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HISTORICAL POLAR BASES – PRESERVATION AND MANAGEMENT

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XVII



NORTHUMBERLAND HOUSE, FORT CONGER AND THE PEARY HUTS IN THE CANADIAN HIGH ARCTIC: CURRENT CONDITION AND ASSESSMENT OF WOOD DETERIORATION TAKING PLACE

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Wooden structures built in 1852 during the Franklin rescue expedition on Beechey Island (74°43'N, 91°54' W) and by American expeditions led by Adolphus Greely (1881) called Fort Conger (one of the first International Polar Year stations) and Robert Peary (1900) on Ellesmere Island (81° 44' N, 64°44' W) are deteriorating. Since little to nothing is known about the agents and processes involved with wood degradation in the Arctic, an assessment of the biological and non-biological degradation processes found at the sites, evaluations of the current condition of the wood and environmental monitoring over a 2 year period is reported. Wind erosion and salt defibrillation of the wood were types of non-biological degradation found. In addition, advanced decay by wood-destroying soft rot fungi was evident in all structures. Molecular characterization of the fungi causing decay indicated that they are a unique group of polar fungi with the capacity to survive extreme environmental conditions and cause significant degradation. Warming trends in the Arctic will undoubtedly increase degradative actions by these organisms and accelerate decay of the historic woods. Information on the various agents causing wood deterioration and decay at these historic sites and a better understanding of how degradation processes take place in the Polar environment can be used in management plans to help preserve this Arctic cultural heritage.

Introduction

In 1852, Sir Edward Belcher led a squadron of five ships in search of the lost expedition of Sir John Franklin. During the expedition a wooden shore depot of supplies was erected on Beechey Island by the crew of the *North Star* under Commander W. J. S. Pullen. This building, called Northumberland House, represents some of the oldest introduced wood in the Canadian High Arctic. The building was still intact during a visit by the Captain Allen Young in the *Pandora* in 1875 (Young 1879) but deterioration has taken a significant toll on the structure and only ruins currently remain of the original building and contents. In addition to Northumberland

The remains of Northumberland House at Beechey Island built in 1852 by members of the Belcher squadron during a Franklin rescue expedition. Photo: R.A. Blanchette



House, graves from the Franklin expedition, monuments erected as memorials and several caches can be found on Beechey Island and add to the historic significance of the site (Phillips 1985).

A United States army expedition to the Arctic in 1881-1883 led by Adolphus Greely was part of an American contribution for the first International Polar Year activities. The expedition established Fort Conger at Lady Franklin Bay in northern Ellesmere Island. A very large wooden structure was built to house 26 members of the expedition during their exploration and scientific investigations. Unfortunately, relief ships carrying food supplies did not arrive and Greely was forced to abandon the Fort and head south in small boats. After an arduous journey and long periods of starvation at an improvised camp, only 6 survived and were rescued. Although the expedition ended in disaster, a large amount of scientific information was obtained and published (Greely 1886, 1888).

Fort Conger was a massive structure that was 18 m long, 5 m wide and had a 3 m high ceiling. It took enormous amounts of coal to heat the structure and was not well suited to the severe arctic environment. Robert Peary, who made many expeditions to the Arctic from 1890 to 1909, decided in 1900 to use Fort Conger as a wintering base. Robert Peary considered Fort Conger to be “a great barn of a structure ... grotesque in its utter unfitness and unsuitableness for polar winter quarters” (Peary 1917) and his crew of Mathew Henson, Dr. T. S. Dedrick and several Inuit dismantled most of Fort Conger and erected several small wooden shelters. The igloo-sized shelters were 2.5 to 3 m long and 2 to 3 m wide and were built low into the ground (Dick 2001). The huts were connected by a series of canvas covered passageways that became covered with hardened snow. Instead of a wooden hut, Peary decided to build a tent dwelling for his own living quarters that was covered by mattresses from Greely’s Fort. Snow and ice was used to cover the tent and mattresses, providing a solid layer of insulation. Subsequent expeditions by American, Norwegian, Danish, and British/Canadian expeditions in 1915, 1920, 1921, and 1935 also used the structures and supplies left at the site. Today, Peary’s tent cannot be found but the wooden structures and many other materials still remain at the site. The huts and wooden artifacts, however, are in various states of deterioration.

