
A history of multiple Denisovan introgression events in modern humans

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Individual ID	Location	Cave	Hominin	Date (kya)	DNA	Type	Publication	Ref.
Baishiya Karst Cave	China	Baishiya Karst Cave	Denisova	> 160	mtDNA	Sediments	Zhang et al. 2020	1
Chagyrskaya8	Russia	Chagyrskaya Cave	Neanderthal	~80	WGS HighCov	Phalanx	Mafessoni et al. 2020	2
Denisova 11	Russia	Denisova cave	N-D	79.3–118.1	WGS	Long bone	Slon et al. 2018	3
Denisova 17	Russia	Denisova cave	Neanderthal	134.1–150.6	mtDNA	bone fragment	Brown et al. 2022	4
Denisova 19	Russia	Denisova cave	Denisova	187.0–216.9	mtDNA	bone fragment	Brown et al. 2022	4
Denisova 2	Russia	Denisova cave	Denisova	122.7–194.4	WGS	Tooth	Slon et al. 2017	5
Denisova 20	Russia	Denisova cave	Denisova	187.0–216.9	mtDNA	bone fragment	Brown et al. 2022	4
Denisova 21	Russia	Denisova cave	Denisova	187.0–216.9	mtDNA	bone fragment	Brown et al. 2022	4
Denisova 3	Russia	Denisova cave	Denisova	51.6–76.2	WGS HighCov	Phalanx	Meyer et al. 2012	6
Denisova 4	Russia	Denisova cave	Denisova	55.2–84.1	WGS	Tooth	Sawyer et al. 2015	7
Denisova 5	Russia	Denisova cave	Neanderthal	120–130	WGS HighCov	Phalanx	Prufer et al. 2014	8
Denisova 8	Russia	Denisova cave	Denisova	105.6–136.4	WGS	Tooth	Sawyer et al. 2015	7
ElSidron1253	Spain	El Sidron, Asturias	Neanderthal	~49	WGS	Bone	Green et al. 2010	9
Feldhofer1	Germany	Feldhofer Cave	Neanderthal	~42	WGS	Bone	Green et al. 2010	9
GoyetQ305_4	Belgium	Troisième Caverne	Neanderthal	43–45	mtDNA	Tibia	Rougier et al. 2016	10
GoyetQ305_7	Belgium	Troisième Caverne	Neanderthal	Unknown	mtDNA	Tibia	Rougier et al. 2016	10
GoyetQ374a_1	Belgium	Troisième Caverne	Neanderthal	Unknown	mtDNA	Tibia	Rougier et al. 2016	10
GoyetQ56_1	Belgium	Troisième Caverne	Neanderthal	43–42	WGS	Femur	Hajdinjak et al. 2018	11
GoyetQ57_1	Belgium	Troisième Caverne	Neanderthal	43–45	mtDNA	Tibia	Rougier et al. 2016	10
GoyetQ57_2	Belgium	Troisième Caverne	Neanderthal	40–41	mtDNA	Femur	Rougier et al. 2016	10
GoyetQ57_3	Belgium	Troisième Caverne	Neanderthal	42–43	mtDNA	Tibia	Rougier et al. 2016	10
LesCottesZ4_1514	France	Les Cottes Cave	Neanderthal	42–43	WGS	Tooth	Hajdinjak et al. 2018	11
Mezmaiskaya1	Russia	Mezmaiskaya Cave	Neanderthal	60–70	WGS	Skeleton	Hajdinjak et al. 2018	11
Mezmaiskaya2	Russia	Mezmaiskaya Cave	Neanderthal	43–44	WGS	Skull fragment	Hajdinjak et al. 2018	11
Okladnikov2	Russia	Okladnikov Cave	Neanderthal	30–40	mtDNA	Bone	Krause et al. 2007	12
Sima de los Huesos	Spain	Sima de los Huesos cave	Sima de los Huesos	~430	WGS	Bone	Meyer et al. 2014	13
Spy94a	Belgium	Spy Cave	Neanderthal	37–39	WGS	Tooth	Hajdinjak et al. 2018	11
Vi33.16	Croatia	Vindija Cave	Neanderthal	~38	WGS	Bone	Green et al. 2010	9
Vi33.25	Croatia	Vindija Cave	Neanderthal	Unknown	WGS	Bone	Green et al. 2010	9
Vi33.26	Croatia	Vindija Cave	Neanderthal	~44	WGS	Bone	Green et al. 2010	9
Vindija 33.19	Croatia	Vindija Cave	Neanderthal	~50	WGS HighCov	Bone	Prufer et al. 2017	14
Vindija 87	Croatia	Vindija Cave	Neanderthal	>44	WGS	Bone fragment	Hajdinjak et al. 2018	11

