American Association of Biological Anthropologists 91st Annual Meeting 2022

Ancient dog mitochondrial lineages indigenous to North America recovered from Jamestown Colony

Ariane Thomas[1], Alida de Flamingh[2], Kelsey E. Witt[3], Matthew E. Hill, Jr.[1], Ripan S. Malhi[2], Andrew Kitchen[1]

[1]Department of Anthropology, University of Iowa, [2]Department of Anthropology, University of Illinois Urbana-Champaign, [3]Center for Computational and Molecular Biology, Brown University

Figures

Figure 1: Bayesian phylogeny of North American dogs. Tree was generated using a sample of ancient dog mitochondrial sequences (n = 173). Jamestown dogs are labelled in red, Inuit (Thule) dogs are colored blue, and dogs from sites in Greenland, Canada, and Alaska without a known cultural affiliation are shown in green. Posterior probabilities greater than 60% are shown.

Figure 2: Cutmarks on dog elements.
A. Image of JR68100 cranial fragment and magnified image of two parallel cutmarks.
B. Image of JR118236 and magnified image of cutmarks on the lateral portion of the maxilla bone.

Figure 3: Locations of ancient North American dog sequences used in the phylogeny. Samples were collected from previously published studies. Black dots represent the geographic locations of 159 ancient dog samples for which latitude and longitude data were available.

Key Findings

- This is the earliest known example of maternal indigenous dog lineages recovered from dog remains at a European colonial site.
- Phylogenetic analysis places the dogs from Jamestown with other ancient North American dog lineages of the Midwest.

Introduction

Dogs of the Americas share a unique genetic history with humans. Humans introduced domesticated dogs to the Americas from Asia approximately 17-13 kya (Ni Leathlobhair *et al.* 2018), concurrent with the first migrations of humans to North America (Moreno-Mayar *et al.* 2018). Though subsequent introductions of dogs occurred in the far north, maternal lineages derived from the first dogs spread throughout the Americas until European contact in the late 15th century. The European colonization of the Americas drastically impacted the demography of indigenous dogs. Multiple studies have demonstrated that mitochondrial lineages of

European dogs almost completely replaced indigenous ones during the ongoing process of European colonization (Castroviejo-Fisher *et al.* 2011, Leonard 2002, van Asch *et al.* 2013). However, it is unclear when and how rapidly this replacement occurred.

Other major historical events in recent centuries have also substantially altered global dog diversity and variation. Modern dog breeding, which arose near the beginnings of European colonialism, intensified artificial selection (Jansson and Laikre 2018). Large conflicts, most notably World War I and World War II, had profound effects for many dog populations, with some breeds reaching extremely low population numbers (Howell 2013), and many European breeds had to be reconstituted due to loss of mating control. Thus contemporary European dog breeds only represent a fraction of the total dog diversity that existed 500 years ago. To further explore the complicated genetic history of European and North American dogs and reveal the diversity of dogs before the effects of colonization and 20th century conflicts, we extracted mitochondrial DNA from cranial elements recovered from the earliest permanent English colony in the Americas, Jamestown.

Methods

Extractions and ancient DNA pipeline

Six premolars underwent ancient DNA extraction and library preparation protocols as outlined in Cui *et al.* (2013) at a dedicated ancient DNA facility at the Carl R. Woese Institute for Genomic Biology at the University of Illinois Urbana-Champaign. Five of six samples were sequenced using the NovaSeq$^{(TM)}$ 6000 platform. Read files were run through Schubert *et al.*'s (2014) PALEOMIX pipeline and mapped to the dog mitochondrial genome (NC_002008.4) using BWA-MEM. Reads with Phred quality scores less than 30 were filtered out. Consensus sequences were generated using a Perl script (Bergey 2018).

Phylogenies

Jamestown sequences were combined with publicly available modern and ancient canid sequences including coyotes and wolves. Sequences (n = 1380) were aligned using MUSCLE (Edgar 2004) and manually curated. Neighbor-joining trees were created using PAUP* (Swofford 2003) with red fox (*Vulpes vulpes*) as the outgroup. A Bayesian phylogeny was constructed using BEAST 1.10.4 (Suchard *et al.* 2018) with a strict clock informed by tip dates, a Bayesian skyline plot demographic model, and a GTR substitution model. Multiple MCMC chains were run for 250 million generations and inspected for convergence in Tracer v1.7 (Rambaut *et al.* 2018).

Results

Of the five samples submitted for sequencing, only two [JR118236 (1607-1610) and JR68100 (1617-1624)] had enough quality reads to reconstruct the mitochondrial genome. The Jamestown sequences clustered with other ancient North American dog sequences from previously published works (Ameen *et al.* 2019 and Ni Leathlobhair *et al.* 2018) in both the neighbor-joining tree and the Bayesian phylogeny. In these analyses, they form a clade with dogs from the Janey B. Goode, Angel Mounds, and Scioto Cavern sites in the Midwest.

Zooarchaeological analysis identified cutmarks on the cranial elements of all dogs except one. Most of the cutmarks were located on the lateral surface of the maxilla, posterior to the infraorbital foramen, and superior to fourth premolar. Cutmarks were also found along the medial surface of the mandible inferior to the first molar. Cutmarks were relatively shallow and narrow.

