Supporting Information

Supporting Materials and Methods

DNA extraction, amplification, sequencing

Handling and preparation of samples, DNA isolation and PCR setup were conducted in two laboratories dedicated for ancient DNA: the Swedish Museum of Natural History (E-labelled specimens), and the Centre for Precolumbian Studies at the University of Warsaw (L-labelled specimens), following standard procedures to avoid contamination.

Description of DNA analyses for E-labelled specimens: 10-50mg of bone powder was obtained from each specimen using a multitool drill. DNA extractions were performed following a modified version of protocol C in Yang *et al.* (1998) as described in Brace *et al.* (2012). In brief, ~10-50mg of bone powder were incubated overnight in extraction buffer including 0.45M EDTA, 0.1M Urea (instead of SDS) and 0.15mg proteinase K. The extracts were concentrated using 30K MWCO Vivaspin filters (Sartorius) and purified with silica spin columns (QIAGEN). Because of the degraded nature of DNA in ancient material, we first screened all specimens for DNA by amplifying a 171bp fragment of the mitochondrial cytochrome *b* (cyt *b*) gene using primer pair A in Brace *et al.* (2012). Successfully amplified specimens were further amplified for 780bp of the cyt *b* gene in eight overlapping fragments using primer pairs A-G, I from Brace *et al.* (2012). Primers were tagged on their 5'end with custom-designed six-nucleotide sequences (indexes) to allow for parallel sequencing of multiple individuals (Binladen *et al.*, 2007). Each forward and reverse primer was tagged with 8 different indexes producing 8 x 8 unique tag combinations that enabled sequencing of 64 individuals in parallel. This strategy resulted in amplicons that were tagged in both ends. PCR reactions and conditions were the same as those described for Caverne Marie Jeanne samples in Brace *et al.* (2012). Negative controls were included in each extraction and amplification batch to control for contamination. Each fragment was replicated at least once with independent amplification of each individual to monitor DNA damage.

Tagged amplicons from different individuals were pooled and purified using a MinElute column (QIAGEN) for library preparation. We followed the Rapid Library (RL) preparation protocol from 454 Life Sciences for sequencing on a GS Junior instrument. The following modifications were made to the library protocol: *i)* The DNA fragmentation by nebulization step was omitted since we were sequencing PCR products. *ii)* The fragment end-repair step was omitted and instead only phosphorylation of the pooled PCR products was performed in a mix of 2.5µl RL 10x buffer, 2.5µl RL ATP, 1µl PNK and 3µl elution buffer (EB; QIAGEN). This modification was introduced to eliminate the problem of switched indexes that we observed during initial experiments; out of the 64 unique tag combinations at least two combinations were used for amplification of negative controls (NC). Although NCs did not yield PCR products when checked on an agarose gel and thus were not included in the pool of PCR products, resulting sequences possessed NC tag combinations indicating that PCR products were switching tags at some point during library preparation, emulsion PCR or sequencing. We discovered that tag-switching occurred during the end-repair step and therefore proceeded by excluding this step from the protocol. *iii)* After adaptor ligation, purification was performed using a MinElute column (QIAGEN) instead of AMPure beads since our amplicons were comparatively short. *iv*) The quality of the libraries was assessed on agarose gels and high-sensitivity DNA chips on the Bioanalyzer 2100 (Agilent). Library quantification was performed on a TBS 380 Fluorometer (Turner Biosystems) as described on the RL preparation protocol. Each library was amplified in an emulsion PCR following the emPRC Amplification Method Manual – Lib-L from 454 Life Sciences. We used Live Amp Mix B for paired-end libraries with 0.6 DNA molecules per bead and 35 cycles instead of 50 because our amplicons were shorter than 400bp. Bead recovery and enrichment were performed as described in the manual. Amplified libraries were sequenced on a GS Junior instrument following the Sequencing Method Manual from 454 Life Sciences with 200 nucleotide cycles. We performed a total of 5 sequencing runs (5 libraries of pooled PCR products).

Following data processing, we discovered cases of *i)* missing fragments for a few individuals, *ii)* fragments from which replicates did not work, *iii)* replicate-fragments of the same individual that contained mismatches. In order to fill in these gaps and resolve mismatches between replicates, we re-amplified the particular fragments/individuals and purified them using Exonuclease I and FastAP Thermosensitive Alkaline Phosphatase. Sequencing was performed in both directions on an ABI3730xl (Applied Biosystems) instrument.

Description of DNA analyses for L-labelled specimens: Prior to DNA extraction each tooth was washed with bleach solution (6% w/v sodium hypochlorite), rinsed with water and UV-irradiated for 20 minutes on each side. Then it was crushed with a sterile pipette tip and up to 50mg of bone powder were used for DNA extraction following a protocol described in Baca *et al.* (2012). Bone powder was incubated overnight at 40°C with agitation in 1.5 ml of buffer containing 100mM EDTA, 20mM DTT, 5mM PTB, 0.5% *N*-Lauroylsarcosine, 0.4mg/ml Proteinase K (Applichem). Then a phenol/chloroform/isoamyl alcohol (25:24:1) extraction followed by chloroform extraction was performed followed by a isopropanol precipitation with 750 mM ammonium acetate. The obtained DNA pellet was dissolved in 60 µl TE buffer. For initial screening, a 163bp fragment of the mitochondrial cyt *b* was amplified using primer pair *cytb4* designed in this study (Table S4, Supporting Information). Successfully amplified samples were further amplified for 1050bp of the cyt *b* gene in two multiplex PCR reactions using eleven primer pairs designed in this study (Table S4, Supporting Information). PCR reactions were set up in 25µl reactions containing 1X AmpliTaq Gold MasterMix (LifeTech), 5µg BSA, 0.1-0.2µM of each primer and 1.5µl of DNA extract. Reaction conditions were

95°C for 12 min; 18 cycles of 95°C for 30 s, 53°C for 30 s, 72°C for 30 s; and 72°C for 5 min. In each reaction, primer pairs amplifying non overlapping fragments were used. Multiplexed PCR products from each individual were pooled and purified using solid phase reversible immobilization (SPRI) beads. Sequencing libraries for each individual pool were prepared according to the protocol proposed by Stiller *et al.* (2009). Briefly: i) multiplexed PCR products were blunt end-repaired and phosphorylated in 30µl reactions that contained 15µl purified PCR products, 1X Tango buffer, 1mM ATP, 15U T4 PNK, 3U T4 DNA Polymerase and 100µM dNTPs for 7 min and 30 s at 12 °C and 7 min and 30 s at 25 °C, followed by purification with SPRI, ii) truncated 454 FLX adapters A and B were ligated to the multiplexed amplicons. Each A adapter contained a unique barcode sequence of ten nucleotides. Barcode sequences differed from each other by at least three nucleotides. Up to 96 different A adaptors were used in each sequencing experiment. Ligation was performed in 30µl reactions that contained 15µl purified blunt-end products, 1X Ligase buffer, 5% PEG-4000, 5U T4 DNA Ligase and 3mM of each adapter. Reactions were incubated for 20 min at 22°C and purified using SPRI. iii) Fill-in reactions were performed to eliminate single-stranded overhangs in the ligated adapters including 15µl ligation products, 1X Thermopol buffer, 8U Bst polymerase and 250µM dNTPs in a total of 30µl mix. Reactions were incubated at 37 °C for 20 min and were SPRI purified. iv) Final amplification was performed with primers MP-make454-A and MP-make454B to produce sequencing libraries with full length universal 454 FLX Titanium adapters. Reactions included 10µl fill-in products, 1X AmpliTaq Gold MasterMix (LifeTech) and 250nM primers. PCR conditions were 95°C for 12 min; 18 cycles of 95°C for 30 s, 60°C for 30 s and 72°C for 40 s; and 72°C for 5 min. PCR products were checked on agarose gels. The amount of DNA molecules in each library was estimated with real-time PCR using a 454 FLX Titanium Library Quantification kit (KAPA). Libraries were pooled in equimolar concentrations and sequenced on 1/8 of a Pico-Titer plate on the GS FLX Titanium platform in the Institute of Biochemistry and Biophysics, PAS. Amplification and sequencing of each fragment was replicated at least once and in cases of mismatches between replicates appropriate fragments were amplified in single-plex PCR (with the same conditions as described above but with 45 cycles instead of 18) and sequenced with the Sanger method on an ABI3730xl (as described below).

For modern L-labelled *Dicrostonyx* specimens, DNA was isolated from dried tissue using the Wizard Genomic DNA extraction kit according to manufacturer's recommendations. Amplification of 849bp of the mitochondrial cyt *b* was performed using primers CytBwspF, CytBwspR (Table S4, Supporting Information) in 20µl reactions containing 1X polymerase master mix (Biomix, Bioline), 0.1µM primers and 1µl of DNA extract. Reaction conditions were: 95°C for 5 minutes; 35 cycles of 95°C for 30 seconds, 53°C for 30 seconds, 72°C for 30 seconds; and 72°C for 5 minutes. PCR products were purified with Exonuclease I and FastAP Thermosensitive Alkaline Phosphatase and sequenced on an ABI3730xl (Applied Biosystems) in the Institute of Biochemistry and Biophysic, Polish Academy of Sciences PAS. Sequences were analysed and aligned in BioEdit version 7.2.5.

