

## **Dating the emergence of human endemic coronaviruses**

### **Supplemental Information**

**Table S1.** List of endemic coronavirus strains.

HCoV-OC43		
Accession ID	Isolate	Collection Date
NC_006213	ATCC VR-759	1967
KY014281	2002-04	2002
JN129834	HK04-01	2004
JN129835	HK04-02	2004
AY903459	87309	2004
AY903460	19572 Belgium 2004	2004
KY014282	2007-09	2007
KY983583	HCoV_OC43/Seattle/USA/SC2481/2015	2015
KY983585	HCoV_OC43/Seattle/USA/SC2854/2015	2015
KY983588	HCoV_OC43/Seattle/USA/SC3118/2015	2015
KY967356	HCoV_OC43/Seattle/USA/SC2924/2015	2015
KY967358	HCoV_OC43/Seattle/USA/SC2770/2015	2015
KY967359	HCoV_OC43/Seattle/USA/SC2730/2015	2015
KY967360	HCoV_OC43/Seattle/USA/SC2476/2015	2015
KY967361	HCoV_OC43/Seattle/USA/SC2345/2015	2015
KY554972	N07-1541B_433X	2016
KY554973	N07-1689B_116X	2016
KY554974	N08-33B_360X	2016
KY554975	N09-382B	2016
KY674917	N07-1609B	2016
KY674918	N07-1647B	2016
KY674920	N09-595B	2016
KY684759	HCoV_OC43/Seattle/USA/SC2269/2016	2016
KY369905	HCoV_OC43/Seattle/USA/SC831/2016	2016
KY369906	HCoV_OC43/Seattle/USA/SC622/2016	2016
KY369907	HCoV_OC43/Seattle/USA/SC9741/2016	2016
MN306036	HCoV_OC43/Seattle/USA/SC0682/2019	2019
MN306041	HCoV_OC43/Seattle/USA/SC0810/2019	2019
MN306042	HCoV_OC43/Seattle/USA/SC0839/2019	2019
MN306043	HCoV_OC43/Seattle/USA/SC0841/2019	2019
MN306053	HCoV_OC43/Seattle/USA/SC9430/2018	2019
MN310476	HCoV_OC43/Seattle/USA/SC9428/2018	2019
MN310478	HCoV_OC43/Seattle/USA/SC0776/2019	2019
KF530093	OC43/human/USA/832-27/1983	1983
KF530060	OC43/human/USA/851-15/1985	1985
KF530085	OC43/human/USA/871-25/1987	1987
KF530086	OC43/human/USA/872-5/1987	1987
KF530087	OC43/human/USA/873-6/1987	1987
KF530077	OC43/human/USA/873-16/1987	1987
KF530083	OC43/human/USA/873-19/1987	1987
KF530073	OC43/human/USA/8912-37/1989	1989
KF530066	OC43/human/USA/901-33/1990	1990
KF530065	OC43/human/USA/901-41/1990	1990