Conclusions

Our analysis suggests that Jamestown dogs carried mitochondrial lineages derived from the first population of dogs introduced during the first peopling of the Americas. The Jamestown sequences cluster with sequences from Scioto Cavern dogs that date to 200 BC - 500 AD, dogs from Angel Mounds (12VG1) dated between 1050 – 1450 AD, and dogs from the Janey B. Goode site (11S1232), which was occupied between 650 and 1400 AD. Interestingly, the large clade containing the Jamestown dogs and pre-contact mid-Atlantic and Midwest dogs is a sister to a small clade that includes a mitogenome of an ancient Alaskan dog. We included dogs from Thule archaeological sites in our analysis, and it is clear that the indigenous mitochondrial lineages of the Jamestown dogs were distantly related to those of Thule dogs, which likely arrived in the Americas around 1000 AD (Tackney *et al.* 2019; Ni Leathlobhair *et al.* 2018). The Jamestown dogs thus belong to a very successful maternal lineage of dogs with a geographic distribution extending from Alaska through the mid-Atlantic until the time of European contact and colonization.

Notably, the mitochondrial lineages recovered from the Jamestown dogs were not European. This is not entirely unexpected based on historical accounts (Haile 1998) and archaeological data (Kelso and Straube 2012) that indicate a degree of exchange and interaction between indigenous Algonquian-speakers with European colonists at Jamestown. However, the nature of the interactions between indigenous and European populations is unknown, as is the role of dogs in any interactions or exchange. The skeletal elements analyzed here were found to have cutmarks on them, and the archaeological context is consistent with these dogs having been eaten for food by humans. One of the dogs (JR118236) is associated with the Starving Time (the winter of 1609-1610), which was a period of resource scarcity that forced residents to eat other animals not typically consumed as food and, in some cases, humans (Kelso and Straube 2012). Dog remains from layer JR2361C, however, likely represent continued reliance on Indigenous dogs for a decade or more after the starving time. Notably, the colony suffered many periods of potential collapse after its initial establishment because of failure to generate reliable food sources. Though our analysis cannot determine if these dogs were a common food source for either indigenous or European individuals at Jamestown, it was not unusual for indigenous North Americans (Tito *et al.* 2011) or European colonists (Schwartz 1997) to use dog meat as a protein source during periods of stress.

Further analysis is required to determine the full ancestry of the Jamestown dogs, as these dogs may either represent an early admixed population or be of entirely indigenous dog ancestry. Sequencing of the nuclear genome is necessary to accurately infer the full ancestry of these dogs and provide a window into dog diversity in North America (and possibly Europe) circa 1600 AD Genomic analysis of these unique 17th century samples would shed light on the ways

in which dogs were involved in the interactions between indigenous populations and early Europeans.

References

1. Ameen, C. *et al.* Specialized sledge dogs accompanied Inuit dispersal across the North American Arctic. *Proceedings of the Royal Society B: Biological Sciences* **286**, 20191929 (2019).
2. Bergey, C. vcf_tab_to_fasta_alignment. Source code **Perl 5.34.0**, 2018.
3. Castroviejo-Fisher, S., Skoglund, P., Valadez, R., Vilà, C. & Leonard, J. A. Vanishing native American dog lineages. *BMC Evolutionary Biology* **11**, 73 (2011).
4. Cui, Y., Lindo, J., Hughes, C. E., Johnson, J. W. & Hernandez, A. G. Ancient DNA Analysis of Mid-Holocene Individuals from the Northwest Coast of North America Reveals Different Evolutionary Paths for Mitogenomes. *PLoS ONE* **8**, 66948–66948 (2013).
5. Edgar, R. C. MUSCLE: multiple sequence alignment with high accuracy and high throughput. *Nucleic Acids Res* **32**, 1792–1797 (2004).
6. Haile, E. W. *Jamestown Narratives: Eyewitness Accounts of the Virginia Colony: The First Decade: 1607-1617*. (RoundHouse, 1998).
7. Howell, P. The Dog Fancy at War: Breeds, Breeding, and Britishness, 1914-1918. *Society & Animals* **21**, 546–567 (2013).
8. Kelso, W. M. & Straube, B. *2007-2010 Interim Report on the Preservation Virginia Excavations at Jamestown*. (2012).
9. Jansson, M. & Laikre, L. Pedigree data indicate rapid inbreeding and loss of genetic diversity within populations of native, traditional dog breeds of conservation concern. *PLOS ONE* **13**, e0202849 (2018).
10. Leonard, J. A. Ancient DNA Evidence for Old World Origin of New World Dogs. *Science* **298**, 1613–1616 (2002).
11. Moreno-Mayar, J. V. *et al.* Early human dispersals within the Americas. *Science* eaav2621 (2018) doi:10.1126/science.aav2621.
12. Ní Leathlobhair, M. *et al.* The evolutionary history of dogs in the Americas. *Science* **361**, 81–85 (2018).
13. Rambaut, A., Drummond, A. J., Xie, D., Baele, G. & Suchard, M. A. Posterior Summarization in Bayesian Phylogenetics Using Tracer 1.7. *Systematic Biology* **67**, 901–904 (2018).
14. Schubert, M. *et al.* Characterization of ancient and modern genomes by SNP detection and phylogenomic and metagenomic analysis using PALEOMIX. *Nat Protoc* **9**, 1056–1082 (2014).
15. Suchard, M. A. *et al.* Bayesian phylogenetic and phylodynamic data integration using BEAST 1.10. *Virus Evolution* **4**, vey016 (2018).
16. Schwartz, M. *A History of Dogs in the Early Americas*. (Yale University Press, 1997).
17. Swofford, D.L. PAUP*. Phylogenetic Analysis Using Parsimony (*and Other Methods). Sinauer Associates **4**.
18. Tackney, J., Jensen, A. M., Kisielinski, C. & O'Rourke, D. H. Molecular analysis of an ancient Thule population at Nuvuk, Point Barrow, Alaska. *American Journal of Physical Anthropology* **168**, 303–317 (2019).