Supplementary Table 1. List of sequenced archaic individuals. Kya stands for kylo years ago.

Detecting Introgression	Publication	Ref.	Link
Admixfrog	Peter 2020	15	https://github.com/BenjaminPeter/admixfrog
ARGWeaver-D	Hubisz et al. 2020	16	https://github.com/CshlSiepellab/argweaver
CRF	Sankararaman et al. 2014, 2016	17,18	https://www.sciencedirect.com/science/article/pii/S0960982216302470?via%3Dihub#bib24
diCal-admix	Steinrucken et al. 2018	19	http://dical-admix.sourceforge.net/
f stats	Martin et al. 2014	20	https://uqrmaie1.github.io/admixtools/articles/admixtools.html
df stats	Pfeifer and Kapan 2019	21	
Dp stats	Hamlin et al. 2020	22	
D stat	Green et al. 2010	9	https://uqrmaie1.github.io/admixtools/articles/admixtools.html
D+ stat	Fang et al. 2024	23	
HMM	Prufer et al. 2014	8	
HMM	Bergstrom et al. 2020	24	
HMM	Seguin-Orlando et al. 2014	25	
IBDMix	Chen et al. 2020	26	https://github.com/PrincetonUniversity/IBDMix
HMM	Skov et al. 2018	27	https://github.com/LauritsSkov/Introgression-detection/
S*	Vernot and Akey 2014, Vernot et al. 2016	28,29	https://github.com/bvernot/freezing-archer
Sprime	Browning et al. 2018	30	https://github.com/browning-lab/sprime
Archie	Durvasula and Sankararaman 2019	31	https://github.com/sriramlab/ArchIE
Parameters estimation	Publication	Ref.	Link
ABC-DL	Mondal et al. 2019	32	https://github.com/oscarlao/ABC_DL
CSFS	Durvasula and Sankararaman	33	http://web.cs.ucla.edu/~sriram/software.html
CNN	Flagel et al. 2019	34	https://github.com/flag0010/pop_gen_cnn
IMa3	Hey et al. 2018	35	https://github.com/jodyhey/IMa3
Legofit	Rogers 2019	36	https://github.com/alanrogers/legofit
Moments	Ragsdale and Gravel 2019	37	https://moments.readthedocs.io/en/latest/index.html
Visualising Introgression	Publication	Ref.	Link
Contour plots	Browning et al. 2018	30	https://github.com/browning-lab/sprime
Heatmaps			
Haplostrips	Marnetto and Huerta-Sanchez 2017	38	https://bitbucket.org/dmarnetto/haplostrips/src/master/
Adaptive introgression	Publication	Ref.	Link
genomatnn	Gower et al. 2021	39	https://github.com/grahamgower/genomatnn
MaLAadapt	Zhang et al. 2023	40	https://github.com/xzhang-popgen/maladapt
Rd, U, Q95	Racimo and Marnetto et al. 2017	41	https://academic.oup.com/mbe/article/34/2/296/2633371#61701351
Volcano finder	Setter et al. 2020	42	http://degiorgiogroup.fau.edu/vf.html

Supplementary Table 2. Methods and resources to study introgression.

