It has no water and then itself it—

YUP'IK TRANSLATOR: (*translates from Yup'ik*)—it fills up. That's why the area over there [is used—it's right for that]

INTERVIEWER: So it has to be in a swampy area.

YUP'IK TRANSLATOR: They dug into the ground, take out the material—

YUP'IK RESPONDENT: —the first earth (*the top strip of tundra*), then after we put it (*the full seal poke*), they'll re-cover it.

Sea mammal oil rendered from these bags is arguably the most important element in northern cuisine and diet (Starks 2002). We asked 32 adult Yup'ik residents how often they

consume seal oil today (21 women, 11 men, ages 19–68 years, mean = 43) and 74% of respondents (10 men and 13 women) still eat seal oil at least a few times a week (see Table 1). We also asked respondents if they have changed the amount of seal oil they eat from when they were younger (see Table 2). From both of these tables, it is evident that people did and still do continue to consume seal oil frequently—men and women alike.

Coupled with caloric consumption, in the past, the oil was also absolutely vital for trade (Hughes 1984: 330; Spencer 1984: 330; VanStone 1967: 128). The seal pokes were durable containers for long-distance trade (Vanstone 1984b: 215). Apart from the blubber and oil, the additional contents of the seal pokes varied and likely depended on multiple factors such as the resources available in a particular locale, the timing of the harvesting round and local taste preferences. One account comes from Hoygaard (English translation in Eidlitz 1969: 113) who worked among the Angmagssalik in eastern Greenland. He recorded the contents of *imigarmit*, a term for the "mass of different food which have been stored with seal blubber in skin bags." These included:

Dried seal meat and organs

Land plants

Boiled seal flippers

Boiled narwhale skin: "*mattaq*" [cut pieces of blubber attached to the skin], and "*mamit*"—fat which has been scraped off the inside of seal skins, rolled together and boiled

Dried marine algae

Fish and meat that were added to the pokes were likely pre-processed (usually dried or boiled) and were fish species/sizes or meat cuts that would not otherwise dry properly on their

own. According to Hoygaard (English translation in Eidlitz 1969: 112-114), fattier parts of the seal, such as the seal flipper, were included in the pokes after boiling. Submerging plants, fish, and meat in pokes of oil was part of food security throughout the year, serving as a means to preserve these items past their season of harvest for winter consumption (Vanstone 1984b).

Foods in the seal skin bags have also been described as “favored festival food” during the winter dance and feasting cycles across the north (Smith 1984: 351). Among Greenlanders, Freuchen (English translation in Eidlitz 1969: 113) noted that the “orsut” or poke feast food was the “finest food” that invariably “induces silence during a feast.” Bagged wild greens and berries were also considered special foods. Along the Alaskan coast, communities sponsored gatherings such as the Messenger Feast in which neighboring villagers were invited in to eat, dance, and network (Nelson [1889] 1983). VanStone (1967: 128) reports that fish eggs stored in seal oil were “considered a delicacy to be eaten during the winter festivals.” And this was not just a cuisine preference but one intimately linked with display. For instance Lantis (1946: 181) reports that, during the Yup’ik Bladder Feast, “now was the time to show what one had been doing all year” and on display were the “berries, fish eggs, pokes of oil, and heaps of dried fish.”

Women’s pre-processing techniques (air drying, smoking, boiling, salting, fermenting, pounding, etc.) were absolutely critical for the success of these communal gatherings. With their labor and expertise, they transformed the subsistence foods not only for secondary products (like oil) but also to enable long term storage and stockpiling for successful delayed consumption, distribution, and trade. Not only did they produce the goods for the feasts, but women were often actors at the very epicenter of ritualistic display and distributions of these foods (Lantis 1946; Spencer 1959).

There appear to be geographic limits for the utility of the seal poke storage system. For instance, along the northwest coast, the Chinookans of Lower Columbia "extensively used [oil] with dried foods" but, instead, boiled the blubber and skimmed off the oil (Silverstein 1990: 537). One reported danger in the process of rendering in a skin bag is that if the blubber is at too low a temperature, the rendering takes more time and the oil can turn rancid in the meantime (Starks 2002: 33). Thus, temperature appears to be one important limiting factor for the utility of pokes. Tlingit used sealskin bags apparently not to render oil but to keep oil and fish for a few days (De Laguna 1990: 211-212). The process of making and using a skin bag was complex and people knew well that "each step must be carefully executed or the quality of the oil will suffer" and according to one elder the "finest cooks prepare the best seal oil" (Starks 2002: 33).

Critical to the storage of the seal poke was limiting the effects of light, heat, and air. As our consultants, women were keenly aware of keeping the bag air-tight and out of the sun during warmer months (Starks 2007: 43). Hoygaard (English translation in Eidlitz 1969: 113) reports that that the "skin bag was sewn together very carefully to prevent the access of air." Freuchen and Salomonsen (1958: 200) report that the seal bag opening is "tied with a string and it is then covered with stones and left to wait for the winter to come. The sun must be prevented from shining directly on the giviak [bag] as this would turn the blubber, which melts into oil during the summer and penetrates the entire contents of the bag, rancid." According to Starks (2002: 33), the "ideal" temperature for rendering of oil is approximately 55 degrees; warmer and there is risk of the oil becoming rancid and at the very least acquiring a "fishy" flavor.

Tununak women butcher seal and render blubber into oil but today most use 5-gallon plastic buckets to render and store oil. Nonetheless, there are still older Yup'ik women and men who know the system and recall the steps required to render and store oil. Based on the responses

in our questionnaires about seal oil (n = 32), 62.5% of respondents had some knowledge of the seal poke. Despite the replacement of the pokes with buckets today, this knowledge remains necessary and highly valued since seal oil continues to be one of the most frequently consumed subsistence foods in the village and holds a cultural importance that cannot be overemphasized.

Discussion

The seal poke storage system was an innovative and multifaceted wet storage technology. Whole seal skins were used to render blubber into oil, and other meats and greens were stored, marinated, and preserved for winter consumption and feasting. It was the primary means by which women rendered and stored oil and it demanded an impressive set of knowledge and skills. The proper making, filling, and maintenance of these bags was "based on the experience of generations" (Rasmussen 1938: 19) and the "preparation of a blubber bag of this kind was, in reality, a great art with which only the old people were completely familiar" (English translation of Hoygaard in Eidlitz 1969: 114). But, thus far, little research has shed light on the expert techniques of processing and storage nor the origins and historical context of their invention, use, and discontinuation. However, one can imagine that the seal poke container would have been revolutionary for those tasked with ensuring food security in the extreme ecology of the arctic. Similar to the argument of Watson and Kennedy that plant domestication most likely originated with women because of their primary role in plant processing (1991), Yup'ik women's sole control of subsistence food management in the arctic suggests that they were most likely to have been the original designers of the seal poke storage system. This distinction is important because the evolution of food storage practices is used by anthropologists to make inferences about human social behavior and recent critiques have highlighted the gender-bias of both the scientific

community and the general public when it comes to assumptions about technological innovation and invention – namely, that these are primarily the activities of men (Wajcman 2010).

Women are intimately involved in subsistence food production but their specific skills and innovative technologies have been underexplored. Without proper care and transformation of many foods, there is no successful surplus for storage. The remnants of food care are often perishable like the seal poke storage bag, but we can still infer women's productive and technological signature indirectly. For example, when the *qapiarun* knife is found in an archaeological context, we may infer that the poke could have been used.

For Arctic groups, the ability to process and store oil was significant. Not only was oil essential for everyday food and fuel consumption but fundamental to ceremonial events and trade. The seal poke storage system allowed the transformation of blubber into oil, protection from the elements which threatened spoilage, and permitted the storage and transport of the oil; hence the system was storage technology engineering at its adaptive best. This builds a case for hunter-gatherer technological sophistication and debunks the idea of economic insularity particularly in the context of household production. The northern seal poke storage system makes a strong case as to why anthropology will profit from paying closer attention to the roles of women and their food technologies and techniques.

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Note

1. Although the vast majority of Yup'ik people in Tununak are bilingual (fluent in both Yup'ik and English), most communicate with each other in Yup'ik on a daily basis unless in the presence of English speakers. Elder women and men tend to be less fluent in English and/or prefer to speak Yup'ik, especially when describing subsistence food practices. Therefore, the authors work with a Yup'ik translator who provides them with English translations as needed when interviewing/talking with elders.

Chapter 3: An Arctic Hunter-Gatherer Technique for Maintaining Food Security in Cold Climates without the Controlled Use of Fire

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Preface and Author Contributions

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Abstract

There exists in the literature an assumption that the migration of humans into colder climates, or temperate zones with seasons that reach freezing temperatures, is a time period when the controlled use of fire became critical. Indeed, the absence of evidence for the controlled use

of fire at hominin sites in Europe during the Pleistocene (Dmanisi, Atapuerca, La Caune'Arago, Boxgrove, Notarchirico, and Isernia) remains perplexing. Fire would not only have been crucial for providing warmth, light, and predation deterrence, but for rendering food edible via thawing and cooking. Here a case study is presented of traditional food processing techniques among an indigenous arctic hunter-gatherer community where many members still practice and/or retain knowledge of these techniques, to propose the hypothesis that the controlled use of fire may not have been a regular requirement for maintaining food security in such ecological contexts. Evidence from ethnohistoric accounts of circumpolar groups is presented in order to demonstrate that these food processing techniques are not limited to this particular community but, rather, are common throughout the North American and Eurasian Arctic and Subarctic. The potential contribution of this insight to our interpretation of the archaeological record and our understanding of human adaptability is discussed.

Introduction

The controlled use of fire would have been a critical resource for hominin occupation outside of Africa during the Pleistocene (Gowlett 2006). It would have been important for providing warmth, light, and predation deterrence for our early tropically-adapted ancestors (Straus 1989; Dennell 1983). It has also been suggested that the controlled use of fire would have rapidly become important for energy maintenance (Carmody and Wrangham 2009; Wrangham and Conklin-Brittain 2003). Indeed, it has been proposed that the controlled use of fire for purposes of cooking food, whether meat or tubers (Wrangham et al. 1999), may have been an important driver of human evolution, providing human ancestors with the extra energetic requirements needed to maintain a large brain, perhaps by permitting a reduction in gut size (Aiello and Wheeler 1995) and creating a platform for encouraging other pro-social traits

(Gowlett and Wrangham 2013). However, it has been argued previously that in certain hunter-gatherer ecological contexts, particularly arctic coastal environments where driftwood is the only source of wood fuel, where limited but essential nutrients are easily lost by heat, and where raw food is perhaps more easily digested (Frink and Harry 2008; Harry and Frink 2009), cooking may not have been the primary process utilized to ensure annual food security. Nevertheless, it is difficult to ignore the advantages of increased digestibility, flavor and texture enhancement, detoxification, and - perhaps most importantly for cold climates - the thawing of frozen food that become possible with cooking. Indeed, despite the fact that wood is scarce in many circumpolar regions, sea mammal oil (namely, whale and seal oil), which can also be used as a fuel, is abundant.

Here we describe a method used by arctic hunter-gatherers to maintain food security without the controlled use of fire, which not only changes food in a way comparable to cooking, but also prevents food from hard-freezing while simultaneously preventing food spoilage for extended periods of time. Evidence for undesirable effects of cooking that may be particularly problematic in this ecological context is also presented. We also explore what are likely comparable strategies for similar reasons in the ethnographic record among other circumpolar groups outside of the study area, and provide a potential functional explanation for a cooking taboo in some of these regions. Finally, we discuss the possibility that other environmental contexts may have existed in the past where similar issues could have been at stake (perhaps including certain early hominin Pleistocene sites where evidence for the controlled use of fire associated with food is scant) and the implications for future interpretations of the archaeological record and the evolution of the human diet.

Case Study

The following is a case study with an Alaska Native Yup'ik community in the Yukon-Kuskokwim Delta region of southwestern Alaska who continue to hunt and gather many foods and either continue to practice, or retain knowledge about, traditional food processing techniques. Information is based on ethnographic field work conducted in Tununak and Chefornak during the Summer and Fall seasons between June 2013 and November 2015.

Environment, Prehistory, and History of Study Area

The Yukon-Kuskokwim Delta region of southwestern Alaska is a treeless area that consists of flat, marshy, tundra with high humidity, low precipitation, perennial permafrost, and temperatures as high as 80 °F in the summer and as low as -40 °F in the winter (Stager and McSkimming 1984). Yup'ik Alaskans are descendants of the Thule culture group who were one of the last migrations of people from Siberia to cross the Bering Land Bridge and whose descendants today reach from eastern Siberia to Greenland – an expanse that was fully inhabited by 2000 BC (Dumond 1977). The Yupiit (pl.) are an arctic hunter-gatherer group (at least still partially seasonally mobile and highly dependent on local foods as recent as one generation ago) whose members today live in 70 small village communities (ranging from approx. 100-1,000 people) located within and around the Yukon-Kuskokwim Delta of southwestern Alaska (Fienup-Riordan 2000). The Yupiit remained relatively isolated from intense colonialist influence compared to other northern indigenous groups until the early twentieth century (Vanstone 1984b; Frink 2016). The earliest contact with Europeans dates to around 1778, but the settled presence and direct interference of colonialists and missionaries primarily took place after the American purchase of Alaska in 1867 (Oswalt 1990). There were multiple reasons for this including the high sea shelf that extends for many muddy miles from the coast, which prevented

the anchoring of ships, and a lesser amount of exploitable resources by colonialists such as fur, whale, and gold (Fienup-Riordan 1983).

The village communities in this study are two Nelson Island area Alaskan Yup'ik villages: Tununak (pop. 352 people, 95% Yup'ik) and Chefornak (pop. 436 people, 96% Yup'ik). Chefornak and Tununak are two of five villages within the same "village group," according to Fienup-Riordan's classification, whose ancestors were members of extended families who hunted and gathered along the same seasonal routes together, prior to the establishment of permanent villages in the early 1900s (1984). These two villages are ideal study sites for the study of prehistoric arctic dietary habits because of the continued practice of local subsistence activities and, consequently, many of the associated traditional food processing, storage, and preparation practices (Frink and Harry 2008).

The most recent data available on harvesting counts of subsistence species is from 1986 reports (Alaska Department of Fish and Game). There is data from the 1980s and 90s for Tununak for most subsistence species, but no data has been collected in Chefornak aside from one report on salmon fishing (Wolfe, Stockdale, and Scott 2012). In Tununak, 370 estimated marine mammals were harvested in the year 1986. Of these, 361 were seals (sea lions and whales constituted the remaining 9) of 4 types: 54.3% ringed seals (*Pusahispida*), 21.6% spotted seals (*Phocalargha*), 16.6% bearded seals (*Erignathusbarbatus*), 7.5% ribbon seals (*Histriophocafasciata*). The majority of seals caught were the more common ringed seal; however, bearded seals contributed the highest amount harvested by weight because of their much larger size (41.6% of harvest from bearded, 35.5% from ringed, 17.9% from spotted, and 4.9% from ribbon). Based on all subsistence species harvested, Pacific herring (*Clupeapallasii*) is the most important subsistence resource in the Nelson Island villages, making up the highest

proportion of all subsistence species harvested in this region followed by seal (Pete 1991: i). Out of 370,536 estimated pounds of subsistence foods harvested in Tununak in the year 1986, roughly 20% of this was from marine mammals (seal) and 70% from fish. Out of the many fish (> 22 species) harvested in the region that year, herring made up over half of the pounds harvested (Alaska Department of Fish and Game, 1986).