19. Tito, R. Y. *et al.* Brief communication: DNA from early Holocene American dog. *American Journal of Physical Anthropology* **145**, 653–657 (2011).
20. van Asch, B. *et al.* Pre-Columbian origins of Native American dog breeds, with only limited replacement by European dogs, confirmed by mtDNA analysis. *Proceedings of the Royal Society B: Biological Sciences* **280**, 1–9 (2013).

Sample ID	Accession	Age	Source	Site Number	Site	County/State	Country	Latitude	Longitude
560028-21	ENA | LR742734	140 BC – 650 AD	Ameen et al. 2019	49-KOD-145	Uyak Site	Alaska	USA	57.535916	-153.946901
560028-28	ENA | LR742735	570 AD – 1470 AD	Ameen et al. 2019	49-KOD-145	Uyak Site	Alaska	USA	57.535916	-153.946901
560028-29	ENA | LR742736	570 AD – 870 AD	Ameen et al. 2019	49-KOD-145	Uyak Site	Alaska	USA	57.535916	-153.946901
5MT316	dryad.s1k47j4	1100 - 1400 YBP	Ni Leathlobhair et al. 2018	5MT23	Grass Mesa Village	Colorado	USA	39.469051	-107.77138
5MT501	dryad.s1k47j4	800 - 1000 YBP	Ni Leathlobhair et al. 2018	5MT5	Yellow Jacket Village	Colorado	USA	37.560349	-108.710563
5MT520	dryad.s1k47j4	1100 - 1300 YBP	Ni Leathlobhair et al. 2018	5MT4475	McPhee Village	Colorado	USA	37.470497	-108.503286
AL2772	dryad.s1k47j4	750 - 550 YBP	Ni Leathlobhair et al. 2018	33PI8880	Reinhardt, Scioto Valley	Ohio	USA	39.779123	-83.004481
AL2784	ENA | LR742728	1500 AD	Ameen et al. 2019	GDN-248	Nunalleq	Alaska	USA	59.753333	-161.902778
AL2788	ENA | LR742729	1500 AD	Ameen et al. 2019	GDN-248	Nunalleq	Alaska	USA	59.753333	-161.902778
AL2791	ENA | LR742730	1500 AD	Ameen et al. 2019	GDN-248	Nunalleq	Alaska	USA	59.753333	-161.902778
AL2792	ENA | LR742731	1500 AD	Ameen et al. 2019	GDN-248	Nunalleq	Alaska	USA	59.753333	-161.902778
AL2794	ENA | LR742732		Ameen et al. 2019	GDN-248	Nunalleq	Alaska	USA	59.753333	-161.902778

AL2795	ENA | LR742733		Ameen et al. 2019	GDN-248	Nunalleq	Alaska	USA	59.753333	-161.902778
AL3194	dryad.s1k47j4	4402 – 3912 calibrated BP	Ni Leathlobhair et al. 2018		Port au Choix	Newfoundland	Canada	50.703056	-57.352222
AL3198	dryad.s1k47j4	2000 – 200 BP	Ni Leathlobhair et al. 2018	49-KOD-145	Uyak Site	Kodiak Island, Alaska	USA	57.519185	-154.01663
AL3223	dryad.s1k47j4	985 – 935 cal BP	Ni Leathlobhair et al. 2018	44PG51	Weyanoke Old Town	Virginia	USA	37.289397	-77.065975
AL3226	dryad.s1k47j4	750 AD - 1450 AD	Ni Leathlobhair et al. 2018	44PG51	Weyanoke Old Town	Virginia	USA	37.290399	-77.303371
AM310A	dryad.s1k47j4	1000 YBP	Ni Leathlobhair et al. 2018	12VG1	Angel Mounds	Indiana	USA	37.943211	-87.457802
AM310B	dryad.s1k47j4	1000 YBP	Ni Leathlobhair et al. 2018	12VG1	Angel Mounds	Indiana	USA	37.943211	-87.457802
AM310C	dryad.s1k47j4	1000 YBP	Ni Leathlobhair et al. 2018	12VG1	Angel Mounds	Indiana	USA	37.943211	-87.457802
AM474	dryad.s1k47j4	1000 YBP	Ni Leathlobhair et al. 2018	12VG1	Angel Mounds	Indiana	USA	37.943211	-87.457802
Argentina_1000	KF661084	1000 YBP	Thalmann et al. 2013		Cerro Lutz		Argentina	-33.646667	-58.605556
BELA-37369	ENA | LR742737	1675 AD – 1800 AD	Ameen et al. 2019	49-KTZ-088	Cape Espenberg, Seward Peninsula, Kotzebue Sound	Alaska	USA	66.558108555	-163.614568

