Mammoth steps: an overview of the fauna of Wally's Beach (DhPg-8), a late Pleistocene locality from southwestern Alberta

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Summary

Containing skeletal remains, tracks, trackways, and archaeological artefacts, Wally's Beach (DhPg-8) provides a rare chance to examine southwestern Alberta's latest Pleistocene post glacial megafauna just prior to extinction. Because the tracks provide the opportunity to look at the behaviour of these extinct animals, many long held palaeontological ideas can be examined. These include using modern animals and their behaviour as analogues for extinct animals even though they diverged from a common ancestor millions of years previously and reconstruction of Pleistocene ecosystems to show the true concentration of animals in the ice age steppe environment of southern Alberta. In addition, interaction of extinct megafauna with Palaeo-indians can be examined to help better understand the role humans may have played in the end Pleistocene extinction event. Excellent preservation of skeletal material from the site allows small populations of animals to be distinguished, providing information and insight into their geographical ranges and migration patterns.

Introduction

Wally's Beach is located on the floor of the eastern shore of the St. Mary Reservoir in Southern Alberta, Canada. The site is normally underwater, but construction of a new spillway, followed by several dry years dropped water levels, exposing the site. The site is located on what was an island in the paleo St. Mary River. The south channel of the river, which shows up on a pre-reservoir topographic map, was later abandoned as the shorter north channel eroded more deeply into bedrock and cut off its water supply. Tracks, bones and artifacts are contained within post-glacial Pleistocene loess, windblown sand and silt deposits formed during the retreat of glaciers at the end of the last Ice Age. Radio Carbon dating on *Equus conversidens* (Mexican horse), *Bison antiquus* (ancient bison), *Rangifer tarandus* (caribou), and *Bootherium bombifrons* (extinct musk ox), indicate that the site is between 11,000 and 11,300 radio carbon years old (Kooyman *et al*., 2001).

Theory and/or Method

Pleistocene animal tracks are rare worldwide. Wally's Beach is the only known site in Canada. They provide an alternative way of identifying ice age inhabitants of southern Alberta, as well as providing information on their behaviour. Five new track ichnospecies are found at the site. The five ichnospecies (*Proboscipeda panfamilia*, *Lamaichnum sarjeanti*, *Hippipeda cardstoni*, *Bijugopeda anteriofossa*, and *Bijugopeda bisymmetrica*) are assigned to their respective most probable track-makers: woolly mammoth (*Mammuthus primigenius*), western camel (*Camelops hesternus*), Mexican horse (*Equus conversidens*), ancient bison (*Bison bison antiquus*), and caribou (*Rangifer tarandus*). The importance of additional information that can be provided by tracks is shown in that while four of the track-makers are represented at the site by skeletal remains (horse, bison, caribou, and just recently, camel), mammoth is only known from track evidence.

Tracks, trackways, and trampleground from the site provide a record of the living animals and as such offer evidence of movement and behaviour that bones cannot (McNeil, *et al*., 2008). Analysis of the mammoth tracks reveals that the walking speed of adult woolly mammoths was between four and five km/h. The tracks, trackways, and tramplegrounds also reveal that the behaviour of the Pleistocene megafauna is similar to that exhibited by their extant relatives despite a long period since sharing a common ancestor. Examples include the family behaviour of the mammoths and camels, and the herd behaviour of the extinct horses. While some Wally's Beach mammals are still extant (i.e. the caribou, *Rangifer tarandus*), and the line of descent for other of the Wally's Beach animals, such as the bison and horse, is relatively direct (perhaps a few thousand to a few tens of thousands of years), for others, their common ancestor is much more distant. The time of separation for mammoths, Indian elephants, and African elephants, based on molecular and morphological evidence, is between four and six million years (Thomas *et al*., 2000). The divergence of the true camels and the South American camelids occurred at least two million years ago based on morphologic differences (Wheeler, 1995). This separation may have been much earlier, up to 25 million years ago, based on molecular evidence (Cui *et al*., 2007). This indicates that extrapolating behaviour to fossil animals based on the behaviour of their modern relatives is valid.

Frozen mammoths from Siberia (Vereshchagin and Tikhonov, 1999) show that the relationship of foot size to age is similar in mammoths and African elephants (Roth, 1984; Lee and Moss, 1995). By examining the size of mammoth tracks at Wally's Beach, ages are assigned to the track maker. These ages can be grouped into age classes; Class 1 - immature (0-12 years), Class 2 - sub-adult (12-24 years), Class 3 - mature (24-36 years), and Class 4 - mature/old (36+ years). By comparing the distribution of the number of animals in each class, the health of the Pleistocene mammoth population can be determined just prior to their extinction. A stable or expanding population has a large number of juvenile animals with fewer mature or old animals (Haynes, 1991). The St. Mary mammoth population has fewer juveniles, indicating that several hundred years before their extinction, they were already in decline. This time coincides with the arrival of humans in North America. In addition, evidence that hunting for horse and bison was occurring at St. Mary has been found (Kooyman *et al*., 2001). Selective hunting of the juveniles of large mammals, and mammoths in particular, could have led to the observed extinctions at the end of the last Ice Age (Martin, 1975; Alroy, 2001). Mammoth tramplegrounds are rare at the site, indicating that they did not spend a great deal of time near water. However, the few that have been found closely mirror the overall results of previous studies from Wally's Beach (McNeil *et al*., 2005), with a deficit of juveniles suggesting that the Late Pleistocene mammoth populations of southern Alberta may have been in decline.

