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Editorial *Ken S. Coates* 3

Special Collection: Rapid Landscape Change and Human Response in the Arctic and Subarctic

Introduction: Rapid Landscape Change and Human Response in the Arctic and Subarctic
Antony R. Berger and David G. Liverman 8

Rapid Landscape Changes, Their Causes, and How They Affect Human History and Culture
Antony R. Berger 15

The Life and Death of Kwäday Dän Ts'ìnchí, an Ancient Frozen Body from British Columbia: Clues from Remains of Plants and Animals
James H. Dickson and Petra J. Mudie 27

Climate, Society, and Natural Hazards: Changing Hazard Exposure in Two Nunavut Communities
James D. Ford 51

The Domino Effect: Culture Change and Environmental Change in Newfoundland, 1500–1100 cal BP
Trevor Bell and M.A.P. Renouf 72

Rapid Landscape Change, Vulnerability, and Social Responsibility
Thomas Heyd 95

Perpetual Perishing, Perpetual Renewal
Holmes Rolston, III 111

Conference Abstracts: *Rapid Landscape Change and Human Response in the Arctic and Subarctic*, Whitehorse, June 2005 124

General Articles

The Need to Conduct Studies of Swedish Saami Reindeer-Herder Subsistence Behaviours: A Case of Indigenous Resource-Use Rights
Robert P. Wheelersburg 161

The Oral Tradition is Like the Mackenzie Delta
Robert Kroetsch 181

Questioning Mine Mill in Yellowknife: The Need for a Northern Labour History
Chris Powell 187

...continued

Testing, Testing, Testing: Rural and Urban Responses to Alaska's High-Stakes Assessment Regime
Jerry McBeath and Maria Elena Reyes 207

Counsellor Training via Distance Education: Opportunities for Rural Alaskan Communities
Christine Cook, Anthony Strange & Susan Renes 230

Village Public Safety Officer Turnover and Reported Violent Crime in Alaska Native Villages
Darryl S. Wood 246

The First Inuit Autobiography: Text and Context(s). An extended book review of *The Diary of Abraham Ulrikab: Text and Context*. Hartmut Lutz, ed. and head translator
Corey Coates 261

Call for Papers: Number 30 (Winter 2008/2009)

The *Northern Review* invites manuscript submissions from the arts, social sciences, and humanities that concern human experience in, and thought about, the Circumpolar North. Papers received by midnight on August 15 will be considered for publication in Number 30 (Winter 2008/2009). Refer to the website for contributor guidelines or email review@yukoncollege.yk.ca.

Notice of forthcoming call for submissions: Special Literary Issue, Number 31 (Summer 2009)

Number 31 will be the *Northern Review*'s second Special Literary Issue—the first was Number 10 (Summer 1993). We will publish short works of fiction, poetry, and creative non-fiction about the North and/or set in the North. A formal call for submissions will appear in the next issue, or email review@yukoncollege.yk.ca for guidelines.

The Life and Death of Kwäday Dän Ts'ìnchí, an Ancient Frozen Body from British Columbia: Clues from Remains of Plants and Animals

James H. Dickson and Petra J. Mudie

Abstract: The body of a prehistoric Aboriginal man (Kwäday Dän Ts'ìnchí, Long Ago Person Found) was recovered in 1999 from a melting glacier in northwestern British Columbia. The frozen man was lying at 1,600 metres above sea level and about fifty kilometres from the Chilkat River estuary in southeastern Alaska. Archaeobotanical studies, ethnobotanical research, and forensic palynology have been carried out to address the following questions: What had he been doing there? Where had he come from? What was his lifestyle and diet? Was his death related to sudden climate change at the start of the Little Ice Age? We can now answer some of these questions partially or completely, and point towards the start of his last journey in a salt marsh on the coast of southeastern Alaska.

Introduction

In 1999, the body of a prehistoric Aboriginal man (Kwäday Dän Ts'ìnchí, meaning Long Ago Person Found) was recovered from a melting ridge on the Samuel Glacier in northwestern British Columbia by three young men hunting for Dall's sheep (Beattie et al., 2000; Pringle, 2002). The frozen man was lying at 1,600 metres above sea level, about fifty kilometres inland from the upper estuary of the Chilkat River in southeastern Alaska, and eighty kilometers south of Klukshu, a traditional fishing camp in southeastern Yukon (figure 1). Archaeobotanical studies, ethnobotanical research, and forensic palynology have been carried out to address the following questions: What had he been doing there on the remote glacier? Had he traveled from the Alaskan coast or from southeast Yukon? Was his home on the coast or inland? Who were his kin—the Southern Tutchone people or the Tlingits?

What was his lifestyle and was his diet mainly of marine or inland origin? By examining the plant, animal, and microscopic sediment particles in samples from the man's intestines and clothing, we hope to clarify our earlier work (Dickson et al., 2004; Mudie et al., 2005) that points toward the start of his last journey in a salt marsh on the coast of southeast Alaska. We also hope to unravel more clues as to why this apparently healthy, strong young man died on such a remote glacier. His remains showed no evidence of attack or struggle (Beattie et al., 2000), and it seems that he was most likely caught in a sudden, unpredicted blizzard that buried him to a depth of about three metres for several centuries until the recent climate warming began to melt out his remains. The lack of desiccation of his body, and the small amount of change in his skin and fat tissue (adipocere) also show that his body was continuously buried by ice and snow until the recent rapid melting of the southern glacier margin.

At the 2005 "Rapid Landscape Change and Human Response in the Arctic and Subarctic" conference in Whitehorse, Yukon, most of the archaeological

Figure 1. Map showing the location of the discovery site and other important places mentioned in the text

and paleoecological presentations talked about changes in human societies on time scales of decades to millennia. Our work on the life and death of Kwäday Dän Ts'ìnchí is almost unique in that we are looking at the life of one person, on a *scale of months, days, and hours*. The only other known example of such detailed archaeobotanical work is the study of the European frozen man, Ötzi, who lived near the border of Austria and Italy about 5,300 years ago (Dickson et al., 2003, 2005, 2008; Oeggl et al., 2007). Learning about the past can be difficult when the informant has been frozen for 550 years. Fortunately, microscopic remains of plants and animals from the frozen body and its clothing can tell us a story about the last days of the young man known as Kwäday Dän Ts'ìnchí. This Southern Tutchone name means Long Ago Person Found. It was given to him because he was discovered in the traditional territory of the Yukon's Champagne and Aishihik First Nations, on a glacier high in the southern part of Tatshenshini-Alsek Park in northwestern British Columbia (Beattie et al., 2000; Pringle, 2002). The Champagne and Aishihik First Nations have also taken a leadership role in the management of this important find that has triggered international public and scientific interest (Greer et al., 2005).