Data analysis

Data generated with the 454 GS junior technology were processed by the 454 Sequencing System Software (version 2.9) using the full processing option for Shotgun or Paired End Rapid Libraries. Passed filter reads were used in further analyses. We used SFF Tools' (454 Sequencing System Software version 2.9) command 'sfffile' to assign reads to each individual, based on tag identification in both ends allowing for one mismatch. Indexes were designed to differ from each other by at least two base pairs in order to avoid misidentification due to sequencing errors. Following individual identification, 'sff' files were converted to 'fastq' files using the program sff2fastq (https://github.com/indraniel/sff2fastq).

After this step we followed the bioinformatics pipeline described in Clarke *et al.* (2014). In brief, primer sequences were trimmed from both ends using TagCleaner (Schmieder *et al.* 2010). The complete cyt *b* sequence of a *Dicrostonyx torquatus* specimen available in GenBank (accession number AF119275) was used as a reference sequence. BWA's (Li & Durbin 2009); version 0.7.8) 'index' command was used to index the reference sequence. Reads were aligned to the reference using the BWA-MEM algorithm, which is recommended since it's faster and more accurate than BWA-SW. SAM format files were converted to BAM format, sorted according to coordinates and indexed with SAMtools version 0.1.19 (Li *et al.* 2009). Picard's (http://picard.sourceforge.net; version 1.92) 'MergeSamFiles' function was used to merge BAM files from the same individual/replicate into one BAM file. Consensus sequences were called using SAMtools' 'mpileup' command, bcftools and vcfutils' 'vcf2fq' command. Consensus sequences were converted to fastq files and renamed according to individual/replicate using the perl script provided in Clarke *et al.* (2014). Replicate-consensus sequences from each individual were then aligned and visually inspected for mismatches on Geneious version 5.5.7. In cases of mismatches between replicates from the same individual, we re-amplified the particular fragments containing the mismatches to resolve these positions (see above).

Data generated with the 454 FLX technology were processed by the 454 Sequencing System Software (version 2.9). SFF Tools were used to assign reads to each individual and convert 'sff' files to 'fna' files. Primer sequences were trimmed in BioEdit (Hall, 1999). Reads were assembled and consensus sequences were called in SeqMan Pro (DNASTAR). For each individual, consensus sequences from two replicates were aligned and visually inspected in BioEdit.

Sequences generated from Sanger sequencing on the ABI3730xl were assembled and analysed on Geneious version 5.5.7.

References

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Table S1. List of sampling localities.

Locality	Country	Number of samples	Number of samples with complete cyt *b* sequences	Coordinates
Marie-Jeanne cave	Belgium	24	9	50°7'48" N, 4°28'33.6" E
Trou Al'Wesse cave	Belgium	16	4	50°25'15.6" N, 5°17'38.4" E
Kitley cave	UK	1	1	50°20'36" N, 4°00'12" W
Merlin cave	UK	6	6	51°50'6" N, 2°39'24" W
Bois laiterie	Belgium	2	2	50°21'47.88" N, 4°52'19.2" E
Walou Cave	Belgium	5	0	50°34'44" N, 5°40'24" E
Kleine Scheuer am Hohlenstein	Germany	4	4	48°32'57.57" N, 10°10'20.75" E
Neanderthal Cave	Germany	5	0	51°13'36" N, 6°56'49" E
Biśnik cave	Poland	256	137	50°25′35" N, 19°39′54" E
Obłazowa cave	Poland	12	2	49°25′48" N, 20°9′36" E
Deszczowa cave	Poland	6	0	50°35'15" N, 19°32'34" E
Nietoperzowa cave	Poland	2	0	50°11′38" N, 19°46′28" E
Mamutowa cave	Poland	3	0	50°10'14" N, 19°48'20" E
Jankovich cave	Hungary	15	0	47°43'38"N, 18°33'21" E
Pilisszanto rock shelter	Hungary	4	0	47°43' N, 18° 55' E
Mezin site	Ukraine	9	0	51°48'41"N, 33°4'12"E
Nowgorod Sewerski	Ukraine	10	0	52°00'24"N, 33°15'49"E
Yudinovo	Russia	9	4	52°40'14.5" N, 33°15'44.64" E
Eliseevichi	Russia	9	0	55°16'48.72" N, 32°04'02.64" E
Studenaya	Russia	18	15	62°00' N, 58°44’ E
Betovo	Russia	42	38	53°20'38.76" N, 34°1'1.9" E
Lobva	Russia	22	8	59°10'44.79" N, 60°29'54.12" E
Pymva Shor	Russia	8	8	67°10' N, 60°51' E
Yangana Pe-	Russia	12	9	
Rasik	Russia	15	13	59°02'24" N 57°19'48" E
Makhnevskaya-2 cave	Russia	30	16	59°27'00” N, 57°41'20” E
Sikiyaz Tamak 22	Russia	1	1	55°11'24" N, 59°11'24" E
Ushminskaya cave	Russia	3	0	61°16'12" N, 60° 01'48" E
Dyrovatyi Kamen cave	Russia	3	2	57°23'24" N, 58°32'24" E
Staroe Logovo	Russia	3	1	55°13'31" N, 58°07'33" E
Kipievo site	Russia	1	1	65°39'48" N, 54°31'29" E
Shapkina-18	Russia	1	0	67°10'46" N, 53°59'04" E
Shapkina-1	Russia	1	1	67°40'32" N,.56°43'01" E
Kur'yador	Russia	1	0	61°40'60" N, 54°53'34" E
Sedyu-1	Russia	1	1	63°24'57" N, 53°59'46" E
Pizhma-1	Russia	1	1	64°55'09" N, 51°39'49" E
Serche'yu-3	Russia	1	0	67° 00'28" N, 55°33'13" E
Laya-2 site	Russia	1	0	67°10'10" N, 55°46'41" E
Bison's site	Russia	7	1	65°27' N, 124°07' E

Ostrov Bolshevik	Russia	7	7	79°29'47.95" N, 97°19'00.82" E
Kyttyk peninsula	Russia	16	15	69°29'17" N, 167°45'6" E
Batagaika	Russia	1	1	67°41'33.98" N, 134°39'14.15" E
Yana HRS site	Russia	2	2	70°43' N, 135°25' E
Tordokh site	Russia	2	1	75°20'50" N, 146°47'50" E
Duvanny Yar site	Russia	3	2	68°37' N, 159°11' E
Bulunskiy district, Sakha Republic (modern)	Russia	5	5	72°34'12"N, 124°43'48"E
Taymyr Peninsula-Lukunskiy sector (modern)	Russia	6	6	72° 29' 24"N, 105° 4' 48"E
Taymyr Peninsula-Verchnya Taymira river (modern)	Russia	2	2	74° 6' 36"N, 98° 50' 24"E
January Cave	Canada	2	2	50°10'60" N, 114°31'00" W
Eagle Cave	Canada	5	2	49°38'10" N, 114°38'24" W
Total		621	317	

Table S2. Details of collared lemming specimens analysed in this study. Radiocarbon dates (^{14}C) and median, 95% upper and lower calibrated dates are given in years before present. Median ages, although not recommended for use on single age calibration, were used as tip-dates for internal calibration of the tree. Specimens that provided complete cyt *b* sequences are shown.

Specimen ID	Region	Site	^{14}C date	^{14}C error (±)	14C Lab Nr	Median cal. date	lower 95% cal. date	upper 95% cal. date	Median age or age-range used for tip-dating	Haplotype	Accession No.
E011	Belgium	Marie-Jeanne cave	-	-	-	-	-	-	-	H51	KT867382
E031	Belgium	Marie-Jeanne cave	-	-	-	-	-	-	-	H52	KT867383
E032	Belgium	Marie-Jeanne cave	-	-	-	-	-	-	-	H53	KT867384
E033	Belgium	Marie-Jeanne cave	-	-	-	-	-	-	-	H54	KT867385
E039	Belgium	Marie-Jeanne cave	-	-	-	-	-	-	-	H55	KT867386
E040	Belgium	Marie-Jeanne cave	-	-	-	-	-	-	-	H56	KT867387
E042	Belgium	Marie-Jeanne cave	20310	150	OxA-30002	24412	24022	24942	24412	H57	KT867388
E043	Belgium	Marie-Jeanne cave	13760	70	OxA-30003	16630	16350	16923	16630	H06	*JX867569*
E046	Belgium	Marie-Jeanne cave	-	-	-	-	-	-	-	H58	KT867389
E073	W.Russia	Yudinovo	14465	80	OxA-X-2575-46	17634	17408	17895	17634	H59	KT867390
E081	W.Russia	Studenaya	-	-	failed	-	-	-	26200-29385	H60	KT867391
E082	W.Russia	Studenaya	-	-	failed	-	-	-	26200-29385	H61	KT867379
E083	W.Russia	Studenaya	-	-	failed	-	-	-	26200-29385	H62	KT867392
E084	W.Russia	Studenaya	-	-	failed	-	-	-	26200-29385	H63	KT867393
E085	W.Russia	Yudinovo	14345	75	OxA-30001	17481	17202	17711	17481	H59	KT867390
E088	W.Russia	Yudinovo	-	-	failed	-	-	-	17202-17895	H64	KT867394
E089	W.Russia	Yudinovo	-	-	failed	-	-	-	17202-	H59	KT867390

