Short Communication

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Novel reassortants of clade 2.3.4.4 H5N6 highly pathogenic avian influenza viruses possessing genetic heterogeneity in South Korea in late 2017

Yu-Na Lee, Sun-Ha Cheon, Soo-Jeong Kye, Eun-Kyoung Lee, Mingeun Sagong, Gyeong-Beom Heo, Yong-Myung Kang, Hyun-Kyu Cho, Yong-Joo Kim, Hyun-Mi Kang, Myoung-Heon Lee, Youn-Jeong Lee*

Avian Influenza Research & Diagnostic Division, Animal and Plant Quarantine Agency, Gimcheon 39660, Korea

Novel H5N6 highly pathogenic avian influenza viruses (HPAIVs) were isolated from duck farms and migratory bird habitats in South Korea in November to December 2017. Genetic analysis demonstrated that at least two genotypes of H5N6 were generated through reassortment between clade 2.3.4.4 H5N8 HPAIVs and Eurasian low pathogenic avian influenza virus in migratory birds in late 2017, suggesting frequent reassortment of clade 2.3.4.4 H5 HPAIVs and highlighting the need for systematic surveillance in Eurasian breeding grounds.

Keywords: H5N6, H5N8, clade 2.3.4.4, highly pathogenic avian influenza, reassortment

The H5 Goose/Guangdong-lineage highly pathogenic avian influenza virus (HPAIV) was first isolated in China in 1996, has since evolved into multiple hemagglutinin (HA) phylogenetic clades, and has undergone reassortment with other avian influenza viruses (AIVs) [4]. The ancestral strain of H5 clade 2.3.4.4 was isolated in eastern China in 2010 [16]. Clade 2.3.4.4 H5 viruses have evolved into four genetic groups (A–D) [6]. Of these, the H5N8 HPAIVs belonging to group A spread to East Asia, Europe, and even North America [12]. In May 2016, novel reassortant group B H5N8 HPAIVs were detected in wild birds around Uvs-Nuur Lake at the border between Russia and Mongolia and, subsequently, in southeastern Asia, Europe, and North Africa in the 2016/17 winter season [1,7]. During that winter season, group C H5N6 HPAIV, which originated in China, outbreaks occurred in South Korea, Japan, and Taiwan [9,13].

In November 2017, two novel H5N6 viruses were identified in South Korea: A/duck/Korea/HD1/2017 (HD1) and A/mallard/Korea/Jeju-H24/2017 (Jeju-H24) [8]. Both HD1 and Jeju-H24 are closely related to European clade 2.3.4.4b (group B) H5N8 viruses in all gene segments except neuraminidase (NA), which is derived from a Eurasian low pathogenic avian influenza (LPAI) lineage. In December 2017, we identified A/duck/Korea/H35/2017 (H35) and nine more H5N6 viruses in Korean domestic duck farms and wild-bird habitats (Table 1, Supplementary Table 1). Whole-genome sequencing showed that HD1 and Jeju-H24 had 99.69% to 100% nucleotide-sequence identity, and H35 had 99.43% to 100% identity to the other viruses isolated in December 2017. Sequence identity was lower (96.96–99.38%) between HD1/Jeju-H24 and the other isolates.

To clarify the origins of novel H5N6 reassortants possessing genetic heterogeneity and to estimate the timing of reassortment events that led to their emergence, we performed genetic analyses based on time-scaled phylogenies, gene constellations, and molecular clocks with the available clade 2.3.4.4b H5Nx sequences and other N6 viruses from the Global Initiative on Sharing All Influenza Data (GISAID) and GenBank databases (Supplementary Table 2).

We estimated the time-scaled phylogenies, nucleotide substitution rates, and the most recent common ancestors (tMRCAs) using the Bayesian Markov chain Monte Carlo (MCMC) method implemented in BEAST v.1.8.4 [3]. Genomic sequences were selected on the basis of sampling locations and collection dates. Genotypes were defined on the basis of the gene segment-specific phylogenetic trees for clade 2.3.4.4b 17 H5N6 and 160 H5N8 HPAIVs. All genes of clade 2.3.4.4b H5 viruses were classified into different clusters according to tree

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*Corresponding author: Tel: +82-54-912-0968; Fax: +82-54-912-0977; E-mail: leeyj700@korea.kr
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Table 1. Clade 2.3.4.4b H5N6 highly pathogenic avian influenza viruses isolated in South Korea in 2017

Avian species		Virus name	Collection date (mo/d)	Region	Sample	Genetic group	Reference
Domestic	Duck	A/duck/Korea/HD1/2017 (H5N6)	11/17	JB	Carcass	B3.2.1	[8]
	Duck	A/duck/Korea/H35/2017 (H5N6)	12/10	JN	Carcass	B3.1.1	This study
	Duck	A/duck/Korea/H56/2017 (H5N6)	12/19	JN	Carcass	B3.1.1	This study
	Duck	A/duck/Korea/H70/2017 (H5N6)	12/22	JB	Carcass	B3.1.1	This study
	Duck	A/duck/Korea/H80/2017 (H5N6)	12/26	JN	Carcass	B3.1.1	This study
	Duck	A/duck/Korea/H81/2017 (H5N6)	12/26	JN	Carcass	B3.1.1	This study
	Duck	A/duck/Korea/H103/2017 (H5N6)	12/28	JN	Carcass	B3.1.1	This study
	Duck	A/duck/Korea/H107/2017 (H5N6)	12/28	JN	Carcass	B3.1.1	This study
Wild	Mallard	A/mallard/Korea/Jeju-H24/2017 (H5N6)	11/27	JJ	Feces	B3.2.1	[8]
	Mandarin duck	A/mandarin duck/Korea/H69/2017 (H5N6)	12/19	CN	Feces	B3.1.1	This study
	Mandarin duck	A/mandarin duck/Korea/H71/2017 (H5N6)	12/20	CN	Feces	B3.1.1	This study
	Mandarin duck	A/mandarin duck/Korea/H119/2017 (H5N6)	12/28	CN	Feces	B3.1.1	This study

JB, Jeonbuk; JN, Jeonnam; JJ, Jeju; CN, Chungnam.

topology and a posterior probability > 0.8. The genotype is the combination of the cluster assignment of eight gene segments.

By performing MCMC analysis, the nucleotide substitution rate estimated for the clade 2.3.4.4b H5 gene was 8.803×10^{-3} substitutions/site/year (95% highest posterior density [HPD] interval, 6.626×10^{-3} to 1.11×10^{-2} substitutions/site/year), which was higher than a previous estimate for the HA gene of H5N1 viruses from China in 1996 to 2012 (4.378×10^{-3} substitutions/site/year) [15], but comparable to that of group A H5N8 viruses from South Korea in 2014 to 2015 (9.23×10^{-3} substitutions/site/year) [5]. We found a mean rate of nucleotide substitution in the N8 gene of 9.802×10^{-3} substitutions/site/year (95% HPD interval, 6.931×10^{-3} to 1.270×10^{-2} substitutions/site/year). Previously, it was reported that the surface proteins of the influenza A virus evolve in a coordinated way under selection pressures to escape immune responses [11]. The high evolutionary rate of surface genes of these viruses resulting from positive selection by the immune system may have contributed to the observed genetic diversity.

Genes of clade 2.3.4.4b H5 viruses were classified into clusters as described above. The PB2, PB1, PA, and NP genes of these viruses formed six, three, five, and four distinct clusters, respectively (panels D–G in Supplementary Fig. 1), which identified eight H5N8 genotypes and three novel reassortant H5N6 genotypes (Fig. 1). The B0 genotype (including H5N8 viruses isolated from eastern China in 2013 and South Korea in 2014) is the prototype of the currently circulating group B H5 viruses. The B1 viruses were first identified in Russia–Mongolia in May 2016. In August 2016, B1.1 emerged in Russia, with a B1 backbone and a PA gene from Eurasian LPAI viruses. In September 2016, B3.1 (containing novel PB2, PA, and NP segments) emerged in Russia. Our results suggest that at least five H5N8 genotypes (B2, B2.1, B3.1, B3.2, and B3.3) circulated in Europe in the winter of 2016 to 2017 and contributed genes to novel H5N6 viruses.

HD1 and Jeju-H24 have seven genes derived from the B3.2 genotype, along with N6 genes from Eurasian LPAI virus. H35 and additional viruses have seven genes from the B3.1 genotype, along with Eurasian LPAI N6 genes. The N6 gene of HD1-like and H35-like viruses had the highest nucleotide identity with A/barnacle goose/Netherlands/2/2014 (H3N6) (> 97.3%). Compared to wild-bird isolates, we identified unique substitutions K or T133A in HA (H5 numbering) and A350T in NP protein from H35-like viruses isolated from domestic duck. Molecular dating estimates of the mean tMRCAs of HD1-like and H35-like viruses for each gene are shown in Table 2. These tMRCAs overlapped the breeding seasons of many wild birds inhabiting Eurasia. The tMRCA 95% HPD interval for the NA gene of the HD1-like virus was wider than that for the H35-like virus. Previous results suggested that reassortment events of H5N8 viruses in the Netherlands in winter 2016 to 2017 were completed by August 2016, and might have taken place in wild birds in the Russia–Mongolia region [1]. Our results indicated that reassortment of HD1-like viruses (B3.2.1) was complete by September 2016, whereas reassortment of H35-like viruses (B3.1.1) was complete by June 2017. Along with the 2.69% mismatches in NA sequences between HD1 and H35, these results suggest that the reassortment events in these viruses took place separately in wild birds in Eurasia.

In early 2017, the first H5N6 virus outside of Asia (A/chicken/Greece/39_2017/2017; Greece39) was detected in a backyard flock in Greece. It had 98.51% to 99.4% nucleotide identity with HD1. Despite genotypic similarity (Fig. 1), the MCC trees of six genes (panels A, D–G, and I in Supplementary Fig. 1) indicated that HD1 and Greece39 evolved along

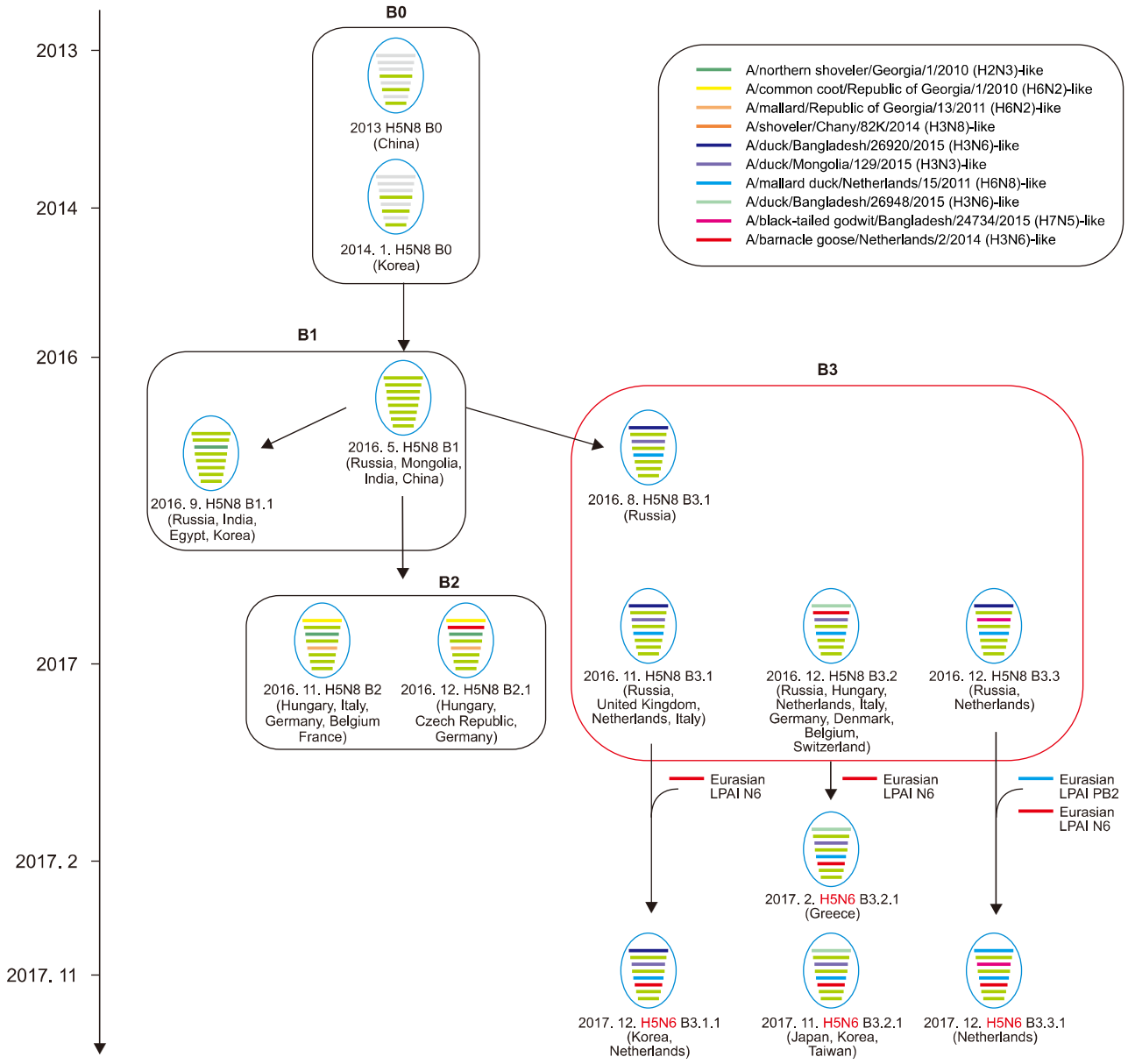

Fig. 1. Schematic diagram of reassortment among clade 2.3.4.4b highly pathogenic avian influenza viruses (HPAIVs) in Eurasia. Each oval represents a viral isolate, within which the eight gene segments (from the top to the bottom: PB2, PB1, PA, HA, NP, NA, M, and NS) are indicated by horizontal bars. The color of each bar identifies its origin. The H5N8 B1 ancestor is indicated by light green. The original genes of the B0 ancestor are shown in gray. Other colors represent different Eurasian avian influenza lineages.