The frozen body was located on the edge of the Samuel Glacier in the southern St. Elias Mountains, near the head of Fault Creek, about halfway between the traditional Champagne village of Klukshu, in the Tatshenshini River drainage basin, and the Tlingit village of Klukwan, in the Chilkat River drainage basin (figure 1). Because of this position on the mountain divide between the Yukon Plateau and the Alaskan coast, there is much interest in trying to find out where Kwäday Dän Ts'ìnchí was travelling to, whether his home was on the coast or in the interior, and whether differences in the glacial landscape may have made it easier to cross the mountain divide before the start of the Little Ice Age in the region about 550 years ago.

The results from the identification of plants and animals found with the body and from chemical analysis of the bones and hair are helping to answer these questions (Dickson et al., 2004; Mudie et al., 2005). Information on traditional plant use contributed by Alaskan Native Americans and Yukon First Nation elders is also helping to solve the puzzle (Mudie et al., 2005). In this article, we first briefly review the previously published archaeological, archaeobotanical, and chemical information that addresses these questions about Kwäday Dän Ts'ìnchí's homeland and last journey. We then report on the results of new studies of microscopic plant and animal remains and silt-sized mineral grains that have been found in tiny samples from the stomach and intestines of the frozen body. These samples record the meals that Kwäday Dän Ts'ìnchí ate and the water that he drank during the last two to three days of his life. The samples from his intestines and clothing provide us with a detailed diary of his last journey, and if we can identify the geographically varying, local sources of the food and water recorded in this unique proxy-diary, we can backtrack his travel route in the days just before he died. Finally, we use all of these data sources to draw a few conclusions about the climate and possible landscape changes at the discovery site between about 1500 and 2005 AD.

Previous Studies

The frozen body of Kwäday Dän Ts'ìnchí was found by three British Columbian hunters on the morning of Saturday, August 14, 1999 (Beattie et al., 2000). Although the body was fractured by the glacier ice, it showed no sign of foul play prior to death. After consultation with First Nations elders and with archaeologists in Whitehorse, the body was packed in ice and taken to the Royal British Columbian Museum in Victoria where it was examined by an anatomist, botanists, a microbiologist, and a parasitologist. Following completion of the autopsy and consultation with neighbouring Yukon and British Columbia First Nations and southeast Alaska Tribes, the remains were cremated in 2001 and returned to the mountain where Kwäday Dän Ts'ìnchí lost his life (Greer et al., 2005). His belongings and various other artifacts from the site area were retained, and these are the focus of ongoing research conservation work and replication efforts by archaeologists and anthropologists. The discovery site is also monitored yearly and additional finds have been made in high-melt summers. At the autopsy, many samples were obtained from the frozen body of Kwäday Dän Ts'ìnchí and his clothing—a robe made of Arctic ground squirrel skin—and all of these are the subject of ongoing studies as outlined by Beattie et al. (2000) and by Dickson et al. (2004). Because of the excellent preservation of the body and the standard autopsy, his intestines could be sampled much more carefully and completely than for the older frozen body of Ötzi, whose intestines are very shrivelled, and for whom an autopsy was never conducted to examine his internal organs directly. Ötzi's intestines could only be examined by endoscopic probes that could not see the full layout of his internal organs and were much less precise in taking samples for medical and forensic studies. The presence of chyme in the stomach of Kwäday Dän Ts'ìnchí shows that death must have occurred only a few hours after he ate his last meal. The complete sampling from stomach to rectum gives us a full food diary of the last three days of his life.

Radiocarbon dating of collagen from the bones of Kwäday Dän Ts'ìnchí (Richards et al., 2007) provides uncalibrated ages of 952 ± 28 yr BP (OxA-

10224) and 935 ± 75 yr BP (NZA-15675), which give a combined age of 944 ± 80 yr BP (i.e., 929 to 1089 AD). The range of possible calibrated ages for the time of his death, however, is much larger, varying from a maximum of 1480 AD to a minimum of 1850 cal AD (Richards et al., 2007). However, most of the radiocarbon ages obtained from the clothing associated with his frozen body suggest that Kwäday Dän Ts'ìnchí lived from between 1400 AD and 1490 AD (Beattie et al., 2000; Richards et al., 2007). The structure of his bones indicates that he died at a young age of about twenty years old, at which time he appeared to be in good health (Beattie et al., 2000). Study of the archaeological artifacts, together with microscopic studies of the intestinal samples, isotopic assays of bone, muscle, and hair, and the identification of organic remains adhering to clothing, all provide different clues with which to unravel not just the contents of his last several meals but also the timeline and geographical details of his last journey.

Archaeological Clues

The published archaeological evidence for the kinship and domicile of the Kwäday Dän Ts'ìnchí is somewhat ambiguous. Initial results of DNA analysis (Monsalve et al., 2002) has shown that he was clearly a North American Aboriginal, belonging to the mtDNA haplogroup A that today is most common among Native Americans of the Dogrib Continental Na-Dene and the Haida of the Queen Charlotte Islands. However, this DNA group is also found in ancient remains as far afield as South America. His fur robe was made of about ninety-five skins of the Arctic ground squirrel (Mackie, 2004). Today, the Arctic ground squirrel (*Spermophilus parryi plesius*), commonly called a gopher, does not live on the coast but is very common in the interior where it is traditionally used for food and clothing. The ethnographer Catharine McClellan (1975, 158) noted that "almost every older Indian woman in southern Yukon owns a gopher-skin robe," thus suggesting an interior origin for this garment, although it may have ended up on the coast through trade. In contrast, his hat of finely woven spruce roots (Pringle, 2002; Mudie et al., 2005) is of a coastal style, and is possibly made of Sitka spruce, which does not grow inland of the mild wet Pacific Maritime Ecozone. Very large spruce pollen grains, like those of the Sitka spruce, and marine diatoms are present in the fur robe (Mudie, unpublished and table 1), but pollen analysis of the spruce root hat (by R. H. Hebda) has not yet been published.