									17895		
E092	W.Russia	Studenaya	-	-	failed	-	-	-	26200-29385	H65	KT867395
E093	W.Russia	Studenaya	23730	170	OxA-X-2581-7	27819	27534	28179	26200-29385	H66	KT867396
E094	W.Russia	Studenaya	24180	180	OxA-X-2581-8	28218	27834	28625	26200-29385	H67	KT867397
E096	W.Russia	Studenaya	24790	220	OxA-30032	28842	28380	29385	28842	H68	KT867398
E097	W.Russia	Studenaya	22470	170	OxA-30033	26783	26304	27229	26783	H69	KT867399
E098	W.Russia	Studenaya	22380	170	OxA-30034	26676	26200	27143	26676	H70	KT867400
E099	W.Russia	Studenaya	-	-	-	-	-	-	26200-29385	H71	KT867401
E100	W.Russia	Studenaya	-	-	-	-	-	-	26200-29385	H72	KT867402
E101	W.Russia	Studenaya	-	-	-	-	-	-	26200-29385	H73	KT867380
E102	W.Russia	Betovo	-	-	failed	-	-	-	26254-31599	H74	KT867403
E103	W.Russia	Betovo	-	-	failed	-	-	-	26254-31599	H75	KT867404
E104	W.Russia	Betovo	-	-	failed	-	-	-	26254-31599	H76	KT867405
E105	W.Russia	Betovo	-	-	failed	-	-	-	26254-31599	H77	KT867406
E106	W.Russia	Betovo	27240	290	OxA-29989	31188	30813	31599	31188	H78	KT867407
E107	W.Russia	Betovo	23610	190	OxA-29750	27733	27427	28072	27733	H79	KT867408
E108	W.Russia	Betovo	-	-	failed	-	-	-	26254-31599	H80	KT867409
E109	W.Russia	Betovo	24320	210	OxA-29751	28351	27889	28774	28351	H81	KT867410
E110	W.Russia	Betovo	-	-	failed	-	-	-	26254-31599	H82	KT867411
E111	W.Russia	Betovo	-	-	failed	-	-	-	26254-31599	H83	KT867412
E112	W.Russia	Betovo	23150	220	OxA-29681	27433	27057	27769	27433	H84	KT867413
E113	W.Russia	Betovo	24660	220	OxA-29752	28705	28195	29245	28705	H81	KT867410
E114	W.Russia	Betovo	-	-	failed	-	-	-	26254-	H82	KT867411

									31599		
E115	W.Russia	Betovo	24080	200	OxA-29753	28132	27755	28571	28132	H79	KT867408
E116	W.Russia	Betovo	-	-	failed	-	-	-	26254-31599	H85	KT867414
E117	W.Russia	Betovo	-	-	-	-	-	-	26254-31599	H84	KT867413
E118	W.Russia	Betovo	22460	190	OxA-29682	26769	26254	27241	26769	H82	KT867411
E119	W.Russia	Betovo	22680	150	OxA-29754	27014	26576	27368	27014	H86	KT867415
E120	W.Russia	Betovo	24030	190	OxA-29755	28085	27731	28517	28085	H87	KT867416
E121	W.Russia	Betovo	-	-	-	-	-	-	26254-31599	H88	KT867417
E122	W.Russia	Betovo	-	-	-	-	-	-	26254-31599	H81	KT867410
E123	W.Russia	Betovo	23970	200	OxA-29756	28036	27687	28487	28036	H77	KT867406
E125	W.Russia	Betovo	25630	250	OxA-29757	29821	29175	30552	29821	H89	KT867418
E126	W.Russia	Betovo	23000	190	OxA-29683	27322	26927	27675	27322	H74	KT867403
E127	W.Russia	Betovo	-	-	-	-	-	-	26254-31599	H90	KT867419
E128	W.Russia	Betovo	-	-	-	-	-	-	26254-31599	H74	KT867403
E132	W.Russia	Betovo	-	-	-	-	-	-	26254-31599	H82	KT867411
E133	W.Russia	Betovo	-	-	-	-	-	-	26254-31599	H91	KT867420
E134	W.Russia	Betovo	-	-	-	-	-	-	26254-31599	H82	KT867411
E140	UK	Merlin cave	-	-	failed	-	-	-	14362-15301	H06	*JX867569*
E141	Canada	January Cave (P80.1.7900)	-	-	-	-	-	-	33688-39994	H92	KT867421
E142	Canada	January Cave (P80.1.7886)	-	-	failed	-	-	-	33688-39994	H93	KT867422
E146	W.Russia	Studenaya	-	-	failed	-	-	-	26200-29385	H94	KT867423
E147	W.Russia	Studenaya	-	-	failed	-	-	-	26200-29385	H95	KT867424

E157	E.Russia	Bison's site	-	-	-	-	-	-	50000-70000	H96	KT867425
E165	W.Russia	Lobva	-	-	-	-	-	-	0-14401	H97	KT867426
E166	W.Russia	Lobva	-	-	-	-	-	-	0-14401	H98	KT867427
E175	W.Russia	Lobva	-	-	-	-	-	-	0-14401	H99	KT867428
E176	W.Russia	Lobva	-	-	failed	-	-	-	0-14401	H100	KT867429
E177	W.Russia	Lobva	-	-	failed	-	-	-	0-14401	H101	KT867430
E180	W.Russia	Lobva	-	-	-	-	-	-	0-14401	H102	KT867431
E181	W.Russia	Lobva	-	-	-	-	-	-	0-14401	H103	KT867432
E183	W.Russia	Lobva	12540	60	OxA-29633	14834	14401	15130	14834	H104	KT867433
E184	W.Russia	Betovo	23760	170	OxA-29758	27843	27558	28219	27843	H83	KT867412
E185	W.Russia	Betovo	-	-	failed	-	-	-	26254-31599	H87	KT867416
E186	W.Russia	Betovo	-	-	failed	-	-	-	26254-31599	H105	KT867434
E187	W.Russia	Betovo	23020	150	OxA-29759	27345	27055	27615	27345	H106	KT867435
E188	W.Russia	Betovo	23210	180	OxA-29760	27480	27181	27753	27480	H107	KT867436
E189	W.Russia	Betovo	-	-	failed	-	-	-	26254-31599	H108	KT867437
E191	W.Russia	Betovo	26440	230	OxA-29761	30712	30214	31089	30712	H109	KT867438
E192	W.Russia	Betovo	-	-	failed	-	-	-	26254-31599	H110	KT867439
E193	W.Russia	Betovo	23100	170	OxA-29762	27403	27097	27684	27403	H111	KT867440
E195	C.Russia	Ostrov Bolshevik	1,30992	0,00352	OxA-29748	***50***	***46***	***54***	50	H112	KT867441
E196	C.Russia	Ostrov Bolshevik	-	-	-	-	-	-	(0) modern	H113	KT867442
E197	C.Russia	Ostrov Bolshevik	-	-	-	-	-	-	(0) modern	H114	KT867443
E199	C.Russia	Ostrov Bolshevik	-	-	-	-	-	-	(0) modern	H115	KT867444
E200	C.Russia	Ostrov Bolshevik	-	-	-	-	-	-	(0) modern	H116	KT867445
E202	C.Russia	Ostrov Bolshevik	-	-	-	-	-	-	(0) modern	H117	KT867446
E206	C.Russia	Ostrov Bolshevik	-	-	-	-	-	-	(0) modern	H118	KT867447
E208	UK	Merlin cave	-	-	failed	-	-	-	14362-15301	H104	KT867433
E313	E.Russia	Batagaika	>50100	-	OxA-29747	***50229***	***48290***	***Date out***		H119	KT867448

								of range			
E314	Canada	Eagle Cave (P83.1.762)	-	-	failed	-	-	-	25121-100000	H120	KT867449
E315	Canada	Eagle Cave (P95.7.419)	-	-	failed	-	-	-	25121-100000	H121	KT867450
E316	E.Russia	Kyttyk peninsula	-	-	failed	-	-	-	0-1000	M05	*AJ131442*
E317	E.Russia	Kyttyk peninsula	335	24	OxA-28677	386	310	471	386	M05	*AJ131442*
E318	E.Russia	Kyttyk peninsula	-	-	-	-	-	-	0-1000	H122	KT867451
E319	E.Russia	Kyttyk peninsula	-	-	-	-	-	-	0-1000	M05	*AJ131442*
E320	E.Russia	Kyttyk peninsula	-	-	-	-	-	-	0-1000	H123	KT867452
E321	E.Russia	Kyttyk peninsula	260	24	OxA-28678	***301***	***151***	***428***	301	M05	*AJ131442*
E322	E.Russia	Kyttyk peninsula	-	-	-	-	-	-	0-1000	M05	*AJ131442*
E324	E.Russia	Kyttyk peninsula	-	-	-	-	-	-	0-1000	M05	*AJ131442*
E325	E.Russia	Kyttyk peninsula	-	-	-	-	-	-	0-1000	H122	KT867451
E326	E.Russia	Kyttyk peninsula	842	27	OxA-29255	748	690	794	748	H123	KT867452
E327	E.Russia	Kyttyk peninsula	-	-	failed	-	-	-	0-1000	M05	*AJ131442*
E328	E.Russia	Kyttyk peninsula	1,55063	0,0043	OxA-29256	***50***	***46***	***54***	50	M05	*AJ131442*
E329	E.Russia	Kyttyk peninsula	-	-	-	-	-	-	0-1000	M05	*AJ131442*
E330	E.Russia	Kyttyk peninsula	-	-	-	-	-	-	0-1000	M05	*AJ131442*
E331	E.Russia	Kyttyk peninsula	-	-	-	-	-	-	0-1000	H122	KT867451
E332	W.Russia	Pymva Shor	-	-	-	-	-	-	10780-12511	H124	KT867453
E333	W.Russia	Pymva Shor	-	-	failed	-	-	-	25707-26807	H125	KT867454
E334	W.Russia	Pymva Shor	-	-	failed	-	-	-	15408-15946	H102	KT867431
E335	W.Russia	Pymva Shor	-	-	failed	-	-	-	15408-15946	H126	KT867455
E336	W.Russia	Pymva Shor	-	-	failed	-	-	-	15408-15946	H104	KT867433
E337	W.Russia	Pymva Shor	-	-	failed	-	-	-	15408-15946	H127	KT867456
E338	W.Russia	Pymva Shor	-	-	failed	-	-	-	15408-15946	H128	KT867457