Methods

An experiment investigating the technique for making *ninamayuk* or "poked herring" was conducted in Chefornak, Alaska between June 2014 and November 2014. *Ninamayuk* was chosen as the subject of study because it involves traditional processing techniques for two subsistence resources, seal and herring, that make-up over half of the subsistence foods consumed in the region and because the series of food processing steps that go into their preparation include strategies frequently used by other circumpolar groups. *Ninamayuk* is the Yup'ik word that refers to "half-dried herring" that is immersed in rendered seal oil and left to age for a minimum of 2 to 3 months before being considered ready for consumption. After this period it can be consumed as needed for the following 1 to 2 years. In the past, the primary food container was the seal poke, or the inverted skin of a whole seal which is expanded with air (human breath), sealed, and left to dry for a period of weeks prior to being filled, and the primary place of storage was an underground pit (a process described in detail in Frink and Giordano 2015). Within the past generation or so, plastic buckets have almost completely replaced the traditional seal poke as the primary food processing/preservation container and the above-ground food shed has become increasingly more common than the underground pit (although both are still used) for aging and storing foods (Frink and Giordano 2015). This is also true for the making of *ninamayuk*.

Herring fish come to the shores to spawn in early summer - usually in the beginning of June. The spawning run lasts for a short period of time (for one week or less) during which time the village completely turns their attention to the netting and processing of herring (Fienup-Riordan, 1983). Herring are caught by men close to the shore using gill nets. Men bring the herring nets to shore and place the fresh herring into previously dug pits lined with grass or moss where they rest for a period of 2-3 days (Knudson and Frink 2010; Frink 2002). After this they are ready to be processed for drying and/or further preservation which is carried out by women (Frink 2002). The herring are gutted, braided through the head with dried grasses, and hung on large fish racks one row after another (Frink 2009b; Frink 2009a). The most recent fish racks seen in Tununak (Summer 2014) each had 20 lines of braided herring containing 50 or so individual fish and this household had three fish racks (i.e., 3,000 fish). This particular family had a limited number of women doing the processing that year and, according to Fienup-Riordan (1983), the average household amount for Nelson Island villages is about double this (6,000 fish). The fish are then checked periodically for the next month or more, depending on the weather, until they are properly dried ("hard when you squeeze them" according to local expertise). This primarily involves flipping the braided rows over to get even drying and covering and uncovering the racks with tarps according to the weather and insects. The process usually takes about 1 month. The fattier herring that do not sufficiently dry in time for direct storage (again, according to local expertise) are used for making *ninamayuk*. Fully dried herring fish are consumed that way dipped in rendered seal oil.

Initial seal blubber processing

Seal is hunted by men in the spring and the fall. The exact timing for when the spring seal hunting can begin depends on the timing of ice break-up and certain weather conditions (mainly

the wind) (Barker 1993a). For the coastal Nelson Island villages, if the ice breaks up and it is too windy, the ice floes will drift and (depending on the direction of the wind) may either cram up to the shore making it impossible to find an open lead to fit a boat through, or drift out to the ocean, taking the seal out along with them (as the seals situate themselves by ice floes) (Barker 1993a).Once a seal head is spotted, it is harpooned and the boat is brought to it, at which point it can be shot and killed with a hunting rifle, and pulled aboard (Barker, 1993). Very large seals (such as bearded seals) are sometimes too big to bring onto the boat and will be dragged to a nearby solid ice floe for initial processing before making the trek back, but often the medium and smaller-sized seals are brought back whole to the women for processing (Barker, 1993).

Women do the great majority of the seal processing, the only exception is the circumstance mentioned above when the seal is too large for the men to bring back whole, and this is a common world-wide phenomenon regarding subsistence activities and the gendered division of labor (Jarvenpa and Brumbach 2006). The processing depends on what the seal is intended for, but, generally, the seal is cut down the middle from chin to anus, divided into muscle, organs and blood, and the thick layer of subcutaneous fat (blubber) is scraped off of the skin, cut off of the carcass, and cut into strips of connected cubes (increasing the surface area to assist with aging and rendering) for further processing (Frink and Giordano 2015).

Today, the seal organs and blood are usually saved for soup and the muscle is dried, fermented, or fermented and stewed for consumption (*qellukaq* or fermented seal flipper is a particular delicacy). However, the most important part of seal for northern groups is the blubber and rendered oil (Borre 1991). The blubber is consumed in solid form as *tangviarrluk*; a small proportion of the strips of blubber chunks do not fully render into oil and are consumed that way often with salt and rendered seal oil for dipping. However, most of the blubber is rendered into

oil and used as a dipping sauce (dried meat and fish are regularly slathered in it), as a preservative (dried meat and fish can be immersed in it), and as an ingredient (e.g., flavoring cooked wild greens like beach grass or, in the past, whipped with berries for making *agutak* – a dish often described to outsiders as "eskimo ice cream"). In the past, seal oil was an important fuel for providing heat and light. This is no longer a primary use of seal oil today, although it is still occasionally used as fuel for the *maqi* or steamhouse for bathing purposes (an especially good use of seal oil that is considered no longer suitable for consumption).

The *Ninamayuk* Experiments

One of the authors (CG) arrived in Chefornak June 2014 when she was told the herring were sufficiently dry for storage and, therefore, when the fattier, "half-dried" fish were ready to be processed for making *ninamayuk*. A female head-of-household in Chefornak did the majority of the work involved in this experiment with the assistance of her son (who hunted the seal), her husband (who dug the poke pit and assisted with all other steps of the experiment when needed), and her two daughters and one of the authors (CG) (who helped with the herring processing). The seal poke was made by the female head-of-household from the skin of a seal her son caught that Spring using the methods described above (and see Frink and Giordano 2015) which was ready to be filled. The braids of half-dried herring were pulled from the drying racks, their heads and tails were cut off, and they were very tightly packed (sometimes by standing on them) into either a plastic bucket or the seal poke (Figure 1). Because the herring fish are filleted (bone-in, skin on) and gutted for drying, when the heads and tails are cut off, each fish can be folded in half along the spine and they are packed into the container folded like this, with skin side out. Seal oil from mixed species that was rendered in 2012 and stored since in tightly closed 5-gallon buckets under the house (newer houses are raised on approx. 3 foot stilts) was assessed as

“good” or “bad” by the female and male head-of-household (by smell, color, and cloudiness), and the “good” batches (clear or bright yellow, not cloudy, and a smell that does not “tingle the throat”) was poured into the poke and bucket packed with half-dried herring until the oil reached just to the rim (or neck opening). Both were left open and each day, for the next 4 days, they were checked and more oil was added. The authors (CG and LF) have been told that the containers had to be kept out of the sun and uncovered until no more bubbles were visible before they could be sealed up for aging and storage. The male head-of-household said that it was best to keep the open containers in a place where people walk, as this assists with the removal of bubbles (i.e., air pockets). After sealing, the bucket was placed in the above-ground outside storage shed and the poke was placed in an underground storage pit covered with wood planks and moss. Both were left alone until one of the authors (CG) was told the *ninamayuk* would be finished and ready to eat the following November 2014.

Data loggers were placed inside the bucket (taped to the inside of the lid) and inside the poke pit (rigged with wood and screws) to record the temperature every hour prior to sealing in June 2014 and collected when the *ninamayuk* was finished in November 2014. The following samples were analyzed for nutritional composition: (1) fresh blubber (frozen just after butchering) from a previous catch, (2) the baseline seal oil from the *ninamayuk* bucket and poke prior to sealing the containers for storage, (3) the seal oil 5.5 months later from the complete *ninamayuk* bucket and poke, (4) fresh herring (taken from the net and frozen) from the Summer 2014 run, and (5) the finished *ninamayuk* from the bucket and poke when it was ready 5.5 months later. Seal blubber and oil samples were collected at different stages of storage and were analyzed for melting point and smoke point.

Figure 5. Photograph of Half-dried Herring Packed in Seal Poke (Giordano, 2014).

Nutritional Analysis

The *ninamayuk* was processed the way it is locally prior to consumption (excess oil squeezed off, skin pulled off each side, spine pulled out with the majority of small bones attached to it) before packaging samples for analysis (i.e., primarily fish muscle). Samples were frozen in available freezer space in the village until they were transported to Anchorage, put on dry ice, and brought back to the university laboratory facilities. Samples were shipped on dry ice and analyzed by Midwest Laboratories, Inc. in Omaha Nebraska. Protein content was measured

via nitrogen release (AOAC 992.15), fat was measured by acid hydrolysis (AOAC 922.06), carbohydrates were calculated based on protein and fat concentration, moisture was measured via loss of mass after heating (i.e., AOAC 990.19), fatty acid profile was measured via methanol-treatment (AOAC 996.06), and energy calculated using Atwater Methods (21 CFR PART 101.9) where 1 gram of protein, carbohydrates, and fat equal 4, 4, and 9 kilocalories, respectively. All nutritional measures provided by Midwest Laboratories, Inc. were calculated on a wet-weight (ww) basis. In order to account for the effect of moisture loss on food weight, measures presented here have also been adjusted to the solid portion of each sample to provide measures on a dry weight (dw) basis as well (i.e., each value is divided by the decimal fraction of the solids).

Temperature Analysis

Temperature was analyzed with EL-USB-2-LCD data loggers, created by Lascar Electronics, which record the temperature and relative humidity every hour for a year (operational between minus 31° F and 176° F), and data was viewed and imported into Microsoft Excel using EasyLog USB Version 7.5.0.0. Descriptive statistics and figures were performed using MegaStat for Excel.

Melting Point and Smoke Point

Seal blubber and oil samples were collected from household samples stored for different time lengths in the communities of Tununak and Chefornak, shipped frozen on dry ice and analyzed by Midwest Laboratories, Inc. in Omaha Nebraska. The melting point is measured as follows: the sample is melted and drawn into a capillary tube. The tube is cooled and then placed in a water bath and the temperature at which the sample starts to rise in the tube is reported as the

melting temperature. The smoke point is determined by heating the sample until a continuous smoke is observed.

Results

Ninamayuk bucket and poke processed herring (ww) have higher energy content (370 and 335 kcal/100g) compared to both raw herring (110 and 195 kcal/100g) and USDA (15197) dry-heat, cooked Pacific herring (250 kcal/100g) (Table 3). The increased caloric value of *ninamayuk* herring does not seem to only have been caused by the presumed saturation with seal oil as both fat (17 and16 g/100g) *and* protein (54 and 47.50) showed large increases compared to the fat and protein content of raw herring (3.50 and 19). On a dry weight (dw) basis (Table 4), the *ninamayuk* food processing technique leads to a minor loss of protein relative to the experimental raw herring samples (72.53 and 73.68 versus 87.16 g/100g) and an expected increase in fat (due to immersion in seal oil) (22.84 and 24.56 versus 14.83). A comparison with the USDA raw and cooked herring samples on a dry weight basis cannot be determined since it is not known whether or not the herring used for these analyses came from the same source or season.

Table 3. Nutritional Composition of Raw Herring, *Ninamayuk*, and Cooked Herring Muscle on a Wet Weight (ww) Basis.

	Experimental Samples			USDA Values	
Processing Storage Container	Raw[a]	*Ninamayuk*[a] Bucket	*Ninamayuk*[a] Seal Poke	Raw	Cooked
Moisture (%)	77.95	25.55	35.40	71.52	63.49
Macronutrients (g/100g)					
Protein	19.00	54.00	47.50	16.39	21.01
Total Fat	3.50	17.00	16.00	13.88	17.79
SFA	1.00	4.75	5.50	3.26	4.17
MUFA	2.00	9.00	8.50	6.87	8.81
PUFA	0.50	3.50	2.25	2.42	3.11
Carbohydrates	0.00	0.00	0.00	0.00	0.00
Ash (%)	1.05	4.10	3.20	2.37	3.04
Energy (kcal)	110.00	370.00	335.00	195.00	250.00
Micronutrients (mg/100g)					
Sodium	80.00	285.00	245.00	74.00	95.00
Potassium	400.00	1185.00	1080.00	423.00	542.00
Calcium	35.00	160.00	417.50	83.00	106.00
Iron	1.00	4.50	3.00	1.12	1.44

Source –USDA "Raw" values are #15043, Fish, herring, Pacific, raw and "Cooked" values are #15197, Fish, herring, Pacific, dry heat.
[a]Average of two samples.

Table 4. Nutritional Composition of Raw Herring, *Ninamayuk*, and Cooked Herring Muscle on a Dry Weight (dw) Basis.

	Experimental Samples			USDA Values	
Processing Storage Container	Raw[a]	*Ninamayuk*[a] Bucket	*Ninamayuk*[a] Seal Poke	Raw	Cooked
Macronutrients (g/100g)					
Protein	87.16	72.53	73.68	57.55	57.55
Total Fat	14.83	22.84	24.56	48.74	48.73
SFA	4.10	6.38	8.43	11.44	11.43
MUFA	8.44	12.09	13.02	24.13	24.12
PUFA	2.05	4.72	3.47	8.51	8.51
Carbohydrates	4.41	0.00	0.00	0.00	0.00
Ash (%)	4.84	5.51	5.07	8.32	8.33
Energy (kcal)	494.82	497.17	517.23	684.69	684.74
Micronutrients (mg/100g)					
Sodium	371.87	382.82	381.43	259.83	260.20
Potassium	1827.57	1590.58	1678.28	1485.25	1484.52
Calcium	163.00	216.17	664.34	291.43	290.33
Iron	4.59	6.03	4.59	3.93	3.94

Source –USDA “Raw” values are #15043, Fish, herring, Pacific, raw and “Cooked” values are #15197, Fish, herring, Pacific, dry heat.
Note – Dry weight values were calculated from wet weight values by dividing each value by the decimal fraction of solids for each sample
[a]Average of two samples.

The fatty acid composition of rendered seal oil appears to have remained relatively stable during 5.5 months of storage (Table 5). There is a noticeable decrease in the total concentration of polyunsaturated fatty acids (PUFAs) and an increase in the concentration of Omega-9 fatty acids (FAs), particularly oleic acid, in the seal oil stored in the seal poke compared to the bucket which is indicative of greater oxidation (break-down) in the former (Solazzo et al. 2008). This is not surprising considering the effect that increased temperature has on lipid oxidation, a process which occurs more rapidly with higher concentrations of PUFAs (Shahidi, Wanasundara, and Brunet 1994), and the cooler temperatures of the above-ground bucket storage. However, it may

also be related to the more anaerobic conditions of bucket relative to seal poke storage. The changes in the fatty acid composition of the poke versus bucket *ninamayuk* reflect this same trend (Table 3).

Fresh seal blubber (Table 5) was reported as having 32.1g of carbohydrates per 100g. A sample of fresh seal blubber (frozen directly after butchering) examined for a previous study (Frink and Giordano 2015) shows 0% carbohydrates, as do all other samples of seal blubber at different rendering times throughout the research period (Table 6). The carbohydrate measure in the current study is not a direct measure but a calculated value based on the difference between the fresh weight (ww) of the sample and grams of protein + grams of fat. The particular sample of fresh blubber provided (Table 5) for the current study was collected directly after processing and was cut close from the skin of the seal and the carbohydrate value may, therefore, represent the presence of mucilaginous material in unrefined marine mammal blubber that is not yet well-defined and/or structural fats that remain stable during acid hydrolysis (see Wanasundara 1996: 23-24). The lower fat percentage (52%) of the fresh seal blubber sample (Table 5) relative to all other seal blubber/oil samples lends support to this hypothesis.

Table 5. Effect of Storage on Nutritional Composition of Rendered Seal Oil.