KF530061	OC43/human/USA/901-43/1990	1990
KF530088	OC43/human/USA/901-54/1990	1990
KF530076	OC43/human/USA/911-11/1991	1991
KF530096	OC43/human/USA/911-38/1991	1991
KF530091	OC43/human/USA/911-58/1991	1991
KF530089	OC43/human/USA/911-66/1991	1991
KF530095	OC43/human/USA/912-6/1991	1991
KF530067	OC43/human/USA/912-10/1991	1991
KF530082	OC43/human/USA/912-11/1991	1991
KF530094	OC43/human/USA/912-36/1991	1991
KF530079	OC43/human/USA/913-29/1991	1991
KF530071	OC43/human/USA/925-1/1992	1992
KF530097	OC43/human/USA/9211-43/1992	1992
KF530074	OC43/human/USA/9212-33/1992	1992
KF530090	OC43/human/USA/931-85/1993	1993
KF530059	OC43/human/USA/951-15/1995	1995
KF530084	OC43/human/USA/951-18/1995	1995
KF530062	OC43/human/USA/952-23/1995	1995
KF530075	OC43/human/USA/953-23/1995	1995
KF530098	OC43/human/USA/965-6/1996	1996
KF530064	OC43/human/USA/9612-9/1996	1996
KF530078	OC43/human/USA/9612-29/1996	1996
KF530063	OC43/human/USA/9612-48/1996	1996
KF530099	OC43/human/USA/971-5/1997	1997
KF530072	OC43/human/USA/9712-13/1997	1997
KF530080	OC43/human/USA/9712-31/1997	1997
KF530069	OC43/human/USA/982-4/1998	1998
KF530081	OC43/human/USA/991-5/1999	1999
KF530070	OC43/human/USA/991-19/1999	1999
KF530068	OC43/human/USA/007-11/2000	2000
KF530092	OC43/human/USA/008-5/2000	2000
KF923905	229/2005	2005
KF923889	1926/2006	2006
KF923899	3582/2006	2006
KF923900	3647/2006	2006
KF923890	39A/2007	2007
KF923892	5345/2007	2007
KF923894	5352/2007	2007
KF923907	5370/2007	2007
KF923921	69A/2007	2007
KF923891	5240/2007	2007
KF923901	5472/2007	2007
KF923908	5414/2007	2007
KF923909	5442/2007	2007
KF923910	5445/2007	2007
KF923911	5479/2007	2007
KF923912	5484/2007	2007
KF923913	5485/2007	2007
KF923914	5508/2007	2007

KF923915	5517/2007	2007
KF923916	5519/2007	2007
KF923917	5566/2007	2007
KF923919	5595/2007	2007
KF923920	5617/2007	2007
KF923923	892A/2008	2008
KF923922	8164/2009	2009
KP198611	1783A/10	2010
KF923886	1908A/2010	2010
KF923887	1997A/2010	2010
KF923918	10108/2010	2010
KP198610	2058A/10	2010
KF923893	2151A/2010	2010
KF923895	10285/2010	2010
KF923924	10290/2010	2010
KF923888	2145A/2010	2010
KF923925	10574/2010	2010
KX344031	LRTI_238	2011
KU131570	HCoV-OC43/UK/London/2011	2011
KJ958218	LY341	2011
KJ958219	LY342	2011
KF923896	3074A/2012	2012
KX538964	MY-U002/12	2012
KF923898	3184A/2012	2012
KF923906	3194A/2012	2012
KX538965	MY-U208/12	2012
KX538966	MY-U236/12	2012
KF923902	12689/2012	2012
KF923903	12691/2012	2012
KF923904	12694/2012	2012
KX538967	MY-U413/12	2012
KX538968	MY-U464/12	2012
KX538969	MY-U523/12	2012
KF923897	3269A/2012	2012
KX538970	MY-U710/12	2012
KX538971	MY-U732/12	2012
KX538972	MY-U774/12	2012
KX538973	MY-U868/12	2012
KX538974	MY-U945/12	2012
KX538975	MY-U1024/12	2012
KX538976	MY-U1057/12	2012
KX538977	MY-U1140/12	2012
KX538978	MY-U1758/13	2013
KX538979	MY-U1975/13	2013
MG197718	YC-55	2015
MG197709	BJ-112	2015
MG197710	BJ-124	2015
MG197715	GZFYF-26	2015
MG197719	YC-67	2015

MG197720	YC-68	2015
MG197716	WZ-303	2015
MG197711	BJ-164	2015
MG197712	BJ-165	2015
MG197721	YC-72	2015
MG197717	WZ-522	2015
MG197714	CC-23	2015
MG197713	BJ-221	2015
MG197722	YC-207	2015
MG977446	TNP F1791_2	2016
MF374983	HCoV-OC43/USA/TCNP_0070/2016	2016
MF314143	HCoV-OC43/USA/ACRI_0052/2016	2016
MG197723	HZ-459	2016
MG977451	TNP 12636	2016
MG977452	TNP 12643	2016
MH121121	HCoV-OC43/USA/ACRI_0213/2016	2016
MG977447	TNP F1832_2	2016
MG977448	TNP F1833_2	2016
MG977449	TNP F1834_2	2016
MG977450	TNP F1835_2	2016
MG977445	TNP F1790_2	2016
MF374984	HCoV-OC43/USA/TCNP_00204/2017	2017
MG977444	TNP F1778_2	2017
MF374985	HCoV-OC43/USA/TCNP_00212/2017	2017
MN026165	OC43_KLF_02_2017	2017
MN026164	OC43_KLF_01_2018	2018
NC_003045	Bovine coronavirus (BCoV-ENT)	1997