BELA-37374	ENA | LR742739	1260 AD – 1400 AD	Ameen et al. 2019	49-KTZ-304	Cape Espenberg, Seward Peninsula, Kotzebue Sound	Alaska	USA	66.55810855	-163.614568
BELA-37375	ENA | LR742740	1260 AD – 1400 AD	Ameen et al. 2019	49-KTZ-304	Cape Espenberg, Seward Peninsula, Kotzebue Sound	Alaska	USA	66.55810855	-163.614568
BELA-52965	ENA | LR742741	1450 AD – 1650 AD	Ameen et al. 2019	49-KTZ-087	Cape Espenberg, Seward Peninsula, Kotzebue Sound	Alaska	USA	66.55810855	-163.614568
Canada_2040	ENA | LR742843	1922 AD – 1923 AD	Ameen et al. 2019		Kaleruserk	Nunavut	Canada	69.378179	-81.830165
Canada_2041	ENA | LR742844	1923 AD	Ameen et al. 2019		Danske Øen	Nunavut	Canada	66.656854	-83.736581
Canada_Sort	ENA | LR742845	1906 AD	Ameen et al. 2019		Gjøa Havn	Nunavut	Canada	68.64412	-96.021997
CAO1	dryad.s1k47j4	6000 - 2000 YBP	Ni Leathlobhair et al. 2018		Channel Islands	California	USA	34.045107	-119.723425
CAW2	dryad.s1k47j4	6000 - 2000 YBP	Ni Leathlobhair et al. 2018		Channel Islands	California	USA	33.961451	-119.755407
CIAS	dryad.s1k47j4	6000 - 2000 YBP	Ni Leathlobhair et al. 2018		Channel Islands	California	USA	34.410263	-119.691328

CICVD	dryad.s1k47j4	4000 BP	Ni Leathlobhair et al. 2018	CA-SRI-41	Canada Verde	Santa Rosa Island	USA	34.024486	-120.131518
CINH7	dryad.s1k47j4	5000 BP or 2000 BP	Ni Leathlobhair et al. 2018	CA-SNI-21	North Head	San Nicolas Island	USA	33.27018	-119.566165
CINHA	dryad.s1k47j4	5000 BP or 2000 BP	Ni Leathlobhair et al. 2018	CA-SNI-21	North Head	San Nicolas Island	USA	33.27018	-119.566165
CISG	dryad.s1k47j4	2000 BP or 700 BP	Ni Leathlobhair et al. 2018	CA-SRI-2	Santa Rosa Island	California	USA	34.005452	-120.180836
CK-H4-M2	ENA | LR742742	1000 AD – 1250 AD	Ameen et al. 2019	49-NOA-002	Cape Krusenstern, Kotzebue Sound	Alaska	USA	67.1271	-163.744343
CK-H6-M5	ENA | LR742743	1000 AD – 1250 AD	Ameen et al. 2019	49-NOA-002	Cape Krusenstern, Kotzebue Sound	Alaska	USA	67.1271	-163.744343
CK-H8-M7	ENA | LR742744	1000 AD – 1250 AD	Ameen et al. 2019	49-NOA-002	Cape Krusenstern, Kotzebue Sound	Alaska	USA	67.1271	-163.744343
Cox6	dryad.s1k47j4	3000 - 1500 YBP	Ni Leathlobhair et al. 2018	1Jo176	Cox Mound	Alabama	USA	34.823571	-86.010945
DRG-99-0043	ENA | LR742745	720 AD – 970 AD	Ameen et al. 2019	49-KTZ-169	Deering, Seward Peninsula	Alaska	USA	66.07522	-162.718529
E_Greenland_2587	ENA | LR742801	1934 AD	Ameen et al. 2019		Angmagssalik	East Greenland	Greenland	65.594096	-37.641611
E_Greenland_32135	ENA | LR742803	1911 AD	Ameen et al. 2019		Tasiilak	East Greenland	Greenland	65.607788	-37.615787

E_Greenland_32179	ENA | LR742804	1911 AD	Ameen et al. 2019		Tasiilak	East Greenland	Greenland	65.607788	-37.615787
E_Greenland_3294	ENA | LR742802	1928 AD	Ameen et al. 2019		Scoresbysund	East Greenland	Greenland	70.487538	-21.974989
E_Greenland_35561	ENA | LR742805	1932 AD	Ameen et al. 2019		Tasiilak	East Greenland	Greenland	65.607788	-37.615787
FR11	dryad.s1k47j4	7000 - 3000 YBP	Ni Leathlobhair et al. 2018	MAO48	Flint River	Alabama	USA	34.976588	-86.538644
Greenland_Obersten_2	ENA | LR742806	1911 AD	Ameen et al. 2019				Greenland		
HJCL-9.14	ENA | LR742847	1700 AD – 1900 AD	Ameen et al. 2019		Uivak Point 1	Labrador	Canada	57.585792	-62.11633
ISM070	dryad.s1k47j4	2500 – 1000 YBP	Ni Leathlobhair et al. 2018		Apple Creek	Illinois	USA	40.145289	-89.171655
ISM090	dryad.s1k47j4	8560 – 8210 cal BP	Ni Leathlobhair et al. 2018		Modoc Rock Shelter	Illinois	USA	38.062723	-90.063822
ISM172	dryad.s1k47j4	8930 - 7930 BP	Ni Leathlobhair et al. 2018	13CK61	Simonsen Bison Kill	Iowa	USA	42.627129	-95.658902
ISM21C	dryad.s1k47j4	1400 AD – 1500 AD	Ni Leathlobhair et al. 2018	IAS CK 21	Anker Site	Illinois	USA	41.73238	-87.687791
ISM256	dryad.s1k47j4	10110 - 9680 YBP	Ni Leathlobhair et al. 2018	11GE4	Koster	Illinois	USA	39.209167	-90.549167
ISM357	dryad.s1k47j4	10110 - 9680 YBP	Ni Leathlobhair et al. 2018	11GE4	Koster	Illinois	USA	39.209167	-90.549167