	Fresh Seal Blubber[a]	Rendered Seal Oil		
Storage Container		Bucket	Seal Poke	Bucket
Storage Time		2 years[b]	2.5 years[b]	2.5 years[b]
Moisture (%)	8	0	6	0
Micronutrients (g/100g)				
Protein	0.92	1.00	1.38	1.00
Total Fat	52.33	99.00	88.74	99.00
SFA	15.61	17.50	13.67	18.00
MUFA	23.87	48.50	49.10	49.00
TFA	0	0.75	0.72	0.50
PUFA	12.85	32.50	24.58	32.00
TFA	0	0.75	0.72	0.50
Omega-3	10.92	29.30	22.27	28.30
EPA	5.01	12.30	7.07	12.10
DHA	3.81	10.60	8.72	9.98
Omega-6	1.68	2.96	2.59	3.14
Omega-9	13.22	24.30	26.67	25.00
Oleic	13.04	24.05	26.43	24.80
Carbohydrates	31.21	0	0	0
Ash (%)	0	0	0	0
Energy (kcal)	597	900	802	900
Micronutrients (mg/100g)				
Sodium	36.72	0	33.44	0
Potassium	0	0	0	0
Calcium	0	0	0	0
Iron	0.92	0	0.88	0

[a]The nutritional composition of fresh seal blubber is provided for comparison and is not from the same source as the rendered seal oil samples. The rendered seal oil samples are from the same batch, but that batch includes the oil of mixed seal species, which is customary practice in the study region.

[b]Average of two samples.

Table 6. Nutritional Composition of Rendering Seal Oil.

	Baseline[a]	Stage 2[a]	Stage 3[a]
Storage time	2 weeks	4 months	1 year
Storage Container	Bucket	Bucket	Bucket
Moisture	5.00	0	1.77
Macronutrients (g/100g)			
Protein	2.43	0.23	0.98
Total Fat	90.62	100.00	93.98
SFA	19.45	15.50	17.36
MUFA	46.11	54.83	58.61
TFA	1.65	1.87	1.80
PUFA	23.41	27.73	16.70
Omega-3	21.11	25.48	14.47
EPA	9.74	9.24	5.32
DHA	10.97	10.01	5.32
Omega-6	2.11	2.16	1.74
Omega-9	20.52	24.61	26.20
Oleic	20.33	24.41	25.97
Carbohydrates	0	0	1.96
Ash (%)	0	0	0
Energy (kcal)	826	901	855
Micronutrients (mg/100g)			
Sodium	4.12	1.93	0
Potassium	4.35	1.74	0
Calcium	0.54	0.19	0
Iron	0.23	0.06	0

[a]Average of three samples from one of three experimental batches, where each batch contains the seal oil of a single seal.

Temperature Data

The data logger in the *ninamayuk* poke pit stopped working approximately 2 months before the collection of the finished *ninamayuk* samples in November 2014. This was not surprising since temperature and humidity data loggers are not waterproof (they cannot be sealed off from the environment they are designed to measure) and can overcome minor bouts of

precipitation, but stop working when fully emerged. The poke pit was dug approximately 2 feet into the ground down to the beginning of the permafrost layer. The risk of the loggers ceasing to function at some point was considered high at the beginning of the project due to the possibility of melting permafrost (as it will in the warm summer temperatures, especially when it is not covered by soil) and/or the accumulation of precipitation in areas below the level of the top soil. However, the loggers were still rather rugged, and managed to save the data that was recorded prior to the submersion, which were uploaded after a period of drying. Approximately 1,722 temperature readings were recorded consistently between July 2014 and September 2014 to enable a comparison between the underground poke pit and the above-ground food shed (Table 7 and Figure 6).

The results demonstrate that the temperature is less variable in the underground pit than the above-ground food shed (SD of 3.61 versus 5.51 and a range of 22° versus 33°) (Table 7 and Figure 6). This is consistent with temperature data from a previous study in Tununak comparing underground pit versus above-ground food shed covering nearly an entire year (June 14, 2013 to March 16, 2014) which shows the same trend, but one that is more pronounced (SD of 12.15 and range of 64° in the underground pit versus a SD of 17.63 and a range of 90° in the above-ground food shed) (Table 8 and Figure 3) (Frink and Giordano 2015).

Analysis of the temperature data show that underground pit storage is on average cooler than above-ground food shed storage during the summer (Table 7 and Figure 6) with a colder mean (47.6°F versus 54.59°F) a similar minimum (38°F versus 39°F) and a lower maximum (60°F versus 72°F). Interestingly, the opposite effect is apparent in the year-long temperature data from previous work in Tununak (Table 8 and Figure 3) (Frink and Giordano 2015). Here, the mean temperature between the underground pit and the above-ground food shed are almost

identical (36.31 versus 36.11) but the underground pit has a higher minimum temperature (7°F) than the above-ground food shed (-12°F), with no outliers (i.e., appears warmer on average). By contrasting the warmer months of the left half (June to October) of Figure 3 with the colder months of the right half (November to March), however, it is evident that the low variability of the underground storage pit relative to the outside temperature specifically results from its ability to remain cooler in the summer and warmer in the winter. Part of the cooling effect during the summer may be the result of the *ninamayuk* poke being submerged in water during the warmer months – a consequence of the partial melting of the permafrost around the poke pit.

Table 7. Descriptive Statistics for Temperature (°F) in Underground Pit and Above-ground Food Shed in Chefornak, Alaska.

Time Period	July 18, 2014 to September 27, 2014	
Location	Underground Pit	Above-ground Food Shed
Count	1,722	1,722
Mean	47.61	54.59
Standard deviation	3.61	5.51
Variance	13.00	30.40
Minimum	38	39
Maximum	60	72
Range	22	33
Median	48.00	55.00
Interquartile range	5.00	7.00
Mode	48.00	55.00

Note – Temperature was recorded hourly.

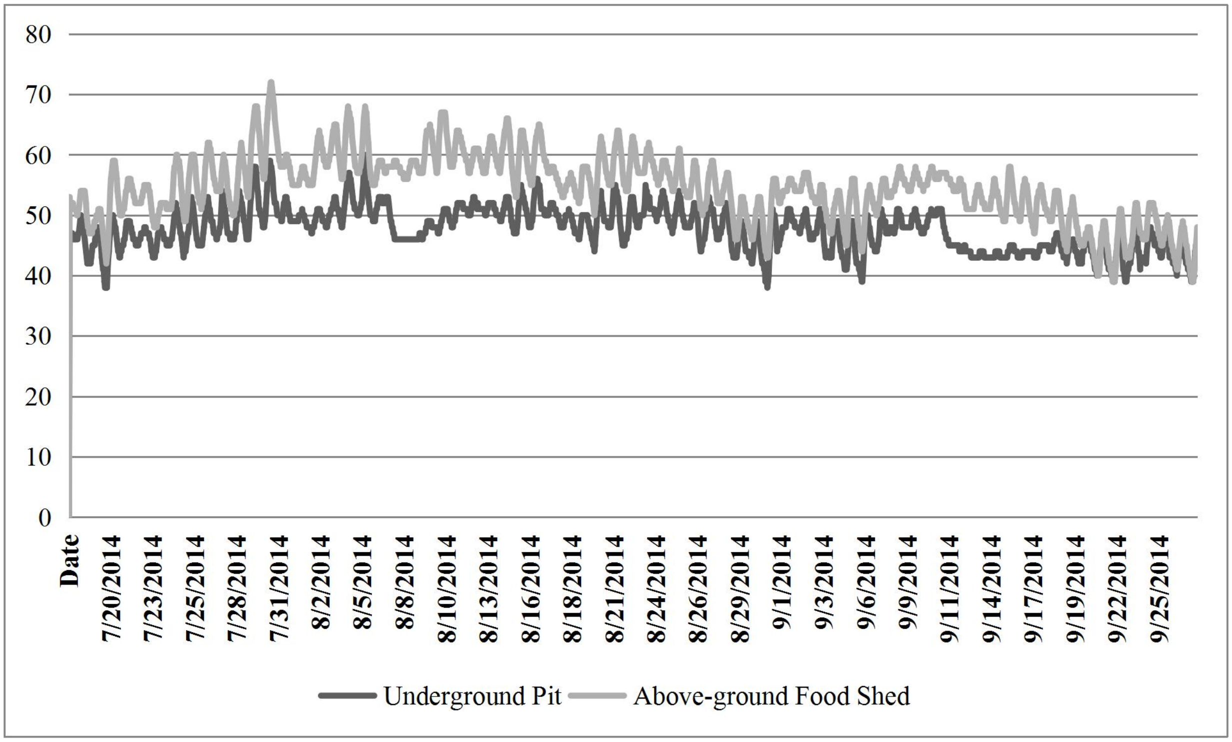

Figure 6. Temperature (°F) Comparison of Underground Pit and Above-ground Food Shed in Chefornak, Alaska June 2014 to September 2014.

Table 8. Descriptive Statistics for Temperature (°F) in Underground Pit and Above-ground Food Shed in Tununak, Alaska.

Time Period	June 14, 2013 to March 16, 2014	
	Underground Pit	Above-ground Food Shed
Count	6,624	6,624
Mean	36.31	36.11
Standard deviation	12.15	17.63
Variance	147.68	310.79
Minimum	7	-12
Maximum	71	78
Range	64	90
Median	36.00	37.00
Interquartile range	17.00	25.00
Mode	32.00	51.00

Note – Temperature was recorded hourly.

Melting Point and Smoke Point

The melting point and smoke point of seal oil at all stages of aging and rendering are lower than those of other cooking oils (Table 9). Fully rendered seal oil has the lowest melting point (point of crystallization/solidification) compared to all other fats listed in Table 9 (at -5.44°F and -6.88°F). The smoke point of all seal oil samples is below the optimal temperature for the Maillard Reaction (330 °F) and the melting point of all seal oil samples are below the lowest temperature reached in the underground storage pit (7°F).

Table 9. Melting and Smoke Points (°F)of Differently Aged Seal Oils and Common Cooking Oils.

	Melting Point	Smoke Point
Seal blubber/oil		
Sample 1 aged 2 weeks	-0.4	287.6
Aged 8 months	4.28	312.8
Sample 2 aged 2 weeks	-4	318.2
Aged 8 months	-1.12	298.4
Sample 3 aged 2 weeks	-4.9	289.4
Aged 8 months	9.86	305.6
Fully rendered bearded (*Erignathusbarbatus*)	-5.44	321.8
Fully rendered ribbon (*Histriophocafasciata*)	-6.88	327.2
Common cooking oils[a]		
Coconut oil	77	392-449.6
Palm oil	100.4	449.6
Canola (rapeseed) oil	86-104	428-446
Groundnut (peanut) oil	37.4	444.2-449.6
Soybean oil	86-104	453.2-460.4

[a]Source - Kochhar, Parkash. 2015. "Thermal Stability of Fats for High Temperature Applications." In Functional Dietary Lipids: food formulation, consumer issues, and innovation for health, edited by Thomas AB Sanders, 103-148. Cambridge: Elsevier Science.

Discussion

The results of this study demonstrate that alternative food processing techniques exist in the circumpolar north which specifically address problems that arise when freezing and cooking are problematic (or impossible) options for maintaining food security. This study shows that the underground storage pit maintains temperature stability while immersion in seal oil permits temperatures to drop below freezing (i.e., the freezing temperature of water) without actually solidifying the food that is immersed in it. The nutritional results demonstrate that this does not necessarily mean a loss of the energetic benefits that cooking can offer. In this case, the nutritional quality of *ninamayuk* (a traditional form of preserved herring that involves a complex

series of processing techniques, none of which involve the controlled use of fire) far surpasses the nutritional quality and energetic value of cooked Pacific herring on a wet weight basis (i.e., per 100g of food consumed). Whether or not the loss of nutrients that occurs during the processing of any fresh/raw foods (i.e., when viewed on a *dry weight* basis and in the absence of any additional ingredients) is greater with thermal versus non-thermal processing techniques was not assessed in this study - since Yupiit do not use heat to process herring fish – but it remains important to consider in discussions of the evolution of the human diet. For instance, it is reasonable to hypothesize that aging and fermentation processes like *ninamayuk* processing, during which the breakdown of fibrous food components often takes place in an enclosed container (e.g., see Chapter 7), result in less nutritional/energetic loss when compared to cooking techniques (which often take place in open containers/vessels or on open surfaces).

The results of the present study also suggest why, in arctic environments, animal lipids used in heat processing of foods (both for use as a cooking fuel and as a medium in which to cook foods) likely create more problems than they solve. Heat can be used to render marine mammal oil (Nilsen 2016), and one account was found among the Aleut (Shade 1949: 50), but it is not necessary (Harry and Frink 2009). Indeed, it is most likely undesirable since sea mammal fats, because of their high PUFA content, are particularly prone to oxidation especially upon heating (Shahidi, Wanasundara, and Brunet 1994). One of the most significant findings of this study is the low melting point and smoke point of rendered seal oil indicating that while it functions as a type of natural, anti-freezing agent, simultaneously preserving food and keeping it soft, it would be an inferior cooking fat since it begins to smoke prior to reaching the optimal temperature for the Maillard Reaction (the meat-browning effect) to occur. This adds a new line of data to support previous arguments that cooking was not an ideal practice for prehistoric

hunter-gatherers occupying arctic coastal environments (Frink and Harry 2008; Harry and Frink 2009). Similarly, using seal blubber to cook foods in (i.e., frying to avoid sticking/burning of protein) would have been problematic since the temperature of the oil does not become hot enough to brown the meat, prevent adhesion to the cooking vessel, and allow even heat transfer before smoking. When heated oil begins to smoke, this indicates greatly accelerated lipid oxidation and also imparts undesirable flavors to the food (Fullana, Carbonell-Barrachina, and Sidhu 2004).

In an evolutionary context, the ability of seal blubber to maintain fluidity in freezing temperatures makes biological sense since seals inhabit aquatic environments, swimming through ocean temperatures that can drop below freezing (i.e., 0° C or 32° F) and resting and rearing offspring on solid ice floes. The chemical characteristic of blubber that allows it to retain fluidity at low temperatures (i.e., in culinary terms, have a low melting point) is its high concentration of PUFAs – particularly the Omega-3 FAs EPA and DHA which have some of the lowest melting points (respectively, between -65.2 and -63.4° F and between -48.1 and -47.4° F) (Table 7 from Wanasundara 1996). And, in fact, this property of Omega-3 FAs has been used by the commercial industry to filter and concentrate Omega-3 FAs for making supplements for consumers (Shahidi and Wanasundara 1998).

Based on experimental findings presented here, using seal oil as an indoor cooking fuel (rather than a frying medium) would have been problematic as well since it begins to smoke at low temperatures and also, presumably, would produce less heat at a greater cost compared to alternative fuel sources (such as wood). In a separate experiment designed to simulate the arctic Thule blubber-burning lamp, Solazzo and Erhardt reported that the heat above the flame of the lamp reached approximately 200° C (392° F) (2007: 170). When an attempt was made to boil

water in a cup above the flame of the blubber-burning lamp, they were able to get the water to simmer but not to boil (Solazzo and Erhardt 2007: 162). Conducting field experiments in the same region as the current study, Harry and Frink compared the time needed to heat water to boiling using wood fuel for stone-boiling versus direct fire cooking (2009). The authors found that stone-boiling using wood fuel was extremely inefficient and largely ineffective, and that direct fire methods would have been necessary to boil water with wood fuel (Harry and Frink 2009). They point out that an indoor wood fire would have been highly problematic in traditional homes where it would not only create smoke inhalation problems, but cause structural damage from melting permafrost soil used in the construction of semi-subterranean sod homes, a point supported by the memories of local community members (Harry and Frink 2009). Although not specifically tested in the current study, the emission of volatile organic compounds that are potential human health hazards are known to increase exponentially when cooking oil reaches its smoke point and have been investigated for that reason (Katragadda et al. 2010). Thus, a seal oil burning lamp would have been the available source of fire needed in this environment for warmth and light, but a source of fuel with a burning temperature and smoke point that would have been highly problematic for regular cooking purposes.