Individual ID	Country	Location	Time Period	Date (kya)	DNA	Type	Publication	Ref.
AR33K	China	Amur River Basin	UP	33	Genome-wide	Bone fragment	Mao et al. 2021	43
Bacho Kiro AA7-738	Bulgaria	Bacho Kiro Cave	IUP	43	Genome-wide	Bone fragment	Hajdinjak et al. 2021	44
Bacho Kiro BB7-240	Bulgaria	Bacho Kiro Cave	IUP	44	Genome-wide	Bone fragment	Hajdinjak et al. 2021	44
Bacho Kiro BK-1653	Bulgaria	Bacho Kiro Cave	UPa	35	Genome-wide	Bone fragment	Hajdinjak et al. 2021	44
Bacho Kiro CC7- 2289	Bulgaria	Bacho Kiro Cave	IUP	43	Genome-wide	Bone fragment	Hajdinjak et al. 2021	44
Bacho Kiro CC7-335	Bulgaria	Bacho Kiro Cave	IUP	45	Genome-wide	Bone fragment	Hajdinjak et al. 2021	44
Cioclovina1	Romania	Peștera Cioclovina Uscată	UP	32	Genome-wide	Cranium	Fu et al. 2016	45
GoyetQ116-1	Belgium	Troisième Caverne	UPa	35	Genome-wide	Humerus	Fu et al. 2016	45
GoyetQ376-19	Belgium	Troisième Caverne	UP	27	Genome-wide	Humerus	Fu et al. 2016	45
GoyetQ53-1	Belgium	Troisième Caverne	UP	28	Genome-wide	Fibula	Fu et al. 2016	45
GoyetQ56-16	Belgium	Troisième Caverne	UP	26	Genome-wide	Fibula	Fu et al. 2016	45
Kostenki12	Russia	Volkovskaya	UPa	32	Genome-wide	Cranium	Fu et al. 2016	45
Kostenki14	Russia	Markina Gora	UPa	38	WGS	Tibia	Seguin-Orlando et al. 2014	25
Krems1-1	Austria	Krems-Wachtberg	UP	29	Genome-wide	Petrous	Teschler-Nicola et al. 2020	46
Krems1-2	Austria	Krems-Wachtberg	UP	29	Genome-wide	Petrous	Teschler-Nicola et al. 2020	46
KremsWA3	Austria	Krems-Wachtberg	UP	29	Genome-wide	Cranium	Teschler-Nicola et al. 2020	46
Les Cottes Z4-1514	France	Les Cottes	IUP/UPa	41	WGS	Tooth	Hajdinjak et al. 2018	11
Mal'ta	Russia	Mal'ta	UP	24	WGS	Humerus	Raghavan et al. 2014	47
Muierii2	Romania	Peștera Muierilor	UP	32-33	Genome-wide	Temporal	Fu et al. 2016	45
Oase1	Romania	Peștera cu Oase	IUP/UPa	40	WGS	Mandible	Fu et al. 2015	48
Ostuni1	Italy	Apulia, Ostuni	UP	25	Genome-wide	Long bone	Fu et al. 2016	45
Ostuni2	Italy	Apulia, Ostuni	UP	27	Genome-wide	Long bone	Fu et al. 2016	45
Paglicci108	Italy	Apulia, Paglicci	UP	26	Genome-wide	Phalanx	Fu et al. 2016	45
Paglicci133	Italy	Apulia, Paglicci	UP	33	Genome-wide	Tooth	Fu et al. 2016	45
Pavlov1	Czech Republic	Dolni Vestonice	UP	28	Genome-wide	Femur	Fu et al. 2016	45
PM1	Baia de Fier, Peștera Muierii	Romania	UP	32	Genome-wide	Tooth	Svensson et al. 2021	49
Salkhit	Mongolia	Khentii Province, Norovlin County, Salkhit Valley	UP	34	WGS	Skull cap	Massilani et al. 2020	50
Spy 94a	Belgium	Spy Cave	IUP/UPa	39	WGS	Molar	Hajdinjak et al. 2018	11
Sunghir1	Russia	Sunghir	UP	32	WGS	Tooth, bone	Sikora et al. 2017	51
Sunghir2	Russia	Sunghir	UP	32	WGS	Tooth, bone	Sikora et al. 2017	51
Sunghir3	Russia	Sunghir	UP	34	WGS	Tooth, bone	Sikora et al. 2017	51
Sunghir4	Russia	Sunghir	UP	32	WGS	Bone fragment	Sikora et al. 2017	51
Tianyuan	China	Tianyuan	IUPa	40	Genome-wide	Femur, tibia	Fu et al. 2013	52
Ust'Ishim	Russia	Ust'-Ishim, Siberia	IUPa	45	WGS	Femur	Fu et al. 2014	53