Wood in the polar environment is not free from degradation and these important historic wooden structures in the Arctic have suffered serious deterioration. Many forms of degradation continue to attack and cause significant losses. This report provides needed information on the current condition of the historic woods and gives new details on the destructive degradative processes occurring in wood at these Arctic sites. This work was carried out under Scientific Research License numbers 0100501 and 0201102R-M from the Nunavut Research Institute and permits QQ-01-01 and QQ-02-04 from Quttinirpaaq National Park, Parks Canada.

Northumberland House

Large quantities of wood from the Northumberland House structure remain at Beechey Island and are protected as part of Canada’s National Historic sites. Although only a partial wall of the building is still standing, large



Wall boards, posts and various wooden artifacts associated with Northumberland House. This wood at Beechey Island is some of the oldest wood introduced into the Arctic by European explorers. Extensive decay is present in the wood and decay fungi are actively causing degradation.
Photo: R. A. Blanchette

An illustration of Fort Conger as it appeared in 1881 (from Greely 1886). The structure was built by a U.S. army expedition led by Adolphus Greely and served to house the men and act as a research station during the first International Polar Year.



numbers of the house posts and wall boards are on the ground within and around the location of the original structure. The structural wood present at the site is spruce, hard pine (most likely *Picea abies* and *Pinus sylvestris*) and oak. Some woods are affected by salt deterioration and have white defibrated surfaces. This type of non-biological degradation occurs in wood of historic huts at other polar locations and has been well described from the expedition huts located in the Ross Sea Region of Antarctica (Blanchette et al. 2002). It is caused by the corrosion of wood cells due to the chemical attack on lignin. Salts migrate into wood and accumulate resulting in the chemical degradation of the middle lamella between cells (the cementing material that holds cells together) and cells separate. Over time the cells on the wood surfaces become defibrated and detach. This process is relatively slow and gradually erodes the wood. Of greater importance is the destruction of wood by wood decay fungi. All woods have evidence of decay and many are affected with advanced stages of decay. There are several types of wood decay that occur throughout the world but only one form of degradation was found. This decay was characterized by cavities forming inside the secondary walls of wood cells and is commonly referred to as soft rot. Other types of wood decay, normally found in temperate regions of the world, were not found. Isolations from the decayed wood produced cultures that were identified by sequenc-

Little remains of the original Fort Conger due to dismantling by Peary and his expedition crew members in 1901 to make smaller dwellings for overwintering. Parts of the Fort's wooden floor, miscellaneous timbers and many artifacts are still at the site. Photo: R.A. Blanchette





Structures built by Peary and his crew using wood from Fort Conger. Few people know that these historic structures are still present on the shores of Lady Franklin Bay and relatively little information has been published about them. Hut used by Matthew Henson is on right and T. S. Dedrick's hut is at left.

Both photos: R.A. Blanchette

ing of the ITS region of rDNA. Many of the fungi obtained were *Cadophora* species that cause soft rot. Species of this genus have recently been found attacking wood in many locations in Antarctica and current information suggests that these decay fungi are indigenous to Polar Regions (Arenz et al. 2006, Blanchette et al. 2004). The wood from Northumberland House has been in the arctic environment for over 150 years. Decay fungi have slowly caused considerable degradation and strength losses to the historic wood over the past many decades. The fungi are still active in the woods and continue to cause decay when the moisture and temperature conditions are favorable for degradation to occur.

