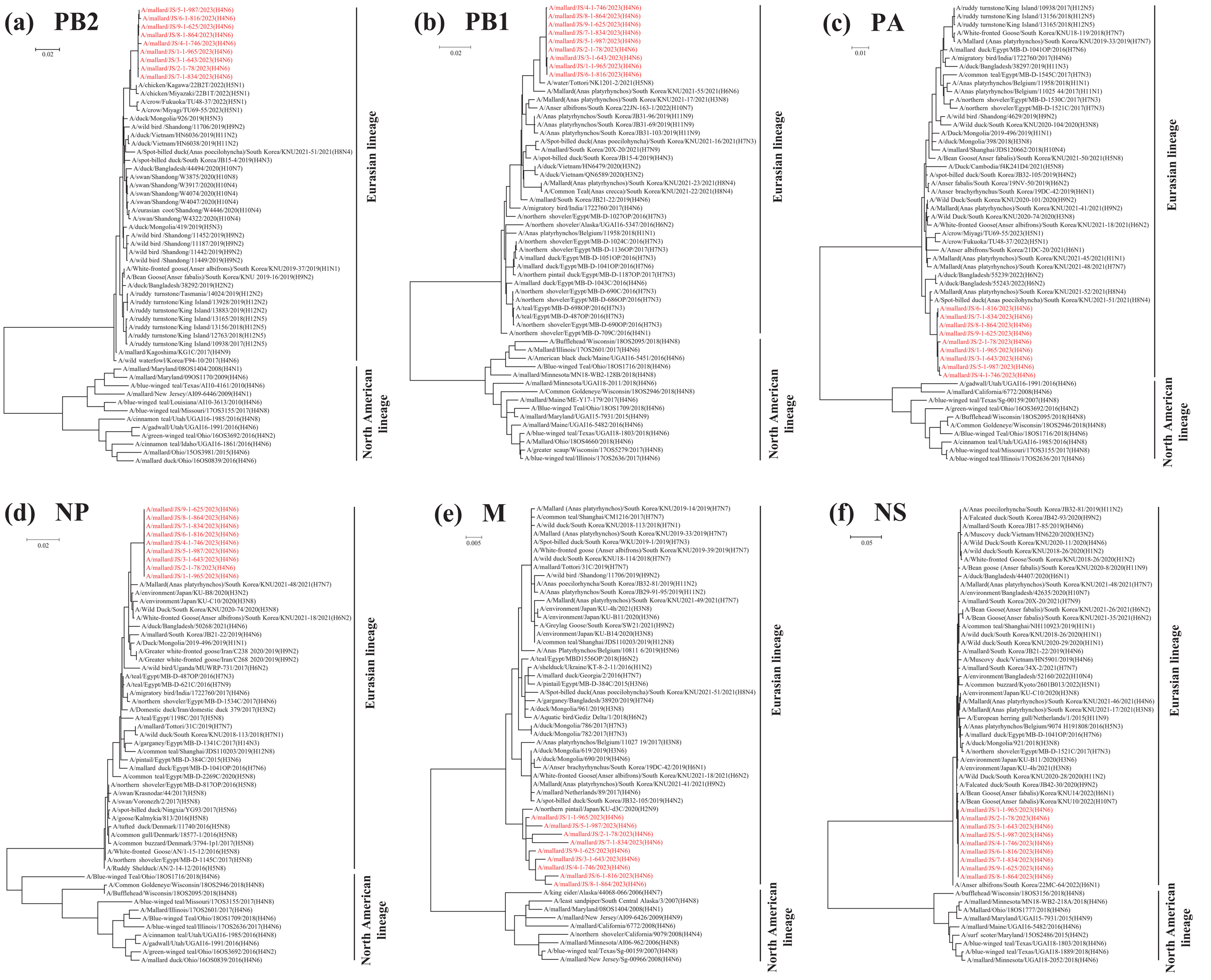
(a) PB2
0.02
A/mallard/JS/5-1-987/2023(H4N6)
A/mallard/JS/6-1-816/2023(H4N6)
A/mallard/JS/9-1-625/2023(H4N6)
A/mallard/JS/8-1-864/2023(H4N6)
A/mallard/JS/4-1-746/2023(H4N6)
A/mallard/JS/1-1-965/2023(H4N6)
A/mallard/JS/3-1-643/2023(H4N6)
A/mallard/JS/2-1-78/2023(H4N6)
A/mallard/JS/7-1-834/2023(H4N6)
A/chicken/Kagawa/22B2T/2022(H5N1)
A/chicken/Miyazaki/22B1T/2022(H5N1)
A/crow/Fukuoka/TU48-37/2022(H5N1)
A/crow/Miyagi/TU69-55/2023(H5N1)
A/duck/Mongolia/926/2019(H5N3)
A/wild bird /Shandong/11706/2019(H9N2)
A/duck/Vietnam/HN6036/2019(H11N2)
A/duck/Vietnam/HN6038/2019(H11N2)
A/Spot-billed duck(Anas poecilohyncha)/South Korea/KNU2021-51/2021(H8N4)
A/spot-billed duck/South Korea/JB15-4/2019(H4N3)
A/duck/Bangladesh/44494/2020(H10N7)
A/swan/Shandong/W3875/2020(H10N8)
A/swan/Shandong/W3917/2020(H10N4)
A/swan/Shandong/W4074/2020(H10N4)
A/swan/Shandong/W4047/2020(H10N4)
A/eurasian coot/Shandong/W4446/2020(H10N4)
A/swan/Shandong/W4322/2020(H10N4)
A/duck/Mongolia/419/2019(H5N3)
A/wild bird /Shandong/11452/2019(H9N2)
A/wild bird /Shandong/11187/2019(H9N2)
A/wild bird /Shandong/11442/2019(H9N2)
A/wild bird /Shandong/11449/2019(H9N2)
A/White-fronted goose(Anser albifrons)/South Korea/KNU2019-37/2019(H1N1)
A/Bean Goose(Anser fabalis)/South Korea/KNU 2019-16/2019(H9N2)
A/duck/Bangladesh/38292/2019(H2N2)
A/ruddy turnstone/Tasmania/14024/2019(H12N2)
A/ruddy turnstone/King Island/13928/2019(H12N2)
A/ruddy turnstone/King Island/13883/2019(H12N2)
A/ruddy turnstone/King Island/13165/2018(H12N5)
A/ruddy turnstone/King Island/13156/2018(H12N5)
A/ruddy turnstone/King Island/12763/2018(H12N5)
A/ruddy turnstone/King Island/10938/2017(H12N5)
A/mallard/Kagoshima/KG1C/2017(H4N9)
A/wild waterfowl/Korea/F94-10/2017(H4N6)
A/mallard/Maryland/08OS1404/2008(H4N1)
A/mallard/Maryland/09OS1170/2009(H4N6)
A/blue-winged teal/Texas/AI10-4161/2010(H4N6)
A/mallard/New Jersey/AI09-6446/2009(H4N1)
A/blue-winged teal/Louisiana/AI10-3613/2010(H4N6)
A/blue-winged teal/Missouri/17OS3155/2017(H4N8)
A/cinnamon teal/Utah/UGAI16-1985/2016(H4N8)