Multigeneric trample grounds, formed quickly, indicate that several mammal species shared the Pleistocene plains of Alberta. The tracks of different genera sometimes overlap, allowing the order of track-makers to be determined. Because the conditions required to create and then preserve tracks are short-lived, this suggests that large groups of many different animals inhabited the site concurrently. Therefore the commonly made comparison of the Late Pleistocene of North America to the African savannah is valid. The high density of wildlife and the high nutritional requirements of members of the Pleistocene megafauna, the intense root-etching of the upper surface of the skeletal remains, as well as the remnant tap-roots preserved at the site, suggest that reconstructions of glacial landscape as sparsely vegetated tundra are doubtful. A more appropriate model is that of highly-productive low brushy grassland, or as it is often referred to, the mammoth steppe ecosystem.

Skeletal material at Wally's Beach provides many new insights into human utilization of Pleistocene horses, characteristics for identifying fossil and recent horses, and relationships between Late Pleistocene horses. Evidence for exploitation of fossil horses by Palaeo-indians is supported by butchering marks and the scattering pattern of the bones (Kooyman, *et al*., 2006), as well as protein residue analysis (Kooyman, *et al*., 2001).

Fossil horses are often identified based on tooth characteristics, particularly the enamel patterns on the occlusal surface. However, these patterns show great variation between individuals as well as variation along each tooth as the crown is worn. The orientation controls the angle of intersection for the grinding surface, and ultimately the size of the grinding surface of each tooth. It is therefore important to take the age of the horse into consideration when examining dental characteristics as well as to look at many other characteristics to separate species.

The relationships between Pleistocene horses are complex, with up to 59 different species of horse having been named, many on the basis of inadequate material. The variations in the characteristics of individual specimens often exceed their diagnosed species characteristics, making identification difficult and relationships hard to determine. Recent molecular work has even suggested that there are only two horse species in the Pleistocene of North America (Weinstock *et al*., 2005), the stout-legged and stilt-legged. All other variation occurs geographically within these two populations. The Wally's Beach horses, *E. conversidens*, as a single associated population, allow for an excellent opportunity to study horse variation, and to determine if it can be separated from another population of horses. The Yukon horse, *E. lambei*, provides an excellent comparison as it has been thought to be co-specific with *E. conversidens* (Harington and Clulow, 1973). Analysis using qualitative characteristics and quantitative methods showed that *E. conversidens* and *E. lambei* can be separated by both methods.

Qualitative characteristics, normally used to separate species, are highly variable between individual horses, making identification based on single characteristics difficult. However, by looking at a suite of characteristics, populations can be separated. As compared to *E. lambei*, Wally's Beach *E. conversidens* has: smaller canines that are widely restricted to only males, enamel patterns of the teeth that are more complex, the masseter ridge is gently-curved with a well-defined ridge and termination, P2 is elongate and triangular, and the maxillary molar series is relatively smaller and thinner than the premolar series.

Qualitative analysis on the metapodials, humeri, skulls and mandibles of the two horse populations shows little difference between the two populations. Using scatter plots, the metapodials cannot be separated out through quantitative methods. However, the humeri of *E. conversidens* average slightly longer than those of *E. lambei,* indicating that there is a small relative limb length difference in the upper limb portions.

Multivariate techniques, primarily Principal Component Analysis show that Wally's Beach horses and Yukon horses can be separated based on measurements taken from the skull, but not from the mandibles. Based on this analysis *E. conversidens* has a broader, more box like braincase, but a relatively longer, narrower snout than *E. lambei*. While some separation of the two groups of horses based on the mandible was found, this separation was slight and there is considerable overlap. The cranial separation indicates that Wally's Beach *E. conversidens* and Yukon *E. lambei* populations were distinct populations, suggesting that there was a geographic barrier between southern Albertan and Yukon horses. The "Ice-Free Corridor" hypothesis for the peopling of North American requires a latest Pleistocene geographic connection between these two localities. Without this connection, the West Coast Route becomes much more plausible.

Conclusions

Wally's Beach (DhPg-8) is an important site because the diversity of material (tracks, skeletal material, and archaeological artifacts) allows for many different avenues of investigation to recreate the latest Pleistocene environment of southwestern Alberta. Tracks show extinct animal behaviours that are similar to extant relatives, demonstrating the validity of using modern animals as a model for extinct animals. Tracks, as a record of living animals, also allow extinct populations and ecosystems to be evaluated in a way that bones cannot, indicating that post glacial Alberta was a rich steppe environment with abundant megafauna. Tracks, artifacts and skeletal remains indicate that Palaeo-indians were exploiting the local fauna and may have played a role in its extinction. Horse populations can be separated based on qualitative and quantitative characteristics of the skull, and this methodology will allow the identity, range, and migration patterns of extinct animals to be better understood.

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