Fort Conger and the Peary Huts

The dismantling of Fort Conger by Peary and his crew left little of the original wooden structure at the site. Some foundation posts, beams and floor boards remain as well as many miscellaneous pieces of structural wood and wooden artifacts that are dispersed across a large area along the shore of Lady Franklin Bay. The largest section of floor remaining, approximately 4 x 2 meters, has floorboards raised 18 cm above the ground on sleepers running across the width. Many other artifacts made from metal, glass and other materials are also



The Dedrick hut at Fort Conger. All three hut structures used by the Peary expedition have had serious deterioration over the past decades and the degradation processes continue unabated. Outer boards of the hut's multi-layered wall construction have blown off, windows and doors are open and the roof has blown off one hut. Non-biological deterioration (wind erosion and salt corrosion) as well as decay by wood destroying fungi has severely affected the wood in the huts.

The remains inside the Dedrick hut showing stove and other materials that were left. The huts were built low into the ground which has resulted in moisture accumulation and very wet conditions inside the hut. Conditions are favorable for decay and soft rot fungi have caused extensive degradation in the wooden structure and wooden artifacts. Photo: R.A. Blanchette



at the site. In addition, human remains can be found among the old timbers. The source of these bones and how they came to be dispersed around the site is not clearly understood. Wood used in the construction of Fort Conger and the wood that is now part of the Peary huts was primarily white pine (*Pinus strobus*) and a hard pine (possibly southern yellow pine). There is also aspen (*Populus* sp.), birch (*Betula* sp.) and oak (*Quercus* sp) wood at the site.

The Peary huts, individually called the Henson, Dedrick or the Inuit hut, were made with an unusual construction consisting of many layers including paper on the inside of tongue-and-groove boards, tar paper, silt and gravel in a 15 cm space, another wall of wood and exterior tar paper (Phillips et al. 1978). These multi-layered "soil" insulated wooden walls were covered with mounds of earth and turf as well as snow and ice in the winter. The huts were built into the ground and the floor of the hut was approximately 40 cm below the ground surface. Additional details on hut construction can be found in an archaeological report by Phillips et al. (1978). Most of the outer wall boards are missing from the huts but a few locations still have the double wall construction sandwiching the soil and gravel. One of these boards on Dedrick's hut bears the inscription, CHIEF SIGNAL OFFICER/WASHINGTON DC USA, and is from the Greely Expedition. Windows and doors are open and the roof has blown off the Inuit hut. It can be found on the ground several meters away. One of the first photographs taken of the huts in 1935 (Shackleton 1938) suggests that the roof may have been off the hut since that time (Phillips et al. 1978).

The effects of serious wood-deterioration are clearly evident on the hut woods. Wind has eroded the surfaces of the outer boards that remained on the structures producing a grooved appearance where early-wood cells of the annual rings have eroded faster than the more resilient latewood regions. The sand and ice blasting that affected the wood was tempered in places where the wood has some protection. Even paint, used to write an inscription, can protect the underlying wood. However, the historic inscription on the outer boards of the Dedrick hut originally from Greely's 1881 expedition, is becoming worn and unreadable due to its age and the severe wind erosion that occurs. Some wood throughout the site also has evidence of salt damage, but precipitation appears sufficient at the site to leech excessively high concentrations of salt from the wood and this form of deterioration is limited. Most significant is the degradation of wood taking place by wood-destroying fungi. Advanced decay is evident in all wood in ground contact and varying stages of decay are found in woods located above ground. Since the huts were built low into the ground, moisture easily accumulates inside and provides conditions that are ideal for decay to take place. Wood inside the huts is so decayed that it is soft to the touch. Although the decay can appear brown in color and look like a brown rot form of degradation, microscopic examination indicates that all of the decay found in all woods at the site is

caused by soft rot fungi. The decay produced by soft rot fungi results in a distinct signature in the residual wood consisting of cavities formed inside the secondary walls of the wood cells. As the fungus continues its attack, the cavities enlarge and coalesce leaving large holes in the cell wall. In advanced stages of decay, most of the cellulolytic secondary wall is removed leaving only a weak skeleton of lignin in the remaining cells. Strength properties of the wood are greatly affected by the actions of the fungus. A major soft rot fungus found at the site was identified as species of the ascomycete, *Cadophora*. The decay fungi are still very active at the site and since plenty of moisture is present they continue to degrade the wood when temperatures rise above 0° C.

