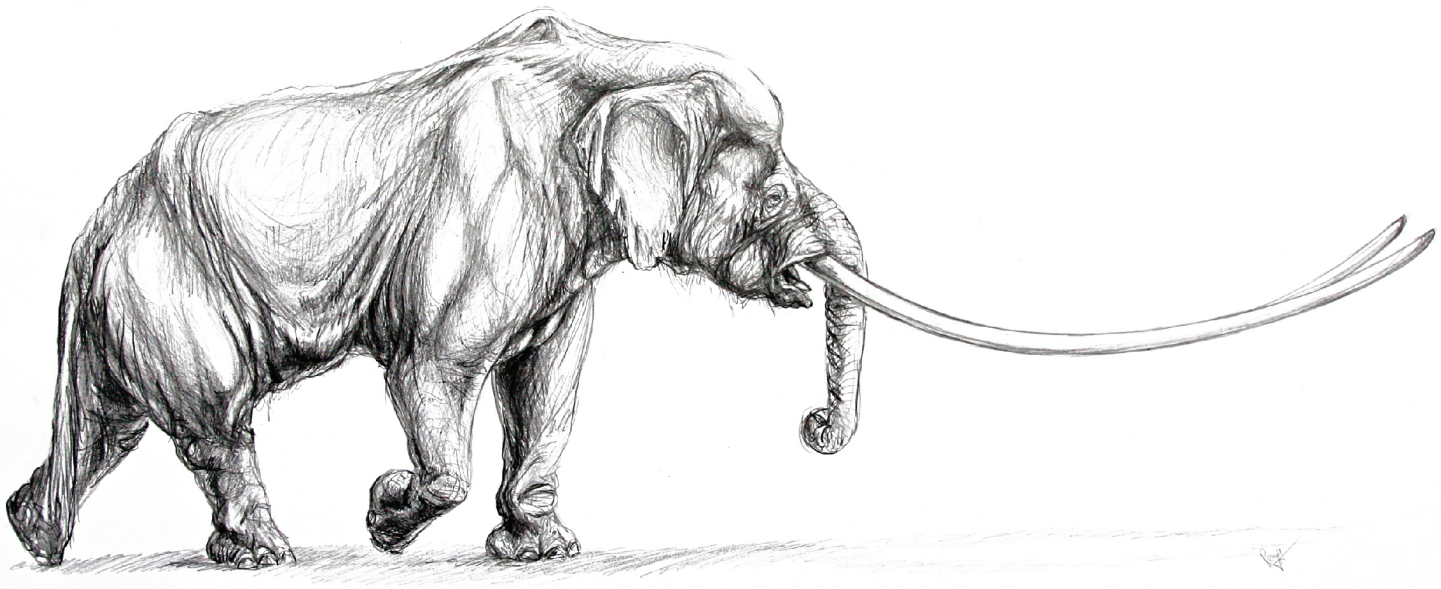
SCIENTIFIC ANNALS of the School of Geology,
Aristotle University of Thessaloniki

SPECIAL VOLUME 102



GREVENA
SIATISTA
GREECE 2014

VIth International Conference on Mammoths and their Relatives

ABSTRACT BOOK

Editors:
Dimitris S. KOSTOPOULOS, Evangelos VLACHOS, and Evangelia TSOUKALA

THESSALONIKI, MAY 2014

Scientific Annals, School of Geology, Aristotle University of Thessaloniki, Greece
VIth International Conference on Mammoths and their Relatives, Grevena - Siatista
Special Volume 102 51-52 Thessaloniki, 2014

Final years of life and seasons of death of woolly mammoths from Wrangel Island

Joseph EL ADLI ✉, Daniel FISHER, Sergey VARTANYAN, Alexei TIKHONOV, and Bernard BUIGUES

By the onset of the Holocene, many large terrestrial mammal species that had characterized the Pleistocene had gone extinct worldwide, including the majority of proboscidean taxa. However, Wrangel Island, off the northern coast of the Chukchi Peninsula in Siberia, provided a small refugium for the last remaining population of woolly mammoths (*Mammuthus primigenius*). This population of mammoths survived for much of the Holocene, until their extinction at approximately 4,000 rcybp (Vartanyan et al., 2006). Initially, it was hypothesized that Wrangel Island supported a relict community of glacial vegetation throughout much of the Holocene (Vartanyan et al., 1993), but palynological data suggest that a modern flora and climate was in place by 10,000 ybp (Lozhkin et al., 2001). Regardless, few hypotheses on the extinction of Wrangel Island mammoths have been well tested.