independent pathways. Furthermore, the differences in the tMRCA of the PB2 segment of Greece39 versus that of HD1 (Table 2) suggest that this genotype has a selective advantage over other competing genotypes, even though the HPD intervals overlap. By contrast, an entire genome sequence of an H5N6 virus isolated in Japan (A/mute swan/Shimane/3211A001/2017) and Taiwan (A/spoonbill/Taiwan/DB645/2017) in November 2017 had 99.39% to 100% similarity with HD1, and the two viruses formed a branch cluster together with HD1 in the MCC trees of all genes. In December 2017, H5N6 HPAIVs A/Great Black-backed Gull/Netherlands/1/2017 (GBBG1) and A/Great Black-backed Gull/Netherlands/2/2017 (GBBG2) were isolated in the Netherlands. GBBG1 had a B3.1.1 genotype, but GBBG2 had six genes derived from the B3.3 genotype, along with PB2 and N6 genes that clustered with LPAI viruses identified in Eurasia. These results demonstrated that H5N6 reassortants of various genotypes (B3.1.1, B3.2.1, and B3.3.1) originating from clade 2.3.4.4b H5N8 viruses appeared in East Asia and Europe in late 2017. Migratory birds moving within flyways in Eurasia overlap in

Table 2. Times of the most recent common ancestors (tMRCAs) for novel reassortant clade 2.3.4.4b H5N6 highly pathogenic avian influenza viruses by gene

Gene	tMRCA (95% HPD interval, posterior probability)			
	A/CK/Greece/39_2017/2017	A/DK/Korea/HD1/2017	A/DK/Korea/H35/2017	A/Great Black-backed Gull/ Netherlands/2/2017
PB2	Jul. 2016 (May 2016–Sep. 2016, 0.9986)	Mar. 2016 (Nov. 2015–Jun. 2016, 0.9991)	Jun. 2016 (Apr. 2016–Aug. 2016, 0.9961)	May 2011 (Dec. 2010–Aug. 2011, 0.9958)
PB1	Jul. 2016 (May 2016–Aug. 2016, 0.9952)	Jul. 2016 (May 2016–Aug. 2016, 0.9952)	Jul. 2016 (May 2016–Aug. 2016, 0.9952)	Jul. 2016 (May 2016–Aug. 2016, 0.9952)
PA	Jun. 2016 (Mar. 2016–Jul. 2016, 0.9991)	Jun. 2016 (Mar. 2016–Jul. 2016, 0.9991)	Jun. 2016 (Mar. 2016–Jul. 2016, 0.9991)	Sep. 2016 (Jul. 2016–Oct. 2016, 0.9993)
HA	May 2016 (Mar. 2016–Jul. 2016, 0.9987)	May 2016 (Mar. 2016–Jul. 2016, 0.9987)	May 2016 (Mar. 2016–Jul. 2016, 0.9987)	May 2016 (Mar. 2016–Jul. 2016, 0.9987)
NP	May 2016 (Jan. 2016–Jul. 2016, 0.9989)	May 2016 (Jan. 2016–Jul. 2016, 0.9989)	May 2016 (Jan. 2016–Jul. 2016, 0.9989)	May 2016 (Jan. 2016–Jul. 2016, 0.9989)
NA	Oct. 2015 (Aug. 2014–Sep.2016, 0.9994)	Oct 2015 (Aug. 2014–Sep. 2016, 0.9999)	Jan. 2017 (Jun. 2016–Jun. 2017, 0.9995)	Feb. 2017 (Apr. 2016–Oct. 2017, 0.9345)
M	Aug. 2016 (Jun. 2016–Aug. 2016, 0.9050)	Aug. 2016 (Jun. 2016–Aug. 2016, 0.9050)	Sep. 2016 (Jul. 2016–Oct. 2016, 0.9086)	Sep. 2016 (Jul. 2016–Oct. 2016, 0.9086)
NS	May 2016 (Feb. 2016–Jul. 2016, 1)	May 2016 (Feb. 2016–Jul. 2016, 1)	May 2016 (Feb. 2016–Jul. 2016, 1)	May 2016 (Feb. 2016–Jul. 2016, 1)

HPD, highest posterior density; CK, chicken; DK, duck; PB2, polymerase basic 2; PB1, polymerase basic 1; PA, polymerase acidic; HA, hemagglutinin; NP, nucleoprotein; NA, neuraminidase; M, matrix; NS, nonstructural.

circumpolar arctic and sub-arctic breeding areas [12]. Novel H5N6 reassortant viruses seem to have spread between migratory bird species in these breeding sites, subsequently disseminating in different directions during the 2017 migration period.

Since group B1 H5N8 HPAIVs were first detected, these viruses seem to have undergone reassortment with Eurasian LPAI viruses continuously. As a result, at least six genetically distinct H5N8, two H5N5 [1], and one H5N6 reassortant viruses were detected in Europe, Eastern Asia, and North Africa in the winter of 2016 to 2017. Although clade 2.3.4.4 HPAIVs have a tendency to partner with different NA subtypes, H5–NA matching with N6 was only observed in groups C and D until early 2017 [2,12], following reassortment from precursor H5Nx and H6N6 viruses [14]. The interaction and functional balance between HA and NA in AIVs have crucial roles in viral replication efficiency and fitness [10]. The simultaneous appearance of genetically distinct H5N6 reassortants suggests that this HA/NA genetic compatibility might enhance the replication capacity or the viral fitness related to the H5–N8 genetic combination.

In conclusion, our results show that at least three distinct reassortants of clade 2.3.4.4b H5N6 HPAIVs appeared in poultry and wild birds in East Asia and Europe in late 2017. Novel H5N6 reassortants potentially arose independently, spread through migratory birds at their breeding sites, and then disseminated in different directions during the 2017 migration. These findings provide evidence for more frequent reassortment of clade 2.3.4.4b H5 HPAIVs, which may increase their capacity to disseminate worldwide. Systematic surveillance in the Palearctic breeding grounds of Eurasia and timely analysis of the available data are essential to determine viral genetic diversity and to provide early warnings of novel reassortants of clade 2.3.4.4 HPAIVs.

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Conflict of Interest

The authors declare no conflicts of interest.

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JVS

Supplementary Table 1. Accession numbers in the Global Initiative on Sharing All Influenza Data (GISAID) EpiFlu database used for phylogenetic analysis in this study

Virus name	Genotype	Collection date	GISAID PB2 accession No.	GISAID PB1 accession No.	GISAID PA accession No.	GISAID HA accession No.	GISAID NP accession No.	GISAID NA accession No.	GISAID MP accession No.	GISAID NS accession No.	GISAID originating laboartory (where given)	GISAID submitting laboratory
A/domestic duck/Siberia /103/2016(H5N8)	B1.1	2016-10-04	EPI926610	EPI926611	EPI926612	EPI926613	EPI926614	EPI926615	EPI926616	EPI926617	Research Institute of Experimental and Clinical Medicine	Research Institute of Experimental and Clinical Medicine
A/Bar-headed_Goose/Qinghai/BTY17-LU/2016(H5N8)	B1	2016-05-15	EPI774110	EPI774111	EPI774112	EPI774113	EPI774114	EPI774115	EPI774116	EPI774117	State Key Laboratory of Virology and Wuhan Institute of Virology, Chinese Academy of Sciences	Wuhan Institute of Virology
A/Bar-headed_Goose/Qinghai/BTY1-B/2016(H5N8)	B1	2016-05-09	EPI774391	EPI774392	EPI774393	EPI774394	EPI774395	EPI774396	EPI774397	EPI774398	State Key Laboratory of Virology and Wuhan Institute of Virology, Chinese Academy of Sciences	Wuhan Institute of Virology
A/Bk_swan/NL-Den_Oever/16013973-002/2016(H5N8)	B3.2	2016-11-10	EPI1019363	EPI1019364	EPI1019362	EPI1019366	EPI1019359	EPI1019365	EPI1019361	EPI1019360	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Bl_H_gull/NL-Slootdorp/16014102-002/2016(H5N8)	B3.2	2016-11-11	EPI1019371	EPI1019372	EPI1019370	EPI1019374	EPI1019367	EPI1019373	EPI1019369	EPI1019368	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/black_swan/Germany-BW/R1364/2017(H5N8)	B2	2017-02-12	EPI1087661	EPI995484	EPI1002887	EPI988345	EPI1002885	EPI990101	EPI1002886	EPI1002888		Friedrich-Loeffler-Institut
A/black-headed_gull/Tyva/41/2016(H5N8)	B1	2016-05-25	EPI823753	EPI823754	EPI823755	EPI823756	EPI823757	EPI823758	EPI823759	EPI823760	State Research Center of Virology and Biotechnology (VECTOR)	WHO National Influenza Centre Russian Federation
A/Buzzard/NL-Durgerdam/16015100-004/2016(H5N8)	B3.3	2016-11-30	EPI1019379	EPI1019380	EPI1019378	EPI1019382	EPI1019375	EPI1019381	EPI1019377	EPI1019376	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/C_Gull/NL-Slootdorp/16014102-003/2016(H5N8)	B3.2	2016-11-11	EPI1019387	EPI1019388	EPI1019386	EPI1019390	EPI1019383	EPI1019389	EPI1019385	EPI1019384	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Ch/NL-Abbega/X16015736/2016(H5N8)	B3.2	2016-12-12	EPI1019395	EPI1019396	EPI1019394	EPI1019398	EPI1019391	EPI1019397	EPI1019393	EPI1019392	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Ch/NL-Boven_Neeuwen/16016151-006-010/2016(H5N8)	B3.1	2016-12-19	EPI1019403	EPI1019404	EPI1019402	EPI1019406	EPI1019399	EPI1019405	EPI1019401	EPI1019400	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Ch/NL-Den_Oever/16014231-001/2016(H5N8)	B3.2	2016-11-15	EPI1019411	EPI1019412	EPI1019410	EPI1019414	EPI1019407	EPI1019413	EPI1019409	EPI1019408	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Ch/NL-Hiaure/16016112-001-005/2016(H5N8)	B3.2	2016-12-17	EPI1019419	EPI1019420	EPI1019418	EPI1019422	EPI1019415	EPI1019421	EPI1019417	EPI1019416	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Ch/NL-Rhenen/16016141-006/2016(H5N8)	B3.1	2016-12-17	EPI1019427	EPI1019428	EPI1019426	EPI1019430	EPI1019423	EPI1019429	EPI1019425	EPI1019424	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Ch/NL-Zoeterwoude/16016484-021-025/2016(H5N8)	B3.1	2016-12-24	EPI1019435	EPI1019436	EPI1019434	EPI1019438	EPI1019431	EPI1019437	EPI1019433	EPI1019432	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/chicken/Astrakhan/3131/2016(H5N8)	B3.2	2016-12-13	EPI909465	EPI909466	EPI909467	EPI869938	EPI909468	EPI869939	EPI909469	EPI909470		State Research Center of Virology and Biotechnology (VECTOR)
A/chicken/Belgium/807/2017(H5N8)	B3.2	2017-02-01	EPI1007664	EPI1007665	EPI1007666	EPI1007667	EPI1007668	EPI1007669	EPI1007670	EPI1007671		Other Database Import
A/chicken/Czech_Republic/206-17_2/2017(H5N8)	B2.1	2017-01-06	EPI964914	EPI964915	EPI964916	EPI964917	EPI964918	EPI964919	EPI964920	EPI964921		Other Database Import
A/chicken/Czech_Republic/988-17/2017(H5N8)	B2	2017-01-20	EPI1087632	EPI1087634	EPI1087635	EPI1087636	EPI1087639	EPI1087638	EPI1087641	EPI1087642	State Veterinary Institute Prague	State Veterinary Institute Prague
A/chicken/Germany-MV/R10048/2016(H5N8)	B3.2	2016-11-27	EPI932937	EPI931205	EPI931206	EPI932938	EPI926626	EPI956134	EPI922507	EPI956133		Friedrich-Loeffler-Institut
A/chicken/Germany-NI/R11406/2016(H5N8)	B3.2	2016-12-24	EPI926625	EPI956130	EPI959127	EPI922508	EPI933139	EPI956129	EPI956132	EPI956131		Friedrich-Loeffler-Institut
A/chicken/Italy/17VIR1684-2/2017(H5N8)	B2	2017-02-27	EPI961514	EPI961515	EPI961513	EPI961517	EPI961510	EPI961516	EPI961512	EPI961511	Istituto Zooprofilattico Sperimentale Delle Venezie	Istituto Zooprofilattico Sperimentale Delle Venezie
A/chicken/Italy/17VIR3078/2017(H5N8)	B3.2	2017-04-07	EPI1040238	EPI1040237	EPI1040236	EPI1040223	EPI1040234	EPI1040224	EPI1040233	EPI1040235	Istituto Zooprofilattico Sperimentale Delle Venezie	Istituto Zooprofilattico Sperimentale Delle Venezie
A/chicken/Italy/17VIR653-12/2017(H5N8)	B3.1	2017-01-25	EPI954580	EPI954581	EPI954579	EPI954583	EPI954576	EPI954582	EPI954578	EPI954577	Istituto Zooprofilattico Sperimentale Delle Venezie	Istituto Zooprofilattico Sperimentale Delle Venezie
A/chicken/Kalmykia/2643/2016(H5N8)	B3.2	2016-11-21	EPI909457	EPI909458	EPI909459	EPI909460	EPI909461	EPI909462	EPI909463	EPI909464		State Research Center of Virology and Biotechnology (VECTOR)
A/chicken/Korea/Gimje2/2017(H5N8)	B1.1	2017-02-06	EPI1123348	EPI1123349	EPI1123350	EPI1123351	EPI1123352	EPI1123353	EPI1123354	EPI1123355	Avian Influenza Research and Diagnostic Division, Animal and Plant Quarantine Agency	Animal and Plant Quarantine Agency (QIA)
A/chicken/Korea/Gunsan/2017(H5N8)	B1.1	2017-06-03	EPI1123340	EPI1123341	EPI1123342	EPI1123343	EPI1123344	EPI1123345	EPI1123346	EPI1123347	Avian Influenza Research and Diagnostic Division, Animal and Plant Quarantine Agency	Animal and Plant Quarantine Agency (QIA
A/chicken/Republic_of_Macedonia/AR1167-L02131/2017(H5N8)	B2	2017-01-21	EPI987879	EPI987880	EPI987881	EPI987882	EPI987883	EPI987884	EPI987885	EPI987886	University "Ss. Cyril and Methodius" , Veterinary institute, Department of Avian diseases	Friedrich-Loeffler-Institut
A/chicken/Rostov/44/2017(H5N8)	B3.2	2017-04-18	EPI1045606	EPI1045607	EPI1045608	EPI1045611	EPI1045609	EPI1045610	EPI1045612	EPI1045613		State Research Center of Virology and Biotechnology (VECTOR)