JBG11	dryad.s1k47j4	1000 - 1400 YBP	Ni Leathlobhair et al. 2018	11S1232	Janey B. Goode	Illinois	USA	38.658475	-90.162219
JBG12	dryad.s1k47j4	1000 - 1400 YBP	Ni Leathlobhair et al. 2018	11S1232	Janey B. Goode	Illinois	USA	38.658475	-90.162219
JBG13	dryad.s1k47j4	1000 - 1400 YBP	Ni Leathlobhair et al. 2018	11S1232	Janey B. Goode	Illinois	USA	38.658475	-90.162219
JBG17	dryad.s1k47j4	1000 - 1400 YBP	Ni Leathlobhair et al. 2018	11S1232	Janey B. Goode	Illinois	USA	38.658475	-90.162219
JBG19	dryad.s1k47j4	1000 - 1400 YBP	Ni Leathlobhair et al. 2018	11S1232	Janey B. Goode	Illinois	USA	38.658475	-90.162219
JBG1m	dryad.s1k47j4	1000 - 1400 YBP	Ni Leathlobhair et al. 2018	11S1232	Janey B. Goode	Illinois	USA	38.658475	-90.162219
JBG21	dryad.s1k47j4	1000 - 1400 YBP	Ni Leathlobhair et al. 2018	11S1232	Janey B. Goode	Illinois	USA	38.658475	-90.162219
JBG24	dryad.s1k47j4	1000 - 1400 YBP	Ni Leathlobhair et al. 2018	11S1232	Janey B. Goode	Illinois	USA	38.658475	-90.162219
JBG26	dryad.s1k47j4	1000 - 1400 YBP	Ni Leathlobhair et al. 2018	11S1232	Janey B. Goode	Illinois	USA	38.658475	-90.162219
JBG32	dryad.s1k47j4	1000 - 1400 YBP	Ni Leathlobhair et al. 2018	11S1232	Janey B. Goode	Illinois	USA	38.658475	-90.162219
JBG35	dryad.s1k47j4	1000 - 1400 YBP	Ni Leathlobhair et al. 2018	11S1232	Janey B. Goode	Illinois	USA	38.658475	-90.162219

JBG37	dryad.s1k47j4	1000 - 1400 YBP	Ni Leathlobhair et al. 2018	11S1232	Janey B. Goode	Illinois	USA	38.658475	-90.162219
JBG41	dryad.s1k47j4	1000 - 1400 YBP	Ni Leathlobhair et al. 2018	11S1232	Janey B. Goode	Illinois	USA	38.658475	-90.162219
JBG42	dryad.s1k47j4	1000 - 1400 YBP	Ni Leathlobhair et al. 2018	11S1232	Janey B. Goode	Illinois	USA	38.658475	-90.162219
JBG43	dryad.s1k47j4	1000 - 1400 YBP	Ni Leathlobhair et al. 2018	11S1232	Janey B. Goode	Illinois	USA	38.658475	-90.162219
JBG45	dryad.s1k47j4	1000 - 1400 YBP	Ni Leathlobhair et al. 2018	11S1232	Janey B. Goode	Illinois	USA	38.658475	-90.162219
JBG48	dryad.s1k47j4	1000 - 1400 YBP	Ni Leathlobhair et al. 2018	11S1232	Janey B. Goode	Illinois	USA	38.658475	-90.162219
JBG5	dryad.s1k47j4	1000 - 1400 YBP	Ni Leathlobhair et al. 2018	11S1232	Janey B. Goode	Illinois	USA	38.658475	-90.162219
JBG50	dryad.s1k47j4	1000 - 1400 YBP	Ni Leathlobhair et al. 2018	11S1232	Janey B. Goode	Illinois	USA	38.658475	-90.162219
JR118236	-	1609 AD – 1610 AD	This study		Jamestown	Virginia	USA	37.208598	-76.778596
JR68100	-	1617 AD – 1624 AD	This study		Jamestown	Virginia	USA	37.208696	-76.778596
KDDQ-9	ENA | LR742848	420 BC – 120 AD	Ameen et al. 2019		Nanook	Nunavut	Canada	62.796171	-69.665549
KEDQ-2.M1	ENA | LR742849	1200 AD – 1300 AD	Ameen et al. 2019	KeDq-2	Talaguak	Nunavut	Canada	62.737549	-69.451247