#### HCoV-229E

Accession ID	Isolate	Collection Date
NC_002645	Human coronavirus 229E	1962
JX503061	J0304	2009
JX503060	349	2010
KY983587	HCoV_229E/Seattle/USA/SC3112/2015	2015
KY967357	HCoV_229E/Seattle/USA/SC2872/2015	2015
KU291448	HCoV-229E/BN1/GER/2015	2015
KY621348	HCoV_229E/Seattle/USA/SC379/2016	2016
KY674914	HCoV_229E/Seattle/USA/SC399/2016	2016
KY674919	N08-434B	2016
KY684760	HCoV_229E/Seattle/USA/SC2282/2017	2016
KY369908	HCoV_229E/Seattle/USA/SC579/2016	2016
KY369909	HCoV_229E/Seattle/USA/SC677/2016	2016
KY369910	HCoV_229E/Seattle/USA/SC1143/2016	2016
KY369911	HCoV_229E/Seattle/USA/SC1212/2016	2016
KY369912	HCoV_229E/Seattle/USA/SC9731/2016	2016
KY369913	HCoV_229E/Seattle/USA/SC1073/2016	2016

KY369914	HCoV_229E/Seattle/USA/SC9773/2016	2016
MT438696	HCoV-229E/USA/UNM_0186/2016	2016
MF542265	229E/Haiti-1/2016	2016
MN369046	HCoV_229E/Seattle/USA/SC9724/2018	2018
MN306046	HCoV_229E/Seattle/USA/SC0865/2019	2019
KF514429	229E/human/USA/892-11/1989	1989
KF514432	229E/human/USA/932-72/1993	1993
KF514433	229E/human/USA/933-40/1993	1993
KF514430	229E/human/USA/933-50/1993	1993
KF514431	229E/human/USA/953-49/1995	1995
MT438700	HCoV-229E/USA/UAMS_DID_0108/2017	2017
MT438697	HCoV-229E/USA/ACRI_0244/2017	2017
MT438698	HCoV-229E/USA/ACRI_0256/2017	2017
MT438699	HCoV-229E/USA/ACRI_0246/2017	2017
MW039392	HCoV 229E/human/ITA/TE5146/2020	2020
NC_028752	Camel alphacoronavirus (camel/Riyadh/Ry141/2015)	2015

# HCoV-HKU1

Accession ID	Isolate	Collection Date
NC_006577	HKU1	2004
DQ415896	N19	2004
DQ415897	N20	2004
DQ415898	N21	2004
DQ415899	N22	2005
DQ415900	N23	2005
DQ415902	N25	2005
DQ415903	N3	2003
DQ415904	N6	2004
DQ415905	N7	2004
DQ415906	N9	2004
DQ415907	N10	2004
DQ415908	N11	2004
DQ415909	N13	2004
DQ415910	N14	2004
DQ415911	N15	2004
DQ415912	N16	2004
DQ415913	N17	2004
HM034837	Caen1	2005
KF430201	HKU1/human/USA/HKU1-18/2010	2010
KF430202	HKU1/human/USA/HKU1-7/2010	2010
KF686340	HKU1/human/USA/HKU1-5/2009	2009
KF686341	HKU1/human/USA/HKU1-10/2010	2010
KF686342	HKU1/human/USA/HKU1-11/2009	2009
KF686343	HKU1/human/USA/HKU1-13/2010	2010
KF686344	HKU1/human/USA/HKU1-15/2009	2009
KF686345	HKU1/human/USA/HKU1-20/2010	2010
KF850450	HKU1 1102	2005