The problematic nature of sea mammal oil as a cooking fuel may in part help explain ethnographic evidence of a cooking taboo among certain circumpolar groups. For instance among the Nivkh, it was observed that "burning sea mammal fat was considered *uich*—a blasphemous transgression sure to bring misfortune. During the cremation of the dead, no garment made of sea mammal skin could be thrown on the funeral pyre. In general, roasting and frying of meat was viewed with suspicion, even when done by ethnographers (Black 1973: 39)." A cooking taboo may also have had an ecological explanation (melting sea ice) that would have

been a regular feature of the environment among groups dependent on ice-hunting and/or ice-fishing. Working with the Copper Inuit, Jenness observed that:

> These Eskimos of Dolphin and Union Strait forbade any cooking of caribou meat on the sea during the winter months, believing that it would cause the ice under their settlement to upheave and engulf them…the Eskimos then built their settlement closer to the beach, and the hut in which we were living had rock, notice, beneath the snow-floor, making the prohibition technically invalid. We cooked our caribou meat with easy consciences, and, when the natives upbraided us, pointed to a tiny patch of gravel exposed beneath our feet. Some accepted our verdict, most of them still disapproved; but by that time they were better acquainted with the strange ways of the white man, and believed that we could do with impunity what they could not attempt without disaster. (Jenness 1959: 48-49)

More importantly, however, is the ability of the alternative techniques discussed here to *manage* food in a way that cooking cannot. The subsistence cycle of circumpolar hunter-gatherers is characterized by short harvesting windows and large catches (either in terms of quantity as with fish or in size as with marine mammals and large terrestrial mammals) and, because of this, food storage and preservation strategies are critical for ensuring annual food security (Stopp 2002). Despite the common association of cooking (especially meat) with food safety, high heating of food (i.e., > 330° F) does not preserve it, although it can kill already-present food spoilage-causing microorganisms. The realization that cooked meat deteriorates rapidly after cooking (a few hours), even under refrigerated temperatures (a few days), was widely recognized during World War II when addressing ways to preserve meat without refrigeration for soldier rations became critical (Tims and Watts 1958). This remains a primary

concern of the commercial meat industry today and a problem that is circumvented through the regular use of food additives such as antimicrobials (e.g., essential oils) and antioxidants (e.g., phosphates and ascorbic acid). Currently, the United States Food and Drug Administration (USFDA) approve the use of nearly 4,000 food additives. Because of this, normalized concepts related to cooking and food safety based on experiences with commercial meats and oils, where the intentional addition of chemicals are regularly used to bypass the undesirable effects (flavor, color, smell, juiciness, rancidity in general) of naturally aging foods, are not useful proxies for understanding prehistoric hunter-gatherer choices. Chemically, cooking meat can produce many immediate desirable effects, but it does so at the expense of lipid oxidation and nutrient loss, both of which eventually speed up meat rancidity relative to its raw counterpart (Domínguez et al. 2014). The rapid spoilage of cooked meat would have been a problem for hunter-gatherers who remained in one place for any longer than a few days if they, indeed, depended on it to meet regular nutritional demands.

One solution to this problem could be to freeze meat and fish raw and then cook it at mealtime. In this sense, cooking could still have been advantageous. In fact, arctic and subarctic climates might seem like an ideal place for raw food preservation because of either constant below-freezing temperatures in areas of the far north or an annual layer of permafrost a foot or two under the ground even in subarctic regions with relatively warm summers. And yet, one would be hard-pressed to find many examples in the ethnographic record of the circumpolar north of taking out frozen food to be cooked for mealtime. There are two likely reasons for this: the problem of thawing in cold climates and the high risk of freezer burn in the absence of airtight packaging coupled with an inability to tightly regulate fluctuations in storage temperature (problems easily solved in modern industrialized contexts via refrigerators, running water,

temperature controlled freezers, and plastic packaging). For instance among the Innu: "With the help of his snowshoes the hunter now shovels a deep pit…in which he deposits the different pieces of meat, carefully wrapped in the skin with its hair toward the outside. When it is especially cold, he may have to dig at least two feet in depth to keep the meat from freezing. He tries to prevent this by all means since the removal of the bones later at home would be extremely difficult and his family would have to wait unduly long until the roast could be eaten (Lips 1947: 25)" In general, it is not advisable to cook frozen meat before thawing because of the risk of overcooking the outside of the meat while the inside remains frozen, raw, or undercooked. Nevertheless, if the temperature outside does not permit thawing (either by being too warm – over 40° F - for safe thawing before food begins to spoil or being too cold to permit thawing), freezing foods until they harden would not be an appropriate food management technique.

Among the Ingalik in reference to "mousefood" which is a collection of small edible roots: "They are stored in the underground cache deep enough to prevent freezing, for if they do freeze, they dry out and taste like nothing at all (Osgood 1959: 47)" Likewise, local men in Yakutia remarked to ethnographers (in 1884 and 1886) that: "We Yakut never dig pits in small hillocks. If you want to prevent any melting in your cellar, lower into it a large frame with a door and a wooden partition inside. Spread and press down manure between the frame and the earth outside, and above it place a barn. The cellar must remain open all winter to get rid of the smell. Don't put fish and meat right on the ice or it will spoil (Sieroszewski 1993: 80)." Apparently, these Ingalik and Yakut warnings about meat touching ice or plant foods "freezing," are not referring to the problems that freezing temperatures present (i.e., allowing food storage temperatures to reach the freezing temperature of water: 0° C or 32° F). Rather, it is the *contact with frozen water (ice)* – whether in the food itself as moisture content (e.g., "mousefood") or in

the ground on which it is placed (meat) – which lead to undesirable flavor/texture characteristics and/or an inedible hardening of the food due to dehydration and oxidation (i.e., “freezer burn”).

In other words, circumpolar populations faced the same risks associated with freezing foods for later consumption that contemporary populations in industrialized regions face (and perhaps take for granted), albeit without the conveniences of refrigerators, running water, plastic packaging, and frost-free freezers to manage them: thawing (safely and, preferably, with flavor and texture intact), avoiding dehydration and oxidation (i.e., “freezer burn”), and preventing frost build-up from condensation. Certain problems, such as thawing, are more of a concern with high moisture foods, which is one reason why fresh vegetables and, especially, fruits are poor candidates for storage even in modern electric freezers. However, lower moisture foods like fresh meat and fish muscle still contain a substantial amount of water (>50%) and without packaging are susceptible to freezer burn when they are exposed to air during frozen storage. Food processing techniques that are characteristic of circumpolar groups - drying, aging, fermenting, immersion in marine mammal oil, wrapping in animal skins and organ bags – are all ways to mitigate these risks associated with frozen food storage in the absence of modern industrial technology. That these alternative techniques also impart the beneficial energetic and nutritional characteristics that have, thus far, been ascribed primarily to cooking, makes them that much more advantageous in a region where regular cooking would have been problematic.

In addition to increasing the chances of conditions that favor freezer burn, increased flavor/increased rancidity is known to be associated with variability in freezing temperatures in certain kinds of meat even when properly wrapped (Hagyard et al. 1993). It is possible that even with moisture reduction and a barrier to prevent direct contact with ice, the inability to keep the freezing temperature consistent, as might be the case with a ’natural’ freezer like permafrost,

freezing raw meat may have presented a real threat to the palatability of food. It was observed among the Chipewyan that:

> Frozen meat is useable for months, but it does not have the desirability or vitamin content of fresh meat. The largest single amount of meat is kept in storage in the bush and this may have only a slight probability of being used if caribou remain plentiful. This meat tends to be taken after the men begin to move around with the snow and the condition of the bulls has begun to deteriorate in the rut. Early kills, made when the bulls are in their prime, are most likely to be made into dry meat. Dry meat is not subject to taste deterioration over a winter and can last for a year or more but is almost always eaten sooner. Dry meat has qualities other than taste that make it suitable for storage, the most obvious being that storage itself is less of a problem. It takes less space, is less dependent upon temperature for preservation, and can be kept inside the camp. Storing it there reduces its exposure to bear and other bush hazards, but care must be taken so that the dogs do not get loose and get at it. (Sharp 1988: 28)

In light of the issues noted above, it becomes less surprising that techniques designed to tinker with rather than postpone the aging process of foods are routinely found throughout the circumpolar north. Indeed these practices - and the flavors and smells they impart - are proud hallmarks of local identity in many northern regions (Yamin-Pasternak et al. 2014). Fermentation techniques (i.e., controlling the type of spoilage that takes place to favor the growth of beneficial bacteria and inhibit the growth of harmful bacteria by, for instance, the manipulation of air flow) were not only used throughout the circumpolar north (Eidlitz 1969) but by numerous indigenous North American groups during prehistoric times (Brenton 1988).

Evidence that the ethnocentric views of early Euro-American travelers may have inhibited their ability to consider aging and fermentation as uniquely adaptive in northern ecological contexts for food management and palatability, and thus not given them enough weight in the ethnographic record, is one possible explanation for the lack of attention that such alternative techniques have received. In fact, in some cases it was erroneously assumed that local inhabitants had not considered the possibility of freezing food for preservation – hence the consumption of "rotten food" as the only alternative. For instance, an early twentieth century priest attempted to convince members of a Copper Inuit community to build an ice house to preserve fish, a seemingly superior alternative to the usual practice of either sun-drying fish or aging the fattier fish in sealskin underground (De Coccola, King, and Houston 1986: 311-312). Other early observers were less subtle in their opinions, such as Henrik Johan Holmberg's with regard to Alutiiq communities: "…with regard to the Koniags' food, they are even less selective than the Tlingits, for they devour, along with the food used by the Tlingits, various other, even dirty and abhorrent things, which among the other peoples do not even deserve the name of food (Holmberg, Falk, and Jaensch 1985 [1818-1864]: 41)." More intrigued than disgusted, the twentieth century Finnish naturalist Toivo Itkonen wrote of the Saami: "The wild-reindeer were now at calving time scattered in groups of two or three animals…the Lapps killed many of them, wrapped up the meat in birch-bark, and sank it into wells. Although it was rotten and stinking, they ate it with pleasure (Itkonen, Guemati, and Perez-Roman 1984: 31)." Few observers considered a reason why such practices may have been common across the north that went deeper than a shared cultural idiosyncrasy.

Others, such as the artist Joseph Henry Sharp (1988), were more perceptive. Of Chipewyan society he observed that "surprisingly, in a climate this cold, food storage and

transport are a serious problem. Most of the summer, spring, and fall are too damp or too hot to make fresh food storage easy. Temporary expedients, such as putting meat in ice-cold water or under moss next to the permafrost, exist, but they merely slow down the deterioration. Dried meat becomes a crucial resource for several reasons: it can be stored for long periods of time merely by keeping it dry, it is a concentrated food source especially as it is normally consumed with dried caribou fat, and it is light and easily transported (233)."

Drying foods, which is used in the making of *ninamayuk*, is often a part of more complex fermentation processes for various types of foods throughout the world (Steinkraus 1996). Drying itself, however, as a technique for processing meat is especially advantageous for managing surplus food by preserving it for long periods of time without refrigeration and making it more transportable. When ready-to-eat, it can then be dipped in oil for a softening effect (and nutritional boost) - a technique used by Yup'ik people - or mixed with fat, as was done in the making of pemmican – a popular traditional food among indigenous North American groups (Wentworth 1956; Leechman 1951).

Drying meat for commercial purposes (e.g., beef jerky) is regulated by the USFDA because it can spoil (favor too much negative bacterial growth) if it takes too long to dehydrate. However, it would have been a less risky technique in the past because water activity (the most important part of the meat-curing process) is controlled by the ratio of protein to fat – the higher the ratio, the lower the water activity – and it is significantly higher in wild than domestic meat (Crawford et al. 1970). Because of this, the flavor and texture enhancement of domesticated meat due to the effects of cooking may not be a suitable proxy in the consideration of the potential benefits which cooking may have provided our prehistoric hunter-gatherer ancestors. The figure

below (Figure 7) lists the relative proportion of protein and fat in meat from Alaska Native subsistence resources versus US domesticated meats (Mann et al. 1962):

TABLE XXIX
Fat Content of Commonly Eaten Meats*

Alaskan Eskimo Diet			United States Diet		
Item	Protein	Fat	Item	Protein	Fat
Seal........	32	1.8	Veal side......	19	12
Walrus.....	27	12.0	Chicken.......	20	13
Whale......	24	0.7	Pork side......	12	45
Oogruk.....	27	0.4	Lamb side.....	16	28
Caribou.....	27	1.2	Beef roast.....	17	23
Moose......	26	1.1	Beef steak.....	16	25
Polar bear...	26	3.1	Hamburger....	16	28
Beaver......	14	39.0	Frankfurter. ..	14	21

* Grams per one hundred grams edible portion, uncooked.

Figure 7. Protein to Fat Ratio in Alaska Native versus US Domesticated Meats (Table 29 from Mann et al. 1962).

Despite the emphasis placed on the importance of cooking in human evolution, Gowlett and Wrangham (2013: 21) point out the perplexing lack of evidence for the controlled use of fire associated with faunal remains at Early and Middle Pleistocene hominin sites in Europe,

including Dmanisi, Atapuerca, La Cauned'Arago, Boxgrove, Notarchirico, and Isernia. The lack of evidence for the controlled use of fire at these sites may, indeed, be the result of poor or non-existent preservation considering the dramatic effects that fluctuating glacial and interglacial periods have on landscapes, let alone on the archaeological remains of those landscapes 50,000 to 500,000 years later (Gowlett 2006). However, in agreement with other scholars urging for a broader consideration of prehistoric hunter-gatherer diets (Crittenden and Schnorr 2017; Turner and Thompson 2013), we believe the time has come to seriously examine the role other, non-cooking food preparation and preservation techniques may have played in the evolution of the human diet.

Conclusion

A lack of evidence in the archaeological record for the controlled use of fire does not mean that humans did not have methods for processing foods to make them more palatable, digestible, and safer to consume. Clues about the management of fishing and large mammal hunting subsistence in cold climates can be found among living circumpolar groups. This study presents in detail one method that arctic hunter-gatherers used to ensure food security without the controlled use of fire that is exemplary of the general strategy utilized throughout the circumpolar north. Undesirable characteristics of cooking that may be particularly problematic in certain ecological contexts have been presented; namely, the inability of cooking to manage large catches of food for extended periods of time in cold climates. In conclusion, we argue that, in addition to work with hunter-gatherers in tropical, subtropical and temperate climates, ethnographic work and experimental archaeology with living circumpolar hunter-gatherer communities is relevant for drawing inferences about the management of food security at

Pleistocene hominin sites and is, therefore, important for understanding the evolution of the human diet.