KKDO-2270	ENA | LR742850	1150 AD – 1400 AD	Ameen et al. 2019	KkDo-1	Peale Point	Nunavut	Canada	63.733538	-68.696344
KKJG-1.H8-M1	ENA | LR742851	1400 AD – 1650 AD	Ameen et al. 2019	KkJg-1	Silumiut Island	Nunavut	Canada	63.683333	-90.083333
KNK2643X1838	ENA | LR742808	1275 AD – 1650 AD	Ameen et al. 2019		Ilita	Ingelfield Land	Greenland	78.337446	-72.63858
KNK2643X1839	ENA | LR742809	1900 AD – 1910 AD	Ameen et al. 2019		Ilita	Ingelfield Land	Greenland	78.337446	-72.63858
KNK2644X1119	ENA | LR742810	1850 AD – 1900 AD	Ameen et al. 2019		Ilita	Ingelfield Land	Greenland	78.337446	-72.63858
KNK2644X1120	ENA | LR742811	1850 AD – 1900 AD	Ameen et al. 2019		Ilita	Ingelfield Land	Greenland	78.337446	-72.63858
KNK492X33	ENA | LR742807	1275 AD – 1440 AD	Ameen et al. 2019		Qaqaitsut	Paris Fjord	Greenland	79.090775	-66.927081
KP-1	ENA | LR742746	825 AD – 1190 AD	Ameen et al. 2019	49-XSL-010	Kitnepaluk, St. Lawrence Island	Alaska	USA	63.6617	-171.732596
LB2	dryad.s1k47j4	7000 – 3000 YBP	Ni Leathlobhair et al. 2018	CT08	Little Bear Creek	Alabama	USA	34.307486	-87.665349
May10	dryad.s1k47j4	1000 YBP	Ni Leathlobhair et al. 2018		Mayapan	Yucatan	Mexico	20.461097	-89.216501
May2	dryad.s1k47j4	1000 YBP	Ni Leathlobhair et al. 2018		Mayapan	Yucatan	Mexico	20.461097	-89.216501
May3	dryad.s1k47j4	1000 YBP	Ni Leathlobhair et al. 2018		Mayapan	Yucatan	Mexico	20.461097	-89.216501

May4	dryad.s1k47j4	1000 YBP	Ni Leathlobhair et al. 2018		Mayapan	Yucatan	Mexico	20.461097	-89.216501
MW549038	MW549038	10410 – 9890 YBP	da Silva Coelho et al. 2021		Lawyer's Cave/ Phalanges Phreatic Tube	Alaska	USA	56.304245	-131.943
N_Greenland_31867	ENA | LR742812	1909 AD	Ameen et al. 2019		North Star Bay	North West Greenland (Thule District)	Greenland	76.559032	-68.859668
NAPI-2.14	ENA | LR742852	1225 AD – 1400 AD	Ameen et al. 2019	NaPI-2	Clachan	Northwest Territories	Canada	68.212145	-115.253769
NAPI-2.C70-10	ENA | LR742853	1225 AD – 1400 AD	Ameen et al. 2019	NaPI-2	Clachan	Northwest Territories	Canada	68.212145	-115.253769
NCPF-1.8-20	ENA | LR742854	1200 AD – 1300 AD	Ameen et al. 2019	NcPf-1	Nuvuk	Northwest Territories	Canada	68.279017	-114.136963
NHTN-1.2036Ha	ENA | LR742855	1700 AD – 1850 AD	Ameen et al. 2019	NhTn-1	Gutchiak	Northwest Territories	Canada	69.430803	-132.627785
NHTN-1.2048H	ENA | LR742856	1700 AD – 1850 AD	Ameen et al. 2019	NhTn-1	Gutchiak	Northwest Territories	Canada	69.430803	-132.627785
NIHF-4.132C	ENA | LR742859	1200 AD – 1400 AD	Ameen et al. 2019	NiHf-4	Tikilik	Nunavut	Canada	69.371637	-81.608065
NIHF-4.1C	ENA | LR742857	1200 AD – 1400 AD	Ameen et al. 2019	NiHf-4	Tikilik	Nunavut	Canada	69.371637	-81.608065
NIHF-4.9BSMb	ENA | LR742858	800 AD – 1100 AD	Ameen et al. 2019	NiHf-4	Tikilik	Nunavut	Canada	69.371637	-81.608065
NIHF-4.BSP	ENA | LR742860	800 AD – 1100 AD	Ameen et al. 2019	NiHf-4	Tikilik	Nunavut	Canada	69.371637	-81.608065

NIHF-4.PLM	ENA | LR742861	1200 AD – 1400 AD	Ameen et al. 2019	NiHf-4	Tikilik	Nunavut	Canada	69.371637	-81.608065
OATI-1.F2-M1	ENA | LR742862	1410 AD – 1800 AD	Ameen et al. 2019	OaTi-1	McKinley Bay	Northwest Territories	Canada	70.058381	-130.624443
OATI-1.H1R	ENA | LR742863	1410 AD – 1800 AD	Ameen et al. 2019	OaTi-1	McKinley Bay	Northwest Territories	Canada	70.058381	-130.624443
OHRH-1.1462M2b	ENA | LR742864	1200 AD – 1300 AD	Ameen et al. 2019	OhRh-1	Nelson River	Northwest Territories	Canada	71.282088	-122.319089
OJRL-3.534	ENA | LR742865	825 BC – 200 BC	Ameen et al. 2019	OjRi-3	Lagoon	Northwest Territories	Canada	71.446741	-123.477163
OKRN-1.TUR	ENA | LR742866	1600 AD – 1800 AD	Ameen et al. 2019	OkRh-1	Fish Lake	Northwest Territories	Canada		
OSU611	dryad.s1k47j4	2200 - 1600 YBP	Ni Leathlobhair et al. 2018		Scioto Caverns	Ohio	USA	40.113	-83.107
OSU622	dryad.s1k47j4	2200 - 1600 YBP	Ni Leathlobhair et al. 2018		Scioto Caverns	Ohio	USA	40.113	-83.107
OSU624	dryad.s1k47j4	2200 - 1600 YBP	Ni Leathlobhair et al. 2018		Scioto Caverns	Ohio	USA	40.113	-83.107
OSU626	dryad.s1k47j4	2200 - 1600 YBP	Ni Leathlobhair et al. 2018		Scioto Caverns	Ohio	USA	40.113	-83.107
OSU628	dryad.s1k47j4	2200 - 1600 YBP	Ni Leathlobhair et al. 2018		Scioto Caverns	Ohio	USA	40.113	-83.107
OSU634	dryad.s1k47j4	2200 - 1600 YBP	Ni Leathlobhair et al. 2018		Scioto Caverns	Ohio	USA	40.113	-83.107