A/gadwall/Utah/UGAI16-1991/2016(H4N6)
A/green-winged teal/Ohio/16OS3692/2016(H4N2)
A/cinnamon teal/Idaho/UGAI16-1861/2016(H4N6)
A/mallard/Ohio/15OS3981/2015(H4N6)
A/mallard duck/Ohio/16OS0839/2016(H4N6)
Eurasian lineage
North American lineage
(b) PB1
0.02
A/mallard/JS/4-1-746/2023(H4N6)
A/mallard/JS/8-1-864/2023(H4N6)
A/mallard/JS/9-1-625/2023(H4N6)
A/mallard/JS/7-1-834/2023(H4N6)
A/mallard/JS/5-1-987/2023(H4N6)
A/mallard/JS/2-1-78/2023(H4N6)
A/mallard/JS/3-1-643/2023(H4N6)
A/mallard/JS/1-1-965/2023(H4N6)
A/mallard/JS/6-1-816/2023(H4N6)
A/water/Tottori/NK1201-2/2021(H5N8)
A/Mallard(Anas platyrhynchos)/South Korea/KNU2021-55/2021(H6N6)
A/Mallard(Anas platyrhynchos)/South Korea/KNU2021-17/2021(H3N8)
A/Anser albifrons/South Korea/22JN-163-1/2022(H10N7)
A/Anas platyrhynchos/South Korea/JB31-96/2019(H11N9)
A/Anas platyrhynchos/South Korea/JB31-69/2019(H11N9)
A/Anas platyrhynchos/South Korea/JB31-103/2019(H11N9)
A/Spot-billed duck(Anas poecilohyncha)/South Korea/KNU2021-16/2021(H7N3)
A/mallard/South Korea/20X-20/2021(H7N9)
A/spot-billed duck/South Korea/JB15-4/2019(H4N3)
A/duck/Vietnam/HN6479/2020(H3N2)
A/duck/Vietnam/QN6589/2020(H3N2)
A/Mallard(Anas platyrhynchos)/South Korea/KNU2021-23/2021(H8N4)
A/Common Teal(Anas crecca)/South Korea/KNU2021-22/2021(H8N4)
A/mallard/South Korea/JB21-22/2019(H4N6)
A/migratory bird/India/1722760/2017(H4N6)
A/northern shoveler/Egypt/MB-D-1027OP/2016(H7N3)
A/northern shoveler/Alaska/UGAI16-5347/2016(H6N2)
A/Anas platyrhynchos/Belgium/11958/2018(H1N1)
A/northern shoveler/Egypt/MB-D-1024C/2016(H7N3)
A/northern shoveler/Egypt/MB-D-1136OP/2017(H7N3)
A/mallard duck/Egypt/MB-D-1051OP/2016(H7N3)
A/mallard duck/Egypt/MB-D-1041OP/2016(H7N6)
A/northern pintail duck/Egypt/MB-D-1187OP/2017(H7N3)
A/mallard duck/Egypt/MB-D-1043C/2016(H4N6)
A/northern shoveler/Egypt/MB-D-690C/2016(H7N3)
A/northern shoveler/Egypt/MB-D-686OP/2016(H7N3)
A/teal/Egypt/MB-D-698OP/2016(H7N3)
A/teal/Egypt/MB-D-487OP/2016(H7N3)
A/northern shoveler/Egypt/MB-D-690OP/2016(H7N3)
A/northern shoveler/Egypt/MB-D-709C/2016(H4N1)
A/Bufflehead/Wisconsin/18OS2095/2018(H4N8)
