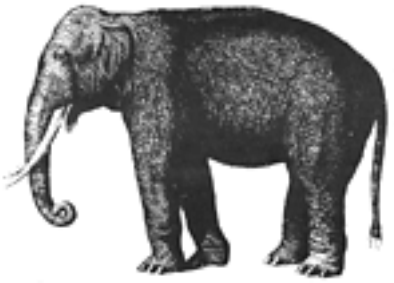
The Mammoth Story

by Grant Keddie

Part 1: Elephants

Elephants are the largest living land mammals. There have been more than 500 different kinds of elephants on the Earth at various times over the last 55 million years. Only two of these remain alive today: the African Elephant and the Asian (or Indian) Elephant. They are restricted to tropical climates, but other species, living long ago, were more adapted to colder climates. These include the mammoths. The remains of four of the extinct species have been found in British Columbia: the Woolly Mammoth, the Columbia Mammoth, the Imperial Mammoth and the Mastodon.



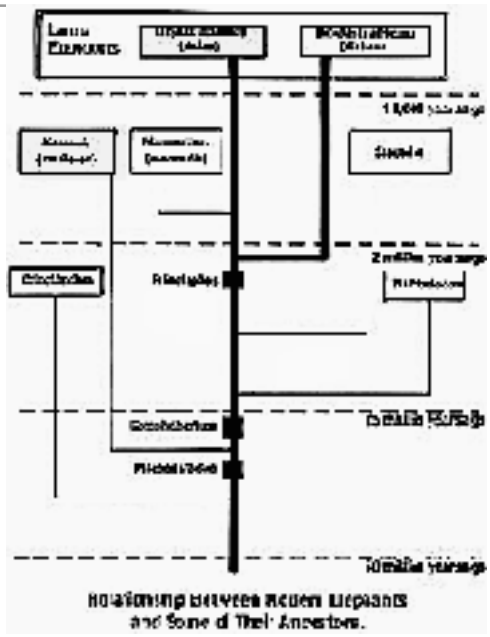
In northern areas of the world, mammoth finds tend to cluster in time periods when exposed soil and moisture were moving sediments downslope and especially when sediments are moving in front of glaciers. Ironically, these were times when mammoths were not particularly abundant, but it was more likely that bones lying on the ground would get buried during these conditions. It is this situation that has preserved many of the fossils found in British Columbia.

Frozen mummified mammoths have been found in Siberia and Alaska. The most famous are the Siberian Beresovka mammoth (excavated in 1901), the Dina mammoth (a complete carcass of a six-month-old baby discovered in 1977) and a mummified baby mammoth, less than three months old, found in Siberia in 1988. No frozen mammoths have been found in British Columbia. Most of the finds here are molars, tusks or leg bones; only a few times have substantial portions of a mammoth skeleton been found.

How closely related were these ancient beasts to the modern elephants? The order of mammals that includes modern and fossil elephants is called Proboscidea. The name derives from the Greek words pro for "before" and boskein, meaning "to feed". The earliest proboscideans were plant eaters about as big as a pig or cow. They did not have tusks and are defined by characteristics such as the cusp patterns on their teeth and the architecture of the skull. Modern day manatees (sea cows) and hyraxes shared this common ancestor with elephants before they began to spread from Africa about 50 million years ago.

The elephants that came to the western hemisphere include the gomphotheres, the mammut (mastodon) and mammuthus (Southern Mammoth, Steppe Mammoth and Woolly Mammoth). Some scientists lump the northern mid-latitude mammoths under the name Steppe Mammoth,

while others see distinct types adapted to regional environments, such as the Imperial Mammoth of the wetter coastal regions.