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Chapter 4: Introduction to Commentary

The draft of an article published in *Current Anthropology* (2014) entitled "The Rotten Renaissance in the Bering Strait: Loving, loathing, and washing the smell of foods with a (re)acquired taste, by Sveta Yamin-Pasternak, Andrew Kliskey, Lilian Alessa, Igor Pasternak, and Peter Schweitzer, was presented to the authors (Frink and Giordano) for comment amidst their own long-term research project with the Yup'ik on the Alaska side of the Bering Strait investigating indigenous food processing and storage techniques. The subject of the article is indigenous aged and fermented foods and it draws from ethnographic work conducted throughout long-term research on a municipals water system project with the Chukchi of the autonomous Russian district of Chukotka (Yamin-Pasternak et al. 2014). The authors demonstrate how the strong smell of these foods and the universally strong attitudes of people about them are reflective of indigenous-colonialist relations over time in Chukotka (Yamin-Pasternak et al. 2014). The actors are the indigenous Chukchi, for whom these foods were local subsistence staples during pre-colonial times, and Russian officials who, during the Soviet-era collectivization movement in Chukotka beginning in the 1950s and ending abruptly in 1991, prompted "the near annihilation of certain aspects of indigenous cuisine" (623) along with a rapid and extreme disruption of numerous other aspects of daily livelihood (including relocation into centralized, Soviet-run villages, 24-hour boarding school for children beginning in infancy, and mandatory bathing and housekeeping rules) (Yamin-Pasternak et al. 2014). Heavily subsidized beef and chicken production (subsidized due to the impracticality of the environment for raising cows and chickens) and imported Russian foods almost entirely replaced the consumption of local subsistence resources and the consumption of traditional aged and fermented foods had to move underground (Yamin-Pasternak et al. 2014). The strong, distinct,

lasting, and penetrating smell of aged and fermented foods from the sea, today referred to locally as the "tastily rotten," developed into a poignant badge – of an identity that had to be hidden and protected during the Soviet-era and an identity that had to be reinvigorated in the sudden post-Soviet era when survival (again) depended on (re)learning traditional food processing techniques and (re)acquiring a taste for traditional foods (Yamin-Pasternak et al. 2014).

The published *Current Anthropology* commentary in Chapter 5 and further elaboration in Chapter 6, consider this discussion in relation to attitudes about aged and fermented foods among the Yup'ik on the Alaska side of the Bering Strait where the authors (Frink and Giordano) conduct fieldwork. The following story from the article by Yamin-Pasternak and colleagues (2014) is referred to in the commentary that follows and deserves to be quoted here for reference:

> Describing her experience as a fox farm employee, one Yupik woman remembered an incident connected to the International Women's Day of March 8. When celebrated in a workplace, this highly regarded holiday is typically spent over a festive spread, put together to honor women employees. Following the established meal protocol, the woman who shared this story sat down with her Yupik coworkers—all wearing their holiday best—'to savor some aged goodies' before the main part of the banquet. The women expected to finish their appetizer course in seclusion, with enough time to clean up and air out the meeting room for the official festivities, when they expected to be joined by other staff. The plan had failed them. Right as the gobblers' fingertips were beginning to take on the fatty gloss from transporting the bite-size pieces of *tuugtaq* [walrus roulade or "tight rolls of meat and fat stuffed inside walrus skin…then aged for several months in a cavity embedded in the permafrost layer" (621-622)] in came the

famed state farm director, carrying the best of intentions: to wish the ladies a happy holiday. ‘Naturally we started apologizing,’ said our confessing conspirator. Her tone was changing between the notes of guilt and affection, as she went on: ‘You know, our aged food has the fragrance that most newcomers don’t like, but [the farm director] was actually a sweet man. . . . He said ‘no worries, ladies, happy holiday!’ and we each took turns running out to wash our hands [to get rid of the gloss and the fragrance].’ (627-628)

Chapter 5: Comment on The Rotten Renaissance in the Bering Strait: Loving, loathing, and washing the smell of foods with a (re)acquired taste by Sveta Yamin-Pasternak, Andrew Kliskey, Lilian Alessa, Igor Pasternak, and Peter Schweitzer

Liam Frink

Celeste Giordano

Author Contributions

The authors contributed equally to this commentary.

In their discussion of the "tastily rotten" Yamin-Pasternak and colleagues present a novel lens through which we can examine indigenous-colonial relations. While smell is a relatively new area of inquiry in anthropology, and one which could offer insight in any number of societies, we agree with the authors that it is particularly applicable to indigenous communities in the Arctic. Many Chukchi, Yup'ik, and Inupiaq communities not only continue to depend on locally harvested plants and animals, but continue to use a multitude of complex traditional food processing and storage techniques that were critical in the past, unique to the area, and taken for granted (and often disparaged) by early outside observers. Ignorance of the unfamiliar by a dominant group is always vulnerable to stigmatization and, as the authors aptly point out, this vulnerability is probably increased when the unfamiliar happens to be so conspicuously scented. After nearly 20 years, Frink remembers the first time he was graciously invited into a Yup'ik home—and what he still recalls most is the unique and strong aroma.

The Russian and Alaskan sides have many comparative aspects, as the authors point out, but they also have some very important differences that are underdeveloped in this article. Although it is sometimes taken for granted that indigenous groups in the Arctic are fairly

homogenous culturally and nutritionally, a closer look usually reveals that this is not the case. There are important parallels, but indigenous-colonial historical interactions are distinct between Russia and Alaska, and the kinds of foods eaten and their preparations and meanings likewise may vary significantly. Nevertheless, we appreciate the authors' attempt to bridge a critical cross-cultural dialogue using this original and insightful olfactory "lens." We think that important information can be learned by viewing the Arctic from a cross-cultural perspective and that there is too little interdisciplinary research in this region; we are pleased that this article stimulates interesting discussion in this regard.

However, at least in Alaska, why the early ignorance of the unfamiliar morphed into a strong negative stigmatization (which perhaps can happen whether foods are strongly scented or not) was highly dependent on two other inter-dependent factors, which we believe deserve the lead in this region. The first is the timing of the arrival of missionaries and later state-level public health figures (i.e., the people first writing about local food practices), both of which were in the wake of numerous catastrophic disease epidemics. And the second is the nature of actual traditional subsistence activities in indigenous arctic communities, which depend on seasonal mobility and the knowledge and expertise of elders, both of which had been severely crippled once state public health figures arrived and learned about local foods. We think most of the stigma against traditional foods and food processing is related to the timing of outside public health intervention— not to the food itself. The authors hint toward this, but we believe it should be made more explicit.

Prevalent in early colonial encounters with Native people were their references to smells, especially within households and in the context of women's activities. Food, and perhaps its smell in particular, was a key marker to who was Native and who was not; although early

colonists also relied heavily on these Native foods, over time they were increasingly replaced by commercial imports. However, as this article points out, despite extraordinary political and economic pressure to rework their cuisine, the people of the Bering Strait and other regions of the Arctic have remained connected to their foods and their indigenous communities. Keeping smells and foods on the quiet may very well be a form of resistance to colonial impacts. The furtiveness of the women at the staff party in the face of being caught by a non-Native man may not have been about food/identity shame; keeping these foods secret may be a source of power for the women—not letting colonizers penetrate their ancestral knowledge and past. The authors offered this alternative meaning, and we thought it was highly accurate based on our own experience. The change in foods most certainly has been a contested space between indigenous and colonists throughout history, and at times this article comes across as though changes in subsistence today simply reflect a decision by families to shift their cuisine. The fact that people are returning to former food practices may show resilience as much as acquiescing to the economic realities of their situation that is inextricably linked to a complex history of colonialism.

Overall there is so much in this article to inspire new scholarship and to connect with research already taking place. What this work does is tap right into the work on indigenous foods from a biocultural perspective, which until recently has been underdeveloped. There are so many fresh ways food is being looked at in the sciences, and this work adds to our current research examining how changes in traditional storage techniques in Yup'ik communities are affecting different social, cultural, and nutritional processes. We look forward to future dialogue with and scholarship from these authors.

Chapter 6: The Stigmatization of Aged and Fermented Foods in Alaska

Attitudes about traditional aged and fermented foods on the Yup'ik side of the Bering Strait in Alaska began with a process slightly different from the one in Chukotka (Yamin-Pasternak et al. 2014), albeit with important parallels. The notion of an untouched and unchanging culture prior to the more thoroughly documented post-contact period should, however, be interpreted with caution (Frink 2003; Frink 2009a; Frink 2009b; Frink et al. 2007; Harry and Frink 2009). For instance, archaeological evidence of iron trade goods and modern-type housing structures in some areas precede the so-called contact period (Frink 2003). The earliest documentation of health status in villages prior to permanent settlements and archaeological skeletal evidence (Keenleyside 1998) indicates that prehistoric Alaskans faced many hardships, including zoonotic and parasitic infections, lice, traumatic injuries from war and hunting, and famine (Fortuine 1989). Nevertheless, it is useful to consider the general social and residential organization of Yup'ik populations prior to Euro-American colonization in order to understand the attitudes surrounding certain traditional subsistence practices.

According to Anne Fienup-Riordan "…during both the traditional and historic periods, the native population of Western Alaska was socially divided into a number of overlapping extended family networks which in turn were united residentially into a number of territorially centered (as opposed to discretely bounded) village groups, ranging in size from 50-250 people" (1984: 64). These extended family networks she refers to as "regional confederations" and, as opposed to being tied to specific patches of land, they are better understood as social alliances indicative of trading and sharing networks, those you could call on in times of famine and war, and those you could marry (Fienup-Riordan 1984). Rights to land for harvesting were relational

rather than territorial and, although sharing land with other regional confederations was disliked, it was tolerated in times of famine and not a direct cause of war (Fienup-Riordan 1984).

There was a sexual division of residence within villages. The traditional social unit was a bilateral, extended family, consisting usually of 2-4 generations (maternal and paternal grandparents, parents, and offspring), and up to 30 people (Fienup-Riordan 1984). The annual seasonal mobility pattern included a spring coastal camp for sea mammal hunting, a summer fish camp at river mouths, a fall fish camp on the tundra flats, and a larger winter settlement located near delta ponds for ice fishing (Fienup-Riordan 1984). All settlements were divided between the men's house (or *qasgiq*) and the women's house (or *ena*). The men's house had plank floors, a huge central bonfire made of driftwood for taking steam baths, and could house 10-12 men (Frink 2003). In the women's house lived 3-4 families, which included mothers, grandmothers, daughters, their young children, and older men who could no longer hunt (Frink 2003).

Although the first Russians arrived on the shores of Alaska in 1741, the western coastal Yup'ik did not come into direct contact with colonialists until 1833 when Russians established a trading post on Saint Michael Island (Oswalt 1990). A few years later, in 1838, a smallpox epidemic spread in the region and marked the beginning of what would become a series of devastating epidemics that decimated close to half of the Yup'ik population (Fortuine 1989). Between 1852 and 1853, and again in 1861, influenza epidemics swept through Alaska Native communities and then in 1900, a time referred to as the "Great Sickness," the worst epidemic of measles and influenza spread to nearly every rural Alaskan village and completely shifted the demography of the entire western coastal region (Fortuine 1989; Fienup-Riordan 1984). The culmination of these epidemics parallels a major demographic shift and the beginning of year-round permanent settlements (Fienup-Riordan 1984).

Of particular note here is that, shortly after the Great Sickness of 1900, the decades long (and before this time, wholly unsuccessful) persistence of Catholic missionaries gained a foothold (Berardi 1999). The following is a quote from the memoirs of a priest who was stationed in a nearby Yukon village toward the end of the 19th century:

> By 1898 the school had to close, no children were available. With the closing of the school, the missionaries also left because they were sure that the only way to penetrate those mentalities would be through the children. Get them before they are taught by the medicine men [Yup'ik shamans]. It seemed that God came to the rescue. In 1900 an epidemic decimated the land, and it was harder on medicine men. Few of them survived. In 1902 Akulurak was revived. In 1904 the school was refurbished and now the Ursuline nuns from Montana came to run it. (Llorente and Renner 1990: 38)

Many of the long-term consequences (that continue today) associated with the creation of permanent villages are related to their original strategic placement far from the city of Bethel (Berardi 1999). According to Berardi, the missionaries who, despite some government contribution, were mainly in control of decisions about the placement and goals of the school until the 1960s, were wary of locating the villages near the city of Bethel because they feared that Alaska Natives would be corrupted by the constant movement of traders in and out of the city (1999). Unfortunately, the location of these large, mixed-community villages had little to do with access to subsistence foods and they were often placed in areas of poor drainage and away from areas rich with local food resources (Berardi 1999).

Scant information exists on the health status of Alaska Natives between 1930 and 1950 until the sudden emergence of health statistics beginning in the later 1950s – a result of Alaska

Statehood and the federal decision in 1955 for the United States Public Health Service to take over all Alaska Native facilities (Fortuine 1969). The 1950s was a turning point in terms of medical attention in Alaska Native communities. Ironically, the medical needs were predominantly post-contact health problems that emerged as a consequence of sanitation and crowding issues created by the new missionary-established permanent villages (U.S. Congress 1994) and the demographic shift in the wake of disease epidemics (Fortuine, 1969). Houses were small and crowded during the 1960s and 70s, with a median size of 6 people, and 80% lacked plumbing and still used “honey buckets” as latrine receptacles (Fortuine 1969). Disease epidemics disproportionately affected elders so that by 1950, the median age of the Alaska Native population in rural villages was 17.7 years (Scott 1956). This was highly detrimental for Alaska Natives who depended on local resources for energy and nutrition because elders held the vast amount of knowledge and expertise needed for learning local food acquisition and management skills (Frink 2003).

During the second half of the twentieth century, infection and malnutrition became a common plight as a result: infectious disease was the most common cause of death among children aged 0 to 4 (next respiratory, then tuberculosis), diarrhea the most common reason for clinic visits for children under 9 years of age, and approximately 80% of pre-school aged children were anemic (Fortuine 1969). As Scott of the Arctic Health Research Center in Anchorage reported in the 1950s, “when schools, churches and stores were built, people who had formerly lived in hundreds of small settlements, of a few families each, tended to concentrate in villages of 100 or more persons. This tended to reduce the local supply of food near villages” (1956: 1-2). Mann and colleagues (1962) pointed out that *prior* to this:

> The primary consideration for the location of an Eskimo or Indian village in Alaska was the available food, fuel, and water supply. The population balance in such an economy was important since overpopulation meant hunger and sometimes starvation. When the population became too large for the available food supply, or if the food supply became scarce because of persistently unfavorable weather conditions or some other accident of nature, family groups would break away and try to find a more favorable place to establish themselves. (33)

In response to what appeared to be the root of "native" problems, state public health representatives turned their attention toward the sanitation and nutrition of Alaska Natives. Similar to the Soviet-era circumstances in Chukotka (Yamin-Pasternak et al. 2014), schools were used to teach children "practical" skills such as personal hygiene and house cleaning techniques (Berardi 1999). School teachers also mediated communication between the villages and the Alaska Native Health Service hospitals - for instance, teachers were supplied with a stock of antibiotics (Mann et al. 1962). Finally, schools played a vital role in teaching children about nutritional needs – administering daily vitamin supplements, school lunches (composed entirely of imported, processed foods) (Johnson, 1965), and teaching students about proper nutrition (what foods to eat and how to prepare them) which was based on US food groups and modern-industrialized standards of living.

The state of local subsistence practices, which were probably less-than-adequate due to the difficulties that people faced managing them during this period of time (of local resource scarcity, over-crowding, malnutrition, sickness, and loss of elder relatives), became the target of concern among state health representatives. Two medical doctors working on the Pribolof

Islands (1949) noted that "at present back houses are used, and the natives hang their seal meat on the sides of these houses to cure. Numerous flies, fur covered, are present in and about these back houses and feed on the seal meat as it hangs. This is an excellent method for transmission of disease, and the commissions could not comprehend the fact that these people had escaped severe epidemics thus far" (Payne and Sexton 1949: 300).