KT779555	BJ01-p3	2009
KT779556	BJ01-p9	2009
KY674943	N09-1605B	2016
KY983584	SC2628	2015
MH940245	SI17244	2017
MK167038	SC2521	2017
NC_012936	Murine coronavirus (Rat coronavirus Parker)	1970

# HCoV-NL63

Accession ID	Isolate	Collection Date
NC_005831	Amsterdam I	2003
KF530110	NL63/human/USA/838-9/1983	1983
KF530106	NL63/human/USA/8712-17/1987	1987
KF530114	NL63/human/USA/891-4/1989	1989
KF530108	NL63/human/USA/891-6/1989	1989
KF530111	NL63/human/USA/901-24/1990	1990
KF530109	NL63/human/USA/903-28/1990	1990
KF530104	NL63/human/USA/904-20/1990	1990
KF530113	NL63/human/USA/905-25/1990	1990
KF530107	NL63/human/USA/911-56/1991	1991
KF530105	NL63/human/USA/012-31/2001	2001
KF530112	NL63/human/USA/0111-25/2001	2001
JX504050	NL63/RPTEC/2004	2004
JQ765568	NL63/DEN/2005/193	2005
JQ765569	NL63/DEN/2005/232	2005
JQ765570	NL63/DEN/2005/235	2005
JQ765571	NL63/DEN/2005/271	2005
JQ900258	NL63/DEN/2005/291	2005
JQ765572	NL63/DEN/2005/347	2005
JQ900259	NL63/DEN/2005/449	2005
JQ765573	NL63/DEN/2005/1062	2005
JQ900260	NL63/DEN/2005/1120	2005
JQ765574	NL63/DEN/2005/1862	2005
JQ765575	NL63/DEN/2005/1876	2005
JQ765566	NL63/DEN/2008/16	2008
JX104161	CBJ 037	2008
JX524171	CBJ123	2009
JQ765565	NL63/DEN/2009/15	2009
JQ900257	NL63/DEN/2009/31	2009
JQ900255	NL63/DEN/2009/6	2009
JQ765564	NL63/DEN/2009/14	2009
JQ900256	NL63/DEN/2009/22	2009
JQ765567	NL63/DEN/2009/20	2009
JQ765563	NL63/DEN/2009/9	2009
MG428702	Kilifi_HH_3807_11-May-2010	2010
MG428699	Kilifi_HH_5709_19-May-2010	2010

MG428704	Kilifi_HH_5402_20-May-2010	2010
MG428707	Kilifi_HH_5401_20-May-2010	2010
MG428705	Kilifi_HH_0522_21-May-2010	2010
MG428706	Kilifi_HH_3808_24-May-2010	2010
MG428700	Kilifi_HH_1602_01-Jun-2010	2010
MG428703	Kilifi_HH_0511_01-Jun-2010	2010
MG428701	Kilifi_HH_0512_04-Jun-2010	2010
MG772808	CN0601/14	2014
KY983586	HCoV_NL63/Seattle/USA/SC2940/2015	2015
KY829118	N07-262B	2015
KT381875	NL63/UF-1/2015	2015
KT266906	HCoV_NL63/Haiti-1/2015	2015
KX179500	NL63/UF-2/2015	2015
KU521535	NL63/UF-2/2015	2015
KY554967	N06-1144B	2016
KY554968	N07-185B	2016
KY554969	N07-196B	2016
KY554970	N07-324B_182X	2016
KY554971	N07-468B_176X	2016
KY674915	N07-6B	2016
KY674916	N07-64B	2016
MN306018	HCoV_NL63/Seattle/USA/SC0179/2018	2018
MN026166	NL63_KLF_01_2018	2018
MK334044	ChinaGD03	2018
MK334047	ChinaGD04	2018
MK334045	ChinaGD05	2018
MK334043	ChinaGD02	2018
MK334046	ChinaGD01	2018
MN306040	HCoV_NL63/Seattle/USA/SC0768/2019	2019
DQ445911	Amsterdam 057	2002
DQ445912	Amsterdam 496	2003
AY518894	Amsterdam 496	1988
NC_032107	NL63-related bat coronavirus (BtKYNL63-9a)	2010