OSU638	dryad.s1k47j4	2200 - 1600 YBP	Ni Leathlobhair et al. 2018		Scioto Caverns	Ohio	USA	40.113	-83.107
P35	dryad.s1k47j4	7000 - 3000 YBP	Ni Leathlobhair et al. 2018	1LU25	Perry	Alabama	USA	34.915399	-87.684085
P59	dryad.s1k47j4	7000 - 3000 YBP	Ni Leathlobhair et al. 2018	1LU25	Perry	Alabama	USA	34.915399	-87.684085
P91/2013KMG-GeoSociety-M4a	ENA | LR742813	1500 AD – 1800 AD	Ameen et al. 2019		Geographical Society Island	East Greenland	Greenland	72.930873	-23.051368
PRD1	dryad.s1k47j4	1500 YBP	Ni Leathlobhair et al. 2018	GbTo-13 or GbTo-54	Prince Rupert Harbour	British Columbia	Canada	54.304849	-130.343108
PRD10	dryad.s1k47j4	1500 YBP	Ni Leathlobhair et al. 2018	GbTo-13 or GbTo-54	Prince Rupert Harbour	British Columbia	Canada	54.304849	-130.343108
PRD9	dryad.s1k47j4	1500 YBP	Ni Leathlobhair et al. 2018	GbTo-13 or GbTo-54	Prince Rupert Harbour	British Columbia	Canada	54.304849	-130.343108
RBJR-1.642.56	ENA | LR742867	1200 AD – 1400 AD	Ameen et al. 2019	RbJr-1	Porden Point	Nunavut	Canada	76.486434	-93.904909
RBJU-1.COLDa	ENA | LR742868	2500 BC – 1500 BC	Ameen et al. 2019	RbJr-1	Port Refuge	Nunavut	Canada	76.486434	-93.904909
SEL-033-0057b	ENA | LR742748	700 BC – 200 AD	Ameen et al. 2019	49-SEL-033	Chugachik Site	Alaska	USA	59.745536	-151.045715
SGFQ-1.H9-1	ENA | LR742869	1500 AD – 1700 AD	Ameen et al. 2019	SgFq-1	Haa Island	Nunavut	Canada	79.037448	-77.570383
TRF-01-23	ENA | LR742749	435 – 353	Ameen et al. 2019		Deering	Alaska	USA	66.07522	-162.718529

		YBP, intCal13							
TRF-01-24	ENA | LR742750	422 YBP, IntCal13	Ameen et al. 2019		Deering	Alaska	USA	66.07522	-162.718529
TRF-01-27	ENA | LR742751		Ameen et al. 2019		Deering	Alaska	USA	66.07522	-162.718529
TRF-02-14	ENA | LR742752	1926 AD	Ameen et al. 2019	49-XPH-003	Point Hope	Alaska	USA	68.34556	-166.81163
TRF-02-16	ENA | LR742753	1939 AD	Ameen et al. 2019		St. Lawrence Island	Alaska	USA	63.389311	-170.115907
TRF.01.01	ENA | LR742814	“Thule”	Ameen et al. 2019		Stormbugt I	North East Greenland	Greenland	76.802292	-18.578379
TRF.01.03	ENA | LR742815		Ameen et al. 2019		Sukersit	East Greenland	Greenland	66.05209	-38.003846
TRF.01.04	ENA | LR742816	1895 AD	Ameen et al. 2019		Hekla Havn	North East Greenland	Greenland	70.473062	-26.219456
TRF.01.05	ENA | LR742817	1895 AD	Ameen et al. 2019		Hekla Havn	North East Greenland	Greenland	70.473062	-26.219456
TRF.01.06	ENA | LR742818	1895 AD	Ameen et al. 2019		Hekla Havn	North East Greenland	Greenland	70.473062	-26.219456
TRF.01.07	ENA | LR742819	1985 AD	Ameen et al. 2019		Monumentet/Hall Land	North East Greenland	Greenland	81.570743	-60.2845
TRF.01.08	ENA | LR742820	1350 AD – 1500 AD	Ameen et al. 2019		Misigtoq	East Greenland	Greenland		
TRF.01.09	ENA | LR742821	“Thule”	Ameen et al. 2019		Dødemandsbugten	North East Greenland	Greenland	74.127659	-20.789772
TRF.01.11	ENA | LR742822	“Thule”	Ameen et al. 2019		Nugarsuk	South Greenland	Greenland	72.736728	-55.172316
TRF.01.31	ENA | LR742870		Ameen et al. 2019		Fort Churchill	Manitoba	Canada	58.796893	-94.212667
TRF.01.32	ENA | LR742871	“Thule”	Ameen et al. 2019		Kuk	Southampton Island	Canada	65.34129	-85.068701