Food borne illness, seen as the result of traditional eating customs, became an increasing area of concern and a top focus of medical research in the Arctic:

> Outbreaks of botulism occur among the relatively small Eskimo population with greater frequency than in any other race in North America except, perhaps, the Indians of the northwest Pacific coast. The reason for this increased occurrence is that Eskimos eat the meat of sea mammals that has become toxic as a result of the growth of *Clostridium botulinum*. Partially decomposed foods such as muktuk (partially dried whale flippers preserved in seal oil), utjak (partially decomposed seal flippers), dried seal meat, and well aged seal meat not preserved in any way are the most common cause. They are frequently eaten without prior cooking; cooking would destroy the toxin. (Stuart et al. 1970: 509)

It is significant to note that "*aged* seal meat" is described as "not preserved in any way," considering that aging techniques were critical food preservation strategies in the north – a region where the composition of meat and fish is particularly conducive to curing and where freezing and cooking are problematic (as demonstrated in Chapter 3). Trichinosis was also seen as a potential "native problem" related to local food practices since "trichinella can pass from one host to another *only* when the infected meat of the first host is eaten raw or imperfectly cooked by a second suitable host" (Connell 1949: 103).

Education was seen as the answer to these problems – not the education of outsiders about the reasons why certain food preservation techniques were customarily used in the region, but the education of Alaska Natives on Euro-American conceptions of health and cleanliness: "As the food habits of the Natives of certain arctic and subarctic regions are very conducive to botulism, its control is mainly a problem of education in public health" (Dolman, 1960: 230-231) and "…it is difficult to see how trichinosis can ever be less than a major public health problem of the Arctic so long as man depends for food upon the spoils of the chase. In the United States, education of the housewife and the wide-spread use of deep-freeze units on farms leads one to hope that the disease will become less common. In the Arctic, education of native populations may reduce somewhat the incidence of trichinosis but on the while we may expect to see in the mirror of today a reflection of tomorrow" (Connell, 1949: 106-107).

Others recognized the potentially harmful effects of prematurely ascribing health problems specifically to the traditional subsistence of Alaska Natives. Following extensive dietary research in Alaska Native villages, Mann and colleagues demonstrated that diet-related health problems were most apparent in children and virtually absent among elders – a trend that these researchers claimed was directly related to the continued consumption of local subsistence foods by elders and the school-lunch diet of children (1962). In 1949, P. J. Brandly of the Alaska Health and Sanitation Activities, U.S. Public Health Service warned that "a greater knowledge of the epidemiology of the disease is necessary before the consideration of any plan for the prevention of trichinosis in the native people. It should be noted that caution must be exercised in the formulation of such a plan in order to avoid serious interference with the nutritional balance of the people in the Arctic" (Brandly and Rausch 1950: 107).

Still others failed to recognize the difficulties of sustaining subsistence food management during the circumstances of the 1950s and ascribed the ensuing hunger, and consequential dependence on imported foods subsidized by the government, to changing preferences: “Whites living among Eskimos have refused to adopt Eskimo eating habits, such as the practice of eating foods uncooked. This refusal has discouraged Eskimos from dependence on native foods. Many Eskimos realize the old way of life represented a low living standard and desire to improve their status” (Scott: 1956: 2).

The first case of botulism in Alaska was confirmed in 1947 (Dolman 1960) and traditional foods have, in fact, been directly linked to this and all subsequent cases (Castrodale 2005). Botulism is a disease that leads to fatal paralysis caused by neurotoxins produced by the bacteria *Clostridium botulinum* (Barker 1993b). These bacteria are naturally present as spores in soil and marine sediment (Barker 1993). Spores can be ingested directly from soil contact or be present in the digestive systems of fish and ingested indirectly (Dolman 1960). The maritime environment does, therefore, put Alaska Natives at an increased risk for ingesting botulism spores, but the disease only manifests if the spores are both present and activated to produce toxins - it is specifically the consumption of the toxins that lead to disease (Sugiyama 1980). Because these toxins are readily destroyed by the application of heat (>212° F), cooking was seen as the only safe way to consume animal-based foods in this maritime environment.

The condemnation of traditional aging and fermentation practices as the link between subsistence food and food borne illness was likely the result of misunderstandings about food preparation activities that did not involve cooking. Specifically, food that was not cooked was automatically considered raw and, therefore, prone to spoilage and dangerous. However, as demonstrated in Chapter 3, these uncooked foods are substantially different from their raw (i.e.,

fresh) counterparts. Importantly, spores (if they are present) only become activated under anaerobic conditions (i.e., in the absence of oxygen) (Horn et al. 2001). Accounts of traditional preservation techniques used by Arctic groups, however, suggest intent to specifically avoid anaerobic conditions (Eidlitz 1969). High protein foods are prone to rapid spoilage in anaerobic environments unless a substantial amount of salt is added (Steinkraus 1997), something which would have been scarce prior to the last century (Eidlitz 1969). Neither, then, are these foods perhaps technically "fermented" which, in the terminology of microbiology, is defined as the metabolic activities of bacteria in an anaerobic environment – a potentially dangerous situation under natural (i.e., non-sterile) conditions. The literal use of this term by public health officials and the less literal adoption of this term by Alaska Natives may have been another miscommunication that led to the vilification of traditional food practices. According to a Yup'ik resident in the Bristol Bay area, the Yup'ik translation of "botulism" is "illness from fermented foods" (Chiou et al. 2002: 59). The term putrefaction has been called a more accurate description of preservation techniques in Alaska (Wainwright 1993), but this is often seen has synonymous with spoilage and still fails to explain how these techniques became traditional practices rather than a cause of population extinction via mass cases of food poisoning among a population that depends on regular food sharing and in a region where cooking (and, especially, boiling) is problematic.

Botulism has certainly been a problem particular to the North (Lancaster 1990), but it is a relatively rare disease. Over the past century, only 200 outbreaks have occurred in the entire Arctic region (Castrodale 2005). Interestingly, the first cases of botulism among the Yup'ik in southwestern Alaskan villages were reported in 1975 and associated with storage in either a wooden barrel or a plastic container, neither of which were available prior to 1940 (Shaffer et

al. 1990). The increase in botulism outbreaks in the latter half of the 20^{th} century has been attributed to the warmer, anaerobic conditions created by storage in plastic containers kept in the home and near a stove (Eisenberg and Bender 1976). Storage in skins, such as walrus skins and seal pokes, has not been implicated in any reported cases of botulism in Alaska. This could be due to the absence of detailed processing descriptions in these investigations; however, the rapid and fatal consequences of ingesting botulism toxins and the long tradition of sea mammal skin use for storage suggests otherwise.

Unfortunately, the (mis)association of traditional aged and fermented foods with poor sanitation and food borne illness was likely to have motivated women to refrain from advertising their food management strategies to outsiders. During an era of scholarship in anthropology when the focus of ethnographic research (which was predominantly carried out by men) was on the subsistence activities and technology of men (Lee and DeVore 1968), this may have further widened an already large gap in the ethnographic record of subsistence food processing activities in the circumpolar north – a region where women, almost universally, control all aspects of food management (i.e., processing, storage, and distribution). The time has come for a reassessment of these practices in an adaptive, ecologically and historically-informed, framework.

Chapter 7: Food Aging and Fermentation in Cross-Cultural and Evolutionary Perspective

As demonstrated in the previous chapter and by Yamin-Pasternak and colleagues (2014), aged and fermented foods are an important part of northern indigenous identity in complex ways and for complex reasons that today transcend functionality. However, the development of strategies to direct the natural aging process of foods in a beneficial way also made adaptive sense. Chapter 3 proposes several reasons why these strategies may have been particularly advantageous in circumpolar hunter-gatherer ecological contexts. Namely, that this was an environment characterized by short and/or unpredictable harvesting windows with large catches where the primary fuel available was sea mammal oil, which is a problematic cooking fuel, but an excellent preservative, anti-freezing agent, and source of energy and nutrients. However, from an evolutionary perspective, there were likely other ecological contexts, outside of the circumpolar north, where similar constraints may have led to the development of similar alternative food management strategies (e.g., limited, unpredictable, and/or costly access to fuel and/or food resources). This chapter first explores food aging and fermentation practices cross-culturally and then discusses why a broader recognition of these practices is important not only for a fuller understanding of the suite of strategies available to humans for managing food security, but for providing additional insight into modern-day diet-related health issues.

Aged and fermented foods have yet to be clearly defined because their meanings differ according to disciplinary specialization (e.g., molecular biology, food microbiology, culinary arts, etc.). Aging, often referred to as "postmortem conditioning" with meat (Koohmaraie and Geesink 2006) and "ripening" with cheese (McSweeney 2004), is a technique used to enhance the flavor and texture of food in a desirable way and involves the manipulation of the *conditions*

in which the food is passing time after initial processing. For instance, in meat, naturally occurring enzymes (e.g., proteases) in muscle are allowed time to further breakdown the tissue post-mortem which has a tenderizing effect. As the aging is taking place, the manipulation of time, temperature, air flow, and humidity are important variables for inhibiting simultaneous food spoilage (which is the growth of microorganisms identified as being harmful to human health). Curing might be considered a type of food aging, but is often differentiated by the intentional addition of preservatives (nitrates/nitrites, salt, ascorbic acid, etc.) during the aging process (Binkerd and Kolari 1975). Fermentation, in food microbiology, usually refers to the action of anaerobic microorganisms (bacteria, yeasts, mold) that activate, metabolize (breakdown compounds), and replicate (colonize) in the absence of oxygen (Montville and Matthews 2013). However, the actual word "ferment" comes from the Latin words *fervere* (to boil) and *fermentum* (yeast). In modern-industrialized contexts, some of the most popular commercially produced fermented foods (not including alcoholic beverages) primarily involve the activity of lactic acid bacteria (e.g., cultured dairy products like yogurt and cheese). As demonstrated in Chapter 6, so-called "fermented" foods may not involve anaerobic bacteria at all. The "fermented foods" discussed in circumpolar regions may, technically speaking, actually be better defined as aged or cured. It is useful when discussing traditional practices, therefore, to define fermentation more loosely as a food processing technique that relies on the activity of microorganisms (bacteria, molds, and yeasts) (Yamin-Pasternak et al. 2014) and aging as a food processing technique designed to inhibit the activities of microorganisms. However, it should be noted that aging and curing can also involve the activities of microorganisms. In addition to the action of proteolytic and hydrolytic enzymes, for instance, cheese ripening depends on the action of lactic acid bacteria at critical stages (Beresford and Williams 2004).

In local subsistence-based non-industrialized communities, with no or limited access to conveniences, such as running water, refrigerators, freezers, and stoves, the advantages of aging and fermentation may be particularly attractive and, in many cases, essential for ensuring annual food security. Indeed, when observations of these techniques have been reported, they often take place at the village or household level and are used in the preparation of a wide range of foods. A review of the literature demonstrates that such foods are common throughout every populated continent of the world and are often linked to indigenous groups of those particular regions: for a review of fermented foods among populations in Asia, Africa, Australia, and Europe see (Steinkraus 1996); for pre-colonialist American Indian populations of North America see (Brenton 1988); for arctic and subarctic indigenous populations of North America, Europe, and Asia see (Eidlitz 1969); for populations of South America see (Penna, Nero, and Todorov 2016).

Far from being a delicacy or special niche food, many aged and fermented foods are staples. For instance, Steinkraus estimates that 100 grams of milk per person per day in India is used for making *dahi* – a yogurt-like product made from cow or buffalo milk and a process that involves 8 to 16 hours of fermentation and a few seconds to 10 minutes of boiling (1996, p.277). In Iraq, a similar product called *liban* (made from sheep, goat, cow or buffalo milk), which requires 10 minutes of boiling and 4 to 8 hours of fermenting, might be consumed in quantities as high as 1 kg per person per day in the summer (Steinkraus 1996: 288). *Kishk* is a fermented milk and wheat mixture (some variation of which is consumed in parts of Egypt, Syria, Lebanon, Jordan, Iraq, Greece, Cyprus, and Turkey) that requires no cooking and can be stored in the form of dried balls in open containers for a period of 2 to 3 years (Van Veen, Graham, and Steinkraus 1969). *Mahewu*, a nonalcoholic maize beverage produced at both the village and industrial level in South Africa, is similarly valuable for its transportability and ability to be reconstituted with

water when ready for consumption – it can either be concentrated or completely dried to a powder (Steinkraus 1996: 229; Schweigart and Fellingham 1963). Western populations are becoming familiar with kefir, a traditional Russian food made from fermented goat, sheep, or cow milk, and consumed throughout countries of the former Soviet in the amount of 10 to 15 pounds per person per year (Steinkraus 1996: 306). In Ethiopia, adults consume 2 to 3 servings of *enjera* per day – a product made from tef grass (*Eragrostis tef*) that requires 19 hours to 3 days of fermentation and 2 to 3 minutes of steam-baking just prior to consumption (Steinkraus 1996: 182).

It is also unlikely that aging and fermentation practices in local subsistence-based communities in non-industrialized regions are a modern phenomenon, considering that the requirements are time, knowledge (based on usually acute experiences of sickness), and a container (often made from local natural resources). For instance, regarding Russian *koumiss* (also called milk wine), Steinkraus claims that "in early times, mare milk was stored in smoked horse skins, but now fresh mare or goat milk is placed in a wooden vessel" (Steinkraus 1996: 304). Egyptian *kishk* is also traditionally fermented and stored in skin bags (called *kerbah*) made from inverting the intact skin of a sheep or goat to create a tight container with an opening at the neck, although today clothe bags are also used (Steinkraus 1996: 285). For traditional processing of the Japanese food *natto* (fermented soy beans), straw was not only used as a container, but was critical for providing the correct fermentation environment: "In the traditional processing of *natto*, the soaked, cooked soybeans are wrapped with straw, which makes inoculation unnecessary because straw contains *B. subtilis*. Inoculation became necessary when straw was eliminated from the process" (Steinkraus 1996: 351; Ko 1982). A similar fermented soybean food from Thailand, called *thua-nao*, is traditionally fermented for 2 to 3 days in bamboo baskets

lined with banana leaves, and still today is produced that way in Northern Thailand where it continues to be a popular, low-cost meat substitute (Chukeatirote 2015). The Thai food *nham*, fermented raw pork, is also prepared with banana leaves – it involves no cooking, and the pork is trimmed and wrapped tightly in banana leaves to ferment for 4 to 5 days (Steinkraus 1996: 271).

In rapidly economically developing countries like Kenya, characterized by having both fully metropolitan areas and non-industrialized local subsistence-based areas, *uji* (or juice/porridge made from maize, millet, sorghum, or cassava) is consumed fermented in the latter and non-fermented in the former, where it is now available as a store-brought already-prepared product (Steinkraus 1996: 222; Mbugua 1981; Mbugua and Njenga 1992). As Steinkraus explained (in 1996), "twenty-five years ago, at least 3 L were consumed per person per day; but at present, fermented *uji* is consumed by very few people in Kenya, largely because of the amount of work involved in processing it, the shortage of some vital cereals used, and the ease of preparing substitutes such as tea or coffee" (1996: 224). In other words, prior to modern conveniences (and new time constraints on individuals) associated with industrialization, fermentation was a critical food processing technique in Kenya. Pit fermentations in the South Pacific are another interesting example of chronologically deeper roots because they appear to require little more than a pit in the ground, leaves for coverage, and a "mother" (starter culture) which is literally passed down from generation to generation (see Steinkraus 1996: 308-310). Regarding Fijian *davuke* (or fermented breadfruit), Aalbersberg and colleagues claim that "fermentation processes are said to have been brought to Tonga during the Lapita period 2000-3000 years ago and thence to Fiji. The linguistic bonds throughout the Pacific are clear. The fermented product *(madrai* in Fiji) is *ma* in the Marquesas, *mahi* in Tahiti, *mahr* in Ponape, *namandi* in Vanuatu and *masi* in Samoa" (Aalbersberg et al. 1988: 174). And, again, far from

being an occasional delicacy, Pollock has argued that "fermented breadfruit was made as much for its contribution to variety of flavor and texture in the diet as for its contribution to storage against food shortages" (1984: 151), despite that in the present-day it may have more social significance in the South Pacific than nutritional (Pollock 2007), similar to the changing significance of traditional subsistence dishes in Alaska Native communities in the face of rapid economic changes (Dombrowski 2007).