Environmental monitoring of temperature and relative humidity was done inside Henson's hut and the Dedrick hut over a two year period. Conditions suitable for decay were found for long periods of time during the summer months. Moisture levels appeared conducive for decay and temperatures were above freezing for 1810 to 2185 hours per year. During the first International Polar Year, Greely's expedition members monitored temperature and found in 1881 and 1882 that there were 1588 and 1691 hours respectively above 0° C (Greely 1888). In comparison to environmental data recently obtained in our investigations, there was approximately 2000 hours per year above 0° C or about 500 more hours per year than when the huts were built. Although only 2 years of data are being compared and more monitoring needs to be done to determine if this is an ongoing trend, any increase in temperature will allow additional time for fungi to grow and metabolize their substrate resulting in greater amounts of decay. Fungi are well adapted to respond quickly to environmental change and apparently can utilize increases in temperature to their advantage to grow longer and have increased decay rates (Gange et al. 2007). Warming trends in the Arctic will undoubtedly have a continued detrimental effect on historic woods by providing more time for these unusual wood destroying fungi to actively cause decay.



Defibration of wood surfaces was found on some woods at Beechey Island and at Fort Conger. Salt accumulation is responsible for causing a chemical attack on wood that results in the separation and detachment of wood cells. Loose surface wood fibers are eroded off exposing new cells to the corrosive action of the salts. Both photos: R.A. Blanchette

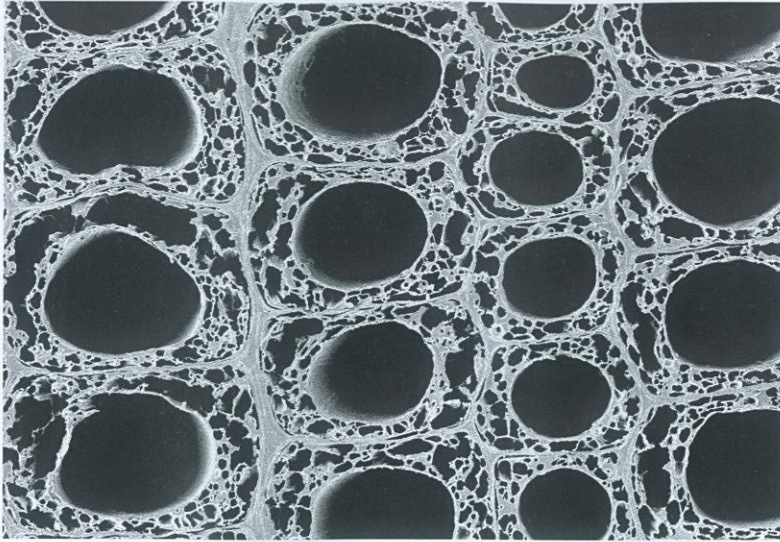


The effects of wind erosion on outer boards of Dedrick's hut cause deep grooves in the wood. The less dense earlywood cells of the wood are eroded faster than the latewood cells resulting in a grooved appearance. An inscription, "CHIEF SIGNAL OFFICER/WASHINGTON DC USA" placed on this reused wood during the Greely expedition (1881) has partially resisted the effects of the wind.