Supplementary Table 1. Continued

Virus name	Genotype	Collection date	GISAID PB2 accession No.	GISAID PB1 accession No.	GISAID PA accession No.	GISAID HA accession No.	GISAID NP accession No.	GISAID NA accession No.	GISAID MP accession No.	GISAID NS accession No.	GISAID originating laboartory (where given)	GISAID submitting laboratory
A/chicken/Sergiyev_Posad/38/2017(H5N8)	B3.2	2017-03-02	EPI961455	EPI961456	EPI961458	EPI961459	EPI961460	EPI961461	EPI961462	EPI961463		State Research Center of Virology and Biotechnology (VECTOR)
A/chicken/Shchyolkovo/47/2017(H5N8)	B3.2	2017-03-05	EPI1045592	EPI1045593	EPI1045594	EPI1045597	EPI1045595	EPI1045596	EPI1045598	EPI1045599		State Research Center of Virology and Biotechnology (VECTOR)
A/chicken/Tatarstan/88/2017(H5N8)	B3.2	2017-05-08	EPI1045614	EPI1045615	EPI1045616	EPI1045619	EPI1045617	EPI1045618	EPI1045620	EPI1045621		State Research Center of Virology and Biotechnology (VECTOR)
A/chicken/Voronezh/19/2017(H5N8)	B3.2	2017-01-06	EPI909409	EPI909410	EPI909411	EPI909412	EPI909413	EPI909414	EPI909415	EPI909416		State Research Center of Virology and Biotechnology (VECTOR)
A/chicken/Wales/23/2016(H5N8)	B3.1	2016-12-31	EPI942940	EPI942941	EPI942942	EPI942943	EPI942944	EPI942945	EPI942946	EPI942947	Animal and Plant Health Agency (APHA)	Animal and Plant Health Agency (APHA)
A/Common_buzzard/Hungary/7061/2017(H5N8)	B2	2017-02-21	EPI954772	EPI954773	EPI954771	EPI954775	EPI954768	EPI954774	EPI954770	EPI954769	Central Agricultural Office Veterinary Diagnostic Directorate	Central Agricultural Office Veterinary Diagnostic Directorate
A/common_teal/Korea/W547/2016(H5N8)	B1.1	2016-12-15	EPI1006731	EPI1006726	EPI1006721	EPI1006680	EPI1006713	EPI1006711	EPI1006706	EPI1006717		Other Database Import
A/common_teal/Korea/W555/2017(H5N8)	B1.1	2017-01-04	EPI1006735	EPI1006730	EPI1006725	EPI1006705	EPI1006716	EPI1006712	EPI1006710	EPI1006686		Other Database Import
A/Common_tern/Hungary/8187/2017(H5N8)	B3.2	2017-02-28	EPI954780	EPI954781	EPI954779	EPI954783	EPI954776	EPI954782	EPI954778	EPI954777	Central Agricultural Office Veterinary Diagnostic Directorate	Central Agricultural Office Veterinary Diagnostic Directorate
A/Cormorant/Hungary/6102/2017(H5N8)	B2	2017-02-15	EPI959520	EPI959521	EPI959519	EPI959523	EPI959516	EPI959522	EPI959518	EPI959517	National Food Chain Safety Office Veterinary Diagnostic Directorate Laboratory for Molecular Biology	Central Agricultural Office Veterinary Diagnostic Directorate
A/Crow/NL-Oostwoud/16015372-004/2016(H5N8)	B3.3	2016-12-05	EPI1019443	EPI1019444	EPI1019442	EPI1019446	EPI1019439	EPI1019445	EPI1019441	EPI1019440	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Cygnus_olor/Belgium/1567/2017(H5N8)	B2	2017-02-21	EPI1007680	EPI1007681	EPI1007682	EPI1007683	EPI1007684	EPI1007685	EPI1007686	EPI1007687		Other Database Import
A/Dk/NL-Biddinghuizen/16014829-011-015/2016(H5N8)	B3.2	2016-11-25	EPI1019451	EPI1019452	EPI1019450	EPI1019454	EPI1019447	EPI1019453	EPI1019449	EPI1019448	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Dk/NL-Kamperveen/16016104-001-005/2016(H5N8)	B3.1	2016-12-15	EPI1019475	EPI1019476	EPI1019474	EPI1019478	EPI1019471	EPI1019477	EPI1019473	EPI1019472	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Dk/NL-Rotterdam/16014008-001-005/2016(H5N8)	B3.2	2016-11-10	EPI1019483	EPI1019484	EPI1019482	EPI1019486	EPI1019479	EPI1019485	EPI1019481	EPI1019480	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Dk/NL-Stolwijk/16016291-016-020/2016(H5N8)	B3.1	2016-12-21	EPI1019491	EPI1019492	EPI1019490	EPI1019494	EPI1019487	EPI1019493	EPI1019489	EPI1019488	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/domestic_duck/Germany-MV/R9764/2016(H5N8)	B3.2	2016-11-21	EPI967463	EPI967462	EPI967670	EPI963516	EPI988588	EPI967672	EPI963517	EPI967671		Friedrich-Loeffler-Institut
A/domestic_duck/Germany-MV/R9869/2016(H5N8)	B3.2	2016-11-23	EPI895486	EPI885204	EPI877540	EPI881292	EPI888670	EPI877536	EPI877537	EPI877539		Friedrich-Loeffler-Institut
A/duck/France/161108h/2016(H5N8)	B2	2016-11-28	EPI869806	EPI869807	EPI869808	EPI869809	EPI869810	EPI869811	EPI869812	EPI869813		French Agency for Food, Environmental and Occupational Health
A/Duck/Hungary/54738/2016(H5N8)	B2	2016-11-09	EPI962041	EPI962042	EPI962040	EPI962046	EPI962036	EPI962044	EPI962039	EPI962038	National Food Chain Safety Office Veterinary Diagnostic Directorate Laboratory for Molecular Biology	Central Agricultural Office Veterinary Diagnostic Directorate
A/duck/Hungary/55191/2016(H5N8)	B2	2016-11-11	EPI860528	EPI860527	EPI860529	EPI860534	EPI860530	EPI860531	EPI860532	EPI860533	National Food Chain Safety Office Veterinary Diagnostic Directorate Laboratory for Molecular Biology	Central Agricultural Office Veterinary Diagnostic Directorate
A/Duck/Hungary/984/2017(H5N8)	B2	2017-01-11	EPI954652	EPI954653	EPI954651	EPI954655	EPI954648	EPI954654	EPI954650	EPI954649	Central Agricultural Office Veterinary Diagnostic Directorate	Central Agricultural Office Veterinary Diagnostic Directorate
A/duck/India/10CA01/2016(H5N8)	B1	2016-10-17	EPI858833	EPI858834	EPI858835	EPI858836	EPI858837	EPI858838	EPI858840	EPI858839	ICAR-National Institute of High Security Animal Diseases	ICAR-National Institute of High Security Animal Diseases
A/duck/Korea/H35/2017(H5N6)	B3.1.1	2017-12-10	EPI1145157	EPI1145158	EPI1145161	EPI1145162	EPI1145163	EPI1145164	EPI1145165	EPI1145166	Avian Influenza Research and Diagnostic Division, Animal and Plant Quarantine Agency	Animal and Plant Quarantine Agency (QIA)
A/duck/Korea/HD1/2017(H5N6)	B3.2.1	2017-11-27	EPI1123314	EPI1123315	EPI1123316	EPI1123317	EPI1123318	EPI1123319	EPI1123320	EPI1123321	Avian Influenza Research and Diagnostic Division, Animal and Plant Quarantine Agency	Animal and Plant Quarantine Agency (QIA)
A/Eur_Wig/NL-Akkrum/16015817-003/2016(H5N8)	B3.2	2016-12-13	EPI1019499	EPI1019500	EPI1019498	EPI1019502	EPI1019495	EPI1019501	EPI1019497	EPI1019496	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Eur_Wig/NL-De_Waal_(Texel)/16014891-003/2016(H5N8)	B3.1	2016-11-27	EPI1019507	EPI1019508	EPI1019506	EPI1019510	EPI1019503	EPI1019509	EPI1019505	EPI1019504	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Eur_Wig/NL-Driebourg_(Dollard)/16015513-001/2016(H5N8)	B3.2	2016-12-06	EPI1019523	EPI1019524	EPI1019522	EPI1019526	EPI1019519	EPI1019525	EPI1019521	EPI1019520	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Eur_Wig/NL-Enumatil-Groningen/16015704-001/2016(H5N8)	B3.2	2016-12-11	EPI1019531	EPI1019532	EPI1019530	EPI1019534	EPI1019527	EPI1019533	EPI1019529	EPI1019528	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Eur_Wig/NL-Ferwert/16015273-002/2016(H5N8)	B3.2	2016-12-01	EPI1019539	EPI1019540	EPI1019538	EPI1019542	EPI1019535	EPI1019541	EPI1019537	EPI1019536	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Eur_Wig/NL-Gouda/16015824-001/2016(H5N8)	B3.1	2016-12-13	EPI1019547	EPI1019548	EPI1019546	EPI1019550	EPI1019543	EPI1019549	EPI1019545	EPI1019544	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research