The modern Asian and African elephants began to evolve as different species before about two million years ago. It was after this that the mammoths diverged from the Asian Elephants. The Woolly Mammoth was, therefore, more closely related to the Asian Elephant than the African. As there is one know case of a pair of Asian and African elephants producing a live (albeit short-lived) offspring, it may have been possible for a Woolly Mammoth to cross-breed with an Asian Elephant if the former were alive today. And it would not be preposterous to consider the prospect of impregnating a living female Asian Elephant with viable genetic material from a frozen mammoth to create a living elephant-mammoth hybrid. Unfortunately, the genetic material found in frozen mammoths so far has not been complete enough to attempt this procedure.

Mammoths were comparable in size to the largest living elephant, the Savannah Elephant, an African subspecies, which weighs 4 to 7 tons and is 3 to 4 metres tall at the shoulder. The other African subspecies, the Forest Elephant, is substantially smaller, weighing 2 to 4 tons. The Asian Elephant has three subspecies, the Sri Lankan (3 to 5 tons), Mainland (2.5 to 4.5 tons) and Sumatran (2 to 4 tons). All have different characteristics, such as skin colour, ear and tusk shape, and bone structure.

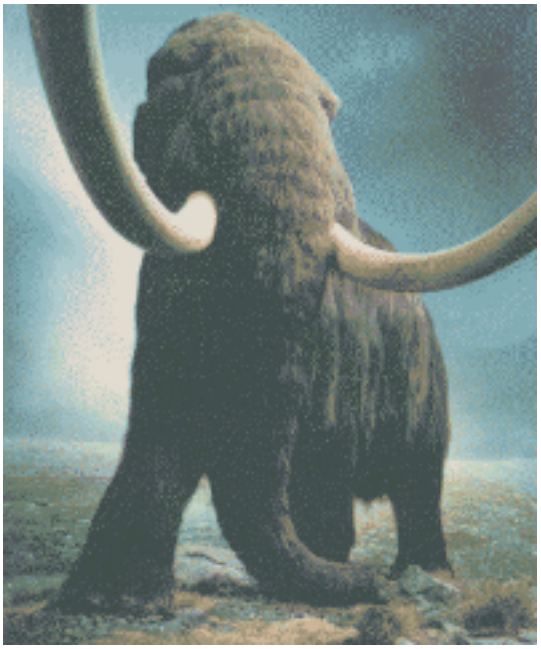
Mammoths had spiral locks of black or dark brown guard hairs covering shorter, silkier underfur. Both males and females had tusks. The trunk of a Woolly Mammoth had a hand-like tip that would have been very effective in gathering short grasses or scooping up snow to expose plants. Male mammoths matured at about age 20; we can tell they matured slowly by examining the growth layers in their teeth.

Most mammoth finds in British Columbia are fossilized molar teeth. Besides the tusks, which are really incisor teeth, an elephant uses only two pairs of molars (upper and lower) at any one time. Each molar is replaced with a larger one up to six times during the elephant's life. When the last molar is worn down, the elephant cannot eat and dies. An African Elephant can live 50 to 60 years before its last set of molars wears down; but the teeth of an Asian Elephant take longer to wear, so it can live up to 80 years.

A mammoth's teeth were high-crowned and complex, more so than teeth of living elephants. Efficient use of sparse, low-quality winter forage was critical to survival, and any additional grinding surface was an advantage in chewing grass and leaves and slowing down tooth wear. Over time, loops of enamel were added until mammoth teeth from the late Pleistocene became the most complex of any proboscidian.

Mammoths were ideally suited for the grassy steppes of the northern hemisphere. How did they come to North America, and why did they die off? How do we know as much as we do about mammoths?

Part 2: The Rise and Fall of Mammoths in North America



Of the mammoths that migrated to North America from Asia, the first and most primitive species was the Southern Mammoth (*Mammuthus meridionalis*), which arrived about 1.8 million years ago during the Nebraskan Glaciation. This was near the beginning of the last sequence of ice ages know as the Pleistocene period, which lasted from about 2 million to 11,000 years ago. During this time, the great ice sheets grew, retreated and grew again.

