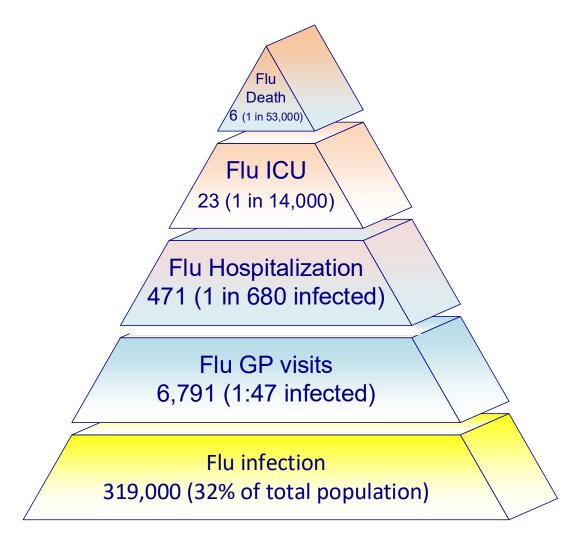


Hold my beer and watch this; explosive spread of A(H5N1) influenza



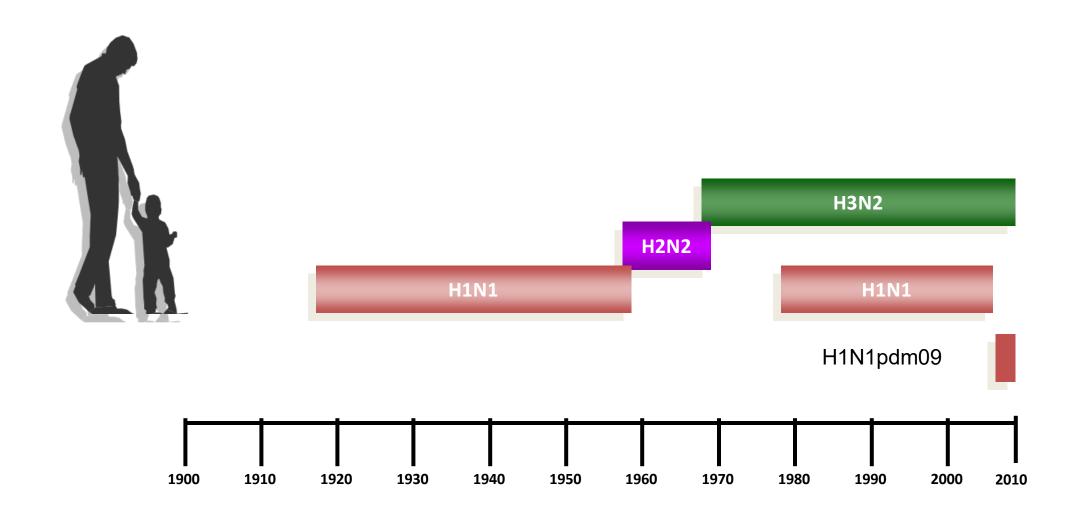
Seasonal Flu is bad



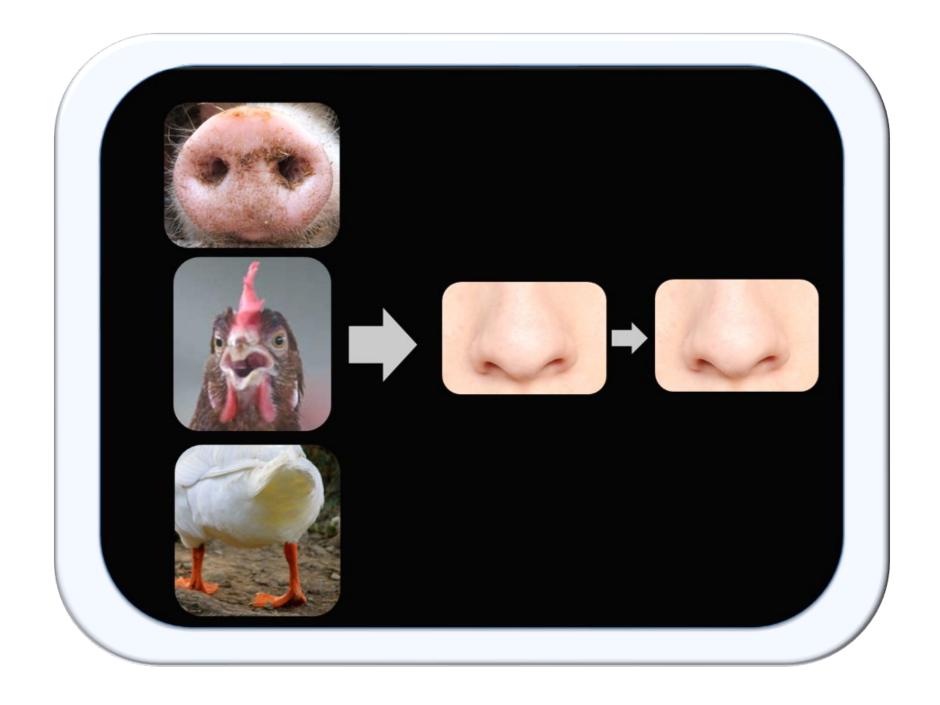




Epidemic flu A evolves from pandemics