Stable Isotope Studies

Studies were made of the carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotopes in the bones and the shoulder-length hair of Kwäday Dän Ts'ìnchí (Richards et al. 2007; Dickson et al., 2004). The bone $\delta^{13}C$ and $\delta^{15}N$ values measure the dominant component of his diet during the past five to ten years, and the results indicate that more than 90 percent of his protein intake was from marine sources. The $\delta^{15}N$ values also indicate consumption of high-trophic-level marine protein, such as predatory fish and marine mammals. The hair isotope data was obtained from two hairs about eight centimetres long, and because one centimetre of hair reflects approximately one month of growth (Richards and Hedges, 1999), they provide information about the last eight months of his life. In contrast with the bone data, the hair $\delta^{13}C$ and $\delta^{15}N$ isotopes show a change from a marine signal to a terrestrial isotope signal along the length of the hair, and they indicate that Kwäday Dän Ts'ìnchí spent four to six months inland, eating meat of land animals during the year before he died. However, the hair isotopes do not allow a precise time-series analysis of the last month of his life, so they cannot clarify the question of whether his last journey was from the coast to the inland or vice versa.

Archaeozoological Clues

Two pieces of fish with scales and many loose scales were on the fur robe and near the body, and these were identified as being from four-year-old chum salmon (*Oncorhynchus keta* Walbaum 1792), probably a single fish (Dickson et al., 2004). The lack of developed circuli (growth rings) near the focus of the scales suggests that the fish had spent only a short time in a freshwater environment before entering the ocean at an early age. Fish bones that may be chum salmon were also found in the lower intestines, but no precise identification has yet been possible.

Five pieces of cartilaginous, internal (endophragmal) skeleton (ten to twelve millimetres long) and similar sized segments of the abdominal outer shell (exoskeleton) of a decapod crustacean were found in the stomach and lower intestines (Dickson et al., 2004). The large size of these pieces show that the crustacean must have been marine, as no terrestrial crustaceans this big are found in the region, and there are no freshwater crayfish north of southern British Columbia. The crustacean pieces are quite similar to that of a crab, but a precise identification has not yet been made.

Eggs of the fish tapeworm (*Diphyllobothrium* sp.) were found in large numbers in the small intestines and in smaller numbers in the descending colon and the rectum (figure 2.1). Five species of *Diphyllobothrium* are known to infect humans in Alaska at present. The eggs could not be definitely identified beyond the genus level, based on available material (Rausch and Hilliard, 1970), but many of them have the characteristic posterior knob (antipodal boss) found in *D. latum* (see fig. 3b in Dickson et al., 2004) that infects freshwater and anadromous fish, including several species of Pacific salmon. Humans can be infected by eating uncooked fish that contain the larval stage of the tapeworm, although the infection is not usually harmful. This larval stage requires fresh water for its survival, suggesting an inland fish source, but the larvae can also remain embedded in muscles or encyst on the viscera of anadromous fish for many years after the fish return to the ocean (Bruce Leighton, personal communication, 2005). The fish tapeworm eggs therefore are not a definitive clue to the source, coastal or inland, of the fish.

Microscopic Plant Remains

The three standard pollen counts from chyme subsamples all have as the largest component Chenopodiaceae pollen (about 25 percent). It is not possible to identify different kinds of Chenopod pollen from the light microscope samples, but the wealth of details revealed by Environmental Scanning Electron Microscopy (ESEM) allowed us to identify glasswort (*Salicornia*) pollen in one stomach subsample and one robe sample (Mudie et al., 2005). Some Chenopod pollen also occur on many samples from the robe.

Macroscopic Plant Remains

The ripe fruit of mountain sweet-cicely (*Osmorhiza berteroi* DC, Apiaceae) was found on the fur robe (Dickson et al., 2004). There are three species of this perennial herb genus in the study area (Cody, 2000; Hultén, 1968). The ripe fruits of all species have recurved, brittle hairs that are an adaptation for briefly clinging to fur. One-half of a broken schizocarp, twenty-two millimetres long, was removed from near the lower left-hand corner of the robe. This length of more than twenty millimetres excludes all species but *O. berteroi* (Douglas et al., 1998). The distribution of mountain sweet-cicely is restricted to parts of the Pacific Coastal Ecozone below the treeline.

One needle of coniferous hemlock tree was also found on the fur robe; it is eight millimetres long and keeled and was identified as that of the mountain hemlock (*Tsuga mertensiana* [Bong.] Carr., Pinaceae). This hemlock species is confined to the coastal region, below about 1,000 metres altitude.

Ethnobotanical Studies

The presence of about 25 percent Chenopod pollen in the stomach sample was surprising because it does not occur in surface lake sediments of the study area (Dickson et al., 2004), and it was not found in snow samples taken at the discovery site (table 1). This strongly suggests that the pollen was consumed with food eaten by the Kwäday Dän Ts'ìnchí. It is well-known from historical documents that many members of the Chenopod family (such as beets and spinach) are edible, and that both the coastal and inland glasswort has long been used in Europe for food or medicine (Mudie et al., 2005). In North America, some Chenopods were eaten by Aboriginal people living far south and east of our study area. For our forensic palynology studies, however, we needed to know about the traditional uses of the Aboriginal peoples of the region. With the help of anthropologists Sheila Greer (University of Alberta) and Judy Brakel (Gustavus), we were able to interview elders from the Champagne and Aishihik, Carcross Tagish, and Teetl'it Gwitchin First Nations, and from two coastal Tlingit communities (Klukwan, near Haines, Alaska and Hoonah, in the Chichagof Archipelago). These elders are all experts in the traditional uses of native plants, and they were willing to share their traditional ecological knowledge (TEK) with us in the hope that written documentation will preserve the centuries-old oral knowledge that is now dying out among the young, computer-age Aboriginal people.

The interviews with the elders from the First Nations in Canada revealed that there are no common-place uses for the little annual red glasswort (*Salicornia rubra*) although larger species were used for grain further south (Mudie et al., 2005). Three of the elders, however, thought that the red glasswort may have been dried and used by men as a special diet food or medicine for long distance travel. It has juicy stems that store salt, iodine, and vitamin C, making it a suitable light-weight snack for strenuous mountain journeys. In the coastal region, the Tlingit elders know that the bigger perennial beach asparagus (*Salicornia perennis*) has been used as a vegetable since at least the 1880s. The fact that it has a traditional name, *Suk kadzi*, meaning "loose rope on the beach," indicates that its use goes far back into Tlingit pre-history. The notebooks of Dr. Archibald Menzies, Captain Vancouver's ship doctor, also show that in 1794 both the beach asparagus and beach orache (*Atriplex* spp.) were given to the Europeans as a cure for scurvy (vitamin C deficiency), which was prevalent on the ship. This medical documentation stands in remarkable proximity to the traditional knowledge revealed to us by the inland elders, Clara Schinkel and Ruth Welsh (see Mudie et al., 2005 for details). Certainly, the fact that both the inland and coastal glassworts have high contents of common salt (NaCl) and high-C acids makes them a useful vegetable and vitamin supplement for rapid travel through the rather barren rocky mountaintops on the path of Kwäday Dän Ts'ìnchí's last journey.