Supplementary Table 1. Continued

Virus name	Genotype	Collection date	GISAID PB2 accession No.	GISAID PB1 accession No.	GISAID PA accession No.	GISAID HA accession No.	GISAID NP accession No.	GISAID NA accession No.	GISAID MP accession No.	GISAID NS accession No.	GISAID originating laboartory (where given)	GISAID submitting laboratory
A/Eur_Wig/NL-Greonterp/16015653-001/2016(H5N8)	B3.2	2016-12-08	EPI1019555	EPI1019556	EPI1019554	EPI1019558	EPI1019551	EPI1019557	EPI1019553	EPI1019552	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Eur_Wig/NL-Groningen/16015376-003/2016(H5N8)	B3.3	2016-12-05	EPI1019563	EPI1019564	EPI1019562	EPI1019566	EPI1019559	EPI1019565	EPI1019561	EPI1019560	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Eur_Wig/NL-Leeuwarden/16015699-002/2016(H5N8)	B3.2	2016-12-10	EPI1019571	EPI1019572	EPI1019570	EPI1019574	EPI1019567	EPI1019573	EPI1019569	EPI1019568	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Eur_Wig/NL-Leidschendam/16015697-007/2016(H5N8)	B3.1	2016-12-10	EPI1019579	EPI1019580	EPI1019578	EPI1019582	EPI1019575	EPI1019581	EPI1019577	EPI1019576	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Eur_Wig/NL-Reeuwijk/16015903-003/2016(H5N8)	B3.1	2016-12-13	EPI1019587	EPI1019588	EPI1019586	EPI1019590	EPI1019583	EPI1019589	EPI1019585	EPI1019584	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Eur_Wig/NL-Terschelling/16015692-010/2016(H5N8)	B3.2	2016-12-09	EPI1019595	EPI1019596	EPI1019594	EPI1019598	EPI1019591	EPI1019597	EPI1019593	EPI1019592	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Eur_Wig/NL-Vianen/16015917-006/2016(H5N8)	B3.1	2016-12-13	EPI1019603	EPI1019604	EPI1019602	EPI1019606	EPI1019599	EPI1019605	EPI1019601	EPI1019600	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Eur_Wig/NL-Walterswald/16015923-003/2016(H5N8)	B3.2	2016-12-14	EPI1019611	EPI1019612	EPI1019610	EPI1019614	EPI1019607	EPI1019613	EPI1019609	EPI1019608	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Eur_Wig/NL-West_Graftdijk/16015746-003/2016(H5N8)	B3.1	2016-12-12	EPI1019619	EPI1019620	EPI1019618	EPI1019622	EPI1019615	EPI1019621	EPI1019617	EPI1019616	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Eur_Wig/NL-Wormer/16016143-002/2016(H5N8)	B3.2	2016-12-18	EPI1019627	EPI1019628	EPI1019626	EPI1019630	EPI1019623	EPI1019629	EPI1019625	EPI1019624	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Eur_Wig/NL-Zoeterwoude/16015702-010/2016(H5N8)	B3.1	2016-12-10	EPI1019635	EPI1019636	EPI1019634	EPI1019638	EPI1019631	EPI1019637	EPI1019633	EPI1019632	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Eur_Wig/NL-Zwolle/16015820-002/2016(H5N8)	B3.1	2016-12-13	EPI1019643	EPI1019644	EPI1019642	EPI1019646	EPI1019639	EPI1019645	EPI1019641	EPI1019640	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/eurasian_wigion/Germany-NI/AR249-L02143/2017(H5N8)	B3.1	2017-01-04	EPI990767	EPI990768	EPI990766	EPI990770	EPI990763	EPI990769	EPI990765	EPI990764		Friedrich-Loeffler-Institut
A/G_c_grebe/NL-Monnickendam/16013865-009-010/2016(H5N8)	B3.3	2016-11-08	EPI1019651	EPI1019652	EPI1019650	EPI1019654	EPI1019647	EPI1019653	EPI1019649	EPI1019648	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/gadwall/Chany/97/2016(H5N8)	B1.1	2016-09-10	EPI925953	EPI925954	EPI925952	EPI925956	EPI925949	EPI925955	EPI925951	EPI925950	Research Institute of Experimental and Clinical Medicine	WHO National Influenza Centre Russian Federation
A/gadwall/Kurgan/2442/2016(H5N8)	B3.1	2016-08-27	EPI961446	EPI961447	EPI961448	EPI961449	EPI961450	EPI961451	EPI961452	EPI961453		State Research Center of Virology and Biotechnology (VECTOR)
A/Go/NL-Roggebotsluis/16014462-010/2016(H5N8)	B3.3	2016-11-17	EPI1019659	EPI1019660	EPI1019658	EPI1019662	EPI1019655	EPI1019661	EPI1019657	EPI1019656	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/goose/Czech_Republic/136-17_1/2017(H5N8)	B2	2017-01-04	EPI1085342	EPI1116594	EPI1085343	EPI1021087	EPI1085344	EPI1116595	EPI1085345	EPI1085346	State Veterinary Institute Prague	State Veterinary Institute Prague
A/Goose/Hungary/1030/2017(H5N8)	B3.2	2017-01-11	EPI954660	EPI954661	EPI954659	EPI954663	EPI954656	EPI954662	EPI954658	EPI954657	Central Agricultural Office Veterinary Diagnostic Directorate	Central Agricultural Office Veterinary Diagnostic Directorate
A/Goose/Hungary/15729/2017(H5N8)	B2	2017-04-07	EPI1032481	EPI1032482	EPI1032480	EPI1032484	EPI1032477	EPI1032483	EPI1032479	EPI1032478	National Food Chain Safety Office Veterinary Diagnostic Directorate Laboratory for Molecular Biology	Central Agricultural Office Veterinary Diagnostic Directorate
A/Goose/Hungary/59712/2016(H5N8)	B2	2016-11-26	EPI956125	EPI956126	EPI956124	EPI956128	EPI956121	EPI956127	EPI956123	EPI956122	Central Agricultural Office Veterinary Diagnostic Directorate	Central Agricultural Office Veterinary Diagnostic Directorate
A/Goose/Hungary/59763/2016(H5N8)	B2	2016-11-27	EPI1032513	EPI1032514	EPI1032512	EPI1032516	EPI1032509	EPI1032515	EPI1032511	EPI1032510	National Food Chain Safety Office Veterinary Diagnostic Directorate Laboratory for Molecular Biology	Central Agricultural Office Veterinary Diagnostic Directorate
A/Goose/Hungary/63743/2016(H5N8)	B2	2016-12-11	EPI1032537	EPI1032538	EPI1032536	EPI1032540	EPI1032533	EPI1032539	EPI1032535	EPI1032534	National Food Chain Safety Office Veterinary Diagnostic Directorate Laboratory for Molecular Biology	Central Agricultural Office Veterinary Diagnostic Directorate
A/Goose/Hungary/65817/2016(H5N8)	B2.1	2016-12-18	EPI954536	EPI954537	EPI954535	EPI954539	EPI954532	EPI954538	EPI954534	EPI954533	Central Agricultural Office Veterinary Diagnostic Directorate	Central Agricultural Office Veterinary Diagnostic Directorate
A/Goose/Hungary/982/2017(H5N8)	B2	2017-01-11	EPI954644	EPI954645	EPI954643	EPI954647	EPI954640	EPI954646	EPI954642	EPI954641	Central Agricultural Office Veterinary Diagnostic Directorate	Central Agricultural Office Veterinary Diagnostic Directorate
A/goose/Italy/17VIR6358-3/2017(H5N8)	B3.2	2017-08-05	EPI1081966	EPI1081967	EPI1081968	EPI1081969	EPI1081970	EPI1081971	EPI1081972	EPI1081973	Istituto Zooprofilattico Sperimentale Delle Venezie	Istituto Zooprofilattico Sperimentale Delle Venezie
A/goose/Krasnodar/3144/2017(H5N8)	B3.2	2017-01-06	EPI909433	EPI909434	EPI909435	EPI909436	EPI909437	EPI909438	EPI909439	EPI909440		State Research Center of Virology and Biotechnology (VECTOR
A/Gr_bk-bd_gull/NL-Slootdorp/16014102-005/2016(H5N8)	B3.3	2016-11-11	EPI1019667	EPI1019668	EPI1019666	EPI1019670	EPI1019663	EPI1019669	EPI1019665	EPI1019664	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/great_crested_grebe/Tyva/34/2016(H5N8)	B1	2016-05-25	EPI823457	EPI823458	EPI823459	EPI823460	EPI823461	EPI823462	EPI823463	EPI823464	State Research Center of Virology and Biotechnology (VECTOR)	WHO National Influenza Centre Russian Federation
A/great_crested_grebe/Uvs-Nuur_Lake/341/2016(H5N8)	B1	2016-05-25	EPI773754	EPI773755	EPI773756	EPI773757	EPI773758	EPI773759	EPI773760	EPI773761	Research Institute of Experimental and Clinical Medicine	Research Institute of Experimental and Clinical Medicine
A/green-winged_teal/Egypt/871/2016(H5N8)	B1.1	2016-12-08	EPI1010497	EPI1010498	EPI1010494	EPI1010489	EPI1010496	EPI1010486	EPI1010490	EPI1010492		Other Database Import

Supplementary Table 1. Continued

Virus name	Genotype	Collection date	GISAID PB2 accession No.	GISAID PB1 accession No.	GISAID PA accession No.	GISAID HA accession No.	GISAID NP accession No.	GISAID NA accession No.	GISAID MP accession No.	GISAID NS accession No.	GISAID originating laboartory (where given)	GISAID submitting laboratory
A/Grey_Go/NL-Groot-Ammers/16015901-012/2016(H5N8)	B3.1	2016-12-14	EPI1019675	EPI1019676	EPI1019674	EPI1019678	EPI1019671	EPI1019677	EPI1019673	EPI1019672	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/grey/heron/W779/2017(H5N8)	B1.1	2017-01-27	EPI1034964	EPI1034972	EPI1034973	EPI1034974	EPI1034975	EPI1034976	EPI1034977	EPI1034978		Other Database Import
A/greylag_goose/Germany-NI/AR703-L02138/2017(H5N8)	B2.1	2017-01-25	EPI990799	EPI990800	EPI990798	EPI990802	EPI990795	EPI990801	EPI990797	EPI990796		Friedrich-Loeffler-Institut
A/Greylag_goose/Hungary/1941/2017 (H5N8)	B2	2017-01-18	EPI954676	EPI954677	EPI954675	EPI954679	EPI954672	EPI954678	EPI954674	EPI954673	Central Agricultural Office Veterinary Diagnostic Directorate	Central Agricultural Office Veterinary Diagnostic Directorate
A/Greylag_goose/Hungary/320/2017 (H5N8)	B3.2	2017-01-04	EPI954810	EPI954811	EPI954809	EPI954813	EPI954806	EPI954812	EPI954808	EPI954807	Central Agricultural Office Veterinary Diagnostic Directorate	Central Agricultural Office Veterinary Diagnostic Directorate
A/GuineaFowl/Hungary/596/2017(H5N8)	B2	2017-01-06	EPI954818	EPI954819	EPI954817	EPI954821	EPI954814	EPI954820	EPI954816	EPI954815	Central Agricultural Office Veterinary Diagnostic Directorate	Central Agricultural Office Veterinary Diagnostic Directorate
A/Gull/NL-Marker_Wadden/16014466-020/2016(H5N8)	B3.2	2016-11-17	EPI1019683	EPI1019684	EPI1019682	EPI1019686	EPI1019679	EPI1019685	EPI1019681	EPI1019680	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Harris_Hawk/Hungary/120/2017(H5N8)	B2	2017-01-02	EPI954636	EPI954637	EPI954635	EPI954639	EPI954632	EPI954638	EPI954634	EPI954633	Central Agricultural Office Veterinary Diagnostic Directorate	Central Agricultural Office Veterinary Diagnostic Directorate
A/Harris_hawk/Hungary/2762a/2017 (H5N8)	B2	2017-01-24	EPI954788	EPI954789	EPI954787	EPI954791	EPI954784	EPI954790	EPI954786	EPI954785	Central Agricultural Office Veterinary Diagnostic Directorate	Central Agricultural Office Veterinary Diagnostic Directorate
A/L-bl-ba-gull/NL-Sovon/16014324-014/2016 (H5N8)	B3.3	2016-11-16	EPI1019707	EPI1019708	EPI1019706	EPI1019710	EPI1019703	EPI1019709	EPI1019705	EPI1019704	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/long-eared_owl/Voronezh/15/2017(H5N8)	B3.2	2017-01-06	EPI909377	EPI909378	EPI909379	EPI909380	EPI909381	EPI909382	EPI909383	EPI909384		State Research Center of Virology and Biotechnology (VECTOR)
A/M_Swan/NL-Roggebotsluis/16014462-019/2016(H5N8)	B3.2	2016-11-17	EPI1019715	EPI1019716	EPI1019714	EPI1019718	EPI1019711	EPI1019717	EPI1019713	EPI1019712	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Magpie/NL-Volendam/16014331-002/2016(H5N8)	B3.3	2016-11-16	EPI1019723	EPI1019724	EPI1019722	EPI1019726	EPI1019719	EPI1019725	EPI1019721	EPI1019720	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Mal/NL-IJsselmuiden/16015448-002/2016(H5N8)	B3.1	2016-12-06	EPI1019731	EPI1019732	EPI1019730	EPI1019734	EPI1019727	EPI1019733	EPI1019729	EPI1019728	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Mal/NL-Mastenbroek/16015378-002/2016(H5N8)	B3.3	2016-12-05	EPI1019739	EPI1019740	EPI1019738	EPI1019742	EPI1019735	EPI1019741	EPI1019737	EPI1019736	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/mallard_duck/Korea/WA137/2017 (H5N8)	B1.1	2017-01-24	EPI952757	EPI952760	EPI952769	EPI952782	EPI952791	EPI952799	EPI952800	EPI952801	Avian disease division, Animal and Plant Quarantine Agency	Animal and Plant Quarantine Agency (QIA)
A/Mallard/Hungary/1574a/2017(H5N8)	B3.2	2017-01-14	EPI954874	EPI954875	EPI954873	EPI954877	EPI954870	EPI954876	EPI954872	EPI954871	Central Agricultural Office Veterinary Diagnostic Directorate	Central Agricultural Office Veterinary Diagnostic Directorate
A/mallard/Hungary/57857/2016(H5N8)	B2	2016-11-21	EPI953764	EPI953765	EPI953761	EPI953337	EPI953731	EPI953544	EPI953518	EPI953757	Central Agricultural Office Veterinary Diagnostic Directorate	Central Agricultural Office Veterinary Diagnostic Directorate
A/Mallard/Hungary/5821/2017(H5N8)	B2	2017-02-13	EPI954842	EPI954843	EPI954841	EPI954845	EPI954838	EPI954844	EPI954840	EPI954839	Central Agricultural Office Veterinary Diagnostic Directorate	Central Agricultural Office Veterinary Diagnostic Directorate
A/mallard/Korea/Jeju-H24/2017(H5N6)	B3.2.1	2017-11-27	EPI1123332	EPI1123333	EPI1123334	EPI1123335	EPI1123336	EPI1123337	EPI1123338	EPI1123339	Avian Influenza Research and Diagnostic Division, Animal and Plant Quarantine Agency	Animal and Plant Quarantine Agency (QIA)
A/Mulard_duck/Hungary/54494/2016 (H5N8)	B2	2016-11-08	EPI860512	EPI860511	EPI860513	EPI860518	EPI860514	EPI860515	EPI860516	EPI860517	National Food Chain Safety Office Veterinary Diagnostic Directorate Laboratory for Molecular Biology	Central Agricultural Office Veterinary Diagnostic Directorate
A/mute_swan/Croatia/70/2016(H5N8)	B2	2016-10-30	EPI867457	EPI869084	EPI867456	EPI861568	EPI865159	EPI861569	EPI861570	EPI861571		Croatian Veterinary Institute
A/mute_swan/Czech_Republic/54-17_2/2017(H5N8)	B2	2017-01-02	EPI1081882	EPI1081883	EPI1081884	EPI930838	EPI1081885	EPI961454	EPI930839	EPI1081886		State Veterinary Institute Prague
A/mute_swan/Germany-NI/AR1529-L02145/2017(H5N8)	B3.2	2017-02-14	EPI990783	EPI990784	EPI990782	EPI990786	EPI990779	EPI990785	EPI990781	EPI990780		Friedrich-Loeffler-Institut
A/Mute_swan/Hungary/1955/2017(H5N8)	B2	2017-01-18	EPI954684	EPI954685	EPI954683	EPI954687	EPI954680	EPI954686	EPI954682	EPI954681	Central Agricultural Office Veterinary Diagnostic Directorate	Central Agricultural Office Veterinary Diagnostic Directorate
A/Mute_swan/Hungary/2193/2017(H5N8)	B2	2017-01-19	EPI954700	EPI954701	EPI954699	EPI954703	EPI954696	EPI954702	EPI954698	EPI954697	Central Agricultural Office Veterinary Diagnostic Directorate	Central Agricultural Office Veterinary Diagnostic Directorate
A/Mute_swan/Hungary/2508/2017(H5N8)	B2	2017-01-22	EPI954708	EPI954709	EPI954707	EPI954711	EPI954704	EPI954710	EPI954706	EPI954705	Central Agricultural Office Veterinary Diagnostic Directorate	Central Agricultural Office Veterinary Diagnostic Directorate
A/Mute_swan/Hungary/3513/2017(H5N8)	B2	2017-01-27	EPI954732	EPI954733	EPI954731	EPI954735	EPI954728	EPI954734	EPI954730	EPI954729	Central Agricultural Office Veterinary Diagnostic Directorate	Central Agricultural Office Veterinary Diagnostic Directorate
A/Mute_swan/Hungary/6092/2017(H5N8)	B2.1	2017-02-15	EPI959528	EPI959529	EPI959527	EPI959531	EPI959524	EPI959530	EPI959526	EPI959525	National Food Chain Safety Office Veterinary Diagnostic Directorate Laboratory for Molecular Biology	Central Agricultural Office Veterinary Diagnostic Directorate
A/Mute_swan/Hungary/6276/2017(H5N8)	B2	2017-02-16	EPI959536	EPI959537	EPI959535	EPI959539	EPI959532	EPI959538	EPI959534	EPI959533	National Food Chain Safety Office Veterinary Diagnostic Directorate Laboratory for Molecular Biology	Central Agricultural Office Veterinary Diagnostic Directorate
A/mute_swan/Kaliningrad/132/2017(H5N8)	B3.3	2017-02-13	EPI1044543	EPI1044546	EPI1044547	EPI1044550	EPI1044548	EPI1044549	EPI1044552	EPI1044551		State Research Center of Virology and Biotechnology (VECTOR)