A/Mallard/Illinois/17OS2601/2017(H4N6)
A/American black duck/Maine/UGAI16-5451/2016(H4N6)
A/Blue-winged Teal/Ohio/18OS1716/2018(H4N6)
A/mallard/Minnesota/MN18-WB2-128B/2018(H4N8)
A/mallard/Minnesota/UGAI18-2011/2018(H4N6)
A/Common Goldeneye/Wisconsin/18OS2946/2018(H4N8)
A/mallard/Maine/ME-Y17-179/2017(H4N6)
A/Blue-winged Teal/Ohio/18OS1709/2018(H4N6)
A/mallard/Maryland/UGAI15-7931/2015(H4N9)
A/mallard/Maine/UGAI16-5482/2016(H4N6)
A/blue-winged teal/Texas/UGAI18-1803/2018(H4N6)
A/Mallard/Ohio/18OS4660/2018(H4N6)
A/greater scaup/Wisconsin/17OS5279/2017(H4N8)
A/blue-winged teal/Illinois/17OS2636/2017(H4N6)
Eurasian lineage
North American lineage
(c) PA
0.01
A/ruddy turnstone/King Island/10938/2017(H12N5)
A/ruddy turnstone/King Island/13156/2018(H12N5)
A/ruddy turnstone/King Island/13165/2018(H12N5)
A/White-fronted Goose/South Korea/KNU18-119/2018(H7N7)
A/Mallard (Anas platyrhynchos)/South Korea/KNU2019-33/2019(H7N7)
A/mallard duck/Egypt/MB-D-1041OP/2016(H7N6)
A/migratory bird/India/1722760/2017(H4N6)
A/duck/Bangladesh/38297/2019(H11N3)
A/common teal/Egypt/MB-D-1545C/2017(H7N3)
A/Anas platyrhynchos/Belgium/11958/2018(H1N1)
A/Anas platyrhynchos/Belgium/11025 44/2017(H11N1)
A/northern shoveler/Egypt/MB-D-1530C/2017(H7N3)
A/northern shoveler/Egypt/MB-D-1521C/2017(H7N3)
A/wild bird /Shandong/4629/2019(H9N2)
A/Wild duck/South Korea/KNU2020-104/2020(H3N8)
A/Duck/Mongolia/2019-496/2019(H1N1)
A/duck/Mongolia/398/2018(H3N8)
A/mallard/Shanghai/JDS120662/2018(H10N4)
A/Bean Goose(Anser fabalis)/South Korea/KNU2021-50/2021(H5N8)
A/Duck/Cambodia/f4K241D4/2021(H5N8)
A/spot-billed duck/South Korea/JB32-105/2019(H4N2)
A/Anser fabalis/South Korea/19NV-50/2019(H6N2)
A/Anser brachyrhynchus/South Korea/19DC-42/2019(H6N1)
A/Wild Duck/South Korea/KNU2020-101/2020(H9N2)
A/Mallard(Anas platyrhynchos)/South Korea/KNU2021-41/2021(H9N2)
A/Wild Duck/South Korea/KNU2020-74/2020(H3N8)
A/White-fronted Goose(Anser albifrons)/South Korea/KNU2021-18/2021(H6N2)
A/crow/Miyagi/TU69-55/2023(H5N1)
A/crow/Fukuoka/TU48-37/2022(H5N1)
A/Anser albifrons/South Korea/21DC-20/2021(H6N1)