The tusks of proboscideans have the potential to contain a continuous record of growth throughout an individual's life. This record can be accessed through analysis of structural and compositional variation in tusk growth increments (Fisher, 2001). In mammoths, these increments have been interpreted to form on annual (first-order), weekly (second-order), and daily (third-order) intervals, with sets of lower-order increments nested within increments of higher-order. Life histories of the Wrangel Island mammoth population, as documented in the record of their tusks, have the potential to yield critical data on effects of extrinsic factors on individuals. Thus, with a large enough sample across a broad temporal scale, life history information provides a test for different hypotheses of extinction (Fisher, 2009). We present here partial life histories and seasons of death of three Wrangel Island mammoths using new techniques for tusk analysis.

Proximal portions of isolated tusks from three individuals (39M, 41M, and 42M) of *Mammuthus primigenius* were analyzed in this study. These individuals are all interpreted as female due to the relatively small diameter of their tusks. All three females are identified as adults based on the shallowness of the pulp cavity and the reverse-taper of the tusks proximal to the gingival margin. However, based on these features, 39M appears to be significantly older than 41M or 42M. Radiocarbon dating of these specimens yields absolute ages ranging from approximately 5,000 to 7,500 rcybp.

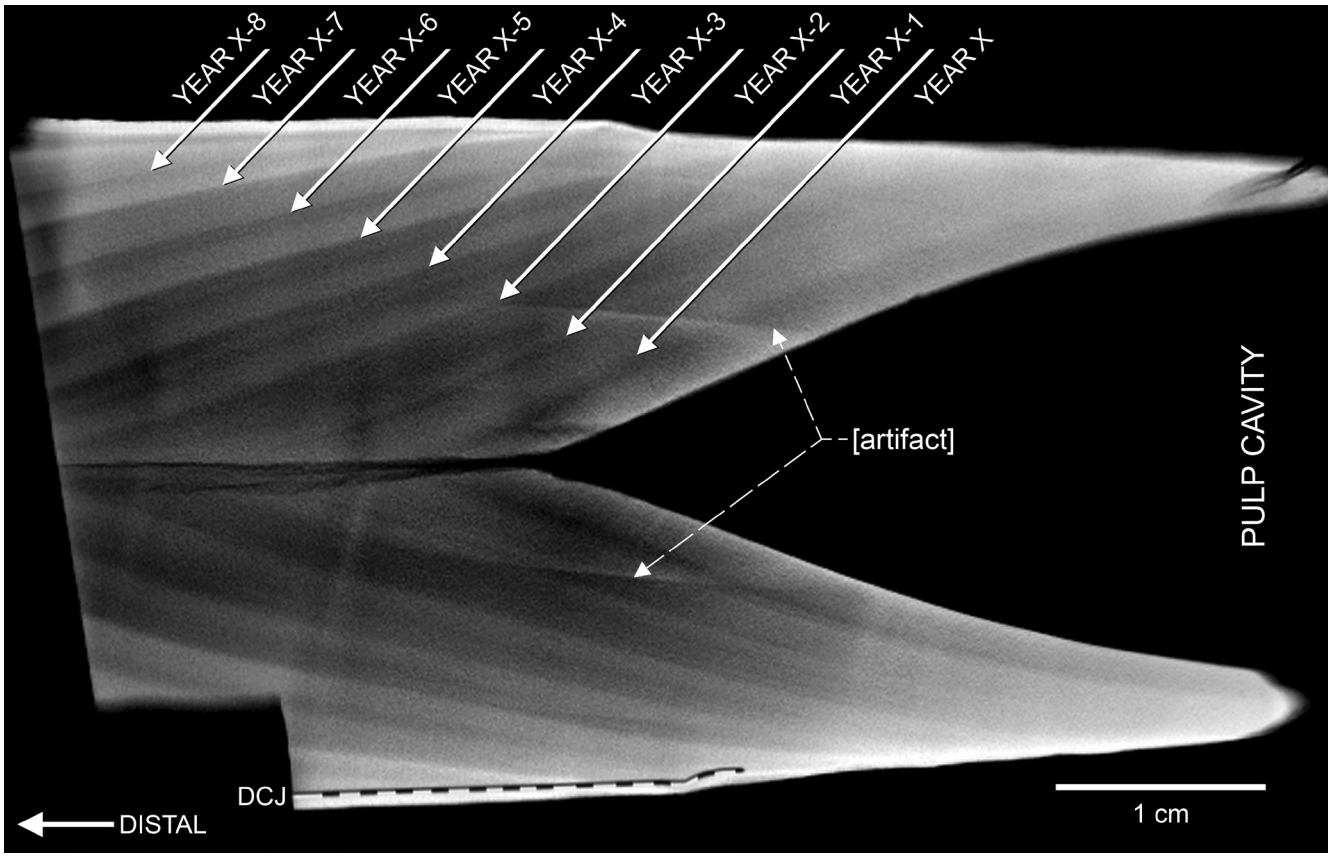


Fig. 1. Micro-computed tomographic slice of tusk 39M in longitudinal section showing annual variations in density. White arrows mark hypothetisized winter-spring boundaries with hypothetisized years labeled in between.