Supplementary Table 1. Continued

Virus name	Genotype	Collection date	GISAID PB2 accession No.	GISAID PB1 accession No.	GISAID PA accession No.	GISAID HA accession No.	GISAID NP accession No.	GISAID NA accession No.	GISAID MP accession No.	GISAID NS accession No.	GISAID originating laboartory (where given)	GISAID submitting laboratory
A/mute_swan/Krasnodar/25/2017(H5N8)	B3.2	2017-01-06	EPI909441	EPI909442	EPI909443	EPI909444	EPI909445	EPI909446	EPI909447	EPI909448		State Research Center of Virology and Biotechnology (VECTOR)
A/mute_swan/Shimane/3211A001/2017(H5N6)	B3.2.1	2017-11-05	EPI1127535	EPI1127536	EPI1127537	EPI1127538	EPI1127539	EPI1127540	EPI1127541	EPI1127556		Other Database Import
A/P_falcon/NL-Vrouwenpolder_(Zeeland)/16015510-001/2016(H5N8)	B3.3	2016-12-07	EPI1019747	EPI1019748	EPI1019746	EPI1019750	EPI1019743	EPI1019749	EPI1019745	EPI1019744	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/painted_stork/India/10CA03/2016 (H5N8)	B1.1	2016-10-20	EPI858841	EPI858842	EPI858843	EPI858844	EPI858845	EPI858846	EPI858847	EPI858848	ICAR-National Institute of High Security Animal Diseases	ICAR-National Institute of High Security Animal Diseases
A/peacock/Belgium/1017/2017(H5N8)	B3.2	2017-02-08	EPI1007672	EPI1007673	EPI1007674	EPI1007675	EPI1007676	EPI1007677	EPI1007678	EPI1007679		Other Database Import
A/Peregrine_falcon/Hungary/4882/2017(H5N8)	B3.2	2017-02-07	EPI954756	EPI954757	EPI954755	EPI954759	EPI954752	EPI954758	EPI954754	EPI954753	Central Agricultural Office Veterinary Diagnostic Directorate	Central Agricultural Office Veterinary Diagnostic Directorate
A/Pheasant/Hungary/6553/2017(H5N8)	B2	2017-02-16	EPI959544	EPI959545	EPI959543	EPI959547	EPI959540	EPI959546	EPI959542	EPI959541	Central Agricultural Office Veterinary Diagnostic Directorate	Central Agricultural Office Veterinary Diagnostic Directorate
A/Rook/Hungary/4975/2017(H5N8)	B2	2017-02-08	EPI959560	EPI959561	EPI959559	EPI959563	EPI959556	EPI959562	EPI959558	EPI959557	National Food Chain Safety Office Veterinary Diagnostic Directorate Laboratory for Molecular Biology	
A/Sea_eagle/NL-Assen/16015398-002/2016(H5N8)	B3.2	2016-12-05	EPI1019755	EPI1019756	EPI1019754	EPI1019758	EPI1019751	EPI1019757	EPI1019753	EPI1019752	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/shelduck/Italy/17VIR1572-24/2017(H5N8)	B2	2017-01-03	EPI961497	EPI961498	EPI961496	EPI961500	EPI961493	EPI961499	EPI961495	EPI961494	Istituto Zooprofilattico Sperimentale Delle Venezie	Istituto Zooprofilattico Sperimentale Delle Venezie
A/swan/Italy/17VIR537-2/2017(H5N8)	B3.2	2017-01-19	EPI954556	EPI954557	EPI954555	EPI954559	EPI954552	EPI954558	EPI954554	EPI954553	Istituto Zooprofilattico Sperimentale Delle Venezie	Istituto Zooprofilattico Sperimentale Delle Venezie
A/swan/Italy/17VIR7064-1/2017(H5N8)	B3.2	2017-08-25	EPI1081918	EPI1081919	EPI1081920	EPI1081925	EPI1081922	EPI1081923	EPI1081924	EPI1081921	Istituto Zooprofilattico Sperimentale Delle Venezie	Istituto Zooprofilattico Sperimentale Delle Venezie
A/T_Dk/NL-Almeerder_Zand/16014341-0037 2016(H5N8)	B3.2	2016-11-16	EPI1019763	EPI1019764	EPI1019762	EPI1019766	EPI1019759	EPI1019765	EPI1019761	EPI1019760	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/T_Dk/NL-Monnickendam/16013865-006-008/2016(H5N8)	B3.3	2016-11-08	EPI1019771	EPI1019772	EPI1019770	EPI1019774	EPI1019767	EPI1019773	EPI1019769	EPI1019768	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/T_Dk/NL-Roggebotsluis/16014462-015/2016(H5N8)	B3.2	2016-11-17	EPI1019779	EPI1019780	EPI1019778	EPI1019782	EPI1019775	EPI1019781	EPI1019777	EPI1019776	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/T_Dk/NL-Rotterdam/16014155-001/2016(H5N8)	B3.2	2016-11-14	EPI1019787	EPI1019788	EPI1019786	EPI1019790	EPI1019783	EPI1019789	EPI1019785	EPI1019784	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/T_Dk/NL-Werkendam/16014159-002/2016(H5N8)	B3.3	2016-11-14	EPI1019795	EPI1019796	EPI1019794	EPI1019798	EPI1019791	EPI1019797	EPI1019793	EPI1019792	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/T_Dk/NL-Zeewolde/16013976-001/2016(H5N8)	B3.2	2016-11-09	EPI1019811	EPI1019812	EPI1019810	EPI1019814	EPI1019807	EPI1019813	EPI1019809	EPI1019808	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/T_Dk/NL-Zuidoost_Beemster/16014148-002/2016(H5N8)	B3.2	2016-11-14	EPI1019859	EPI1019860	EPI1019858	EPI1019862	EPI1019855	EPI1019861	EPI1019857	EPI1019856	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/Teal/NL-Ferwert/16015273-013/2016(H5N8)	B3.2	2016-12-01	EPI1019875	EPI1019876	EPI1019874	EPI1019878	EPI1019871	EPI1019877	EPI1019873	EPI1019872	Wageningen Bioveterinary Research	Wageningen Bioveterinary Research
A/tufted_duck/Denmark/17740-1/2016(H5N8)	B3.2	2016-11-08	EPI909361	EPI909362	EPI909363	EPI909364	EPI909365	EPI909366	EPI909367	EPI909368	Technical University of Denmark	Animal and Plant Health Agency (APHA)
A/tufted_duck/Germany/AR8444-L01986/2016(H5N8)	B3.2	2016-11-07	EPI860494	EPI860495	EPI860496	EPI860509	EPI860497	EPI860510	EPI860498	EPI860499		Friedrich-Loeffler-Institut
A/Tufted_duck/Switzerland/V237/2016(H5N8)	B3.2	2016-11-13	EPI969251	EPI969252	EPI969253	EPI969254	EPI969255	EPI969256	EPI969257	EPI969258	Institute of Virology and Immunology IVI	Faculty of Veterinary Medicine at the University of Bern
A/turkey/Czech_Republic/38-17_1/2017(H5N8)	B2	2017-01-03	EPI1081899	EPI1081892	EPI1081893	EPI1081894	EPI1081895	EPI1081896	EPI1081897	EPI1081898	State Veterinary Institute Prague	State Veterinary Institute Prague
A/turkey/England/3778/2017(H5N8)	B3.1	2017-01-15	EPI942932	EPI942933	EPI942934	EPI942935	EPI942936	EPI942937	EPI942938	EPI942939	Animal and Plant Health Agency (APHA)	Animal and Plant Health Agency (APHA)
A/turkey/England/52131/2016(H5N8)	B3.1	2016-12-15	EPI868845	EPI868846	EPI868847	EPI868848	EPI868849	EPI868850	EPI868851	EPI868852	Animal and Plant Health Agency (APHA)	Animal and Plant Health Agency (APHA)
A/turkey/Germany-SH/R8595/2016(H5N8)	B3.2	2016-11-09	EPI916719	EPI922322	EPI861185	EPI861011	EPI861394	EPI861010	EPI916716	EPI916717		Friedrich-Loeffler-Institut
A/Turkey/Hungary/2030/2017(H5N8)	B2	2017-01-18	EPI954692	EPI954693	EPI954691	EPI954695	EPI954688	EPI954694	EPI954690	EPI954689	Central Agricultural Office Veterinary Diagnostic Directorate	Central Agricultural Office Veterinary Diagnostic Directorate
A/Turkey/Hungary/53136/2016(H5N8)	B2	2016-11-01	EPI962062	EPI962063	EPI962061	EPI962066	EPI962058	EPI962065	EPI962060	EPI962059	National Food Chain Safety Office Veterinary Diagnostic Directorate Laboratory for Molecular Biology	Central Agricultural Office Veterinary Diagnostic Directorate
A/turkey/Italy/17VIR1338-3/2017(H5N8)	B2	2017-02-14	EPI954596	EPI954597	EPI954595	EPI954599	EPI954592	EPI954598	EPI954594	EPI954593	Istituto Zooprofilattico Sperimentale Delle Venezie	Istituto Zooprofilattico Sperimentale Delle Venezie
A/turkey/Italy/17VIR1452-22/2017(H5N8)	B3.2	2017-02-16	EPI954604	EPI954605	EPI954603	EPI954607	EPI954600	EPI954606	EPI954602	EPI954601	Istituto Zooprofilattico Sperimentale Delle Venezie	Istituto Zooprofilattico Sperimentale Delle Venezie
A/turkey/Italy/17VIR538-1/2017(H5N8)	B1.1	2017-01-20	EPI954564	EPI954565	EPI954563	EPI954567	EPI954560	EPI954566	EPI954562	EPI954561	Istituto Zooprofilattico Sperimentale Delle Venezie	Istituto Zooprofilattico Sperimentale Delle Venezie
A/turkey/Italy/17VIR576-11/2017(H5N8)	B3.2	2017-01-23	EPI954572	EPI954573	EPI954571	EPI954575	EPI954568	EPI954574	EPI954570	EPI954569	Istituto Zooprofilattico Sperimentale Delle Venezie	Istituto Zooprofilattico Sperimentale Delle Venezie