The second mammoth to appear in North America was the Steppe Mammoth (some scientists split this type of mammoth into two: Columbian and Imperial). The Steppe Mammoth may have developed from the Southern Mammoth or migrated to North America during the Kansan Glaciation about 1.2 million years ago. Steppe Mammoths occupied North America for more than a million years. The most advanced type, *Mammuthus jeffersonii*, survived on the plains until about 11,000 years ago.

Steppe Mammoths lived north of the British Columbian ice sheets on the arid grasslands of unglaciated parts of the Yukon and Alaska during the peak of the Wisconsin Glaciation, 20,000 to 15,000 years ago. But it was the Woolly Mammoth (*Mammuthus primigenius*) that dominated the northern grasslands during that period. The Woolly Mammoth evolved in Eurasia separately from the Southern Mammoth, and did not enter North America until about 65,000 years ago.

Steppe and Woolly mammoths may have shared their range both north and south of the Wisconsin ice sheets. Present evidence suggests that the Steppe Mammoths may have been more common than the Woolly Mammoths in southern British Columbia.

The early distribution of mammoths in northern North America corresponded to the steppe-land environment. A steppe is a level, grassy plain. Steppe climate is too dry for trees, but rich nutrients in the soil promote the abundant growth of high-quality vegetation. The summer days

in the Pleistocene period were longer than they are today, which meant a comparatively long growing season. This environment helped the development of big-bodied animals like the mammoths. When the great ice sheets lowered the level of the oceans and the global temperature, the vast steppes of the northern hemisphere reached over North America, Asia and Europe.

During the warmer interglacial period and into the last periods of glacial advance, herds of mammoths lived on the central and southern mainland of British Columbia and on what is now southeastern Vancouver Island, along with some American Mastodons, horses, Musk-oxen and Bison.

When the climate became increasingly cold about 29,000 years ago, the steppe zone extended farther south. The grasslands of the northern United States and southern Canada were home to many large species of grazers, such as Musk-oxen, Caribou, camels, Bison, horses and mammoths. Woolly Mammoths may have survived after the glacial periods in northeastern B.C., but no specimens dated after 17,000 years ago have been found in other parts of the province. We know that just to the south on the Olympic Peninsula of Washington State, mastodons, Bison and Caribou were still there about 12,000 years ago, and that Bison moved back over to Vancouver Island at that time as the climate was warming up again. The remains of Bison have been found buried in ancient bogs on the Saanich Peninsula.

Evidence of people hunting mammoths has been found in many parts of the United States dating mostly around 11,000 years ago. Around the same time, at the western end of the steppes in Siberia and in Europe, people left piles of mammoth bones used to construct houses, and images of mammoths painted on cave walls and carved on pieces of antler. Although human hunting may have contributed to the extinction of mammoths in some places, the environment probably played the most important role in their downfall.

Extreme environmental conditions on the steppe lands were brought about by a shift of only a few degrees in average temperatures and a slight change in annual rainfall. When seasonal shifts in weather occur over long periods, they can profoundly alter the vegetation and other aspects of the landscape. About 12,000 years ago, the steppe lands became wetter, toxic plants began to proliferate, and winter snows deepened.

Recent evidence suggests that a sudden short glacial re-advance around 11,000 years ago may have caused profound environmental change. The ranges of many large animals shrank because of the changing environment. Some were no longer able to survive, declining to extinction during this time. The most notable of these unfortunate creatures were the mammoths.

(Caption: Mammoth tusk segment from Cordova Bay gravels. Photo: RBCM)

Part 3: Elephants' Graveyard

The Royal B.C. Museum has 57 specimens of extinct mammoths and 2 of mastodons: 25 from British Columbia, 17 from the Yukon Territories and Alaska, and 2 from Washington; the other 15 are from unknown locations, and may eventually be matched with 11 records for which there are unaccounted specimens.