DCJ, dentin-cementum junction (marked by black and white dashed line); small white arrows with dashed lines mark the outer edges of a cylindrical CT artifact (= [**artifact**]).

The samples were scanned using microtomography to observe changes in density throughout the last few years of life. Annual variations in density observed throughout the tusks provide a basis for determining locations of boundaries between years (Fig. 1). These boundaries are observable in microCT as sharply contrasting contacts between zones of high x-ray attenuation leading into zones of low attenuation, which have been suggested to correlate to the boundary between winter and spring (Fisher et al., in review). Using these contacts as markers for year boundaries, the three Wrangel Island mammoth tusk samples each contain a record of approximately 5 to 9 years. Among these tusks, one specimen (39M) shows a relatively constant annual appositional thickness, while the other two specimens (41M and 42M) show greater variability. This variation is potentially due to calving events in the two younger individuals.

Thin sections of each tusk are used to measure appositional thickness of weekly (second-order) growth increments throughout the last few years of life to observe variations in growth patterns. These variations have been hypothesized to relate to nutritional status of the individual and in the context of seasonal patterns of growth, are used to corroborate the identification of winter-spring boundaries. Furthermore, deviations from a background annual growth pattern allow for interpretation of life history events (e.g., calving, injury, etc.) and provide potential clues for cause of death.

Carbon and oxygen isotopes are serially sampled from collagen and carbonate along a path perpendicular to the appositional surface. The isotopic composition of tusks shifts based on the composition of available food and water sources. Therefore, recovered patterns in isotopic composition reflect seasonal changes in vegetation and water source throughout the year. Patterns of seasonal isotopic change can thus be used to further assist in the assignment of annual boundaries and corroborate the interpretation of zones of low x-ray attenuation as early spring growth.

Based on the patterns observed in dentin density, all three individuals appear to have died within a zone of high x-ray attenuation. Based on comparison with previous years, the thicknesses of these high-density zones appear to be near the expected maximum thickness for that year. Therefore, we interpret all three individuals as having late winter deaths, which is consistent with a natural cause of death. Consistent rates of growth in years prior to death suggest that these individuals were relatively healthy, despite a warmer Holocene climate. Further analyses of tusk samples from approximately 50 other individuals from Wrangel Island will allow for an increased understanding of shifts in the patterns of life histories within the mammoth population through time, and will ultimately allow for greater interpretative power in deducing the cause of their extinction.

References

Fisher, D.C., 2001. Season of death, growth rates, and life history of North American mammoths. In: West, D. (Ed.), Proceedings of the International Conference on Mammoth Site Studies, Publications in Anthropology 22. University of Kansas, Lawrence, KS, pp. 121-135.

Fisher, D.C., 2009. Paleobiology and extinction of proboscideans in the Great Lakes region of North America. In: Haynes, G. (Ed.), American megafaunal extinctions at the end of the Pleistocene. Springer, pp. 55-75.

Fisher, D.C., Cherney, M.D., Newton, C., Graham, R.W., Rountrey, A.N., Calamari, Z.T., Stuckey, R.K., Lucking, C. In review. Taxonomy and tusk growth analyses of Ziegler Reservoir proboscideans. Quaternary Research.

Lozhkin, A., Anderson, P., Vartanyan, S., Brown, T., Belaya, B., Kotov, A., 2001. Late Quaternary paleoenvironments and modern pollen data from Wrangel Island (Northern Chukotka). Quaternary Science Reviews 20, 217-233.

Vartanyan, S., Arslanov, K.A., Tertychnaya, T., Chernov, S., 2006. Radiocarbon dating evidence for mammoths on Wrangel Island, Arctic Ocean, until 2000 BC. Radiocarbon 37, 1-6.

Vartanyan, S., Garutt, V., Sher, A.V., 1993. Holocene dwarf mammoths from Wrangel Island in the Siberian Arctic. Nature 362, 337-340.

jeladli@umich.edu

Citation:
El Adli, J., Fisher, D., Vartanyan, D., Tikhonov, A., Buigues, B., 2014. Final years of life and seasons of death of woolly mammoths from Wrangel Island. Abstract Book of the VIth International Conference on Mammoths and their Relatives. S.A.S.G., Special Volume 102: 51-52.