E339	W.Russia	Pymva Shor	-	-	failed	-	-	-	15408-15946	H129	KT867458
E354	W.Russia	Yangana Pe-4	-	-	failed	-	-	-	1371-1897	H130	KT867459
E355	W.Russia	Yangana Pe-4	-	-	-	-	-	-	1371-1897	H131	KT867460
E357	W.Russia	Yangana Pe-4	-	-	-	-	-	-	1371-1897	H130	KT867459
E358	W.Russia	Yangana Pe-4	-	-	-	-	-	-	1371-1897	H130	KT867459
E359	W.Russia	Yangana Pe-4	-	-	-	-	-	-	1371-1897	H132	KT867461
E370	Belgium	Bois laiterie	-	-	-	-	-	-	14288-15369	H133	KT867462
E371	Belgium	Bois laiterie	-	-	-	-	-	-	14288-15369	H134	KT867463
E372	UK	Merlin cave	12535	65	OxA-29251	14816	14362	15127	14816	H06	*JX867569*
E373	UK	Merlin cave	12665	75	OxA-29252	15060	14720	15301	15060	H06	*JX867569*
E374	UK	Merlin cave	12545	65	OxA-29253	14839	14387	15140	14839	H06	*JX867569*
E375	UK	Merlin cave	12675	65	OxA-29254	15085	14775	15289	15085	H06	*JX867569*
E376	UK	Kitley cave	-	-	failed	-	-	-	-	H135	KT867464
E391	Belgium	Trou Al'Wesse cave	-	-	failed	-	-	-	-	H136	KT867465
E398	Belgium	Trou Al'Wesse cave	-	-	failed	-	-	-	-	H137	KT867466
E405	W.Russia	Yangana Pe-4	-	-	-	-	-	-	0-1174	H130	KT867459
E406	W.Russia	Yangana Pe-4	-	-	failed	-	-	-	0-1174	H130	KT867459
E407	W.Russia	Yangana Pe-4	-	-	-	-	-	-	0-1174	H130	KT867459
E408	W.Russia	Yangana Pe-4	-	-	-	-	-	-	0-1174	H138	KT867467
E446	Belgium	Trou Al'Wesse cave	38000	1100	OxA-28457	42316	40522	44386	42316	H139	KT867468
E454	Belgium	Trou Al'Wesse cave	-	-	failed	-	-	-	-	H140	KT867469
E456	Germany	Kleine Scheuer am Hohlenstein	-	-	failed	-	-	-	15242-16456	H141	KT867470
E457	Germany	Kleine Scheuer am Hohlenstein	-	-	failed	-	-	-	15242-16456	H06	*JX867569*
E458	Germany	Kleine Scheuer am Hohlenstein	-	-	failed	-	-	-	15242-16456	H142	KT867471
E459	Germany	Kleine Scheuer am Hohlenstein	-	-	failed	-	-	-	15242-16456	H141	KT867470
L3	Poland	Biśnik Cave	-	-	-	-	-	-	-	H145	KT867474

L4	Poland	Biśnik Cave	-	-	-	-	-	-	-	H197	KT867525
L6	Poland	Biśnik Cave	-	-	-	-	-	-	-	H147	KT867476
L13	Poland	Biśnik Cave	-	-	-	-	-	-	-	H149	KT867381
L14	Poland	Biśnik Cave	-	-	-	-	-	-	-	H10	*JX867573*
L28	Poland	Biśnik Cave	-	-	-	-	-	-	-	H10	*JX867573*
L29	Poland	Biśnik Cave	-	-	-	-	-	-	-	H59	KT867390
L30	Poland	Biśnik Cave	-	-	-	-	-	-	-	H87	KT867416
L31	Poland	Biśnik Cave	-	-	-	-	-	-	-	H191	KT867519
L32	Poland	Biśnik Cave	-	-	-	-	-	-	-	H59	KT867390
L33	Poland	Biśnik Cave	-	-	-	-	-	-	-	H59	KT867390
L34	Poland	Biśnik Cave	-	-	-	-	-	-	-	H193	KT867521
L36	Poland	Biśnik Cave	-	-	-	-	-	-	-	H143	KT867472
L37	Poland	Biśnik Cave	-	-	-	-	-	-	-	H59	KT867390
L39	Poland	Biśnik Cave	-	-	-	-	-	-	-	H165	KT867493
L47	Poland	Biśnik Cave	-	-	-	-	-	-	-	H05	*JX867568*
L48	Poland	Biśnik Cave	-	-	-	-	-	-	-	H147	KT867476
L49	Poland	Biśnik Cave	-	-	-	-	-	-	-	H59	KT867390
L50	Poland	Biśnik Cave	-	-	-	-	-	-	-	H165	KT867493
L51	Poland	Biśnik Cave	-	-	-	-	-	-	-	H05	*JX867568*
L52	Poland	Biśnik Cave	-	-	-	-	-	-	-	H59	KT867390
L66	Poland	Biśnik Cave	-	-	-	-	-	-	-	H59	KT867390
L68	Poland	Biśnik Cave	-	-	-	-	-	-	-	H198	KT867526
L69	Poland	Biśnik Cave	-	-	-	-	-	-	-	H141	KT867470
L70	Poland	Biśnik Cave	-	-	-	-	-	-	-	H145	KT867474
L71	Poland	Biśnik Cave	-	-	-	-	-	-	-	H10	*JX867573*
L72	Poland	Biśnik Cave	-	-	-	-	-	-	-	H145	KT867474
L73	Poland	Biśnik Cave	-	-	-	-	-	-	-	H87	KT867416
L74	Poland	Biśnik Cave	-	-	-	-	-	-	-	H59	KT867390
L75	Poland	Biśnik Cave	-	-	-	-	-	-	-	H143	KT867472
L76	Poland	Biśnik Cave	-	-	-	-	-	-	-	H199	KT867527

L81	Poland	Biśnik Cave	-	-	-	-	-	-	-	H87	KT867416
L82	Poland	Biśnik Cave	-	-	-	-	-	-	-	H10	*JX867573*
L83	Poland	Biśnik Cave	-	-	-	-	-	-	-	H10	*JX867573*
L84	Poland	Biśnik Cave	-	-	-	-	-	-	-	H10	*JX867573*
L85	Poland	Biśnik Cave	-	-	-	-	-	-	-	H143	KT867472
L86	Poland	Biśnik Cave	-	-	-	-	-	-	-	H147	KT867476
L87	Poland	Biśnik Cave	-	-	-	-	-	-	-	H10	*JX867573*
L88	Poland	Biśnik Cave	-	-	-	-	-	-	-	H200	KT867528
L89	Poland	Biśnik Cave	-	-	-	-	-	-	-	H200	KT867528
L90	Poland	Biśnik Cave	-	-	-	-	-	-	-	H59	KT867390
L95	Poland	Biśnik Cave	-	-	-	-	-	-	-	H10	*JX867573*
L96	Poland	Biśnik Cave	-	-	-	-	-	-	-	H201	KT867529
L98	Poland	Biśnik Cave	-	-	-	-	-	-	-	H59	KT867390
L99	Poland	Biśnik Cave	-	-	-	-	-	-	-	H59	KT867390
L102	Poland	Biśnik Cave	-	-	-	-	-	-	-	H59	KT867390
L104	Poland	Biśnik Cave	-	-	-	-	-	-	-	H143	KT867472
L105	Poland	Biśnik Cave	-	-	-	-	-	-	-	H59	KT867390
L106	Poland	Biśnik Cave	-	-	-	-	-	-	-	H125	KT867454
L107	Poland	Biśnik Cave	-	-	-	-	-	-	-	H144	KT867473
L108	Poland	Biśnik Cave	-	-	-	-	-	-	-	H59	KT867390
L109	Poland	Biśnik Cave	-	-	-	-	-	-	-	H143	KT867472
L110	Poland	Biśnik Cave	-	-	-	-	-	-	-	H145	KT867474
L111	Poland	Biśnik Cave	-	-	-	-	-	-	-	H59	KT867390
L112	Poland	Biśnik Cave	-	-	-	-	-	-	-	H59	KT867390
L113	Poland	Biśnik Cave	-	-	-	-	-	-	-	H59	KT867390
L114	Poland	Biśnik Cave	-	-	-	-	-	-	-	H59	KT867390
L115	Poland	Biśnik Cave	-	-	-	-	-	-	-	H59	KT867390
L116	Poland	Biśnik Cave	-	-	-	-	-	-	-	H59	KT867390
L117	Poland	Biśnik Cave	-	-	-	-	-	-	-	H59	KT867390
L120	Poland	Biśnik Cave	-	-	-	-	-	-	-	H146	KT867475