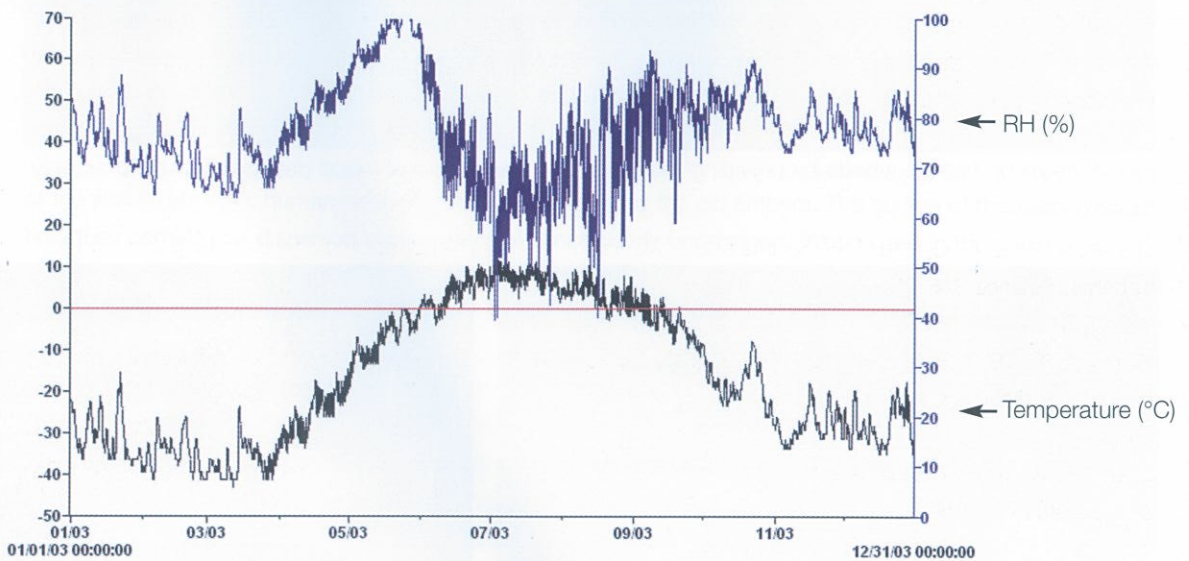
Conservation of historic wood in the Arctic

Great concern for the preservation of historic arctic sites and for the artifacts they contain has been expressed in recent years (Barr 2004, Chaplin 2004, Hett 1985). However, the extreme climate and inaccessible location make preservation efforts exceedingly difficult. In addition, sites such as Fort Conger and the Peary huts are not well known and little has been published about them. Consequently, public interest in protecting this important polar heritage is very limited. Understanding the types of deterioration taking place at these arctic sites and understanding the mechanisms of degradation is a first step in developing successful conservation plans. Recently, research on the historic expedition huts of the Ross Sea Region of Antarctic has been carried out (Farrell et al. this volume) and the Antarctic Heritage Trust has assembled detailed plans to preserve the huts

Environmental monitoring within Henson's hut shows temperatures above 0° C and relative humidity is suitable for decay to take place over an extended period of time in the summer months. Comparisons made with data taken during the Greely expedition in 1881 and 1882 indicate that the duration of time for decay fungi to be active (hours above 0° C) has increased by approximately 500 hours / year in recent times.



Effects of wood decay by soft rot fungi in pine timber from Fort Conger. Cross section of wood cells shows the destructive attack by the fungus causing many cavities inside the wood cell walls. Wood strength is severely compromised in advanced stages of decay.
Photo: Benjamin Held



and obtain funds to carry out the work. A similar scenario is needed for historic huts in the Arctic if these monuments of polar heritage are to be saved. Serious deterioration has occurred at Northumberland House and in the remains of Fort Conger and the Peary huts. Of major concern is the serious wood decay taking place in the historic woods. This is no easy task to control especially since we know very little about these unusual polar microbes. More investigation is needed to better understand these decay fungi and their degradative processes so control methods can be realized. In the meantime, focus should be on general repairs to secure the Peary huts and altering microenvironmental conditions by improving drainage and reducing moisture in and around the huts. Since moisture is essential for decay to take place, reducing moisture in the woods will help to limit decay. Increased study and documentation of the wooden remains of Northumberland House and Fort Conger are also essential since decay is in advanced stages and degradation is continuing. Warming trends in the Arctic appear to be extending the time in which decay can take place and undoubtedly are accelerating decay rates so that these historic woods are being destroyed more rapidly.

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