Supplementary Table 1. Continued

Virus name	Genotype	Collection date	GISAID PB2 accession No.	GISAID PB1 accession No.	GISAID PA accession No.	GISAID HA accession No.	GISAID NP accession No.	GISAID NA accession No.	GISAID MP accession No.	GISAID NS accession No.	GISAID originating laboartory (where given)	GISAID submitting laboratory
A/turkey/Italy/17VIR5878-3/2017(H5N8)	B3.2	2017-07-23	EPI1040227	EPI1040228	EPI1040229	EPI1040225	EPI1040231	EPI1040226	EPI1040232	EPI1040230	Istituto Zooprofilattico Sperimentale Delle Venezie	Istituto Zooprofilattico Sperimentale Delle Venezie
A/turkey/Italy/17VIR973-2/2017(H5N8)	B2	2017-02-01	EPI954588	EPI954589	EPI954587	EPI954591	EPI954584	EPI954590	EPI954586	EPI954585	Istituto Zooprofilattico Sperimentale Delle Venezie	Istituto Zooprofilattico Sperimentale Delle Venezie
A/turkey/Rostov/11/2017(H5N8)	B3.2	2017-01-01	EPI909425	EPI909426	EPI909427	EPI909428	EPI909429	EPI909430	EPI909431	EPI909432		State Research Center of Virology and Biotechnology (VECTOR)
A/Ural_owl/Voronezh/14/2017(H5N8)	B3.2	2017-01-06	EPI909385	EPI909386	EPI909387	EPI909388	EPI909389	EPI909390	EPI909391	EPI909392		State Research Center of Virology and Biotechnology (VECTOR)
A/spoonbill/Taiwan/DB645/2017(H5N6)	B3.2.1	2017-12-01	EPI1119037	EPI1119048	EPI1119057	EPI1119065	EPI1119072	EPI1119073	EPI1119074	EPI1119075		Animal Health Research Institute
A/duck/Korea/H56/2017(H5N6)	B3.1.1	2017-12-19	EPI1145178	EPI1145179	EPI1145180	EPI1145181	EPI1145182	EPI1145183	EPI1145184	EPI1145185	Avian Influenza Research and Diagnostic Division, Animal and Plant Quarantine Agency	Animal and Plant Quarantine Agency (APQA)
A/duck/Korea/H70/2017(H5N6)	B3.1.1	2017-12-22	EPI1145295	EPI1145296	EPI1145297	EPI1145298	EPI1145299	EPI1145300	EPI1145301	EPI1145302	Avian Influenza Research and Diagnostic Division, Animal and Plant Quarantine Agency	Animal and Plant Quarantine Agency (APQA)
A/duck/Korea/H80/2017(H5N6)	B3.1.1	2017-12-26	EPI1145303	EPI1145304	EPI1145305	EPI1145306	EPI1145307	EPI1145308	EPI1145309	EPI1145310	Avian Influenza Research and Diagnostic Division, Animal and Plant Quarantine Agency	Animal and Plant Quarantine Agency (APQA)
A/duck/Korea/H81/2017(H5N6)	B3.1.1	2017-12-26	EPI1145311	EPI1145312	EPI1145313	EPI1145314	EPI1145315	EPI1145316	EPI1145317	EPI1145318	Avian Influenza Research and Diagnostic Division, Animal and Plant Quarantine Agency	Animal and Plant Quarantine Agency (APQA)
A/duck/Korea/H103/2017(H5N6)	B3.1.1	2017-12-28	EPI1145319	EPI1145320	EPI1145321	EPI1145322	EPI1145323	EPI1145324	EPI1145325	EPI1145326	Avian Influenza Research and Diagnostic Division, Animal and Plant Quarantine Agency	Animal and Plant Quarantine Agency (APQA)
A/duck/Korea/H107/2017(H5N6)	B3.1.1	2017-12-28	EPI1145327	EPI1145328	EPI1145329	EPI1145330	EPI1145331	EPI1145332	EPI1145333	EPI1145334	Avian Influenza Research and Diagnostic Division, Animal and Plant Quarantine Agency	Animal and Plant Quarantine Agency (APQA)
A/mandarin_duck/Korea/H69/2017(H5N6)	B3.1.1	2017-12-19	EPI1145335	EPI1145336	EPI1145337	EPI1145338	EPI1145339	EPI1145340	EPI1145341	EPI1145342	Avian Influenza Research and Diagnostic Division, Animal and Plant Quarantine Agency	Animal and Plant Quarantine Agency (APQA)
A/mandarin_duck/Korea/H71/2017(H5N6)	B3.1.1	2017-12-20	EPI1145343	EPI1145344	EPI1145345	EPI1145346	EPI1145347	EPI1145348	EPI1145349	EPI1145350	Avian Influenza Research and Diagnostic Division, Animal and Plant Quarantine Agency	Animal and Plant Quarantine Agency (APQA)
A/mandarin_duck/Korea/H119-3/2017(H5N6)	B3.1.1	2017-12-28	EPI1145351	EPI1145352	EPI1145353	EPI1145354	EPI1145355	EPI1145356	EPI1145357	EPI1145358	Avian Influenza Research and Diagnostic Division, Animal and Plant Quarantine Agency	Animal and Plant Quarantine Agency (APQA)
A/chicken/Greece/39/2017(H5N6)	B3.2.1	2017-02-06	EPI1122874	EPI1122875	EPI1122876	EPI1122877	EPI1122878	EPI1122879	EPI1122880	EPI1122881	Thessalonica Veterinary Centre (TVC)	Animal and Plant Health Agency (APHA)
A/Great_Black-backed_Gull/Netherlands/1/2017(H5N6)	B3.1.1	2017-12-18	EPI1131085	EPI1131086	EPI1131087	EPI1131088	EPI1131089	EPI1131090	EPI1131091	EPI1131092	Erasmus Medical Center	Erasmus Medical Center
A/Great_Black-backed_Gull/Netherlands/2/2017(H5N6)	B3.3.1	2017-12-18	EPI1131093	EPI1131094	EPI1131095	EPI1131096	EPI1131097	EPI1131098	EPI1131099	EPI1131100	Erasmus Medical Center	Erasmus Medical Center
A/breeder duck/Korea/Gochang 1/2014(H5N8)	B0	2014-01-16	EPI509696	EPI509697	EPI509692	EPI509698	EPI509699	EPI509700	EPI509701	EPI509710	Animal and Plant Quarantine Agency (APQA)	Animal and Plant Quarantine Agency (APQA)
A/Baikal teal/Korea/H52/2014(H5N8)	B0	2014-01-20	EPI561492	EPI561494	EPI561498	EPI561495	EPI561503	EPI561493	EPI561504	EPI561505	Animal and Plant Quarantine Agency (APQA)	Animal and Plant Quarantine Agency (APQA)
A/duck/Zhejiang/W24/2013(H5N8)	B0	2013-11-14	EPI530979	EPI530981	EPI530983	EPI530985	EPI530987	EPI530989	EPI530991	EPI530993		Other Database Import
A/duck/Zhejiang/6D18/2013(H5N8)	B0	2013-12-14	EPI530980	EPI530982	EPI530984	EPI530986	EPI530988	EPI530990	EPI530992	EPI530994		Other Database Import
A/barnacle_goose/Netherlands/2/2014(H3N6)		2014-12-15	EPI1010642	EPI1014832	EPI1014069	EPI1010875	EPI1014128	EPI1011098	EPI1010945	EPI1014874		Other Database Import
A/Caspian_seal/Russia/1884/2002(H4N6)		2002-07-20						EPI533775				Other Database Import
A/Caspian_seal/Russia/T1/2012(H4N6)		2012-10-03						EPI533781				Other Database Import
A/chicken/Hunan/S1248/2010(H4N6)		2010-03-03						EPI692338				Other Database Import
A/chicken/India/WB-NIV101006/2009(H4N6)		2009-12-17						EPI395392				Other Database Import
A/duck/Bangladesh/1283/2008(H4N6)		2008-12-21						EPI540374			Institute of Epidemiology Disease Control and Research (IEDCR) & Bangladesh National Influenza Centre (NIC)	Centers for Disease Control and Prevention
A/duck/Bangladesh/1521/2009(H4N6)		2009-10-21						EPI540366			Institute of Epidemiology Disease Control and Research (IEDCR) & Bangladesh National Influenza Centre (NIC)	Centers for Disease Control and Prevention

Supplementary Table 1. Continued

Virus name	Genotype	Collection date	GISAID PB2 accession No.	GISAID PB1 accession No.	GISAID PA accession No.	GISAID HA accession No.	GISAID NP accession No.	GISAID NA accession No.	GISAID MP accession No.	GISAID NS accession No.	GISAID originating laboartory (where given)	GISAID submitting laboratory
A/duck/Bangladesh/1766/2010(H4N6)		2010-10-27						EPI540358			Institute of Epidemiology Disease Control and Research (IEDCR) & Bangladesh National Influenza Centre (NIC)	Centers for Disease Control and Prevention
A/duck/Bangladesh/26918/2015(H3N6)		2015-12-09						EPI965295				Other Database Import
A/duck/Henan/S1091/2010(H7N6)		2010-03-03						EPI692466				Other Database Import
A/duck/Hunan/S1012/2009(H4N6)		2009-03-03						EPI692506				Other Database Import
A/duck/Jiangsu/4/2010(H3N6)		2010-03-01						EPI414148				Other Database Import
A/duck/Korea/DY104/2007(H4N6)		2007-12-01						EPI401303				Other Database Import
A/duck/Mongolia/101/2015(H4N6)		2015-08-30						EPI704269				Other Database Import
A/duck/Mongolia/262/2011(H4N6)		2011-09-01						EPI1133993				Other Database Import
A/duck/Mongolia/769/2015(H4N6)		2015-08-31						EPI704432				Other Database Import
A/duck/Mongolia/OIE-7438/2011(H4N6)		2011-09-10						EPI357825				Other Database Import
A/duck/Moscow/4781/2012(H4N6)		2012-10-01						EPI1036196				Other Database Import
A/duck/Vietnam/OIE-3287/2011(H3N6)		2011-10-05						EPI371576				Other Database Import
A/eurasian_wigeon/Mongolia/340V/2009(H4N6)		2009-08-14						EPI485322				Other Database Import
A/Khaki_Campbell_duck/Karachi/NARC-23963/2010(H4N6)		2010-12-09						EPI407862				Other Database Import
A/mallard/Czech_Republic/12652/2007(H4N6)		2007-08-06						EPI284397				Other Database Import
A/mallard_duck/Netherlands/10/2013(H4N6)		2013-12-04						EPI1013677				Other Database Import
A/mallard_duck/Netherlands/19/2012(H4N6)		2012-09-07						EPI890326				Other Database Import
A/mallard_duck/Netherlands/22/2011(H4N6)		2011-09-30						EPI1011235				Other Database Import
A/mallard_duck/Netherlands/27/2009(H4N6)		2009-12-21						EPI889824				Other Database Import
A/mallard_duck/Netherlands/30/2014(H4N6)		2014-07-21						EPI891032				Other Database Import
A/mallard_duck/Netherlands/6/2006 (H4N6)		2006-06-03						EPI890683				Other Database Import
A/mallard_duck/Netherlands/7/2006(H10N6)		2006-06-05						EPI1014700				Other Database Import
A/mallard/Iceland/1007/2011(H3N6)		2011-10-14						EPI475927				Other Database Import
A/mallard/Sweden/105516/2009(H4N6)		2009-12-02						EPI513184				Other Database Import
A/mallard/Sweden/124228/2010(H4N6)		2010-11-01						EPI513191				Other Database Import
A/mallard/Sweden/93475/2009(H10N6)		2009-08-23						EPI618783				Other Database Import
A/ruddy_shelduck/Mongolia/592/2010(H8N6)		2010-06-22						EPI485357				Other Database Import
A/shoveller/Chany_Lake/101/2012(H4N6)		2012-08-26						EPI823790			Research Institute of Experimental and Clinical Medicine	Research Institute of Experimental and Clinical Medicine
A/teal/Chany_Lake/104_cloaca/2012 (H4N6)		2012-08-26						EPI823909			Research Institute of Experimental and Clinical Medicine	Research Institute of Experimental and Clinical Medicine
A/teal/Egypt/09888-NAMRU3/2005(H4N6)		2005-10-03						EPI372354			U.S. Naval Medical Research Unit No.3	Centers for Disease Control and Prevention
A/chicken/Jiangxi/12272/2014(H10N6)		2014-03-16						EPI600192				Other Database Import
A/chicken/Shenzhen/552/2013(H5N6)		2013-12-10						EPI599294				Other Database Import
A/duck/Dongguan/3069/2013(H5N6)		2013-12-18						EPI599341				Other Database Import
A/silkie_chicken/Dongguan/2809/2013(H5N6)		2013-12-18						EPI599335				Other Database Import
A/goose/Shantou/1763/2014(H5N6)		2014-03-13						EPI599650				Other Database Import
A/duck/Guangdong/GD01/2014(H5N6)		2014-03-01						EPI531458				Other Database Import
A/duck/Guangzhou/18/2014(H5N6)		2014-01-15						EPI775285				Other Database Import
A/duck/Vietnam/LBM758/2014(H5N6)		2014-10-13						EPI596612				Other Database Import
A/chicken/Jiangxi/NCDZT1123/2014(H5N6)		2014-06-29						EPI590808				Other Database Import