L123	Poland	Biśnik Cave	-	-	-	-	-	-	-	H147	KT867476
L124	Poland	Biśnik Cave	-	-	-	-	-	-	-	H147	KT867476
L125	Poland	Biśnik Cave	-	-	-	-	-	-	-	H87	KT867416
L127	Poland	Biśnik Cave	-	-	-	-	-	-	-	H145	KT867474
L129	Poland	Biśnik Cave	-	-	-	-	-	-	-	H143	KT867472
L130	Poland	Biśnik Cave	-	-	-	-	-	-	-	H148	KT867477
L131	Poland	Biśnik Cave	-	-	-	-	-	-	-	H141	KT867470
L132	Poland	Biśnik Cave	-	-	-	-	-	-	-	H148	KT867477
L133	Poland	Biśnik Cave	-	-	-	-	-	-	-	H06	*JX867569*
L134	Poland	Biśnik Cave	-	-	-	-	-	-	-	H141	KT867470
L135	Poland	Biśnik Cave	-	-	-	-	-	-	-	H06	*JX867569*
L141	Poland	Biśnik Cave	-	-	-	-	-	-	-	H150	KT867478
L142	Poland	Biśnik Cave	-	-	-	-	-	-	-	H06	*JX867569*
L143	Poland	Biśnik Cave	-	-	-	-	-	-	-	H10	*JX867573*
L144	Poland	Biśnik Cave	-	-	-	-	-	-	-	H148	KT867477
L145	Poland	Biśnik Cave	-	-	-	-	-	-	-	H145	KT867474
L146	Poland	Biśnik Cave	-	-	-	-	-	-	-	H59	KT867390
L147	Poland	Biśnik Cave	-	-	-	-	-	-	-	H59	KT867390
L148	Poland	Biśnik Cave	-	-	-	-	-	-	-	H145	KT867474
L149	Poland	Biśnik Cave	-	-	-	-	-	-	-	H145	KT867474
L150	Poland	Biśnik Cave	-	-	-	-	-	-	-	H10	*JX867573*
L151	Poland	Biśnik Cave	-	-	-	-	-	-	-	H147	KT867476
L152	Poland	Biśnik Cave	-	-	-	-	-	-	-	H10	*JX867573*
L153	Poland	Biśnik Cave	-	-	-	-	-	-	-	H147	KT867476
L154	Poland	Biśnik Cave	-	-	-	-	-	-	-	H151	KT867479
L156	Poland	Biśnik Cave	-	-	-	-	-	-	-	H87	KT867416
L157	Poland	Biśnik Cave	-	-	-	-	-	-	-	H152	KT867480
L158	Poland	Biśnik Cave	-	-	-	-	-	-	-	H87	KT867416
L159	Poland	Biśnik Cave	-	-	-	-	-	-	-	H153	KT867481
L160	Poland	Biśnik Cave	-	-	-	-	-	-	-	H25	*JX867588*

L161	Poland	Biśnik Cave	-	-	-	-	-	-	-	H10	*JX867573*
L162	Poland	Biśnik Cave	-	-	-	-	-	-	-	H125	KT867454
L163	Poland	Biśnik Cave	-	-	-	-	-	-	-	H147	KT867476
L164	Poland	Biśnik Cave	-	-	-	-	-	-	-	H59	KT867390
L165	Poland	Biśnik Cave	-	-	-	-	-	-	-	H145	KT867474
L166	Poland	Biśnik Cave	-	-	-	-	-	-	-	H10	*JX867573*
L167	Poland	Biśnik Cave	-	-	-	-	-	-	-	H154	KT867482
L168	Poland	Biśnik Cave	-	-	-	-	-	-	-	H10	*JX867573*
L169	Poland	Biśnik Cave	-	-	-	-	-	-	-	H147	KT867476
L170	Poland	Biśnik Cave	-	-	-	-	-	-	-	H59	KT867390
L171	Poland	Biśnik Cave	-	-	-	-	-	-	-	H59	KT867390
L172	Poland	Biśnik Cave	-	-	-	-	-	-	-	H141	KT867470
L173	Poland	Biśnik Cave	-	-	-	-	-	-	-	H141	KT867470
L176	Poland	Biśnik Cave	-	-	-	-	-	-	-	H155	KT867483
L177	Poland	Biśnik Cave	-	-	-	-	-	-	-	H06	*JX867569*
L178	Poland	Biśnik Cave	-	-	-	-	-	-	-	H06	*JX867569*
L179	Poland	Biśnik Cave	-	-	-	-	-	-	-	H141	KT867470
L180	Poland	Biśnik Cave	-	-	-	-	-	-	-	H05	*JX867568*
L181	Poland	Biśnik Cave	-	-	-	-	-	-	-	H156	KT867484
L182	Poland	Biśnik Cave	-	-	-	-	-	-	-	H157	KT867485
L183	Poland	Biśnik Cave	-	-	-	-	-	-	-	H158	KT867486
L184	W.Russia	Dyrovatyi Kamen cave	-	-	-	-	-	-	15187-15991	H102	KT867431
L185	W.Russia	Dyrovatyi Kamen cave	-	-	-	-	-	-	15187-15991	H159	KT867487
L187	W.Russia	Staroe logovo	-	-	-	-	-	-	-	H160	KT867488
L193	Poland	Biśnik Cave	-	-	-	-	-	-	-	H87	KT867416
L194	Poland	Biśnik Cave	-	-	-	-	-	-	-	H161	KT867489
L195	Poland	Biśnik Cave	-	-	-	-	-	-	-	H162	KT867490
L196	Poland	Biśnik Cave	-	-	-	-	-	-	-	H163	KT867491
L197	Poland	Biśnik Cave	-	-	-	-	-	-	-	H164	KT867492

L200	Poland	Biśnik Cave	16040	230	OxA-X-2507-16	19360	18855	19940	19360	H59	KT867390
L202	Poland	Biśnik Cave	14705	65	OxA-27591	17897	17684	18083	17897	H165	KT867493
L209	Poland	Biśnik Cave	15800	70	OxA-27592	19051	18875	19255	19051	H59	KT867390
L210	Poland	Biśnik Cave	15600	80	OxA-27633	18847	18677	19025	18847	H143	KT867472
L211	Poland	Biśnik Cave	19470	130	OxA-27906	23452	23052	23821	23452	H157	KT867485
L215	Poland	Biśnik Cave	13430	75	OxA-27905	16159	15901	16411	16159	H10	*JX867573*
L216	Poland	Biśnik Cave	14390	70	OxA-27589	17539	17295	17795	17539	H148	KT867477
L222	Poland	Biśnik Cave	14480	90	OxA-27907	17652	17407	17920	17652	H166	KT867494
L223	Poland	Biśnik Cave	15025	75	OxA-27631	18256	18011	18475	18256	H59	KT867390
L224	Poland	Biśnik Cave	20610	140	OxA-27632	24822	24407	25251	24822	H167	KT867495
L225	Poland	Biśnik Cave	15220	90	OxA-27908	18487	18265	18711	18487	H147	KT867476
L236	Poland	Biśnik Cave	13580	65	OxA-27514	16362	16146	16626	16362	H59	KT867390
L237	Poland	Biśnik Cave	15120	70	OxA-27634	18380	18151	18581	18380	H147	KT867476
L241	Poland	Biśnik Cave	15485	80	OxA-X-2504-49	18747	18577	18905	18747	H59	KT867390
L242	Poland	Biśnik Cave	13075	65	OxA-2759	15674	15369	15925	15674	H141	KT867470
L243	Poland	Biśnik Cave	17790	90	OxA-27593	21550	21247	21841	21550	H10	*JX867573*
L248	Poland	Obłazowa Cave	21770	180	OxA-X-2543-31	26017	25706	26422	26017	H87	KT867416
L257	Poland	Obłazowa Cave	25930	380	OxA-X-2543-17	30139	29314	30917	30139	H168	KT867496
L260	E.Russia	Yana RHS	-	-	-	-	-	-	30881-33440	H169	KT867497
L261	E.Russia	Yana RHS	-	-	-	-	-	-	30881-33440	H169	KT867497
L269	W.Russia	Sikiyaz-Tamak 22	-	-	-	-	-	-	-	H170	KT867498
L270	W.Russia	Rasik	-	-	-	-	-	-	34871-100000	H171	KT867499
L271	W.Russia	Rasik	-	-	-	-	-	-	34871-100000	H172	KT867500
L273	W.Russia	Rasik	-	-	-	-	-	-	34871-100000	H173	KT867501
L275	W.Russia	Rasik	-	-	-	-	-	-	14239-16281	H102	KT867431
L276	W.Russia	Rasik	-	-	-	-	-	-	14239-16281	H174	KT867502