A/Mallard(Anas platyrhynchos)/South Korea/KNU2021-45/2021(H1N1)
A/Mallard(Anas platyrhynchos)/South Korea/KNU2021-48/2021(H7N7)
A/duck/Bangladesh/55239/2022(H6N2)
A/duck/Bangladesh/55243/2022(H6N2)
A/Mallard(Anas platyrhynchos)/South Korea/KNU2021-52/2021(H8N4)
A/Spot-billed duck(Anas poecilohyncha)/South Korea/KNU2021-51/2021(H8N4)
A/mallard/JS/6-1-816/2023(H4N6)
A/mallard/JS/7-1-834/2023(H4N6)
A/mallard/JS/8-1-864/2023(H4N6)
A/mallard/JS/9-1-625/2023(H4N6)
A/mallard/JS/2-1-78/2023(H4N6)
A/mallard/JS/1-1-965/2023(H4N6)
A/mallard/JS/3-1-643/2023(H4N6)
A/mallard/JS/5-1-987/2023(H4N6)
A/mallard/JS/4-1-746/2023(H4N6)
A/gadwall/Utah/UGAI16-1991/2016(H4N6)
A/mallard/California/6772/2008(H4N6)
A/blue-winged teal/Texas/Sg-00159/2007(H4N8)
A/green-winged teal/Ohio/16OS3692/2016(H4N2)
A/Bufflehead/Wisconsin/18OS2095/2018(H4N8)
A/Common Goldeneye/Wisconsin/18OS2946/2018(H4N8)
A/Blue-winged Teal/Ohio/18OS1716/2018(H4N6)
A/cinnamon teal/Utah/UGAI16-1985/2016(H4N8)
A/blue-winged teal/Missouri/17OS3155/2017(H4N8)
A/blue-winged teal/Illinois/17OS2636/2017(H4N6)
Eurasian lineage
North American lineage
(d) NP
0.02
A/mallard/JS/9-1-625/2023(H4N6)
A/mallard/JS/8-1-864/2023(H4N6)
A/mallard/JS/7-1-834/2023(H4N6)
A/mallard/JS/6-1-816/2023(H4N6)
A/mallard/JS/4-1-746/2023(H4N6)
A/mallard/JS/5-1-987/2023(H4N6)
A/mallard/JS/3-1-643/2023(H4N6)
A/mallard/JS/2-1-78/2023(H4N6)
A/mallard/JS/1-1-965/2023(H4N6)
A/Mallard(Anas platyrhynchos)/South Korea/KNU2021-48/2021(H7N7)
A/environment/Japan/KU-B8/2020(H3N2)
A/environment/Japan/KU-C10/2020(H3N8)
A/Wild Duck/South Korea/KNU2020-74/2020(H3N8)
A/White-fronted Goose(Anser albifrons)/South Korea/KNU2021-18/2021(H6N2)
A/duck/Bangladesh/50268/2021(H4N6)
A/mallard/South Korea/JB21-22/2019(H4N6)
A/Duck/Mongolia/2019-496/2019(H1N1)
A/Greater white-fronted goose/Iran/C238 2020/2019(H9N2)
A/Greater white-fronted goose/Iran/C268 2020/2019(H9N2)
A/wild bird/Uganda/MUWRP-731/2017(H6N2)
A/teal/Egypt/MB-D-487OP/2016(H7N3)
A/teal/Egypt/MB-D-621C/2016(H7N9)
A/migratory bird/India/1722760/2017(H4N6)
A/northern shoveler/Egypt/MB-D-1534C/2017(H4N6)