In order to investigate further the questions about Kwäday Dän Ts'ìnchí's diet (marine or terrestrial) and the route that he followed on his last journey across the high mountains between the Yukon and southeast Alaska, we have begun to make a detailed examination of the microscopic plant, animal, and sediment particles in the samples that were removed from his stomach and along the length of his intestines. Because we knew precisely what part of the intestines were sampled, and because we know the speed with which undigested food normally moves from the stomach through the intestines, any plant and animal particles we could identify would give us a partial menu of what Kwäday Dän Ts'ìnchí ate at various times during the last three days of his life. Furthermore, if the plants or animals that he ate were from a very geographically restricted environment, either on the coast or inland, then this might tell us exactly where he had gathered the food. The chemistry of the mineral grains in the samples would also provide clues as to source of the water that he was drinking or that he used to prepare his food, and it would point to the river valleys along which he travelled. In order to carry out these archaeobotanical studies on the very small samples available (less than one gram wet weight), it was necessary to use very careful preparation methods, as we describe in the next section.

Methods

The preparation of the miniscule (about 0.1 mg) chyme subsamples and five intestinal samples for standard pollen analyses by light microscopy was by painstaking use of the normal methods (Faegri and Iversen, 1998). For stereoscan studies, a new type of electron microscope was used, an Environmental Scanning Electron Microscopy (ESEM). With this tool, the pollen residue is simply suspended in a drop of distilled water, mounted on an aluminum SEM stub, and air-dried in a fume hood before being coated with gold-palladium. The coated stubs were scanned with a KeV of 17 and magnification of x 500. Between ten and fifteen grains of each pollen species were then imaged at magnifications of about x 5,000 and x 13,000. Meat fragments, algal spores, diatoms, and other plant fragments in the sample were also imaged. Plant macroremains were picked or washed with jets of distilled water from the surface of the robe and were compared with herbarium specimens and recent field-gathered reference material.

The ESEM is equipped with an Energy Dispersion Spectrometer (EDS) that allows precise measurement of the atomic composition for silt-size mineral grains in the tiny samples, so we could determine their mineralogy and hence, their likely source area. Reference samples were provided from filtered meltwater at the discovery site, as well as from samples collected at Mineral Lakes about five kilometres to the south, and from several streams draining into the Tatshenshini to the north.

Results of New Archaeobotanical and Forensic Palynology Studies

Mosses

No less than twelve kinds of mosses have been found in the digestive system by Jim Dickson (JHD) compared to only six found in Ötzi (two of which are probably contaminants because of the massive damage to part of his body). Most of these mosses have a very widespread distribution and they are not precise markers of geographical origin. However, three species found in Kwäday Dän Ts'ìnchí provide important environmental clues. The most important mosses for recognising the provenance of the Long Ago Person Found are *Fontinalis* Hedw., a submerged water moss (probably *F. antipyretica*), *Sphagnum Sect. Acutifolia*, a bogmoss, and *Andreaea* cf. *A. rupestris*, a black rock moss.

A leaf of the water moss was found only in the small bowel sample T38-17. This water moss grows in streams, rivers, and lakes and is quite common in the coastal region from southeast Alaska to the Aleutians, but it has not been recorded for the Yukon (W. Schofield, written communication, 2005). *F. antipyretica* is also one of very few mosses that can grow in brackish water and it can tolerate high levels of calcium and heavy metals, although there also some acid tolerant physiological races in the Appalachians (Janis M.Glime, personal communication, 2005). In the Pacific Northwest, the water moss is more frequent at lower elevations: in northern British Columbia, it grows only below the treeline (~1000 m), and in the Yakutat region of southeast Alaska, it was found only in a coastal pond with water lilies and was not seen in any rivers or streams.

A leaf and a leafy branch of the red bogmoss, *Sphagnum Sect. Acutifolia*, was found in the rectum sample P-14 (figure 2.2). Species of *Sphagnum* grow on deep peat or peaty ground, in wet woods, or on wet rocks. They are most abundant in coastal regions and become progressively sparser with increasing altitude in the Pacific Northwest, as elsewhere. *Sphagnum* mosses have antibacterial properties and have been used traditionally for healing wounds or for hygiene, such as diapers or toilet paper (see Dickson and Dickson, 2002). Red bogmoss was also used as a medicinal plant by the Dena'ina (Kari, 1991) and *Sphagnum* moss (*urju*) was used by some Inuit for cooking thin slices of meat between hot, flat rocks (E. Tunnuq; cited by Bennett and Rowley, 2004). A leaf of the black rock moss, *Andreaea* cf. *rupestris* Hedw., was found in one sample from the small bowel (T-38-14). This moss grows only on acidic rocks in exposed areas. Such boulder-sized rocks in the form of glacial erratics occur near the discovery site of the frozen body, and along the Old Mine Road and Stonehouse Creek trails about ten kilometres east and south of the discovery site, respectively.

Other Plant Fragments

Tiny fragments of spirally thickened tissue resembling that in the anthers of *Salicornia perennis* from Glacier Bay have been found in the stomach and colon. A spirally thickened sclereid similar to that of the specialized salt storage cells in *Salicornia* leaves was also found in a faecal sample. A leaf fragment (figure 2.4) of *Nuphar* cf. *N. polysepalum* (water lily) was found in the small bowel (T-39-19). This water lily is a valley plant and indicates a location well below the treeline. Smooth, thick-walled epidermal tissue fragments resembling those of blueberries were found by Petra Mudie (PJM) in the stomach and small bowel, but the identification still awaits validation.