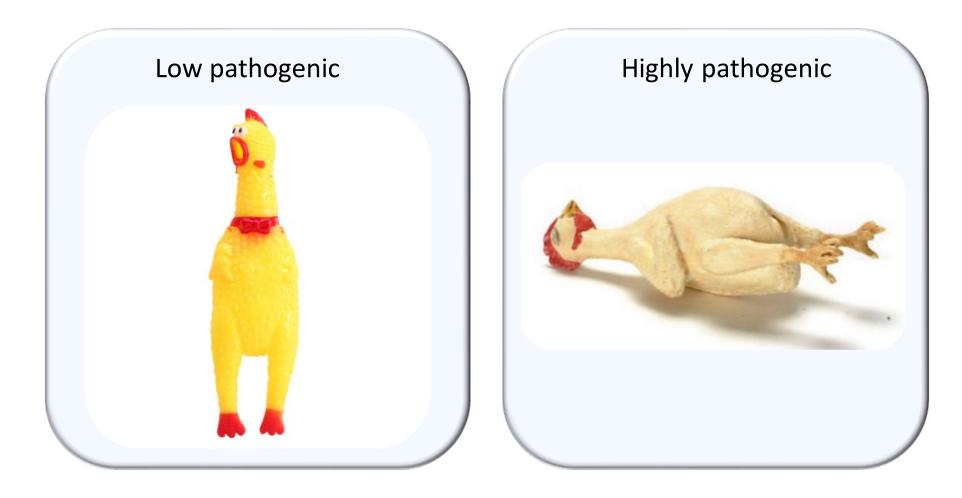






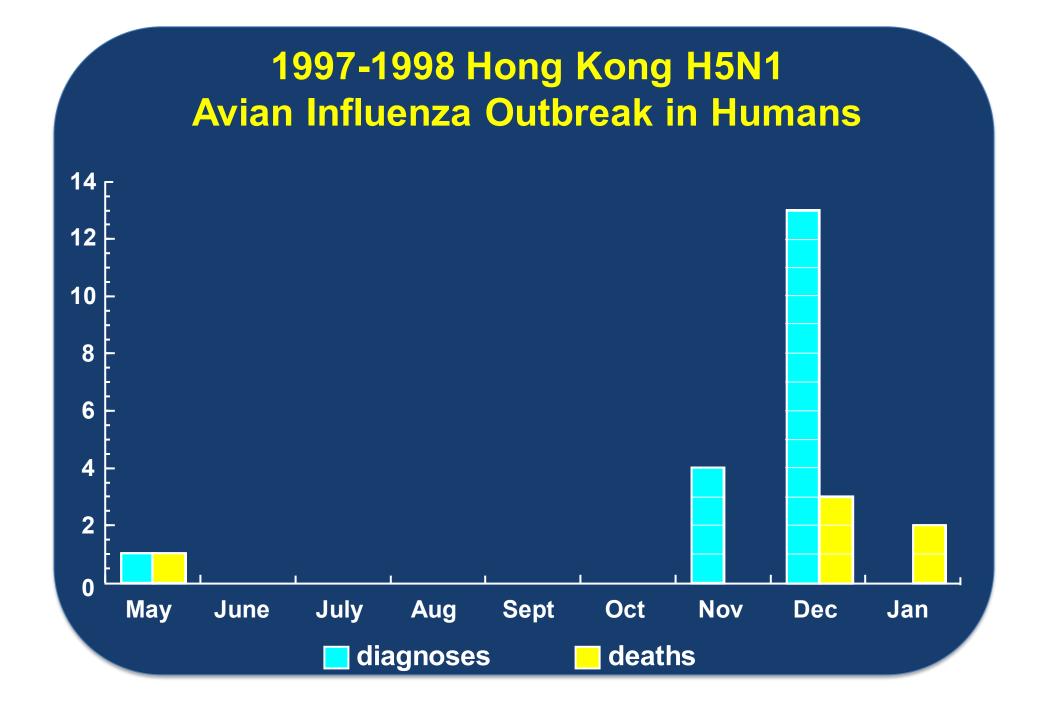


Avian influenza exists in two forms



- Occurs upon transmission to domestic poultry
- Historically self limiting in this host