Supplementary Table 1. Continued

Virus name	Genotype	Collection date	GISAID PB2 accession No.	GISAID PB1 accession No.	GISAID PA accession No.	GISAID HA accession No.	GISAID NP accession No.	GISAID NA accession No.	GISAID MP accession No.	GISAID NS accession No.	GISAID originating laboartory (where given)	GISAID submitting laboratory
A/Yunnan/0127/2015(H5N6)		2015-02-06						EPI641400				Other Database Import
A/Guangzhou/39715/2014(H5N6)		2014-12-11						EPI593891				Other Database Import
A/environment/Guangdong/GZ670/2015 (H5N6)		2015-05-04						EPI758872				Other Database Import
A/duck/Shantou/6233/2004(H5N6)		2004-01-01						EPI268294				Other Database Import
A/mallard/Shantou/972/2005(H5N6)		2005-01-01						EPI268294				Other Database Import
A/duck/Fujian/2087/2007(H5N6)		2007-01-01						EPI365123				Other Database Import
A/chicken/Hunan/S4495/2010(H5N6)		2010-12-10						EPI1007216				Other Database Import
A/duck/Jiangxi/10160/2014(H5N6)		2014-02-17						EPI599355				Other Database Import
A/chicken/Shenzhen/1845/2013(H5N6)		2013-12-12						EPI599308				Other Database Import
A/environment/Zhenjiang/C13/2013 (H5N6)		2013-12-20						EPI547404				Other Database Import
A/chicken/Sichuan/NCJPL1/2014(H5N6)		2014-04-27						EPI590863				Other Database Import
A/chicken/Gifu/1-1T/2017(H5N6)		2017-01-14						EPI885283				National Institute of Animal Health
A/chicken/Miyazaki/2-2C/2017(H5N6)		2017-01-24						EPI891534				National Institute of Animal Health
A/muscovy_duck/Aomori/1-3T/2016(H5N6)		2016-11-28						EPI867088			National Institute of Animal Health	National Institute of Animal Health
A/chicken/Kumamoto/1-2C/2016(H5N6)		2016-12-27						EPI881068				National Institute of Animal Health
A/chicken/Korea/HN1/2016(H5N6)		2016-11-16						EPI866087			Animal and Plant Quarantine Agency (APQA)	Animal and Plant Quarantine Agency (APQA)
A/duck/Korea/ES2/2016 (H5N6)		2016-11-16						EPI866095			Animal and Plant Quarantine Agency (APQA)	Animal and Plant Quarantine Agency (APQA)
A/duck/Korea/H15/2016(H5N6)		2016-11-20						EPI866103			Animal and Plant Quarantine Agency (APQA)	Animal and Plant Quarantine Agency (APQA)
A/Eurasian_eagle_owl/Korea/960/2016 (H5N6)		2016-11-05						EPI866116			Animal andPlant Quarantine Agency (APQA)	Animal and Plant Quarantine Agency (APQA)
A/mandarin_duck/Korea/WB246/2016 (H5N6)		2016-11-17						EPI866134			Animal and Plant Quarantine Agency (APQA)	Animal and Plant Quarantine Agency (APQA)
A/spot_billed_duck/Korea/WB141/2016 (H5N6)		2016-11-10						EPI866146			Animal and Plant Quarantine Agency (APQA)	Animal and Plant Quarantine Agency (APQA)

pISSN 1229-845X · eISSN 1976-555X
J Vet Sci 2018, 19(6), 850-854

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Supplementary Table 2. Clade 2.3.4.4b H5N6 highly pathogenic avian influenza isolates used in this study

Avian species		Virus name	Location	Age (wk)	Clinical sign
Domestic	Broiler duck	A/duck/Korea/HD1/2017 (H5N6)	35°31'N, 126°42'E	5	Lameness
	Breeder duck	A/duck/Korea/H35/2017 (H5N6)	34°54'N, 126°41'E	39	Reduced egg production, increasing mortality, lameness
	Broiler duck	A/duck/Korea/H56/2017 (H5N6)	34°50'N, 126°35'E	5	Not detected
	Broiler duck	A/duck/Korea/H70/2017 (H5N6)	35°40'N, 126°48'E	5	Lameness
	Breeder duck	A/duck/Korea/H80/2017 (H5N6)	34°49'N, 126°40'E	38	Increasing mortality, reduced egg production
	Broiler duck	A/duck/Korea/H81/2017 (H5N6)	34°48'N, 127°20'E	5	Increasing mortality
	Broiler duck	A/duck/Korea/H103/2017 (H5N6)	34°50'N, 126°35'E	5	Increasing mortality
	Breeder duck	A/duck/Korea/H107/2017 (H5N6)	34°57'N, 126°35'E	20	Increasing mortality
Wild	Mallard	A/mallard/Korea/Jeju-H24/2017 (H5N6)	33°30'N, 126°53'E	–	–
	Mandarin duck	A/mandarin duck/Korea/H69/2017 (H5N6)	36°44'N, 127°08'E	–	–
	Mandarin duck	A/mandarin duck/Korea/H71/2017 (H5N6)	36°45'N, 127°06'E	–	–
	Mandarin duck	A/mandarin duck/Korea/H119/2017 (H5N6)	36°44′N, 127°07'E	–	–

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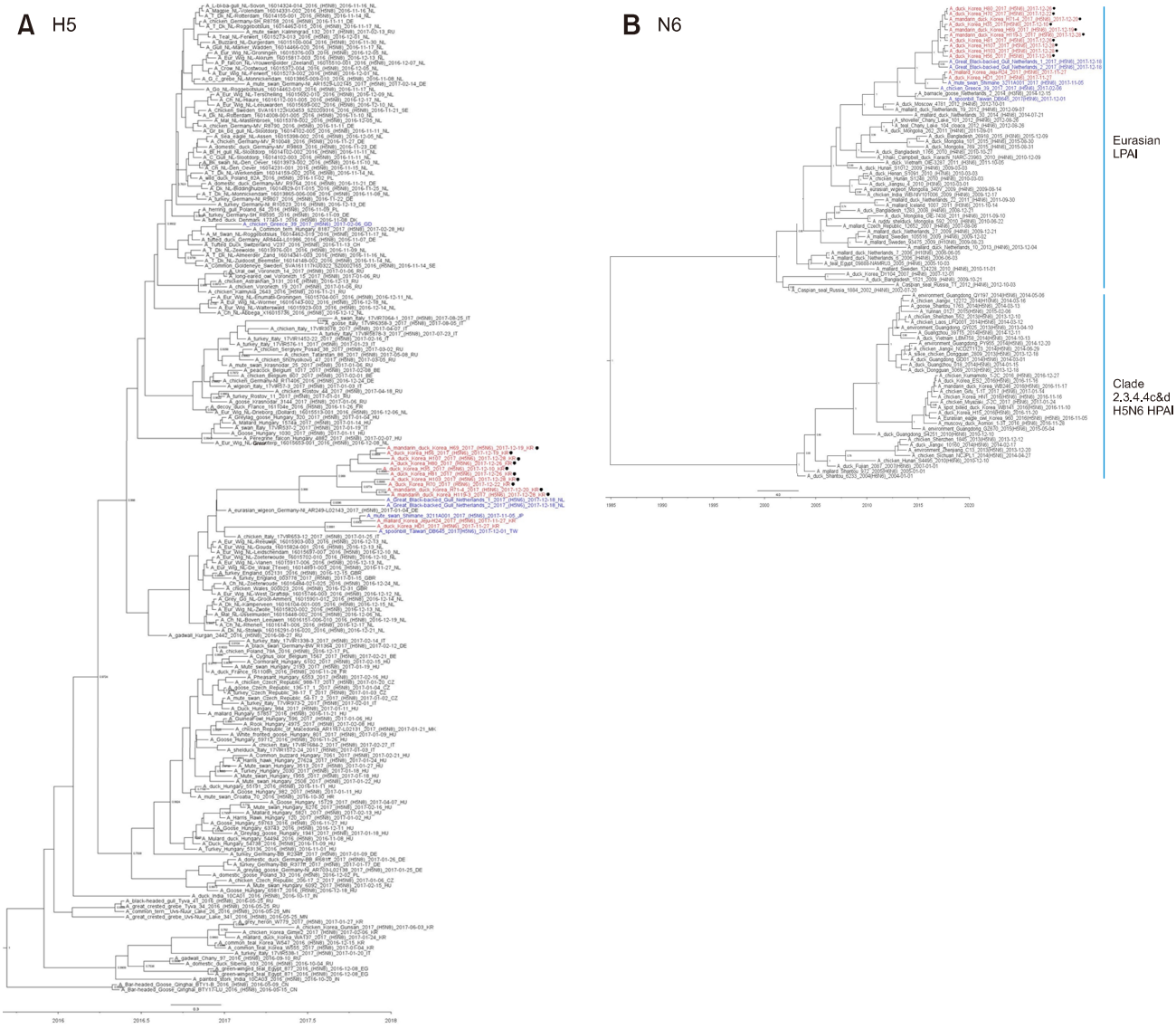
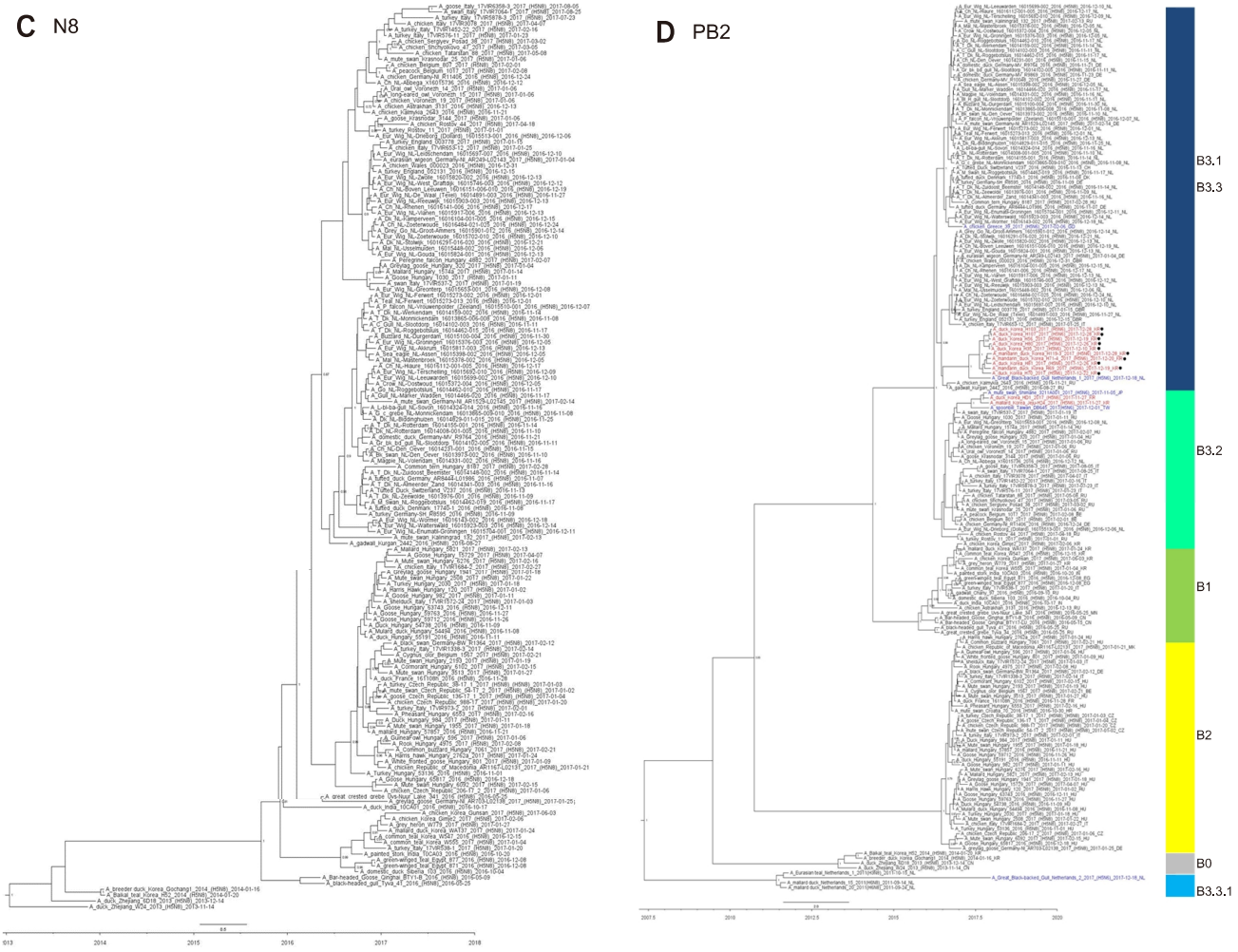
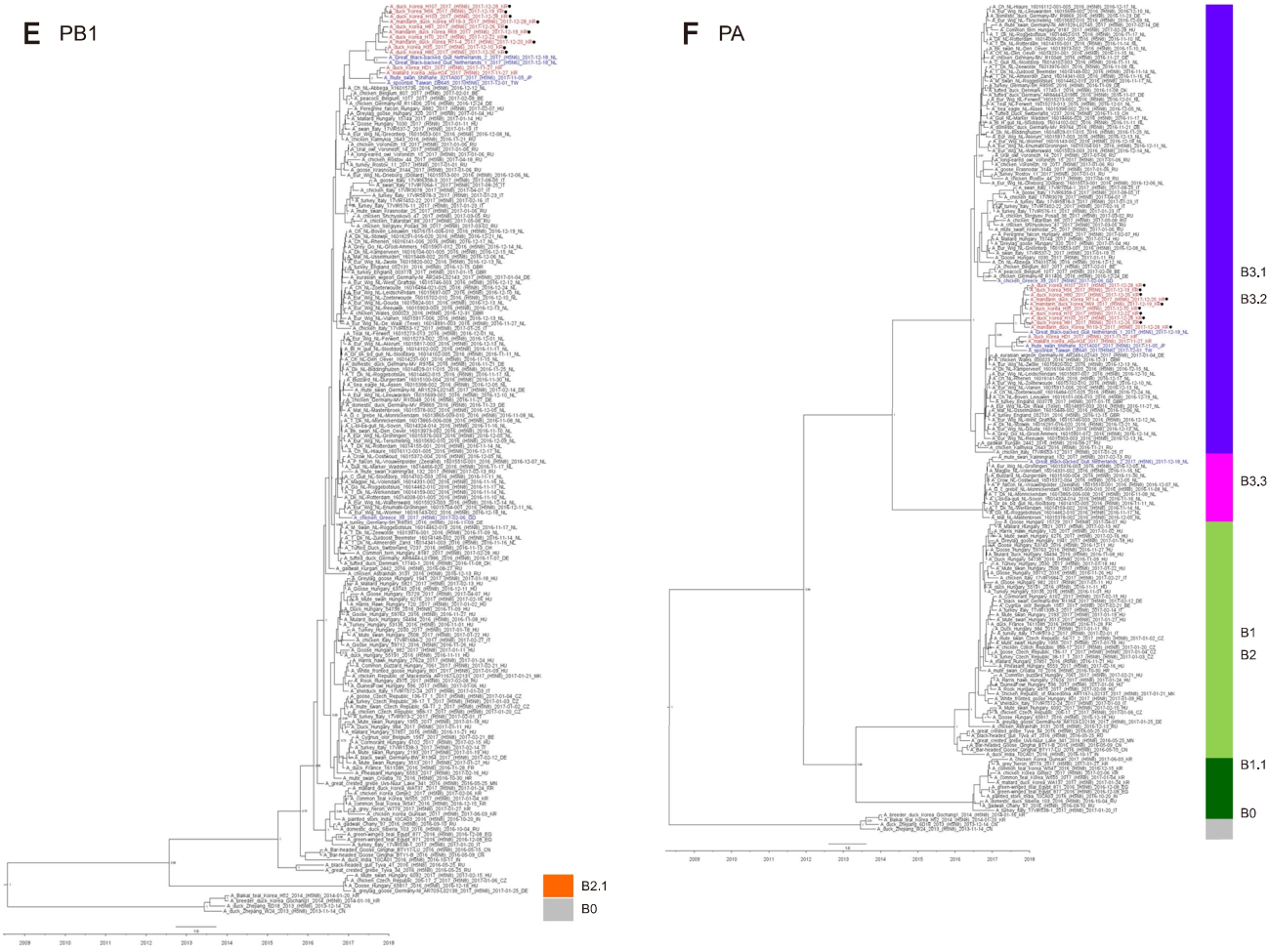