L277	W.Russia	Rasik	-	-	-	-	-	-	14239-16281	H102	KT867431
L278	W.Russia	Rasik	-	-	-	-	-	-	14239-16281	H175	KT867503
L279	W.Russia	Rasik	-	-	-	-	-	-	14239-16281	H104	KT867433
L280	W.Russia	Rasik	-	-	-	-	-	-	14239-16281	H59	KT867390
L281	W.Russia	Rasik	-	-	-	-	-	-	14239-16281	H104	KT867433
L282	W.Russia	Rasik	-	-	-	-	-	-	14239-16281	H176	KT867504
L283	W.Russia	Rasik	-	-	-	-	-	-	14239-16281	H59	KT867390
L284	W.Russia	Rasik	-	-	-	-	-	-	14239-16281	H177	KT867505
L285	W.Russia	Makhnevskaya-2 Cave	-	-	-	-	-	-	-	H178	KT867506
L287	W.Russia	Makhnevskaya-2 Cave	-	-	-	-	-	-	-	H179	KT867507
L295	W.Russia	Makhnevskaya-2 Cave	-	-	-	-	-	-	-	H180	KT867508
L298	W.Russia	Makhnevskaya-2 Cave	-	-	-	-	-	-	-	H181	KT867509
L299	W.Russia	Makhnevskaya-2 Cave	-	-	-	-	-	-	-	H182	KT867510
L300	W.Russia	Makhnevskaya-2 Cave	-	-	-	-	-	-	-	H183	KT867511
L301	W.Russia	Makhnevskaya-2 Cave	-	-	-	-	-	-	-	H184	KT867512
L302	W.Russia	Makhnevskaya-2 Cave	-	-	-	-	-	-	-	H87	KT867416
L303	W.Russia	Makhnevskaya-2 Cave	-	-	-	-	-	-	-	H185	KT867513
L304	W.Russia	Makhnevskaya-2 Cave	-	-	-	-	-	-	-	H186	KT867514
L306	W.Russia	Makhnevskaya-2 Cave	-	-	-	-	-	-	-	H69	KT867399
L307	W.Russia	Makhnevskaya-2 Cave	-	-	-	-	-	-	-	H187	KT867515
L308	W.Russia	Makhnevskaya-2 Cave	-	-	-	-	-	-	-	H87	KT867416
L310	W.Russia	Makhnevskaya-2 Cave	-	-	-	-	-	-	-	H87	KT867416
L312	W.Russia	Makhnevskaya-2 Cave	-	-	-	-	-	-	-	H188	KT867516
L313	W.Russia	Makhnevskaya-2 Cave	-	-	-	-	-	-	-	H189	KT867517
L315	W.Russia	Kipievo Upper	-	-	-	-	-	-	-	H69	KT867399

L317	W.Russia	Shaplkina-1	-	-	-	-	-	-	-	H104	KT867433
L319	W.Russia	Sed'Yu-1	-	-	-	-	-	-	-	H190	KT867518
L320	W.Russia	Pizhma-1	-	-	-	-	-	-	-	H192	KT867520
LP12	Poland	Biśnik Cave	16900	90	OxA-28798	20383	20107	20625	20383	H10	*JX867573*
LP17	Poland	Biśnik Cave	19010	120	OxA-28799	22885	22535	23267	22885	H202	KT867530
LP19	Poland	Biśnik Cave	17210	90	OxA-28800	20757	20511	21025	20757	H145	KT867474
LP20	Poland	Biśnik Cave	18320	320	OxA-X-2543-30	22157	21390	22921	22157	H10	*JX867573*
L372	E.Russia	Tordokh Site	-	-	-	-	-	-	-	H194	KT867522
L373	E.Russia	Duvanny Yar site	-	-	-	-	-	-	-	H195	KT867523
L374	E.Russia	Duvanny Yar site	-	-	-	-	-	-	-	H196	KT867524
LW1	E.Russia	Bulunskiy district	-	-	-	-	-	-	0 (modern)	H205	KT867533
LW2	E.Russia	Bulunskiy district	-	-	-	-	-	-	0 (modern)	H206	KT867534
LW3	E.Russia	Bulunskiy district	-	-	-	-	-	-	0 (modern)	H207	KT867535
LW4	E.Russia	Bulunskiy district	-	-	-	-	-	-	0 (modern)	H208	KT867536
LW5	E.Russia	Bulunskiy district	-	-	-	-	-	-	0 (modern)	H208	KT867536
LW6	C.Russia	Taymyr Peninsula-Lukunskiy sector	-	-	-	-	-	-	0 (modern)	M09	*AJ131440*
LW7	C.Russia	Taymyr Peninsula-Lukunskiy sector	-	-	-	-	-	-	0 (modern)	M09	*AJ131440*
LW9	C.Russia	Taymyr Peninsula-Lukunskiy sector	-	-	-	-	-	-	0 (modern)	H209	KT867537
LW10	C.Russia	Taymyr Peninsula-Lukunskiy sector	-	-	-	-	-	-	0 (modern)	M09	*AJ131440*
LW13	C.Russia	Taymyr Peninsula-Lukunskiy sector	-	-	-	-	-	-	0 (modern)	M09	*AJ131440*
LW14	C.Russia	Taymyr Peninsula-Lukunskiy sector	-	-	-	-	-	-	0 (modern)	M09	*AJ131440*
LW15	C.Russia	Taymyr Peninsula-Verchnya Taymira river	-	-	-	-	-	-	0 (modern)	H203	KT867531
LW16	C.Russia	Taymyr Peninsula-Verchnya Taymira river	-	-	-	-	-	-	0 (modern)	H204	KT867532

Median calibrated date and 95% upper and lower calibrated date in italics indicates that the distribution of the calibrated date extended outside the range of the calibration curve. Accession No. in italics indicates previously published haplotype.

Table S3. Details of previously published modern and ancient DNA collared lemming sequences. Radiocarbon dates (^{14}C) and median, 95% upper, lower calibrated dates are given in years before present.

Specimen ID	Region	Site	^{14}C date	^{14}C error (±)	14C Lab Nr	Median cal. date	lower 95% cal. date	upper 95% cal. date	Median age or age-range used for tip-dating	Haplotype	Accession No.
E012	Belgium	Marie-Jeanne cave	-	-	failed	-	-	-	-	H37	JX867600
E014	Belgium	Marie-Jeanne cave	-	-	failed	-	-	-	-	H33	JX867596
E015	Belgium	Marie-Jeanne cave	47600	3300	OxA24115	***49601***	***42622***	***Date out of range***	49601	H39	JX867602
E017	Belgium	Marie-Jeanne cave	> 43900	-	OxA24116	-	-	-	-	H50	JX867613
E018	Belgium	Marie-Jeanne cave	43000	1900	OxA24117	***46667***	***44124***	***Date out of range***	46667	H41	JX867604
E019	Belgium	Marie-Jeanne cave	43600	2100	OxA24118	***47101***	***44458***	***Date out of range***	47101	H40	JX867603
E020	Belgium	Marie-Jeanne cave	-	-	-	-	-	-	-	H43	JX867606
E023	Belgium	Marie-Jeanne cave	-	-	-	-	-	-	-	H36	JX867599
E024	Belgium	Marie-Jeanne cave	-	-	-	-	-	-	-	H45	JX867608
E026	Belgium	Marie-Jeanne cave	40500	1400	OxA24119	***44356***	***42195***	***47430***	44356	H35	JX867598
E027	Belgium	Marie-Jeanne cave	-	-	-	-	-	-	-	H44	JX867607
E029	Belgium	Marie-Jeanne cave	44400	2300	OxA24120	***47561***	***44919***	***Date out of range***	47561	H42	JX867605
E036	Belgium	Marie-Jeanne cave	> 43700	-	OxA24121	-	-	-	-	H34	JX867597
E045	Belgium	Marie-Jeanne cave	12275	55	OxA24122	14199	14008	14546	14199	H06	JX867569
E047	Belgium	Marie-Jeanne cave	20930	140	OxA24123	25267	24807	25648	25267	H20	JX867583
E049	Belgium	Marie-Jeanne cave	-	-	-	-	-	-	-	H49	JX867612
E050	Belgium	Marie-Jeanne cave	-	-	-	-	-	-	-	H47	JX867610
E051	Belgium	Marie-Jeanne cave	-	-	-	-	-	-	-	H48	JX867611
E052	Belgium	Marie-Jeanne cave	>43000		OxA24124	-	-	-	-	H46	JX867609

BS126	Belgium	Trou Al' Wesse cave	16980	110	OxA-2352-41	20478	20154	20784	20478	H08	JX867571
BS127	Belgium	Trou Al' Wesse cave	16440	100	OxA-23565	19834	19566	20096	19834	H06	JX867569
BS128	Belgium	Trou Al' Wesse cave	14415	70	OxA-2354-15	17570	17341	17831	17570	H06	JX867569
BS129	Belgium	Trou Al' Wesse cave	26830	360	OxA-23566	30952	30354	31439	30952	H32	JX867595
BS130	Belgium	Trou Al' Wesse cave	22500	190	OxA-2354-16	26811	26305	27281	26811	H24	JX867587
BS131	Belgium	Trou Al' Wesse cave	26300	380	OxA-2352-42	30498	29650	31105	30498	H23	JX867586
BS132	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H30	JX867593
BS133	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H28	JX867591
BS134	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H27	JX867590
BS135	Belgium	Trou Al' Wesse cave	25650	450	OxA-2352-11	29852	28879	30806	29852	H26	JX867589
BS136	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H25	JX867588
BS144	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H38	JX867601
BS145	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H29	JX867592
BS146	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H31	JX867594
BS147	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H10	JX867573
BS148	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H10	JX867573
BS149	UK	Bridged Pot Cave	-	-	-	-	-	-	11500-12800	H03	JX867566
BS150	UK	Bridged Pot Cave	-	-	-	-	-	-	11500-12800	H02	JX867565
BS151	UK	Bridged Pot Cave	-	-	-	-	-	-	11500-12800	H03	JX867566
BS152	UK	Bridged Pot Cave	-	-	-	-	-	-	11500-12800	H03	JX867566
BS153	UK	Bridged Pot Cave	-	-	-	-	-	-	11500-12800	H01	JX867564
BS36	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H06	JX867569
BS37	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H06	JX867569
BS38	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H06	JX867569
BS39	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H06	JX867569
BS40	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H06	JX867569
BS41	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H24	JX867587