One sample from the small bowel (T38-17) contained a fragment of hardwood charcoal, possibly inhaled while cooking over a small fire of arctic willow or birch wood, or ingested from water containing the ash fallout of large fires common in the spruce-birch forest of the upper Tatshenshini-Alsek basin. Another sample slightly lower in the small colon (T38-24), however, contained fresh softwood fibres with one to two rows of bordered pits, resembling those found in spruce (*Picea*) and larch (*Larix*). The starch and protein-rich cambium and secondary phloem of spruce was eaten fresh or dried by the coastal Aboriginal people (Turner, 1995) and this might explain the occurrence of these uncarbonized wood fibres. Various other unidentified wood and leaf tissues were seen, but no industrial-age combustion particles were found like those reported for the modern Canadian Arctic by Doubleday and Smol (2005).

Pollen, Diatoms, and Algal Spores

Detailed ESEM studies have now been made of five samples from the digestive system of Kwäday Dän Ts'ìnchí, and four samples from the fur robe have been examined (see table 1). The composition of these samples has been compared with that in two snow samples from the discovery site, and with water and sediment samples from the subalpine Mineral Lakes about three hundred metres below the site, water from several creeks draining into the Tatshenshini River, from saline ponds near the Takhini and Alsek Rivers, and from several salt marshes in southeast Alaska (see table 1). Very little pollen was found in any of the ESEM samples. The largest amount (thirty-five thousand grains per gram) was in the stomach sample where pollen resembling that of *Salicornia perennis* (figure 2.3), the beach asparagus, comprised about 25 percent of the total pollen. The other grains were mainly wind-transported pollen species also common in snow at the site, including *Pinus*, T*suga heterophylla*, *Alnus*, *Betula*, *Artemisia*, and a small grass species (Poaceae). The composition of pollen in the bowel sample and on the robe was similar although less *Salicornia* and no *Artemisia* pollen were found in the intestines, and the pollen was very poorly preserved. The only other ESEM sample with pollen was from the descending colon (T38-46) where a few biscaccate grains (*Picea*, *Pinus*, *Tsuga*) and a *Rubus* species were found.

No diatoms were found in the intestinal samples, but the spores of two chlorophyte algae (figures 2.8 and 2.9), the red snow algae (*Chlamydomonas nivalis*) and *Troschiscia* cf. *T. aspera* (Reinsch) Hansgirg were common in the stomach and upper intestines, along with some smooth spherical chrysophytes. These taxa were also abundant in the snow samples at the discovery site (table 1), along with occasional small pennate and cylindric diatoms. Similar diatoms were found in some samples from the robe, but other robe samples included several larger pennate and cylindrical diatoms like those found in the tidal salt marsh at Groundhog Bay and Swanson Harbour at the south end of the Lynn Canal (see table 1).

A few spiny cysts resembling those of the desmid *Staurastrum sexangulare* (Bulnheim) Lundell were found only in the rectum sample. These are quite different from the *Closterium*-type desmids seen at Mineral Lakes, and the few *Staurastrum* species that have been reported for intertidal areas. Most *Staurastrum* species are restricted to slightly acidic freshwater pond environments, and more fieldwork is required to determine the provenance of the specimens found in Kwäday Dän Ts'ìnchí.

Table 1. Number of pollen grains and relative abundances of diatoms, snow algae, and microzooplankton found in ESEM samples from the ground squirrel robe, snow at the discovery site, and at inland salt marshes near Whitehorse (Tak1A=Takhini), and in coastal salt marshes near the entrance to Lynn Canal (Pleas1 = Pleasant Island salt marsh)

	Robe Samples					Site Snow 2002		Inland	Coastal Salt Marshes		
	R28-31	R28-2	R28-34	R28	R23	Red	Green	Tak 1A	Pleas1	Juneau	Hoonah
Category: Percent abundances											
Centric diatoms <10 μ	20	10	10	0	15	trace	0	0	0	1	1
Centric diatoms 10–20 μ	2	0	5	5	5	trace	0	0	0	0	trace
Centric diatoms >20 μ	0	0	0	0	0	0	0	0	0	2	8
Pennate diatoms <10 μ	15	15	5	0	1	0	0	1	<.05	2	1
Pennate diatoms >10 μ	2	5	5	2	5	trace	0	0	5	5	5
Other diatoms	3	10	2	1	5	trace	0	0	0	0	0
Chrysophyte-smooth	5	5	1	1	1	1	trace	0	0	0	0
Chrysophyte-spiny	0	2	0	0	1	5	5	0	0	0	0
Red snow alga	1	0.5	2	1	1	30	60	0	0	0	0
Trochiscia aspera alga	0	1	1	1	0	0	5	0	0	0	0
?Ostracode	0	0	1	0	0	trace	0	0	0	0	0
Rhizopod	0	0	1	0	0	0	0	0	0	0	0
Pollen: Number of Grains											
Tree/shrub											
Juniper	0	4	0	1	1	1	0	0	0	0	0
Pine	0	1	0	0	4	3	0	1	0	0	0
Spruce	0	0	0	0	0	1	0	0	0	0	0
Mtn. Hemlock	0	0	0	0	0	1	0	0	0	0	0
Alder	0	0	0	0	3	2	0	0	0	0	0
Willow	0	0	1	0	0	0	0	0	0	0	0
cf Douglas Fir	0	0	0	0	4	1	0	0	0	0	0
Coast Hemlock	0	0	2	0	2	2	0	0	0	1	0
Dwarf Birch	0	0	0	0	1	1	0	0	0	0	0
Herbs											
Wormwood	0	0	0	0	4	0	0	0	0	0	0
Mustard	0	1	0	0	2	1	0	0	0	0	0
Salicornia-type	0	0	1	0	4	0	0	0	0	0	0
Salicornia rubra	0	0	0	0	0	0	0	15	0	0	0
Beach Asparagus	0	0	0	0	0	0	0	0	30	20	30
Lily	0	0	0	0	1	0	0	0	0	0	0
Mtn. Burnet	0	0	2	0	0	0	0	0	0	0	0
Unkown Chenopodiaceae	0	0	0	0	1	0	0	0	0	1	0
Other unknown species	0	0	0	0	1	2	0	0	0	0	0

Animal Remains

The largest component of most samples from the stomach and intestines consisted of fibres or chunks of proteinaceous substances and fat, either as light oil or as rounded or shapeless fat globs. The stomach sample contained mostly meat chunks with very coarse black striations (about one millimetre wide), along with a few finely striated fibres, cartilaginous ligaments, and small (less than one millimetre) calcareous branched spines. The overall appearance of the very coarsely striated chunks is most similar to that in seal blubber, which is also consistent with the masses of fat found in the chyme. Visually, the finely striated fibres resemble those in a reference sample of Dungeness crab, but the crab fibres tended to remain in sheets in contrast to the single fibres found in the stomach sample. Future work is planned to confirm our initial identification of the stomach meat fragments by use of the more expensive, time-consuming isotopic and DNA fingerprinting techniques.