A/Domestic duck/Iran/domestic duck 379/2017(H3N2)
A/teal/Egypt/1198C/2017(H5N8)
A/mallard/Tottori/31C/2019(H7N7)
A/wild duck/South Korea/KNU2018-113/2018(H7N1)
A/garganey/Egypt/MB-D-1341C/2017(H14N3)
A/common teal/Shanghai/JDS110203/2019(H12N8)
A/pintail/Egypt/MB-D-384C/2015(H3N6)
A/mallard duck/Egypt/MB-D-1041OP/2016(H7N6)
A/common teal/Egypt/MB-D-2269C/2020(H5N8)
A/northern shoveler/Egypt/MB-D-817OP/2016(H5N8)
A/swan/Krasnodar/44/2017(H5N8)
A/swan/Voronezh/2/2017(H5N8)
A/spot-billed duck/Ningxia/YG93/2017(H5N6)
A/goose/Kalmykia/813/2016(H5N8)
A/tufted duck/Denmark/11740/2016(H5N8)
A/common gull/Denmark/18577-1/2016(H5N8)
A/common buzzard/Denmark/3794-1p1/2017(H5N8)
A/White-fronted Goose/AN/1-15-12/2016(H5N8)
A/northern shoveler/Egypt/MB-D-1145C/2017(H5N8)
A/Ruddy Shelduck/AN/2-14-12/2016(H5N8)
A/Blue-winged Teal/Ohio/18OS1716/2018(H4N6)
A/Common Goldeneye/Wisconsin/18OS2946/2018(H4N8)
A/Bufflehead/Wisconsin/18OS2095/2018(H4N8)
A/blue-winged teal/Missouri/17OS3155/2017(H4N8)
A/Mallard/Illinois/17OS2601/2017(H4N6)
A/Blue-winged Teal/Ohio/18OS1709/2018(H4N6)
A/blue-winged teal/Illinois/17OS2636/2017(H4N6)
A/cinnamon teal/Utah/UGAI16-1985/2016(H4N8)
A/gadwall/Utah/UGAI16-1991/2016(H4N6)
A/green-winged teal/Ohio/16OS3692/2016(H4N2)
A/mallard duck/Ohio/16OS0839/2016(H4N6)
Eurasian lineage
North American lineage
(e) M
0.005
A/Mallard (Anas platyrhynchos)/South Korea/KNU2019-14/2019(H7N7)
A/common teal/Shanghai/CM1216/2017(H7N7)
A/wild duck/South Korea/KNU2018-113/2018(H7N1)
A/Mallard (Anas platyrhynchos)/South Korea/KNU2019-33/2019(H7N7)
A/Spot-billed duck/South Korea/WKU2019-1/2019(H7N3)
A/White-fronted goose (Anser albifrons)/South Korea/KNU2019-39/2019(H7N7)
A/wild duck/South Korea/KNU18-114/2018(H7N7)
A/mallard/Tottori/31C/2019(H7N7)
A/wild bird /Shandong/11706/2019(H9N2)
A/Anas poecilorhyncha/South Korea/JB32-81/2019(H11N2)
A/Anas platyrhynchos/South Korea/JB29-91-95/2019(H11N2)
A/Mallard(Anas platyrhynchos)/South Korea/KNU2021-49/2021(H7N7)
A/environment/Japan/KU-4h/2021(H3N8)
A/environment/Japan/KU-B11/2020(H3N6)
A/Greylag Goose/South Korea/SW21/2021(H9N2)