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**Table S2. Model comparison using BEAST (v.1.10.4) path sampling.**

HCoV-OC43								
Strict Clock				Uncorrelated Relaxed Clock				
Model		Constant Size	Exponential Growth	Bayesian Skyline	Constant Size	Exponential Growth	Bayesian Skyline	
	Likelihood	-28557.62	-28558.62	-28548.08	-28505.56	-28507.31	-28503.15	
Strict Clock	Constant Size	-28557.62	0	1	-9.54	-52.06	-50.31	-54.47
	Exponential Growth	-28558.62	-1	0	-10.54	-53.06	-51.31	-55.47
	Bayesian Skyline	-28548.08	9.54	10.54	0	-42.52	-40.77	-44.93
Uncorrelated Relaxed Clock	Constant Size	-28505.56	52.06	53.06	42.52	0	1.75	-2.41
	Exponential Growth	-28507.31	50.31	51.31	40.77	-1.75	0	-4.16
	Bayesian Skyline	-28503.15	54.47	55.47	44.93	2.41	4.16	0
HCoV-229E								
Strict Clock				Uncorrelated Relaxed Clock				
Model		Constant Size	Exponential Growth	Bayesian Skyline	Constant Size	Exponential Growth	Bayesian Skyline	
	Likelihood	-33495.25	-33494.30	-33492.58	-33501.80	-33502.00	-33500.88	
Strict	Constant Size	-33495.25	0	-0.95	-2.67	6.55	6.75	5.63

<b>Clock</b>	<b>Exponential Growth</b>	-33494.30	0.95	0	-1.72	7.5	7.7	6.58
	<b>Bayesian Skyline</b>	-33492.58	2.67	1.72	0	9.22	9.42	8.3
<b>Uncorrelated Relaxed Clock</b>	<b>Constant Size</b>	-33501.80	-6.55	-7.5	-9.22	0	0.2	-0.92
	<b>Exponential Growth</b>	-33502.00	-6.75	-7.7	-9.42	-0.2	0	-1.12
	<b>Bayesian Skyline</b>	-33500.88	-5.63	-6.58	-8.3	0.92	1.12	0

#### HCoV-NL63

Strict Clock					Uncorrelated Relaxed Clock			
Model		Constant Size	Exponential Growth	Bayesian Skyline	Constant Size	Exponential Growth	Bayesian Skyline	
	Likelihood	-4363.63	-4364.17	-4366.40	-4365.32	-4366.19	-4369.26	
Strict Clock	Constant Size	-4363.63	0	0.54	2.77	1.69	2.56	5.63
	Exponential Growth	-4364.17	-0.54	0	2.23	1.15	1.99	5.09
	Bayesian Skyline	-4366.40	-2.77	-2.23	0	-1.08	-0.21	2.86
Uncorrelated Relaxed Clock	Constant Size	-4365.32	-1.69	-1.15	1.08	0	0.87	3.94
	Exponential Growth	-4366.19	-2.56	-1.99	0.21	-0.87	0	3.07
	Bayesian Skyline	-4369.26	-5.63	-5.09	-2.86	-3.94	-3.07	0

Note: A Bayes Factor >3 indicates positive support for the row model. A strong support is usually considered when BF>20.

**Figure S1.** HCoV-NL63 and HCoV-HKU1 timescaled phylogenetic trees. Maximum clade credibility trees estimated for the non-recombinant region of HCoV-NL63 (a) and HCoV-HKU1 (b). Branch lengths represent the evolutionary time measured by the grids corresponding to the timescale shown at the tree base (in years). For internal nodes 95% HPD bars are shown and black dots indicate a posterior probability >0.80 for that node.