The meat particles in the proximal duodenum and the ileum consisted of blocky chunks (figure 2.1) with ESEM images showing irregular vertical striation and large amounts of fat globs. These particles most closely resemble the meat fibres in caribou and bison samples studied by ESEM, but they lack evidence of faint striae that characterize skeletal muscle tissue. It is possible that they are from visceral or cardiac muscle tissue. The small bowel, descending colon, and rectum all contain narrow, striated meat fibres that are very similar to those seen in a reference sample of dried salmon from Klukshu.

Other animal remains observed in ESEM images included a threadworm or ice worm in the stomach, two very small tapeworms in the duodenum, and two kinds of tapeworm eggs. One of the egg types is relatively large (more than seventy microns) and resembles the oval eggs of the fish tapeworm (*Diphyllobothrium latum*) that has a freshwater or anadromous fish host. The other kind of tapeworm egg is smaller and rounded (figure 2.1), resembling that of *D. pacificum* which has a marine host (seal or fish).

Mineral Grains

The second-largest component of the residues in the chyme is silt-sized mineral particles that are strongly angular (figure 2.7), indicating their freshly plucked origin in contrast to rounded grains found on beaches or lower reaches of rivers. This angularity tends to confirm their origin as glacier flour and the mineral composition is predominantly alkaline feldspar and biotite, as expected for the metamorphic volcanic rocks of the peaks in the southern St. Elias range. In contrast, the mineral grains in the intestine at the top of the duodenum are rounded and of limestone composition. Similar grains of calcite are found in the small Mineral Lakes about five kilometres south of the Samuel Glacier.

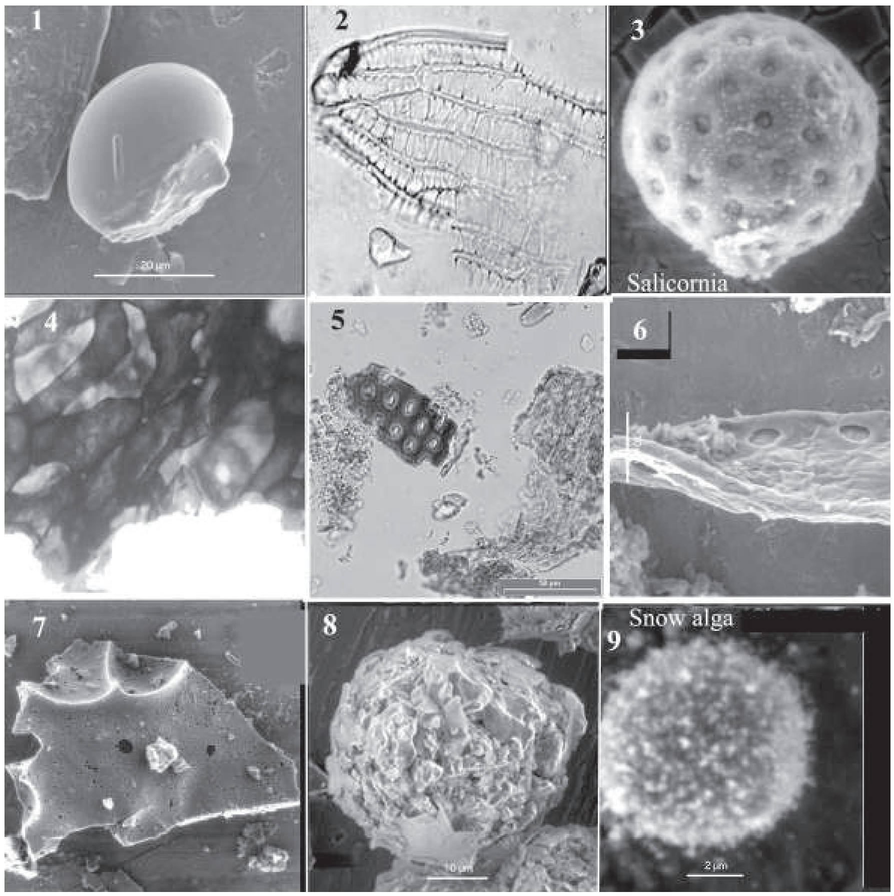

Figure 2. Photographs and ESEM images of various microscopic particles from the intestines of the Kwäday Dän Ts'ìnchi discovery
2.1. Round tapeworm egg and meat chunk resembling caribou
2.2. Leaf of *Sphagnum* Sect. *Acutifolia*
2.3. Pollen of Beach Asparagus, *Salicornia perennis*
2.4. Leaf fragment of waterlily, *Nuphar* cf. *N. polysepala*
2.5. Fragment of hardwood charcoal
2.6. Fresh (non-carbonized) softwood fibre
2.7. Angular grain of alkali feldspar
2.8. Red snow alga, *Chlamydomonas nivalis*
2.9. Chloroccoid snow alga, *Troschiscia* sp.

Grains from the ileum, small bowel, and descending colon are of mostly alkali feldspar types, but they are not sharply angular and some are of limestone origin. Similar sub-angular grains can be found in water from Alsek Lake and in the delta of the Towagh River where it joins the Tatshenshini. However, the water-borne grains from the Tatshenshini-Alsek basin are mostly alkaline hornblendes, with a high magnesium and iron content. No grains of this composition have yet been found in the intestinal sample. It is, therefore, more likely that the grains in the intestines were from rivers flowing through the Chilkat basin where limestone and muddy sandstones are common (Conner and O'Hare, 1988). In 2005, we also collected water samples from the Chilkat River and many of the streams that drain into its basin from the Samuel Glacier. Field tests with litmus paper showed that most of these waters were slightly alkali, as expected for bedrock of carbonate origin. A prevalence of limestone in the Chilkat drainage basin was also suggested by the scarcity of acid-loving mosses, such as bogmoss, on the southern slopes between the discovery site and the Haines Highway. The very small sample from the bowel contained only framboidal pyrites. These minerals are commonly found in the dysoxic soils of poorly drained salt marshes, but it is currently not known if they can also be formed *in situ* within the lower colon and bowel.