BS43	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H10	JX867573
BS46	Belgium	Trou Al' Wesse cave	18260	120	OxA-23567	22126	21839	22404	22126	H19	JX867582
BS47	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H21	JX867584
BS48	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H22	JX867585
BS49	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H05	JX867568
BS51	Belgium	Trou Al' Wesse cave	15150	120	OxA-2352-39	18407	18086	18688	18407	H07	JX867570
BS52	Belgium	Trou Al' Wesse cave	17030	90	OxA-2354-14	20542	20266	20813	20542	H06	JX867569
BS53	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H10	JX867573
BS54	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H09	JX867572
BS55	Belgium	Trou Al' Wesse cave	17780	120	OxA-23563	21531	21145	21871	21531	H10	JX867573
BS56	Belgium	Trou Al' Wesse cave	17780	130	OxA-2352-40	21528	21115	21883	21528	H10	JX867573
BS57	Belgium	Trou Al' Wesse cave	17520	120	OxA-23564	21172	20814	21551	21172	H11	JX867574
BS58	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H06	JX867569
BS61	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H10	JX867573
BS62	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H12	JX867575
BS64	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H10	JX867573
BS65	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H15	JX867578
BS66	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H16	JX867579
BS70	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H09	JX867572
BS71	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H17	JX867580
BS72	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H10	JX867573
BS73	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H13	JX867576
BS74	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H10	JX867573
BS78	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H10	JX867573
BS79	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H04	JX867567
BS80	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H18	JX867581
BS81	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H11	JX867574
BS85	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H10	JX867573
BS86	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H14	JX867577
BS87	Belgium	Trou Al' Wesse cave	-	-	-	-	-	-	-	H10	JX867573

D.t01	E.Russia	Olenekskiy Bay	-	-	-	-	-	-	0 (modern)	M01	AJ238423
D.t02	E.Russia	W.Kolyma	-	-	-	-	-	-	0 (modern)	M02	AJ131441
D.t03	E.Russia	E.Kolyma	-	-	-	-	-	-	0 (modern)	M03	AJ238425
D.t04	E.Russia	E. Kolyma	-	-	-	-	-	-	0 (modern)	M04	AJ238424
D.t05	E.Russia	E. Kolyma	-	-	-	-	-	-	0 (modern)	M05	AJ131442
D.t06	W.Russia	Pechora	-	-	-	-	-	-	0 (modern)	M06	AF119275
D.t07	W.Russia	NE Kanin Peninsula	-	-	-	-	-	-	0 (modern)	M07	AJ238421
D.t08	W.Russia	Yamal Peninsula	-	-	-	-	-	-	0 (modern)	M08	AJ131439
D.t09	C.Russia	Taymyr Peninsula	-	-	-	-	-	-	0 (modern)	M09	AJ131440
D.t10	C.Russia	Taymyr Peninsula	-	-	-	-	-	-	0 (modern)	M10	AJ238422
D.g01	E.Russia	Wrangel Island	-	-	-	-	-	-	0 (modern)	M11	AJ131443
D.g02	Alaska		-	-	-	-	-	-	0 (modern)	M12	AJ131444
D.g03	Alaska		-	-	-	-	-	-	0 (modern)	M13	AJ238426
D.g04	Alaska		-	-	-	-	-	-	0 (modern)	M14	AJ238427
D.g05	Canada		-	-	-	-	-	-	0 (modern)	M15	AJ238428
D.g06	Canada		-	-	-	-	-	-	0 (modern)	M16	AJ238429
D.g07	Canada		-	-	-	-	-	-	0 (modern)	M17	AJ238430
D.g08	Canada		-	-	-	-	-	-	0 (modern)	M18	AJ238431
D.g09	Canada		-	-	-	-	-	-	0 (modern)	M19	AJ238432
D.g10	Canada		-	-	-	-	-	-	0 (modern)	M20	AJ238433
D.g11	Canada		-	-	-	-	-	-	0 (modern)	M21	AJ238434
D.h01	Canada		-	-	-	-	-	-	0 (modern)	M22	AJ238437
D.h02	Canada		-	-	-	-	-	-	0 (modern)	M23	AJ238436
D.h03	Canada		-	-	-	-	-	-	0 (modern)	M24	AJ238438
D.r01	Canada		-	-	-	-	-	-	0 (modern)	M25	AJ238435

Median calibrated date and 95% upper and lower calibrated date in italics indicates that the distribution of the calibrated date extended outside the range of the calibration curve.

Table S4. Primer pairs designed in this study to amplify the cyt *b* gene from *Dicrostonyx* samples.

Primer name	sequence	conc.	Length (bp)	Multiplex reaction
CytB1F	TCGTTGTTATTCAACTATAGAAACACC	0.1 µM	165	1
CytB1R	GGATTTGGATAATTAGGCATAGG	0.1 µM		
CytB2F	GCTCCATCCAACATTTCATCA	0.1 µM	160	2
CytB2R	CGTAATTTACATCTCGGCAAA	0.1 µM		
CytB3F	ACAGCAACAGCATTCTCGTC	0.1 µM	160	1
CytB3R	TTTCAATTATGTTATAGGAGCCGTA	0.1 µM		
CytB4F	TTCATCTGCTTATTCTTACACGTAG	0.1 µM	163	2
CytB4R	CTGTGGCTCCTCAGAAGGAT	0.1 µM		
CytB5F	CAGCATTCATAGGATATGTTCTCC	0.1 µM	169	1
CytB5R	TGGAATGCAAAGAATCGTGT	0.1 µM		
CytB6F	ATGAATCTGAGGGGGCTTCT	0.1 µM	168	2
CytB6R	ATTTTGTCTGCGTCGGAGTT	0.1 µM		
CytB7F	TTTCTTCACGAAACAGGCTCT	0.1 µM	166	1
CytB7R	CTCCGAGAATATCTGGGAAAAA	0.1 µM		
CytB8F	TTTAGGAGCCCTCCTTCTATT	0.2 µM	170	2
CytB8R	GGATCGTAGGATGGCGTAGA	0.2 µM		
CytB9F	CACCACACATTAAGCCAGGA	0.1 µM	160	1
CytB9R	CGGAATGTTAGGCCTCGTT	0.1 µM		
CytB10F	AGTACTAGCCCTCATAACCTTCC	0.2 µM	176	2
CytB10R	TTTGCCGATGATGATGAATG	0.2 µM		
CytB11F	CTCATCCTCACATGAATTGG	0.1 µM	180	1
CytB11R	TTAATCTAGGTCCAGGATGTTGTT	0.1 µM		
Primers for amplification of modern samples				
CytBwspF	GGCTCCCTACTTGGCCTAT	0.1 µM	805	
CytBWspR	ATGTTAGGCCTCGTTGTTTG	0.1 µM		

Figures

Figure S1. Date randomization test performed on original data set (1) and ten replicates with dates ramndomly assigned to sequences (2-11). Filled circles indicate mean estimated substitution rate and lines appropriate 95% HPD intervals. The mean substitution rate estimated from the original dataset falls outside the 95% HPD intervals of substitution rates estimated from the date-randomized datasets, indicating that our original dataset has sufficient temporal signal.

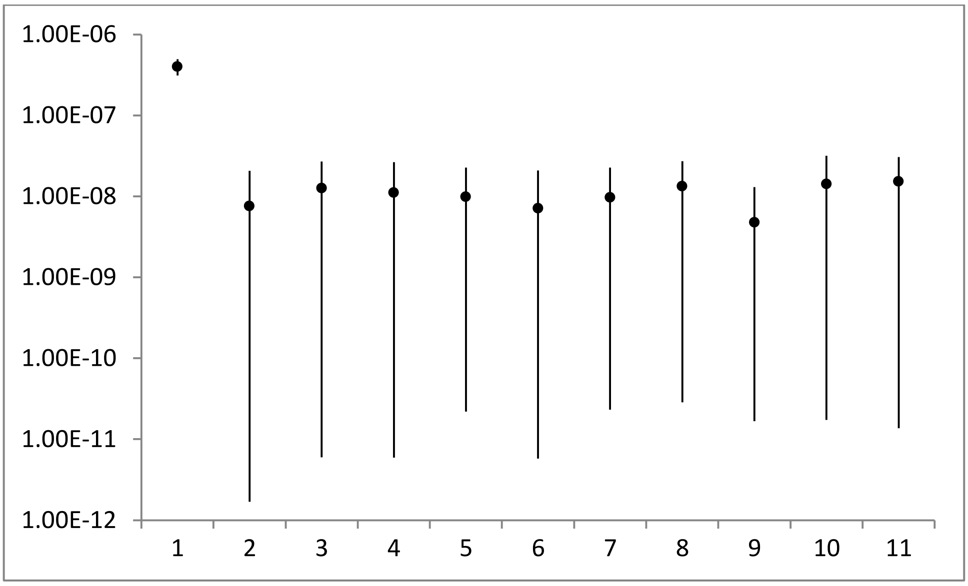

Figure S2. Bayesian phylogeny of mtDNA (cyt *b*) sequences that includes samples with finite radiocarbon dates and samples with assigned prior information on their age based on stratigraphic information and associated dates. Bayesian posterior probabilities of major nodes above 0.8 are shown. The name, locality and median calibrated date or prior range for tip-dating of each sequence are given as tip-labels. Sequences mentioned in the text are coloured in red. The temporal range of each mtDNA lineage is shown next to the vertical dotted lines indicating the lineages. The timescale on the x-axis is in calendar years before present (ky BP).