A/environment/Japan/KU-B14/2020(H3N8)
A/common teal/Shanghai/JDS110203/2019(H12N8)
A/Anas Platyrhynchos/Belgium/10811 6/2019(H5N6)
A/teal/Egypt/MBD1556OP/2018(H6N2)
A/shelduck/Ukraine/KT-8-2-11/2016(H1N2)
A/mallard duck/Georgia/2/2016(H7N7)
A/pintail/Egypt/MB-D-384C/2015(H3N6)
A/Spot-billed duck(Anas poecilohyncha)/South Korea/KNU2021-51/2021(H8N4)
A/garganey/Bangladesh/38920/2019(H7N4)
A/duck/Mongolia/961/2019(H3N8)
A/Aquatic bird/Gediz Delta/1/2018(H6N2)
A/duck/Mongolia/786/2017(H7N3)
A/duck/Mongolia/782/2017(H7N3)
A/Anas platyrhynchos/Belgium/11027 19/2017(H3N8)
A/duck/Mongolia/619/2019(H3N6)
A/duck/Mongolia/690/2019(H4N6)
A/Anser brachyrhynchus/South Korea/19DC-42/2019(H6N1)
A/White-fronted Goose(Anser albifrons)/South Korea/KNU2021-18/2021(H6N2)
A/Mallard(Anas platyrhynchos)/South Korea/KNU2021-41/2021(H9N2)
A/mallard/Netherlands/89/2017(H4N6)
A/spot-billed duck/South Korea/JB32-105/2019(H4N2)
A/northern pintail/Japan/KU-d3C/2020(H2N9)
A/mallard/JS/1-1-965/2023(H4N6)
A/mallard/JS/5-1-987/2023(H4N6)
A/mallard/JS/2-1-78/2023(H4N6)
A/mallard/JS/7-1-834/2023(H4N6)
A/mallard/JS/9-1-625/2023(H4N6)
A/mallard/JS/3-1-643/2023(H4N6)
A/mallard/JS/4-1-746/2023(H4N6)
A/mallard/JS/6-1-816/2023(H4N6)
A/mallard/JS/8-1-864/2023(H4N6)
A/king eider/Alaska/44068-066/2006(H4N7)
A/least sandpiper/South Central Alaska/3/2007(H4N8)
A/mallard/Maryland/08OS1404/2008(H4N1)
A/mallard/New Jersey/AI09-6426/2009(H4N9)
A/mallard/California/6772/2008(H4N6)
A/northern shoveler/California/9079/2008(H4N4)
A/mallard/Minnesota/AI06-962/2006(H4N8)
A/blue-winged teal/Texas/Sg-00159/2007(H4N8)
A/mallard/New Jersey/Sg-00966/2008(H4N6)
Eurasian lineage
North American lineage
(f) NS
0.05
A/Anas poecilorhyncha/South Korea/JB32-81/2019(H11N2)
A/Falcated duck/South Korea/JB42-93/2020(H9N2)
A/mallard/South Korea/JB17-85/2019(H4N6)
A/Muscovy duck/Vietnam/HN6220/2020(H3N2)
A/Wild Duck/South Korea/KNU2020-11/2020(H4N6)
A/wild duck/South Korea/KNU2018-26/2020(H1N2)
A/White-fronted Goose/South Korea/KNU2018-26/2020(H1N2)
A/Bean goose (Anser fabalis)/South Korea/KNU2020-8/2020(H11N9)