Vestonice13	Czech Republic	Dolni Vestonice	UP	31	Genome-wide	Femur	Fu et al. 2016	45
Vestonice14	Czech Republic	Dolni Vestonice	UP	31	Genome-wide	Femur	Fu et al. 2016	45
Vestonice15	Czech Republic	Dolni Vestonice	UP	31	Genome-wide	Femur	Fu et al. 2016	45
Vestonice16	Czech Republic	Dolni Vestonice	UP	30	Genome-wide	Femur	Fu et al. 2016	45
Vestonice43	Czech Republic	Dolni Vestonice	UP	30	Genome-wide	Femur	Fu et al. 2016	45
Yana1	Russia	Siberia	UP	32	WGS High-Cov	Tooth	Sikora et al. 2019	54
Yana2	Russia	Siberia	UP	32	WGS	Tooth	Sikora et al. 2019	54
Zlatý Kůň	Czech Republic	Koněprusy cave	Szeletian/IUPa	>45	Genome-wide	Skull	Prüfer et al. 2021	55

Supplementary Table 3. List of early human genomes available. Kya stands for kylo years ago. UP: Upper Paleolithic, IUP: Initial Upper Paleolithic.

Gene	Trait	Archaic	Population	Publication	Ref.
OAS1/2/3	Immunity (SARS-Cov-2)	Neanderthal	Americans	Zeberg and Pääbo 2021	56
LARS	Liver failure	Neanderthal	Americans	Racimo, Marnetto et al. 2017	42
SLC16A11	Type 2 diabetes	Neanderthal	Americans	Racimo, Marnetto et al. 2017	42
ELMSAN1	Immunity	Neanderthal	Americans	Jagoda et al. 2022	57
CYP450	Drug metabolism	Neanderthal	Americans	Wroblewski et al. 2023	58
MUC19	Immunity	Denisova	Americans	Witt et al. 2023	59
BNC2	Pigmentation	Neanderthal	Europeans	Jacobs et al. 2013	60
OCA2	Pigmentation	Neanderthal	Europeans	Gittelman et al. 2016	61
OAS1/2/3	Immunity	Neanderthal	Europeans	Mendez et al. 2013	62
ELMSAN1	Immunity	Neanderthal	Europeans	Jagoda et al. 2022	57
OAS1/2/3	Immunity (SARS-Cov-2)	Neanderthal	Europeans	Zeberg and Pääbo 2021	56
SELP	Blood coagulation	Neanderthal	Europeans	Simonti et al 2016	63
CYP450	Drug metabolism	Neanderthal	Europeans	Wroblewski et al. 2021	58
Various SNPs	Prostate cancer, blood...	Neanderthal	Icelanders	Skov et al. 2020	64
TBX15	Lipid metabolism	Denisova	Inuit	Racimo et al. 2017	65
WARS2	Lipid metabolism	Denisova	Inuit	Racimo et al. 2017	65
STAT2	Immunity	Neanderthal	Papua New Guinea	Mendez et al. 2012	66
TNFAIP3	Immunity	Denisova	Papua New Guinea	Gittelman et al. 2016	61
OAS1/2/3	Immunity (SARS-Cov-2)	Neanderthal	South & East Asians	Zeberg and Pääbo 2021	56
OCA2	Pigmentation	Neanderthal	South & East Asians	Gittelman et al. 2016	61
POU2F3	Pigmentation	Neanderthal	South & East Asians	Vernot and Akey 2014	29
TLR1/6/10	Immunity	Neanderthal	South & East Asians	Gittelman et al. 2016	60
OAS1/2/3	Immunity	Neanderthal	South & East Asians	Gittelman et al. 2016	60
WARS2	Lipid metabolism	Denisova	South & East Asians	Jacobs et al. 2019	67
TNFAIP3	Immunity	Denisova	South & East Asians	Jacobs et al. 2019	67
EPAS1	Hypoxia tolerance	Denisova	Tibetans	Huerta-Sanchez et al. 2014	68

Supplementary Table 4. Main archaic traits adaptively introgressed in modern populations.

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