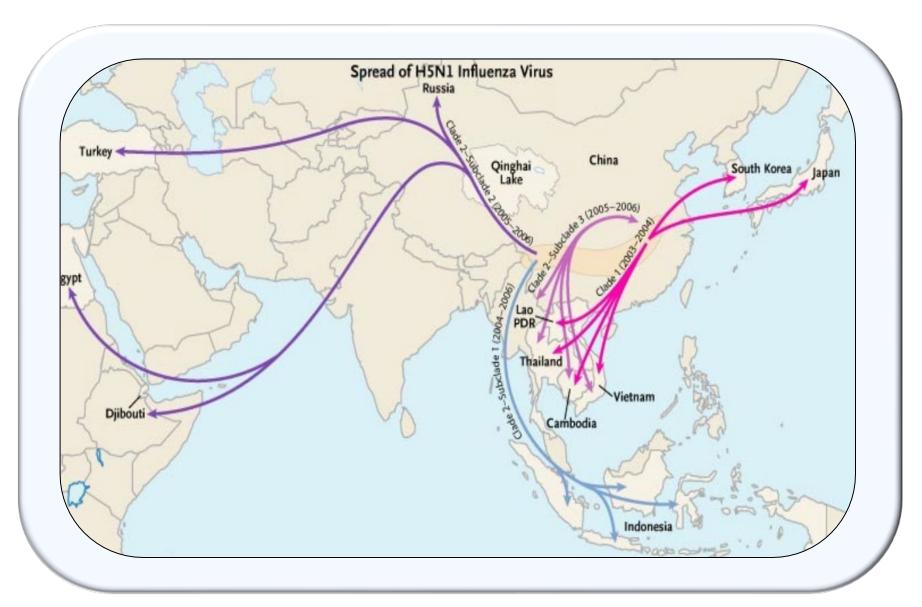


You won't find fire everywhere there is smoke



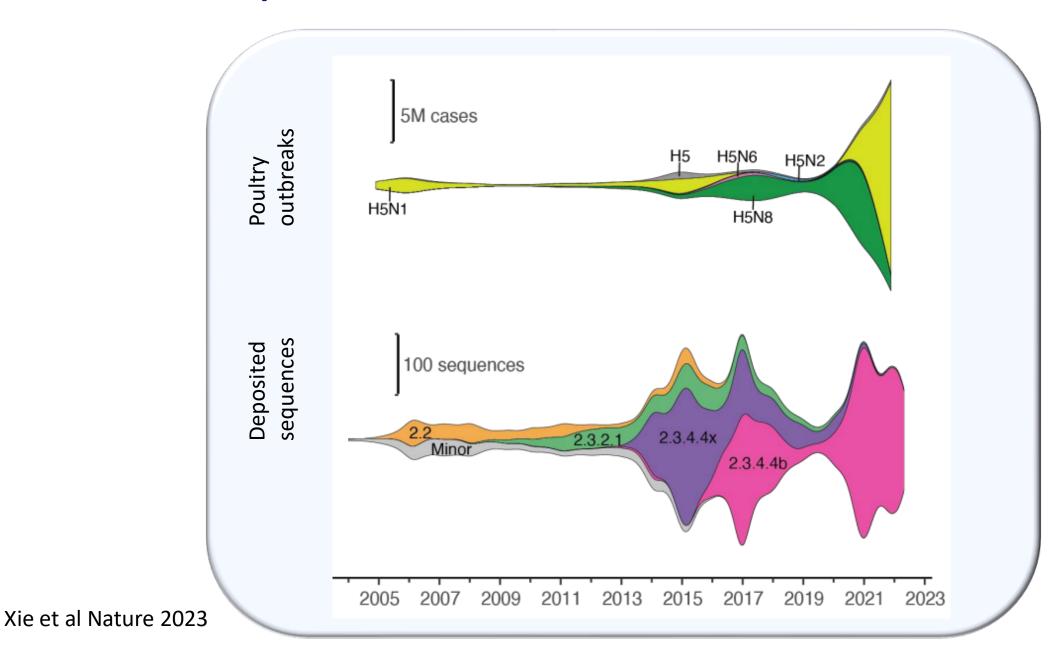


Early H5 activity





The hold my beer bit







Feb 2019

Table 1. Recent A(H5) activity Country, area or territory	Host	Genetic clade
Rangladash	Poultry	2.3.2.1a (H5N1)
Bulgaria	Poultry	23.4.4 (HSN8)
Cambodia	Poultry	unknown (H5)
China	Human (3)	2.3.4.4 (H5N6)
	Poultry	2.3.4.4 (H5N6)
Denmark	Wild birds	2.3.4.4 (H5N6)
Egypt	Poultry	23.4.4 (HSN6)
India	Wild birds	2.3.2.1a (H5N1)
	Poultry	2.3.2.1a (H5N1)
Indonesia	Poultry	unknown (H5N1)
Iran	Poultry	2.3.4.4 (H5N8)
Ruwait	Captive birds	unknown (H5NS)
Lao People's Democratic Republic	Poultry	unknown (H5N1)
Namibia	Wild birds	unknown (H5N8)
Nizeria	Poultry	23.44 (H5)(8)
Russian Federation	Wild birds	2.3.4.4 (H5N6)
	Poultry	2.3.4.4 (H5N8)
South Africa	Poultry	23.4.4 (H3N8)
Taiwan	Poultry	2.3.4.4 (H5N2)
Viet Nam	Doultry	unknown (H5N1); 23.4.4 (H5)