Synthesis of New Data: The Meals of the Last Three Days

Stomach Chyme: The Final Hours

It is clear that the last meal of Kwäday Dän Ts'ìnchí included a lot of fatty meat (the striped chyme of unknown origin) and a smaller amount of a marine crustacean, possibly a crab. The presence of *Salicornia perennis* pollen and anther fragments indicates that he also ate some beach asparagus. Other plant tissue looks like that of blueberry, but it is possibly from some other kind of dried fruit as was commonly carried on long journeys (see Mudie et al., 2005). The very common presence of angular feldspar and quartz grains, together with snow algae, indicate that the meal was probably washed down with meltwater gathered from the edge of the glacier.

Proximal Duodenum: Three to Four Hours Earlier

The duodenum sample was small and contained mainly irregular fatty globs and meat fibres resembling those of the bison reference sample. No pollen or plant tissues were present in this sample. One very small tapeworm was found, both in a state of disintegration although there were many elongate tapeworm eggs present. The few silt-sized grains were calcites, indicating a totally different source of drinking water than for the last meal on the glacier, and indicating an area of limestone bedrock. One of the grains was well-rounded and chalky; the other was a delicate flock of small sparry crystals, indicating a very quiet depositional environment as in a small lake or karst sinkhole.

Distal Ileum: Six to Seven Hours Earlier

This sample also consisted predominantly of vertically striated meat chunks and fibres, along with fat globs. There were also a few animal hairs in this sample, but no recognizable plant tissues and only one grain of coastal hemlock (*Tsuga heterophylla*) pollen, which could have been blown inland from the coast. The sample contained many medium-sized (five to ten microns) chrysophytes or *Troschiscia* spp. with scaly surfaces, and the subangular silt grains of quartz or alkali feldspar indicate that the water was obtained from a different source than the previous (earlier) meal, as described below.

Small Bowel: About Ten to Twenty-two Hours Earlier

Again, most of this sample consisted of meat fibres. These were well striated muscle fibres like the narrow fibres of salmon found in the reference sample from Klukshu. Unidentified plant epidermal tissue, coiled fibres, and a few fibres with two rows of bordered pits indicate that some plant food was eaten at this meal, including uncarbonized tissues of a softwood such as spruce or larch. One of the light microscope samples (JHD) contained the *Fontinalis* moss fragment, indicating a location well below the alpine zone. The silt-sized minerals were all subangular or subrounded, and included a mixed assemblage of alkali feldspars, quartz, and calcite.

Descending Colon: One Day Earlier

The meat fibres in this sample appear to be those of salmon. There are many unidentified, ribbed leaf fragments, as well as bits of plant tissue with large vessels, and numerous coiled fibres like those found in the small bowel. The only pollen grain found in the ESEM sample is a tricolporate grain with numerous small verrucae, resembling that of *Rubus chamaemorus* L., the cloudberry, which is commonly picked in summer by the coastal people of British Columbia (Turner, 1995). This sample also contained a very small, broken spine of a sea urchin, which, in addition to the sea asparagus, may be another clue to a recent coastal contact. The few mineral grains in this sample were subrounded calcite, indicating an origin far upstream in a river flowing through a region of limestone rocks.

Rectum: Two to Three Days Earlier

This sample also contained abundant striated muscle fibres like those found in salmon, and several different kinds of plant fragments including a branch of the red bogmoss with fifteen leaves and spirally thickened tracheids like those of water storage cells in *Salicornia*. Pollen of beach asparagus and a sedge grain were present, in addition to some pine grains that could have been windblown from a long distance. The ESEM and light microscope samples also contained several spiny cysts that are tentatively identified as those of the desmid *Staurastrum sexangulare*. This desmid is usually associated with fresh water, but it was accompanied by two kinds of chrysophytes that are also found in brackish water, and a spherical, multi-plated protist resembling that of a coccolithophorid. The latter group of organisms live only in marine environments. The only mineral grains in this ESEM sample were framboidal pyrites.

Discussion

Because they died while actively pursuing daily life and their remains had not been prepared for burial, Ötzi and Kwäday Dän Ts'ìnchí pose questions different from those arising from frozen burials such as those of the Inuit, the sacrificed Andean children, or the Siberian Pazyryks. What had Kwäday Dän Ts'ìnchí been doing? Had he travelled far and from which direction? What were the events immediately before and after his death? Who were his kin and where was home? Like Ötzi, Kwäday Dän Ts'ìnchí died in a remote mountain-top area so his kinship is uncertain: Did he belong to a coastal people, such as the Tlingit, or to an interior group, such as the Athabaskan Champagne and Aishihik First Nations within whose traditional territory his frozen body was found?

The very high proportion of Chenopodiaceae pollen from the stomach samples is a completely unexpected finding because this family is but a minute element of the plant cover in this area of North America and is absent from local high mountain vegetation. The ESEM studies (Mudie et al., 2005) show that the Chenopod pollen is probably that of *Salicornia perennis*, which appears to have its present northern limit near the south end of Glacier Bay where it grows on mudflats inundated by seawater with a salinity of about 30‰ (Mudie and Dickson, 2005, unpublished report). The flowering time of *S. perennis* also allows us to delimit the season during which Kwäday Dän Ts'ìnchí made his last journey. Our field observations for 2002 and 2004 show that in the Pacific Northwest region, the beach asparagus blooms from the last week in July until the end of August. This is also the time of the main chum salmon runs in the Tatshenshini Basin. This clearly pins down the season of travel to late summer. It may also be relevant that, unlike most other salmon species, chum salmon spawn only in the lower reaches of the Tatshenshini-Alsek River, further indicating a coastal connection for the start of the last journey.

So far, no macro-organism from either the gut or the robe is unequivocally indicative of an inland source in the Yukon or British Columbia to the north and east of the site, whereas there are two plants that grow only in the coastal zone: mountain sweet-cicely and mountain hemlock. Both these plants are confined to the coastal zone of heavy-annual-precipitation vegetation and do not occur in the Yukon (Cody, 1996). Mountain hemlock is "characteristic of maritime subalpine forests" (Klinka et al., 1989, 236). For mountain sweet-cicely, Hultén (1968, 697) plots the maritime distribution and merely states "woods"; but, along the Alaskan coast from Glacier Bay (Gustavus and Pleasant Island) to Yakutat, it grows close to sea level along woodland edges and cleared trails (JHD and PJM, personal observations). To brush through a stand of *Osmorhiza* plants is to inadvertently gather many fruits on clothing, most of which are soon knocked or shaken off.