Supplementary Fig. 1. The estimated maximum-clade-credibility phylogeny of eight genetic segments of clade 2.3.4.4b H5Nx viruses in Eurasia. Time-scaled phylogenies (dates shown on the horizontal axis) were inferred using relaxed-clock Bayesian Markov chain Monte Carlo analysis for each gene segment separately. (A) H5. (B) N6. (C) N8. (D) Polymerase basic 2 (PB2). (E) Polymerase basic 1 (PB1). (F) Polymerase acidic (PA). (G) Nucleoprotein (NP). (H) Matrix protein (MP). (I) Nonstructural (NS). The SRD06 nucleotide-substitution model and a Bayesian skyline coalescent tree prior were used in the analyses. For each gene segment, two independent runs were performed with a chain length of 100 million steps, with sampling every 10,000 steps. Tracer v1.6[1] was used for visual inspection of effective sample size (ESS) and chain convergence. The results from two runs were combined for analyses to ensure that an adequate ESS value ($>$ 200) was reached for relevant parameters using Logcombiner v1.8.1 with 10% burn-in. The maximum-clade-credibility trees were generated with TreeAnnotator v1.8.1 and visualized with FigTree v1.4.2. The clade 2.3.4.4b H5N6 isolates in South Korea and other countries are labeled in red and blue, respectively. The isolates in this study are indicated by dots. Several clusters of the PB2, PB1, PA, and NP genes were indicated by different color. Branch lengths represent time. Posterior probabilities of $>$ 0.7 are provided for key nodes.

1. **Rambaut A, Drummond AJ, Xie D, Baele G, Suchard MA.** Posterior summarization in Bayesian phylogenetics using Tracer 1.7. Syst Biol 2018, **67**, 901-904.



Supplementary Fig. 1. Continued.



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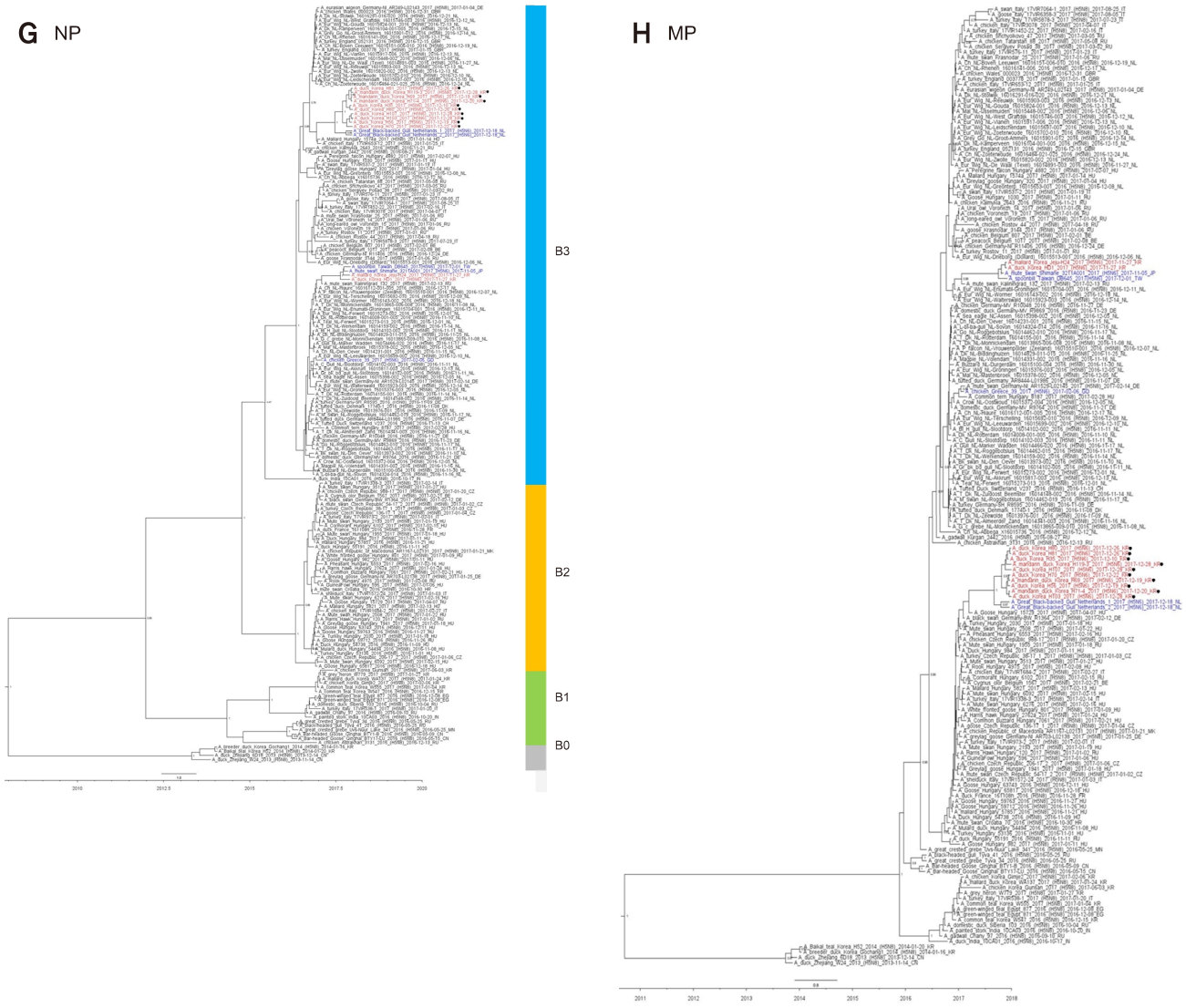
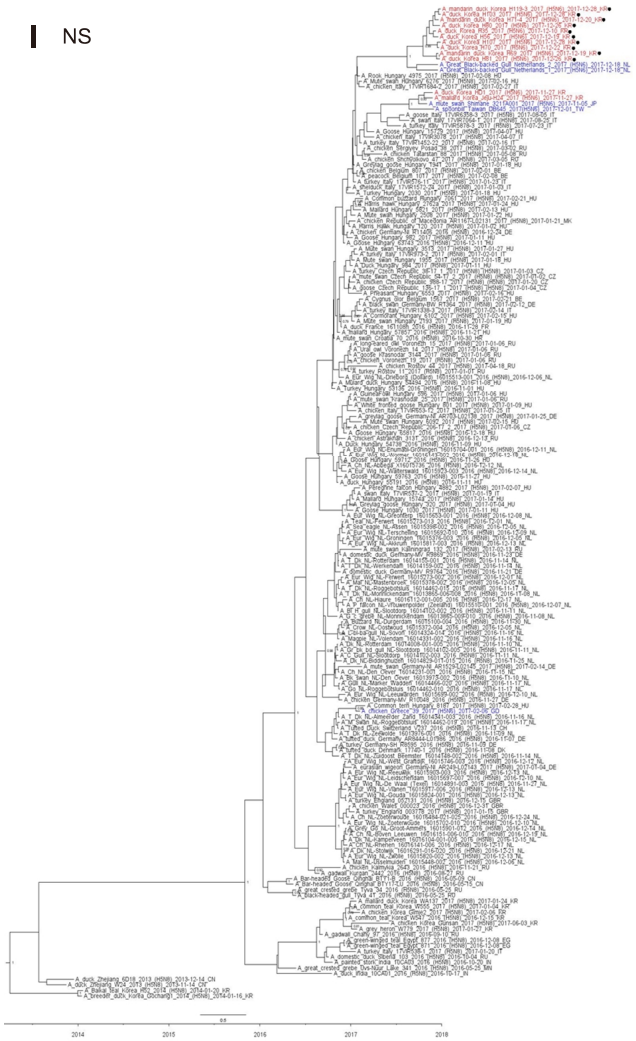


Supplementary Fig. 1. Continued.



Supplementary Fig. 1. Continued.