A/duck/Bangladesh/44407/2020(H6N1)
A/Mallard(Anas platyrhynchos)/South Korea/KNU2021-48/2021(H7N7)
A/environment/Bangladesh/42635/2020(H10N7)
A/mallard/South Korea/20X-20/2021(H7N9)
A/Bean Goose(Anser fabalis)/South Korea/KNU2021-26/2021(H6N2)
A/Bean Goose(Anser fabalis)/South Korea/KNU2021-35/2021(H6N2)
A/common teal/Shanghai/NH110923/2019(H1N1)
A/wild duck/South Korea/KNU2018-26/2020(H1N1)
A/Wild duck/South Korea/KNU2020-29/2020(H1N1)
A/mallard/South Korea/JB21-22/2019(H4N6)
A/Muscovy duck/Vietnam/HN5901/2019(H4N6)
A/mallard/South Korea/34X-2/2021(H7N7)
A/environment/Bangladesh/52160/2022(H10N4)
A/common buzzard/Kyoto/2601B013/2022(H5N1)
A/environment/Japan/KU-C10/2020(H3N8)
A/Mallard(Anas platyrhynchos)/South Korea/KNU2021-46/2021(H4N6)
A/Mallard(Anas platyrhynchos)/South Korea/KNU2021-17/2021(H3N8)
A/European herring gull/Netherlands/1/2015(H11N9)
A/Anas platyrhynchos/Belgium/9074 H191808/2016(H5N3)
A/mallard duck/Egypt/MB-D-1041OP/2016(H7N6)
A/duck/Mongolia/921/2018(H3N8)
A/northern shoveler/Egypt/MB-D-1521C/2017(H7N3)
A/environment/Japan/KU-B11/2020(H3N6)
A/environment/Japan/KU-4h/2021(H3N8)
A/Wild Duck/South Korea/KNU2020-28/2020(H11N2)
A/Falcated duck/South Korea/JB42-30/2020(H9N2)
A/Bean Goose(Anser fabalis)/Korea/KNU14/2022(H6N1)
A/Bean Goose(Anser fabalis)/Korea/KNU10/2022(H10N7)
A/mallard/JS/1-1-965/2023(H4N6)
A/mallard/JS/2-1-78/2023(H4N6)
A/mallard/JS/3-1-643/2023(H4N6)
A/mallard/JS/5-1-987/2023(H4N6)
A/mallard/JS/4-1-746/2023(H4N6)
A/mallard/JS/6-1-816/2023(H4N6)
A/mallard/JS/7-1-834/2023(H4N6)
A/mallard/JS/9-1-625/2023(H4N6)
A/mallard/JS/8-1-864/2023(H4N6)
A/Anser albifrons/South Korea/22MC-64/2022(H6N1)
A/bufflehead/Wisconsin/18OS3156/2018(H4N8)
A/mallard/Minnesota/MN18-WB2-218A/2018(H4N6)
A/Mallard/Ohio/18OS1777/2018(H4N6)
A/mallard/Maryland/UGAI15-7931/2015(H4N9)
A/mallard/Maine/UGAI16-5482/2016(H4N6)
A/surf scoter/Maryland/15OS2486/2015(H4N2)
A/blue-winged teal/Texas/UGAI18-1803/2018(H4N6)
A/blue-winged teal/Texas/UGAI18-1889/2018(H4N6)
A/mallard/Minnesota/UGAI18-2052/2018(H4N6)
Eurasian lineage
North American lineage