It is also interesting that as many traditional aged and fermented foods were becoming less common, they began to be acknowledged more frequently for their purported medicinal qualities rather than their nutritional and energetic benefits. Nigerian *ogi* or *agidi*, a fermented porridge from millet, sorghum, or maize similar to Kenyan *uji* discussed above, are often given to the sick or elderly because they "can be easily digested" (Steinkraus 1996: 219). Drinking large quantities of fermented *uji* has also been prescribed for its purported medicinal properties, such as assisting new mothers with lactation (Steinkraus 1996: 224). In Mexico, moldy *pozol* (maize dough balls fermented in banana leaves) are rumored to have been used as a poultice for infections and wounds in ancient times (Steinkraus 1996: 253), and antimicrobial effects of *pozol* have been demonstrated in one study (Herrera and Ulloa 1975). Other health benefits associated with fermented foods are related to their defining property of inhibiting spoilage and, therefore, preventing food borne illness: "The advantages of the fermentation [for *kefir*] are that it acidifies the milk increasing its storage ability, prevents putrefaction and development of food spoilage organisms and makes the milk an unlikely vehicle for transmission of disease organisms" (Steinkraus 1996: 308). This suggests that aged and fermented foods not only met basic nutritional and energetic demands, but may have offered additional, as yet underexplored, health benefits. An alternative interpretation is that the replacement of locally-derived and locally-made

foods with highly processed, imported, commercially-pasteurized foods may have triggered otherwise unknown health problems. Although salt and other natural preservatives have been used to inhibit food spoilage for thousands of years (Binkerd and Kolari 1975), the use of pasteurization, irradiation, and genetic modification to do so on a large scale is a modern-day phenomenon.

Microorganisms naturally occur in all foods because they are a natural part of the external and internal environment of plants and animals. Bacteria were around long before humans, current estimates are in the range of 3.77 billion years ago (Dodd et al. 2017), emerging about 1 billion years after the origin of the earth. Indeed, that endosymbiosis may itself explain the origin of eukaryotes is a hypothesis that has been around since the 1960s and 1970s and one which remains controversial today (Keeling 2014). Commensal microorganisms are, therefore, literally a fact of life and the origins of this process of symbiosis in humans is a phenomenon that anthropologists can only speculate about from a far distance. However, anthropologists *can* contribute to discussions about modern-day differences between the microbiomes (i.e., the suite of microorganisms that live in and on the human body) of different human populations and, more importantly, are better-equipped to suggest potential explanations for population variation in modern-day health outcomes.

For those interested in human health, one immediate puzzling scenario is how commensal microorganisms are able to breach the human body in the first place. A basic understanding of human anatomy and physiology reveals only a number of possible routes – and they are heavily guarded. These are primarily the respiratory, urinary, reproductive, and digestive tracts. Wounds, burns, bites, and other skin abrasions are, of course, particularly vulnerable but, barring unusual circumstances, intact skin is virtually impenetrable to microorganisms (although the skin itself

has a superficial microbiome (Grice et al. 2009)). Of the available routes for microorganisms to enter the human body, the digestive tract via the oral cavity is the most important route and food the most important carrier (Brandtzaeg 2011).

Microorganisms are present in beef, poultry, pork, milk, and eggs, for instance, because they live in and on cows, chickens, and pigs – in their digestive, respiratory, and reproductive tracts and on the surfaces of their bodies. Microorganisms are present on plants because they are present in soil (their presence, known as the rhizosphere, being critical for plant health) (Hayat et al. 2010) and it was recently discovered that they even play a commensal role *in* plants residing in their seeds (American Society for Microbiology 2014). They are present in seafood, because microorganisms live in all natural bodies of water and are naturally present in the digestive systems of fish (Austin 2006) and other marine life (Dunn 1990; Pinn et al. 1999). Even insects have commensal bacteria in their digestive systems (Mrázek et al. 2008).

When pasteurization was developed in the nineteenth century it was designed to protect the health of consumers in urban areas who no longer procured and processed their own food (as discussed in Chapter 3). People in this situation cannot see the behavioral state of an animal prior to butchering and cannot assess the vitality of a plant before gathering and processing like our ancient ancestors could. The advent of the commercial meat industry before these regulations were put in place was a dangerous time indeed. Stopping these measures today would be disastrous – the positive effects (preventing BSE, E. Coli, Salmonella) currently far outweigh any potential negatives, about which researchers are only beginning to speculate (Reid et al. 2003; Lee and Salminen 1995). Indeed, the makers of so-called “natural” and “organic” food products must use a variety of strategies to circumvent USFDA requirements that prohibit the addition of any chemical preservatives and, rarely, can they avoid the indirect addition of them

anyway via the addition of food items (e.g., celery extract, raw cane sugar) that, themselves, contain such chemicals (Sebranek and Bacus 2007).

Humans did not evolve consuming primarily microorganism-free, non-local food – and understanding this evolutionary history might be important for making inferences about what types of microorganisms may be harmful or beneficial for human health today. So far, this is determined based on largely trial-and-error techniques (Sherman, Ossa, and Johnson-Henry 2009). Humans may have depended on direct benefits from some food microorganisms, tolerated occasional others with temporary discomfort, and evolved specific defenses (culturally and/or biologically) for coping with those that were particularly harmful but which were in or on foods that were regularly depended on for survival. One can think of many such human dietary/ecological transitions that would have introduced new types of food-borne microorganisms during which external aging and fermentation techniques used by humans could have mediated and, therefore, potentially relaxed selective pressure for an internal (genetic or physiological) solution to prevent or promote the ingestion of microorganisms. For example, souring milk involves the activity of lactic acid bacteria which increase acidity and inhibit the growth of pathogens. The fermentation of cassava not only decomposes cyanide (Dufour 2000), but promotes the growth of *G. candidum*, which is beneficial for food flavor and texture (Okafor 1977). The physiological adaptations (proximate causes) that negotiate between keeping pathogenic microorganisms out and letting commensal microorganisms in (Hepworth et al. 2013; Brestoff and Artis 2013; Sonnenberg and Artis 2012; Bunker et al. 2015; Lee and Mazmanian 2010) and the stages of life during which these develop (developmental causes) (Aagaard et al. 2014; Romano-Keeler and Weitkamp 2015; Tourneur and Chassin 2013; Kuhn and Stappenbeck 2013; Rautava and Walker 2007) are only beginning to be unraveled. However, the recognition

that food was not only rich with microorganisms for most of human history, but that humans developed various methods for *externally* influencing this over time to suit their needs, ought to factor into the discussion as an additional biocultural evolutionary causal pathway, about which anthropologists are particularly well-suited to explore.

Conclusion

To describe the current state of scientific research on the origin, development, and function of commensal microorganisms in humans as far from a full understanding is a gross understatement. This is a highly complex area of study, one in which proximate (physiological), developmental, and evolutionary processes are all likely to be significant and to operate interdependently (Nesse 2008). However, one trend that is evident, and about which speculation has begun, is that the gut microbiomes of small-scale, non-industrialized populations seem to be distinct from those of industrialized populations (Schnorr et al. 2014; De Filippo et al. 2010). This difference has yet to be fully explained and has spurred interest across vast disciplines. Those disciplines with an interest in the evolution of the human diet - particularly anthropologists involved in diet-related research with small-scale indigenous communities - represent only a small (but very excited) fraction of this interest. However, speculations by anthropologists have thus far primarily focused on dietary influences (Crittenden and Schnorr 2017; Schnorr et al. 2014), in other words, on differences in the *types* of food that are consumed by different populations. Indeed, the general diets of local-subsistence-based populations are notably different from those of urban-industrialized populations and this, and the parallel differences in the incidence of diet-related health problems (e.g., obesity, diabetes, metabolic syndrome, coronary artery disease, etc.), has been widely recognized by anthropologists and epidemiologists (Eaton, Konner, and Shostak 1988; Benyshek 2003; Fall 2001; Larsen 1995).

However, that the variation in the gut microbiomes between industrialized and non-industrialized populations could also be related to the relative sterility of commercially processed foods in industrialized countries has yet to be explicitly investigated (although, the possible influence of a higher incidence of food borne pathogens in small-scale communities is often casually noted (David et al. 2014)). The present work on aged and fermented foods establishing their critical place in circumpolar hunter-gatherer food security, their prevalence as staples in modern small-scale non-industrialized communities throughout the world, and the limited treatment these processes (whether intentionally driven or naturally occurring) have received by researchers attempting to reconstruct past human dietary behavior is an apt place to suggest this additional line of investigation.

Chapter 8: Conclusion and Future Research Directions

Several major points emerge from this work. The first is that the seal poke storage system is a soft preservation technique that was used by Yup'ik women to manage surplus food up until approximately one generation ago. It is not a simple technology; the construction of a seal poke involves a substantial amount of labor and expertise and the process of filling, storing, and accessing the contents of the seal poke requires careful knowledge of the interplay between the stored food and the external environment in order to ensure the quality and safety of food. Neither is the seal poke storage system a recent technology; modern-day Yup'ik populations are descendants of the Thule who immigrated to Alaska approximately 1000 years ago from the Bering Strait region, bringing with them their sea mammal hunting and processing traditions (Park 1999). The persistence of this complex and time consuming strategy over at least 1000 years (which is only as far back as archaeological evidence of its use has, so far, been considered) and the ensuing spread of this and similar techniques among circumpolar groups from Alaska to Greenland in a relatively short period of time (Park 1999) suggests that this system was highly adaptive in arctic and subarctic ecological contexts.

The article in Chapter 3 highlights several of the specific adaptive advantages of these alternative, non-cooking food processing and preservation strategies. Insights are drawn from a detailed analysis of one specific food processing strategy – the making of *ninamayuk* – that is exemplary of the suite of food processing strategies used in the north, which customarily involve one or more stages of slow drying, aging, fermenting, storing or wrapping in animal skins, and immersion or saturation/dipping in sea mammal oil. The advantages of these techniques stem from the fact that (1) annual subsistence is characterized by having short harvesting windows and/or occasional and unpredictable hunting opportunities but large catches, prompting a need

for managing surplus food, (2) wood fuel is scarce but sea mammal oil is abundant and, while the latter is an inefficient and problematic cooking medium and cooking fuel, it is an effective preservative that has a beneficial "anti-freeze" effect, and (3) freezing foods in the industrialized-sense has many disadvantages as a preservation technique in naturally cold environments where thawing and "freezer burn" threaten the safety, edibility, and taste of foods – risks accentuated by the absence of circumstances conducive to regular cooking. Fortunately, the advantages of a food system that is not dependent on regular cooking practices does not come at the expense of the energetic and nutritional benefits that, so far, have primarily been ascribed only to cooking. Indeed, the nutritional (protein and fat concentration) and energetic value of *ninamayuk*-processed herring (per 100g of fresh food consumed) is nearly triple that of raw herring.

This research demonstrates that among modern-day arctic and subarctic hunter-gatherer populations, processes such as drying, aging, fermentation, and oil immersion are prevalent, highly adaptive, usually involve little to no cooking, and date back to at least prehistoric times. Based on a literature review of food aging and fermentation practices around the world and their prevalence among small-scale non-industrialized populations – where they are often used for managing staple foods, produced at the household level, associated with health benefits in the face of dietary transitions toward commercial, processed food consumption, and suggestive of ancient roots - further speculation is made that these processes may have played a much broader role in human evolution. Despite the cross-cultural prevalence of food aging and fermentation, it has yet to be suggested that these processes may have had any influence on human physiology over the course of evolution. In stark contrast, substantial attention has been focused on the role of heating foods – the primary food preparation technique used in modern industrialized contexts. Since cooking was not likely to have been an efficient strategy for managing excess meat, fish,

or certain gathered plant food in prehistoric ecological contexts, aging and fermentation strategies would have had numerous potential advantages as soon as humans were faced with periods of food shortage for any substantial amount of time (a few weeks or even days). However, as discussed earlier, most of these processes involve tinkering with rather than completely obliterating the natural microorganisms present in foods. Understanding what that might have meant for the ingestion of microorganisms throughout human evolution and, more importantly, how this might inform current trial-and-error investigations of probiotics for human health is a potential area of future research that has yet to be explored.

Investigating claims about alternative food processing techniques that do not involve cooking (or only light boiling) in the archaeological record is going to present researchers with a number of problems. Ethnographic and historic records of drying, aging, and fermentation techniques indicate that many of the types of containers traditionally used for carrying out these processes are not likely to preserve in the archaeological record. Such containers are usually some version of animal skin bag, organ bag (stomach, bladder), leaf or dried grass basket. This is not the case with evidence for the use of controlled fire for cooking purposes (e.g., hearths with burnt seeds, bones, cooking vessels, etc.) which, perhaps, biases inferences about the array of food processing techniques available to our ancient human ancestors. However, ancient lipid residues are relatively sturdy biomarkers and can be used to interpret use-wear patterns on ancient lithic artifacts (Evershed 2008). For instance, lipid residues from Achuelian scrapers found in Israel have been analyzed for use-wear in the processing of elephant fat tissue (Solodenko et al. 2015). Fermentation practices from a 9,000 year old site in Sweden have been inferred based on food storage areas containing high quantities of fish remains coupled with

ethnographic analogy from circumpolar populations occupying ecological zones with important similarities (Boethius 2016).

In the absence of archaeological evidence, inferences can be made about the potential functional roles of different food resources for processing and storage purposes based on what is already known about wild extant mammals that are similar to their prehistoric counterparts. This is a common method used by zooarchaeologists to elucidate, for instance, animal behavioral ecology in order to explain the context of faunal remains at an archaeological site. However, this strategy can also be used to make inferences about, for instance, the suitability of certain animal fat stores for use as a fuel (or not), a preservative, or an "anti-freeze." For example, ruminant herbivores tend to have a higher proportion of saturated fatty acids in their fat tissue due to the microbial hydrogenation that takes place in their hindguts which leads to the saturation of the majority of PUFAs consumed from the diet (Clauss, Grum, and Hatt 2009). Adipose tissue higher in SFAs would presumably not render easily without heat and would be more efficient as a cooking fuel and medium due to the generally higher smoke point and melting point of oils high in SFAs. However, the fatty acid composition of monogastric herbivores (such as horses and rabbits) more directly reflect their diets and, since their diets tend to be rich in clover and grasses, their adipose tissue is likely higher in PUFAs (Clauss, Grum, and Hatt 2009). Only recently has the fatty acid composition of elephant adipose tissue been investigated (Nilsson et al. 2014), an animal which is known to have been hunted and utilized by Middle Pleistocene hominins at Notarchirico, Italy (Pereira et al. 2015). Recently discovered preserved soft tissue from mammoth remains dated to 41,000 to 34,000 years ago and horse remains from 4,600 to 4,400 years ago in Siberia demonstrates that both were hibernators with ample fat stores that were high in PUFAs (Guil-Guerrero et al. 2014). Furthermore, there is now clear evidence for

the exploitation of marine mammals by Neanderthals including seals and dolphins (Stringer et al. 2008) both of which have ample supplies of high PUFA blubber.