17 countries/regions

Feb 2020

ountry, area or territory	Host	Genetic clade*
Bangladesh	Poultry	2.3.2.1a (H5N1)
Bulgaria	Poultry	2.3.4.4b (H5N8)
China	Poultry	2.3.2.1d (H5N1); 2.3.4.4h (H5N6)
	Wild bird	2.3.4.4h (H5N6)
Taiwan, China	Poultry	2.3.4.4c (H5N2/N5);
		Unknown (H5)
Czech Republic	Poultry	2.3.4.4b (H5N8)
Egypt	Poultry	2.3.4.4b (H5N8)
Germany	Poultry	2.3.4.4b (H5N8)
	Wild bird	2.3.4.4b (H5N8)
Hungary	Poultry	2.3.4.4b (H5N8)
India	Poultry	2.3.2.1a (H5N1)
Indonesia	Poultry	Unknown (H5N1)
Iran (Islamic Republic of)	Poultry	2.3.4.4b (H5N3)
Israel	Wild bird	Unknown (H5N8)
Lao People's Democratic Republic	Poultry	2.3.4.4h (H5N6)
Nigeria	Poultry	2.3.4.46 (H5N6/N8)
Poland	Poultry	2.3.4.4b (H5N8)
	Wild bird	2.3.4.4b (H5N8)
Romania	Poultry	2.3.4.4b (H5N8)
Saudi Arabia	Poultry	Unknown (H5N8)
Slovakia	Poultry	2.3.4.4b (H5N8)
	Wild bird	2.3.4.4b (H5N8)
Ukraine	Poultry	2.3.4.4b (H5N8)
Viet Nam	Poultry	2.3.2.1c (H5N1); 2.3.4.4g (H5N6);
		2.3.4.4h (H5N6)

20 countries/regions

Feb 2021

Country, area or territory	Host	Genetic clade
Afghanistan	Poultry	unknown (H5N8)
Algeria	Poultry	unknown (HSNS)
Austria	Wild Birds	unknown (HSN8)
Bangladesh	Wild bird	2.3.4.4h (H5N6) 2.3.2.1a (H5N1)
	Poultry	2.3.2.1a (H5N1)
Belgium	Wild bird	unknown (H5) 23.4.4b (H5N8) 23.4.4b (H5N8) unknown (H5N5)
	Poultry	2.3.4.4b (H5N8) unknown (H5N5)
Bulgaria	Poultry	unknown (HSNE)
Cambodia	Poultry	2.3.2.1c (H5N1)
China	Human (6)	2.3.4.4h, unknown (H5N6)
	Poultry environmental	2.3.4.4h (H5N6), 2.3.2.1f (H5N1)
	Wild birds	unknown (H5N6), 2.3.4.4h (H5N8)
Chinese Taipei	Poultry	unknown (H5N2/5)
	Wild Birds	unknown (H5) 2.3.4.4b (H5N8)
Croatia	Poultry	2.3.4.4b (H5NS)
Czechia	Poultry	2.3.4.4b (H3N8)
	Wild Birds	2.3.4.4b (HSN8)
Denmark	Wild birds	2.3.4.4b (HSN5/N8)
	Poultry	2.3.4.4b (HSN8)
Estonia	Wild Birds	unknown (H5NE)
Finland	Wild Birds	unknown (H5NE)