TRF.01.33	ENA | LR742872	“Thule”	Ameen et al. 2019		Kuk	Southampton Island	Canada	65.34129	-85.068701
TRF.01.34	ENA | LR742874	“Thule”	Ameen et al. 2019	PeFs-1	Qilalukan	Baffin	Canada	72.502318	-76.293428
TRF.01.35	ENA | LR742823	1900 AD – 2000 AD	Ameen et al. 2019		Siorapaluk	Qaanaaq	Greenland	77.789489	-70.615088
TRF.01.39	ENA | LR742873	“Thule”	Ameen et al. 2019	PeFs-1	Qilalukan	Baffin	Canada	72.502318	-76.293428
TRF.01.42	ENA | LR742824	1927 AD – 1928 AD	Ameen et al. 2019		Scorsbysund	East Greenland	Greenland	70.488443	-21.98933
TRF.01.45	ENA | LR742825	1100 AD – 1500 AD	Ameen et al. 2019		Inugsuk	West Greenland	Greenland	72.95182	-56.123425
TRF.01.46	ENA | LR742826	1903 AD	Ameen et al. 2019		Saunders Island	Qaanaaq	Greenland	76.563419	-69.675096
TRF.01.49	ENA | LR742827	1885 AD	Ameen et al. 2019		East	East Greenland	Greenland		
TRF.01.54	ENA | LR742828	1900 AD – 2000 AD	Ameen et al. 2019		Siorapaluk	Qaanaaq	Greenland	77.789489	-70.615088
TRF.01.55	ENA | LR742829	1900 AD – 2000 AD	Ameen et al. 2019		Siorapaluk	Qaanaaq	Greenland	77.789489	-70.615088
TRF.01.56	ENA | LR742830	1900 AD – 2000 AD	Ameen et al. 2019		Siorapaluk	Qaanaaq	Greenland	77.789489	-70.615088
TRF.01.57	ENA | LR742831	1900 AD – 2000 AD	Ameen et al. 2019		Siorapaluk	Qaanaaq	Greenland	77.789489	-70.615088
TRF.01.58	ENA | LR742832	1900 AD – 2000 AD	Ameen et al. 2019		Siorapaluk	Qaanaaq	Greenland	77.789489	-70.615088
TRF.02.04	ENA | LR742833	1892 AD	Ameen et al. 2019			Nuuk	Greenland	64.18049	-51.677667
TRF.02.19	ENA | LR742834		Ameen et al. 2019			West Greenland	Greenland		

TRF.02.37	ENA | LR742835	1911 AD	Ameen et al. 2019		Tasiilak	East Greenland	Greenland	65.607788	-37.615787
TRF.02.38	ENA | LR742836	1932 AD	Ameen et al. 2019		Tasiilak	East Greenland	Greenland	65.607788	-37.615787
TRF.02.40	ENA | LR742837	1962 AD	Ameen et al. 2019			West Greenland	Greenland		
TRF.02.41	ENA | LR742838	1980 AD	Ameen et al. 2019				Greenland		
TRF.02.47	ENA | LR742839	1926 AD	Ameen et al. 2019				Greenland		
TRF.07.03	ENA | LR742875	1700 AD – 1800 AD	Ameen et al. 2019		Double Mer Point	Labrador	Canada	54.22132	-58.408829
UA1-1939-1497-2	ENA | LR742760	55 BC – 125 AD	Ameen et al. 2019	49-XSL-009	Kukulik	Alaska	USA	63.682553	-170.352768
UA1-1941-1856	ENA | LR742761	1150 AD – 1270 AD	Ameen et al. 2019	49-XBM-003	Ahteut	Alaska	USA	67.10281	-159.046589
UA2001-079-0002	ENA | LR742762		Ameen et al. 2019		No information	Alaska	USA	-	-
UA5072-7	ENA | LR742763	1800 AD – 1900 AD	Ameen et al. 2019	49-XPH-008	Point Hope	Alaska	USA	68.34556	-166.81163
UA5231	ENA | LR742764	1900 AD – 1950 AD	Ameen et al. 2019		Cape Dyer	Alaska	USA	68.64804	-166.203162
USA_1000	KF661086	1000	Thalmann et al. 2013			Florida	USA		
USA_8500	KF661083	8500 YBP	Thalmann et al. 2013	11GE4	Koster	Illinois	USA	39.209167	-90.549167
W_Greenland_32987	ENA | LR742840	1926 AD	Ameen et al. 2019		Uummannaq	North West Greenland	Greenland	70.68283	-52.125948
W_Greenland_67941	ENA | LR742841	1918 AD	Ameen et al. 2019		Qeqertarssuatsia		Greenland	70.403798	-54.829241

WAL-B9-J19	ENA | LR742765	650 AD – 1000 AD	Ameen et al. 2019	49-BAR-13	Walakpa	Alaska	USA	71.154033	-157.060768
WAL-B9-J20	ENA | LR742766	650 AD – 1000 AD	Ameen et al. 2019	49-BAR-13	Walakpa	Alaska	USA	71.154033	-157.060768