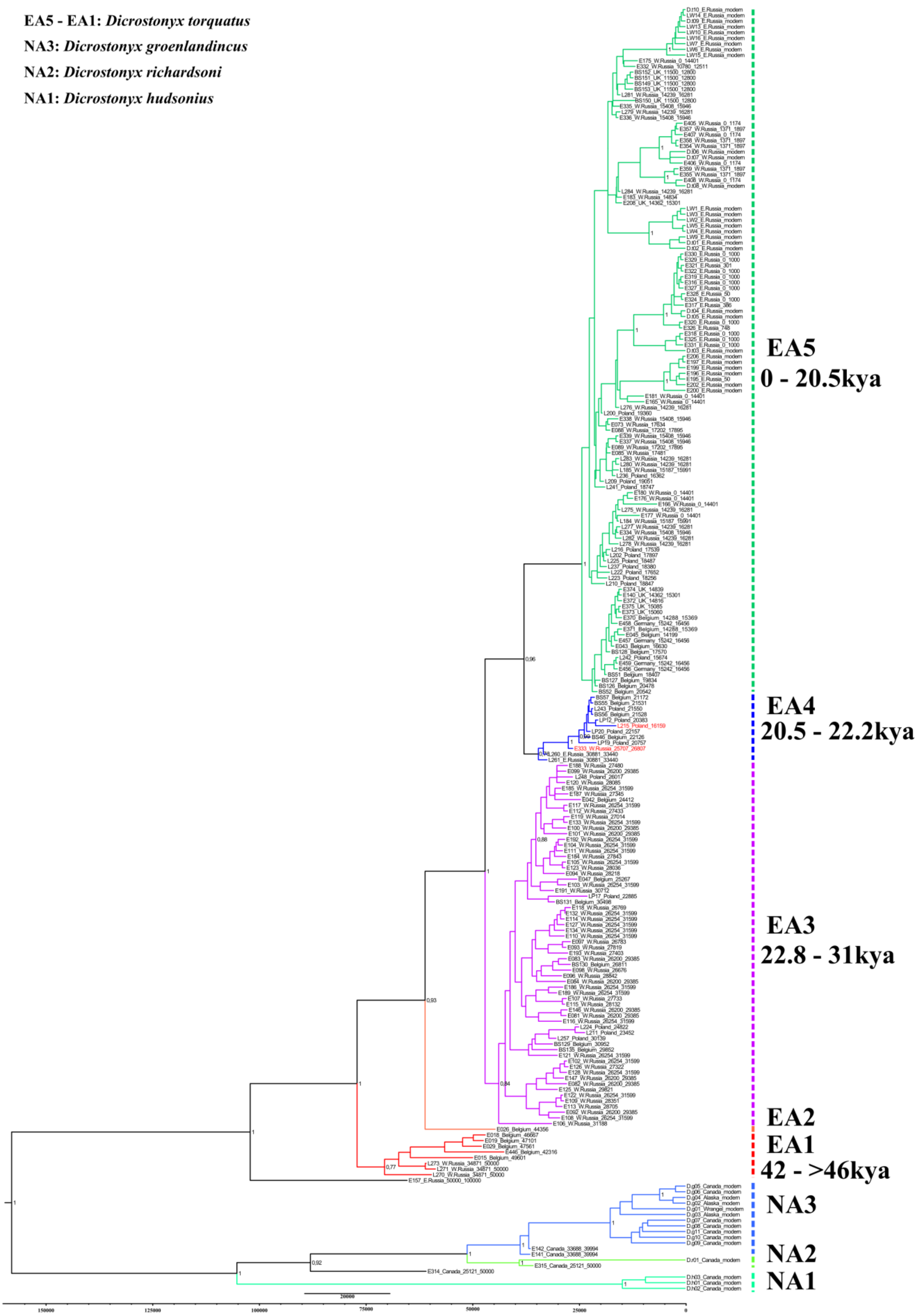
EA5 - EA1: *Dicrostonyx torquatus*
NA3: *Dicrostonyx groenlandincus*
NA2: *Dicrostonyx richardsoni*
NA1: *Dicrostonyx hudsonius*
EA5
0 - 20.5kya
EA4
20.5 - 22.2kya
EA3
22.8 - 31kya
EA2
EA1
42 - >46kya
NA3
NA2
NA1

Figure S3. Three-dimensional statistical parsimony network of *D. torquatus* mtDNA (cyt *b*) sequences. Layers correspond to the different temporal intervals. Haplotypes from different regions are indicated by different colors. Small black dots represent missing haplotypes. Small black circles represent haplotypes that are missing from a layer but are present in other layers. The size of each circle indicates haplotype frequency with the number in each circle indicating the number of samples carrying that particular haplotype when it is higher than one.

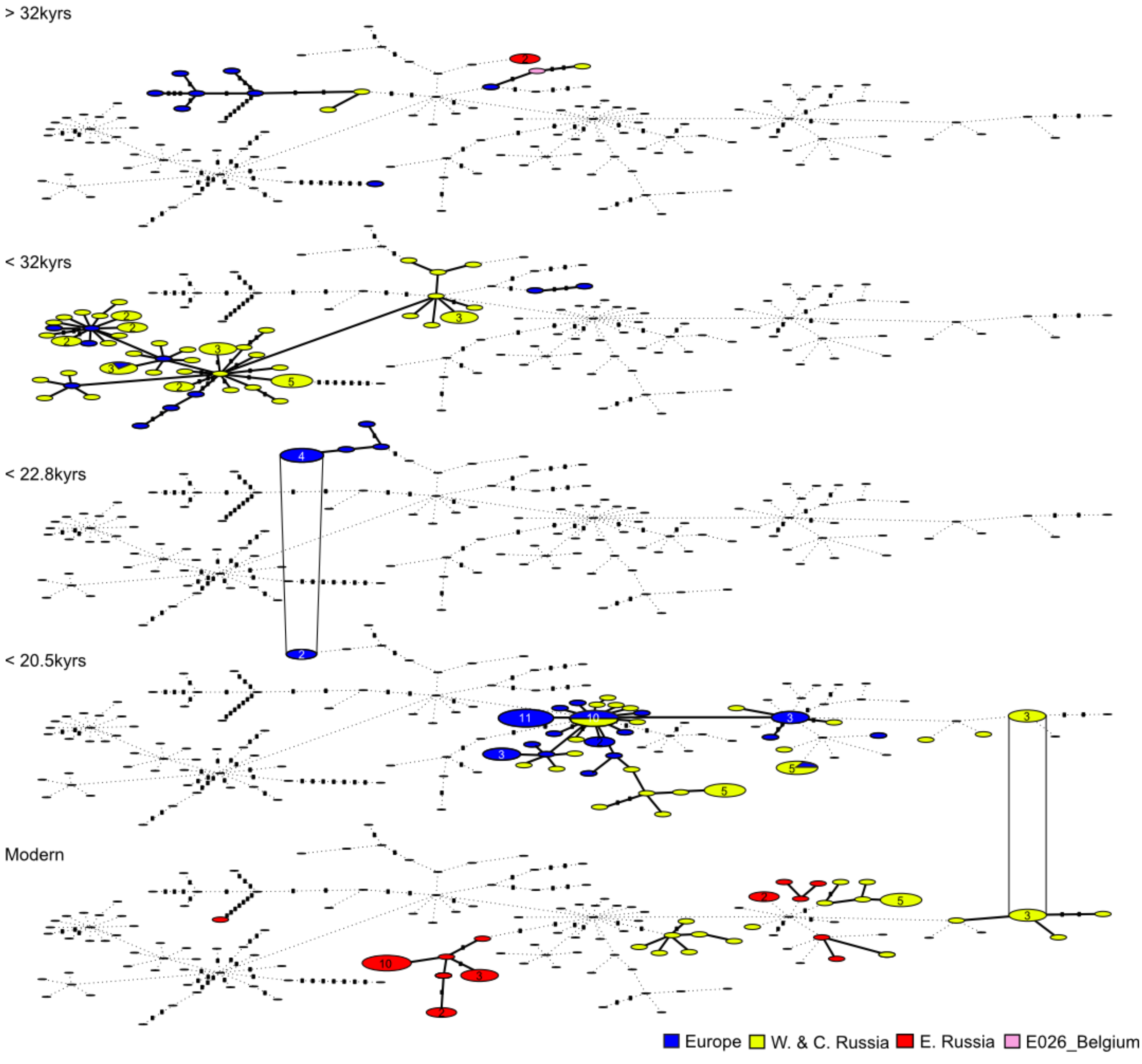

Figure S4. (A) Palynological record from Lago Grande di Monticchio in Italy (Allen *et al.* 1999), (B) $\delta^{18}O$ records from the NorthGRIP ice core (GICC05) (Svensson *et al.* 2008), and (C) distribution of calibrated date ranges of radiocarbon-dated specimens for each of the distinct mitochondrial lineages. Time on the x-axis is given in years before present. Light blue boxes indicate the time ranges of mitochondrial lineage replacements.