France	Wild birds	2.3.4.4b (H5N8) unknown (H5N3) 2.3.4.4b (H5N5/8)
	Poultry	Z.3.4.46 (H2N3/8)
Germany	Wild bird	unknown (HSN/x/1/3/4), 2.3.4.4b (HSN5/8) 2.3.4.4b (HSN5/8)
	Poultry	2.3.4.40 (HSN5/8)
Hong Kong	Wild birds	unknown (HSN\$)
Hungary	Wild birds	unknown (HSNE)
	Poultry	unknown (HSN8)
India	Poultry	unknown (HSN1/8)
	Wild Birds	2.3.4.4b(H5N8) 2.3.4.4b(H5N1)
The Islamic Republic of Iran	Wild bird	unknown (H5NE)
	Poultry	unknown (H5N8)
Republic of Iraq	Poultry	2.3.4.4b (HSN8) unknown (HSN3), 2.3.4.4b (HSN8)
Ireland	Wild birds	unicorum (H5N3), 2.3.4.46 (H5N8)
	Poultry	2.3.4.4b (HSN8) unknown (HSN8)
Israel	Wild birds	unknown (HSN8)
	Poultry	unknown (HSNS)
Italy	Wild birds	2.3.4.4b (H5N1/5/8)
	Poultry Wild birds	unknown (H5N8)
Japan	Wild birds Poultry	2.3.4.4b (H5N8)
		2.3.4.4b (HSN8)
Kazakhstan	Wild birds	2.3.4.4b (HSN8)
	Poultry	2.3.4.4b (HSN8) 2.3.4.4b (HSN8)
Kuwait Lao People's Democratic	Poultry Human (1)	2.3.2.1c (H5N1)
Republic	Poultry	unknown (H5N1)
Kepunik Latvia	Wild Birds	unknown (HSNE)
Latrua Lithuania	Wild birds	unknown (HSNE)
Limbers	Poultry	unknown (HSNS)
Vienel	Poultry	unknown (H5NE)
Nepal Netherlands	Wild birds	STATE (FINE)
VACUALISM	Poultry	2.3.4.4b (HSN1/5/8) 2.3.4.4b (HSN1/8)
Nizeria	Poultry	unknown (HSN1)
Nigena	Pounty	URRIONE (FIGN.)
March 2021		Page 2 of 8
Norway	Wild birds	2.3.4.4b (H5N8) 2.3.4.4b (H5N8)
	Poultry	2.3.4.4b (H5N8)
Poland	Poultry	2.3.4.4b (H5N8)
	Wild birds	2.3.4.4b (H5N5/8)
Republic of Georgia	Wild birds	unknown (HSNE)
Republic of Korea	Wild birds	2.3.4.4b (H5N8)
	Poultry	2.3.4.4b (H5N8)
Romania	Poultry	unknown (H5N8)
	Wild birds	unknown (H5N8)
The Russian Federation	Wild bird	2.3.4.4b (H5N8)
A DEC ACADAMAN A COST BUILDE	Poultry	2.3.4.4b (H5N5/8)
	Human (7)	2.3.4.4b (HSN ₂ /NE)
Saudi Arabia	Poultry	unknown (HSNE)
Senegal	Pounty	GENERAL (STATE)
	Positry 11514 birds	unknown (HSN1)
Slovakia	Wild birds Poultry	unknown (HSN1) unknown (HSN1)