Chapter 6 speculates about some of the reasons why alternative, non-cooking food processing activities have been undervalued in circumpolar regions, despite their ubiquity. The timing of the earliest written observations of Alaska Native subsistence practices prior to intensive colonialist intrusion, was a difficult time. Settlement patterns were changing, demographics shifting, access to local subsistence resources was compromised, and the transmission of subsistence food expertise to future generations was severely compromised. The resilience of Yup'ik communities is the only reason that projects, such as this one, are possible today. Nevertheless, talk of traditional fermented foods to outsiders is cautious and it was automatically assumed, even during my sixth year investigating women's food processing, that I was not interested in trying local foods like fermented seal flippers, stinky head, and *ninamayuk*. Aged and fermented foods were likely stigmatized during the 1950s, becoming erroneously associated with concerns about sanitation and food safety; however, traditional foods (and traditional practices) may have also been kept secret as a form of empowerment (Yamin-Pasternak et al. 2014).

Prior to the sanitation era (which Yamin and Pasternak et al. 2014 also highlight) ignorance about the value of alternative food processing techniques may have had more to do with a general gender bias in research. Among circumpolar populations (with the possible exception of the Saami), women control all aspects of food processing, storage, and distribution. There is also today still, and in the past perhaps more so, a strong sexual division of labor. Early observers of Alaska Native life were primarily male, and were unlikely to have had (and possibly did not see the point in having) adequate access to the activities of females. They, therefore,

tended to follow men on hunting trips. And, if there is one place where cooking was occasionally used, it was along the hunting trail by men. Even so, the ethnographic record also suggests that early observers (travelers and naturalists) did not adopt the methods of participant observation on which cultural anthropologists today rely. The article in Chapter 3 provides a few examples of outsider requests made to locals to prepare foods to their particular liking – cooking at mealtime and freezing for preservation. For these reasons, the ethnographic record prior to the post-modern movement in anthropology, and the ensuing explicit realization of researcher bias from the 1980s into the present day, should be interpreted critically – with *a priori* knowledge of the political and ecological climate of the time and study region.

In order to fully understand the adaptive value of aged and fermented foods as advantageous food management strategies and explore their possible significance in the evolution of the human diet, a re-recognition of gender bias in anthropological research is warranted. And, yet, doing so explicitly is problematic in the gender-neutral climate of today. Nevertheless, there is nothing gender-neutral about hunting practices in human evolution – hunting was predominantly the work of men. An understanding of men's day-to-day activities is required to understand hunting decisions. Likewise, there is nothing gender-neutral about food processing activities in human evolution – food processing was predominantly the work of women. An understanding of women's day-to-day activities is required to understand food management decisions, *particularly* in the absence of modern conveniences. This research highlights some of those taken-for-granted negotiations, many of which still occur on a daily basis even in modern-industrialized kitchens. Cooking – the act of heating food – represents a small part of this picture. Unless cooking is redefined to encompass all food processing activities that take place post-hunting/fishing/gathering that could influence the nutritional composition,

energetic value, and microbiota of foods consumed, which it currently does not – evidenced by the continued search for clues for the controlled use of fire to mark its origin in human evolution – then a definitive earliest finding of it may not reveal as much as is currently hoped.

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Yamin-Pasternak, Sveta, Andrew Kliskey, Lilian Alessa, Igor Pasternak, and Peter Schweitzer. 2014. "The Rotten Renaissance in the Bering Strait: loving, loathing, and washing the smell of foods with a (re)acquired taste." *Current Anthropology* no. 55 (5):619-646.

Curriculum Vitae

Date: May 2017

Celeste Giordano
celestedano@gmail.com

Education

2014	Ph. D. Candidate, Anthropology, University of Nevada Las Vegas
2013	M. A. Anthropology, University of Nevada Las Vegas
2007	B. A. *summa cum laude* Anthropology, Temple University

- Temple University 2005-2007
- Chestnut Hill College 2002-2004

Research Interests

- Nutritional anthropology, medical anthropology, evolutionary medicine
- Arctic hunter-gatherer subsistence, with a focus on traditional Alaska Native foods and food practices
- The developmental origins of health and disease (DOHaD), especially for understanding the etiology of type 2 diabetes and human metabolism and immune system development
- Biocultural research and research methodology

Peer-reviewed Publications

2015	**C Giordano** and Daniel C. Benyshek. 2015. DOHaD Research with Populations in Transition: A case study of prenatal diet remote recall with Yup'ik Alaskan women. *Journal of Developmental Origins of Health and Disease*. 6(2): 79-87.
2015	Liam Frink and **C Giordano**. 2015. Women and Subsistence Food Technology: The arctic seal poke storage system. *Food and Foodways*. 23(4): 251-272.
2014	Frink L and **C Giordano**. Comment on "The Rotten Renaissance in the Bering Strait: Loving, Loathing, and Washing the Smell of Foods with a (Re)Acquired Taste" by Sveta Yamin-Pasternak, Andrew Kliskey, Lilian Alessa, Igor Pasternak, and Peter Schweitzer. *Current Anthropology* (*in press*)
2014	Benyshek DC, M Chino, CD Francis, H Jin, TO Begay, **C Giordano**. Prevention of Type 2 Diabetes in Urban American Indian/Alaska Native Communities: The life in BALANCE pilot study. *Journal of Diabetes Mellitus*. 3(4): 184-191.
2010	Hoover KC and **C Giordano**. The Bioarchaeology of the Quaker Hills Quarry Site.*Journal of Middle Atlantic Archaeology*. 26: 105-114.

Honors and Awards

2017	Society for Cross-Cultural Research (SCCR) 46th Annual Conference Best Student Paper Award. April 2017.
2015	UNLV Presidential Fellowship received March 2015 for academic year 2015-2016. Tuition waiver and $25,000 scholarship.
2014	Liam Frink, PI and Celeste Giordano Co-PI. Storage and Processing in Alaskan Yup'ik Cuisine and the Influence on Persistent Organic Pollutants.National Science Foundation Dissertation Improvement Grant.$25,156.00.Submitted October 21, 2014.Awarded September 3, 2015. Award ID 1504550.
2010	Edwards and Olswang Scholarship: University of Nevada Las Vegas Awarded $1,280.00 to conduct pilot study in Anchorage, AK
2010	GPSA Summer Scholarship: University of Nevada Las Vegas Awarded $680.00 to conduct pilot study in Anchorage, AK
2009	Edwards and Olswang Scholarship: University of Nevada Las Vegas Awarded $1,200 to fund initial fieldwork in Tununak, Toksook Bay, and Bethel Alaska for future Master's Thesis research
2008	President's Scholar: Temple University
2005-07	Dean's List: TempleUniversity, all semesters
2003	Alpha Lamda Delta Honorary Scholarship Society invited member: ChestnutHillCollege
2002-04	Dean's List: ChestnutHillCollege, all semesters
2002-04	Interdisciplinary Scholars Program: Chestnut Hill College, all semesters

Professional Experience

2016 Research Assistant: University of Las Vegas, Department of Anthropology

- Analysis of 24-Hour Dietary Recall data from Hadza hunter-gatherers of East Africa (Summer 2016)

2015 Research Assistant: University of Nevada Las Vegas, Office of Undergraduate Research

- Design and analysis of web surveys using the software Qualtrics; conducted and analyzed interviews with undergraduate researchers (Summer 2015)

2015 Instructor: University of Nevada Las Vegas, Department of Anthropology

- Cultural Anthropology 101 (Spring 2015)

2012-2016 Research Assistant: University of Nevada Las Vegas, Department of Anthropology

- Fieldwork, data collection and analysis, budget manager, and co-writer of grant for externally funded National Science Foundation (NSF), Office of Polar Programs project(NSF Proposal Number 1106362), Principal Investigator Liam Frink, entitled "Ethnoarchaeological Investigation of the Yup'ik Seal Poke Storage System in Southwestern Alaska." *$232,749.00.*

2012 Co-Chair for Society for Cross-Cultural Research (SCCR) Annual Meeting, February 25, 2012 entitled "Women, Children, Health: Selected Topics."

2009-12 Research and Lab Assistant: University of Nevada Las Vegas, Department of Anthropology

- Collection of participant biological and interview data and analysis for Life in BALANCE project, a collaborative diabetes prevention project with the American Indian Research and Education Center (AIREC) and the Department of Anthropology at the University of Nevada Las Vegas, funded by the National Health Institute, fall 2009 to 2012.

2008-12 Graduate Assistant: University of Nevada Las Vegas, Department of Anthropology

- Teaching Assistant 2009-2012
- Instructor
  Introduction to Physical Anthropology Lab, 2008-2009

2007 Research Assistant: Temple University, Department of Anthropology

- The reconstruction and analysis of human skeletal remains of prehistoric Shenks Ferry Native Americans excavated in Lancaster County, Pennsylvania.
- Assisted department chair with SPSS entry and analysis of high altitude population data from fieldwork in Tibet on the effects of economic development and delocalization on obesity and diabetes prevalence.

Fieldwork Experience

2015 Conducted fieldwork in Tununak and Chefornak – rural Native Yup'ik villages in the Nelson Island area of Alaska to investigate food toxicants in prepared traditional subsistence foods, November 2015.

2014 Conducted fieldwork in Tununak and Chefornak – rural Native Yup'ik villages in the Nelson Island area of Alaska to investigate food toxicants in prepared traditional subsistence foods, June 2014.

2013 Conducted fieldwork in Tununak - a rural Native Yup'ik village on Nelson Island in southwestern Alaska - on a traditional Yup'ik food storage system, May/June 2013.

2013 Continued fieldwork in Tununak and Anchorage, Alaska on traditional Yup'ik food storage, October 2013.

2010 Conducted pilot study in Anchorage, Alaska for research on diet during pregnancy and diabetes risk among Native Yup'ik Alaskans, July/August 2010.

2009 Preliminary fieldwork in southwest Alaska to visit the Yukon-Kuskokwim Health Corporation in Bethel and the villages of Tununak and ToksookBay to introduce and discuss future research interests with local community members, September 2009.

Professional Conference Presentations

2017 Celeste Giordano. An Arctic Hunter-Gatherer Technique for Managing Food Security in Cold Climates. Presented at the 46th Annual Meeting of the Society for Cross-Cultural Research (SCCR) in New Orleans, LA March 3, 2017.

2015 Celeste Giordano and Liam Frink. Storage and Processing in Alaskan Native Cuisine: The Influence on Nutrition and Food Contaminants. Presented at the 75th Annual Meeting of the Society for Applied Anthropology in Pittsburgh, PA March 24-28.

2014 Celeste Giordano and Liam Frink. April 25, 2014. *The Effects of the Traditional Yup'ik Seal Poke Storage System on the Safety of Seal Oil Consumption.* Paper presented at the Society for American Archaeology (SAA) 79th Annual Meeting in Austin, Texas.

2014 Celeste Giordano and Liam Frink. March 18, 2014. *An Investigation of the Native Alaskan Seal Poke Food Storage System*. Paper presented at the Society for Applied Anthropology (SfAA) 74th Annual Meeting in Albuquerque, New Mexico.

2014 Celeste Giordano and Alyssa Crittenden. February 11, 2014. *The Colostrum Taboo in Evolutionary Perspective*. Paper presented at the American Association of Behavioral and Social Sciences (AABSS) 17th Annual Meeting in Las Vegas, Nevada.

2013 Celeste Giordano and Liam Frink. April, 5 2013. *Women's Work in the Arctic: What happens between the catch and the meal?* Paper presented at the Society for American Archaeology 78th Annual Meeting in Honolulu, Hawaii.

2012 Celeste Giordano and Daniel C. Benyshek. February 25, 2012. *Diabetes Research Utilizing Remote Dietary Recalls among Elder Native Alaskan Mothers: Why Life Events and Culture Matter.* Paper presented at the Society for Cross-Cultural Research Annual Conference in Las Vegas, Nevada.

2011 Celeste Giordano and Tori Begay. April 27, 2011. *Life in BALANCE: Balancing Actions, Lifestyle, Autonomy, Nutrition, Community, and Environment*. Invited presentation on diabetes prevention for DCI America's Twelfth Annual Native Secretaries' & Administrative Assistants' Conference, Las Vegas, Nevada.

2010 Celeste Giordano and Daniel C. Benyshek. November 17, 2010. *The Importance of Retrospective Data in Diabetes Research: An Exploration on the Use of Remote Dietary Recall among Elder Mothers from a Low Prevalence Native Alaskan Community*. Paper presented at the American Anthropological Association 109th Annual Meeting, New Orleans, Louisiana.

2009 Celeste Giordano. *Investigation of a Low Risk Population: Does Eating Traditional Native Alaskan Foods during Pregnancy Protect against the Development of Type II Diabetes?* Invited presentation for Diabetes Awareness Month at the University of Nevada Las Vegas sponsored by the Hormones and Disease Group.

2008 Celeste Giordano and Kara C. Hoover. *Initial Description of the Quaker Hills Quarry Human Remains, Shenks Ferry Culture*. Poster presented at the American Association for Physical Anthropologists at the 78th Annual AAPA Meeting, Columbus, Ohio.

Research Publicity

2013 Internet blog article published on interviews with Liam Frink and Celeste Giordano on 2013 fieldwork in Tununak, Alaska entitled "Scientists study Arctic

seal poke storage system" by Alicia Clark through the National Science Foundation's Polar Field Services newsletter Field Notes: http://polarfield.com/blog/scientists-study-arctic-seal-poke-storage-system/

Invited Guest Lectures

2014	Celeste Giordano. July 2014. *Arctic Foragers.* Guest lectures for Alexander Dawson Middle School. Anthropology course for Advanced Middle Schoolers.
2014	Celeste Giordano. March 26, 2014. *Introduction to Transcription and Transcription Software*. Guest lecture for University of Nevada Las Vegas ANTH 438/638 undergraduate/graduate course Ethnographic Field Methods.
2013	Celeste Giordano. November 20, 2013. *The Yup'ik Alaskan Seal Poke Food Storage System: A case study in ethnoarchaeology*. Guest lecture for University of Nevada Las Vegas ANTH 455/655 undergraduate/graduate course Archaeological Theory.
2013	Celeste Giordano. April 15, 2013. *Dietary Recall Methods Case Study: Introduction to interview text analysis*. Guest lecture for University of Nevada Las Vegas ANTH 438/638 undergraduate/graduate course Ethnographic Field Methods.
2013	Celeste Giordano. February 7, 2013. *Methods and Theory in Cultural Anthropology*. Guest lecture for University of Nevada Las Vegas ANTH 101 undergraduate course Introduction to Cultural Anthropology.
2012	Celeste Giordano. May 1, 2012. *Human Colostrum Taboo in Evolutionary Perspective*. Guest lecture for University of Nevada Las Vegas undergraduate course ANTH 102 Introduction to Physical Anthropology.
2012	Celeste Giordano. April 19, 2012. *Perspectives from Biocultural Anthropology*. Guest lecture for College of Southern Nevada undergraduate course ANTH 101 Cultural Anthropology.
2011	Celeste Giordano. November, 2011. *Adipositivity*. Guest lecture University of Nevada Las Vegas course ANTH 466 Nutritional Anthropology.

Academic References

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