Fossil and archaeological deposits and ethnographic observations provide a good record from 6500 BP to the present for the consumption of intertidal shellfish, near-shore fish, salmon, sea mammals, and sea birds by coastal Aboriginals (Hebda and Frederick, 1990). That marine crustaceans were a component of the diet is well documented. Dymytryshyn and Crowhart-Vaughan (1976, 36) quote the 1817–1832 reports of Khlebnikov at Sitka, Alaska: "Among shellfish, there are large crabs here, shrimp, and various sorts of mollusks … All these types of shellfish are used as food …" Krause (1885, 107) stated of the Tlingit in the Chilkat region that "the principal dish of the day is always fish, boiled, roasted, dried, but never raw. Next in importance is the meat of land and sea mammals, fowl, crabs, squid, shellfish, sea urchins.…" This listing of crab for the Chilkat Tlingit is important because in other parts of southeastern Alaska, crab was not a favoured food in prehistoric time (Earlandson and Moss, 2001). There are well-documented ethnographic accounts of ancient trade routes between the coast and the interior (Emmons, 1991), and it was noted that in summer, long-distance travellers ate a light diet of salmon and berries during the day, with a large meal only in the evening (Krause 1885, 135). Swanton (1990), in his accounts of Tlingit myths and texts, also mentions that young men who were trained for mountain climbing carried only a stone axe, staff, flint, and a seal's stomach full of grease. This description rather remarkably fits what we know of Kwäday Dän Ts'ìnchí and the artifacts found near him at the discovery site, particularly with regard to the vast amount of unidentified oily substance present throughout his intestines.

Conclusions

The botanical evidence of the gut contents and the plants from the ground squirrel robe lead to the working hypothesis that Kwäday Dän Ts'ìnchí was in the coastal zone shortly before his death, either travelling overland between coastal fjords or walking from coast to interior, not vice versa. This is further supported by the isotopic evidence of a mainly marine-based diet for Kwäday Dän Ts'ìnchí that shows he probably lived near the coast most of the time prior to visiting the inland region for a few months before his last journey across the glacier. The mineral grains in the intestines also provide important clues to the direction of his last journey. Certainly, if he had started up the steep gradient of O'Conner Creek from the Tatshenshini River to Fault Creek two to three days before the end of his life, it would have been almost impossible for him to avoid drinking the river water containing angular iron-rich (hornblende-type) silt grains, as these waters are milk-coloured from their suspended load of glacial flour.

Our research on the flowering time of beach asparagus in southeast Alaska also clearly places the season of Kwäday Dän Ts'ìnchí's last journey in late summer, thus providing an explanation for why he was lightly dressed, but at the same time raising the question of why he died on that summer journey. One speculative answer might be that he was unexpectedly caught in an unpredictable storm during the time of extreme warm-cold weather variations recorded by Rocky Mountain tree-ring data for the interval from 1418–1500 AD (Luckman and Wilson, 2005). Data from alpine ice patches in southwest Yukon (Farnell et al., 2004) also show that the warm interval from about 970–560 years ago was followed by 500 years of cooling, ending in the start of the Little Ice Age 460 years ago. The extremely good preservation of Kwäday Dän Ts'ìnchí's body and lack of either subaerial desiccation or fat alteration (adipocere) on most of his body (Beattie et al., 2002) testify to the fact that his corpse must have remained covered by snow or ice from the time of death until mid-August 1999. Even in high alpine regions, corpses are devoured by predatory birds within a few hours or days after exposure. It is also known from aerial photographs that the approximately six-metre high ice ridge within which the body lay existed from at least 1948 until 1999 AD (Beattie et al., 2000). During the past six years, however, this ridge has almost disappeared, fully exposing several small nunataks that are now linked by gravel fields to the exposed bedrock ridges around the discovery site. During just three days, between August 11 and 14, 2005, we also observed about fifty centimetres of melt-out of a bull moose head trapped in the glacier. These new field observations agree with reports that the average rate of thinning of southwest Yukon and northern British Columbian glaciers was 0.52 m/year from 1950 to 1990, increasing to 1.8 m/year from about 1995 to 2001 (www.pc.gc.ca/pn-np/yt/kluane/natcul/natcul3_E.asp).

If the melting continues at this rate, it will become possible to travel from the Stonehouse Creek tributary of the Chilkat River to the headwater of Parton Creek that joins the upper Tatsenshini River above Dalton Post. It is therefore plausible that the landscape at the start of Kwäday Dän Ts'ìnchí's last journey provided a more open route over the Samuel Glacier between the Chilkat and the Tatshenshini drainage basins, offering a shortcut to travellers or long-distance runners (cf. Mudie et al., 2005). In the few days just before their deaths, both Ötzi and Kwäday Dän Ts'ìnchí must have travelled across vegetation types changing markedly with altitude. These journeys are recorded to some degree in their intestinal contents. The continuation of more detailed examinations of the chyme and the intestinal contents is extremely important because pollen, spores, mineral grains, and other types of analyses may enable not only reconstruction of the routes taken but also of relative timetables. If such detailed results can be achieved, then it will be a first in archaeology and forensic science because hitherto, no ancient frozen bodies have been found in which the internal organs were almost perfectly preserved. For the last days of Kwäday Dän Ts'ìnchí's life it is very clear that he carried seafood, which he must have eaten well away from the coast, probably at high altitude. It is also clear that he enjoyed a healthy mixed diet including both meat and fruit; and possibly the beach asparagus was eaten as a salad food as well as for its source of salt and vitamin C.

Our continued ethnobotanical research and forensic palynology, combined with geological studies of annual climate variations recorded in varved sediments of thermokarst lakes near the discovery site, will continue to address questions about what Kwäday Dän Ts'ìnchí's had been doing on the remote glacier, and why he might have died in the prime of his youth. Already, it is remarkable how the death of this young man has brought the focus of scientific studies to the southwest Yukon, as testified by the 2005 Rapid Landscape Change conference at which papers by Lesleigh Anderson, David Fisher, Brian Luckman, and Wayne Howell all addressed the need to know more about climate variability and its impact on the people of the Pacific Northwest region. The unique three-day diary of food and water sources provided by the frozen body of Kwäday Dän Ts'ìnchí is a most important contribution to the archaeobotanical study of subarctic regions where food remains are not usually well preserved because of the fluctuating climatic conditions.

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