Most of the 25 B.C. specimens are from Vancouver Island; only 3 are from the interior. Except for one molar tooth found at Port Alberni and one from Albert Head, finds on Vancouver Island have been concentrated on the Saanich Peninsula in interglacial and glacial outwash sands and gravels.

Mammoths may have come to the islands by crossing large flood plains that filled the Gulf of Georgia during parts of the Olympia interglacial period between 29,000 and 20,000 years ago. I have dated the humerus of a mammoth, buried in the gravel 20 metres below the surface at Cordova Bay, to 17,000 years ago. This may have been among the last mammoths on Vancouver Island. It was around this time that local environmental conditions changed to the point where mammoths could no longer survive.

(Caption: Cliffs at the south end of Island View Beach. The sands and gravels where mammoth remains are found can be seen below the vertical glacial till at the top. Photo: Grant Keddie)

Where do we find elephant bones?

On the Saanich Peninsula sediments from both glacial and interglacial periods can be seen in partial exposures along the sea cliffs and in the gravel pits in the general area of Cordova Bay and Cowichan Head to the north.

The uppermost sediments were deposited during the advance and retreat of the last glaciers. This period is known locally as the Fraser Glaciation. It correlates with the end of the fourth and last major glacial period of the Pleistocene Ice-age known in North America as the Wisconsin Glacial Period.

It is in the oldest deposits laid down during the advance of the Fraser Glaciation that we find the teeth, tusks and bones of mammoths: the elephants' graveyard.

(Caption: 62,000 year old marine deposits at the bottom of the cliffs at Island View Beach. Photo: Grant Keddie)

One place where Fraser Glaciation deposits can be seen is along the upper part of the exposed cliffs at Cowichan Head at the south end of Island View beach on the Saanish Peninsula. The straight vertical face of the cliff above the sloping portions is composed of a two-metre layer of a brown glaciomarine stony clay called Victoria clay. This clay was laid down when the sea levels were up this high about 13,000 years ago during the melting of local glaciers. Under the clay on the vertical face is a brown glacial till deposited during the time when glaciers covered this area between 16,000 and 13,000 years ago.

It is the next layer down, a 30-metre-thick section of stratified sand and gravel called the Quadra Sand formation, where mammoth bones can be found. The Quadra Sand formation started about 29,000 years ago when the climate began to get colder. These sand and gravel deposits, which were washed out in front of the advancing Fraser glaciers, contain fossilized mammoth bones. About 21,000 years ago, tundra or alpine plant communities became widespread. By 17,000 years ago, before the advancing ice sheets, the climate began to change drastically, making survival difficult for mammoths.

The Quadra Sand formation is easy to find if you look just below it: these are deposits of the Olympia Interglacial period dating 58,000 to 29,000 years ago. These deposits consist of two layers. The upper layer, referred to as the Cowichan Head formation, is a band of dark-coloured silt and sand, about seven metres thick, that can be seen along the lower middle of the cliffs. It was deposited by flood plain silts from streams flowing across a newly exposed sea floor during times of a lowering sea level. The lower layer of the Olympia deposits is a ten-metre layer of rusty brown sand and gravel that accumulated in shallow, brackish water.

Below the Olympia deposits is another dark layer. If you walk about halfway along Island View Beach in front of the cliffs at low tide, you will see it: a four-metre layer of dark marine mud right at beach level. It is quite visible below the lighter interglacial sands and gravels in the cliff, but don't confuse it with the dark layer of the Cowichan Head formation. It contains shells, twigs and other organic material estimated to be about 62,000 years old, just prior to the beginning of the last Interglacial period.

It is the upper dark layer that marks the lower limit of the location of mammoth bones. Look to the lighter sand and gravel above it. Mammoth remains will continue to wash out of the Quadra sand and gravel layer in the cliffs near Cordova Bay and Cowichan Head. If you are walking along the beaches in this area, keep your eyes open. You may find the next clue in this continuing story.

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