49 countries/regions

Why?

- The virus?
- Changes in agricultural practices?
- Changes in wildlife?
- Changes in environmental conditions?

Feb 2022

Belgium	Poultry	2.3.4.4b (H5N1)
- N	Wild Birds	2.3.4.4b (H5N1)
Benin Besnia and Herzegovina	Poultry Wild Birth	2.3.4.4b (H5N1) unknown (H5N1)
Betswana	Poultry	
	Wild Birds	2.3.4.4b (H5N1)
Bulgaria Burkina Faso	Positio	unkmen.(HS)
Cambodia	Poultry Poultry	unknown (H5N1) 2.3.2.1e (H5N1); 2.3.4.4b (H5N8)
Cameroon		unknown (H5N1)
Canada		2.3.4.4b (H5N1)
		2.3.4.4b (H5N1) 2.3.4.4b (H5N1)
China	Human (25)	2.3.4.4b (H5N6); unknown (H5N6) 2.3.4.4b (H5N8)
	Poultry Environmental	2.3.4.4b (H5N8) 2.3.4.4b (H5N6)
	Wild Birds	
Cete d'Iyoire		50k0090.(05NJ) 2.3.4.4b (B5NI) 2.3.4.4b (B5NI)
Croatia		2.3.4.4b (H5N1)
Czech Republic	Wild Birds	2.3.4.4b (H5N1) 2.3.4.4b (H5N1)
	Poultry Wild Birds	2.3.4.4b (H5N1)
Denmark	Poultry Wild Birds	unknown (H5N1/N8) unknown ((H5N1/N8)
	Wild Birds	unknown ((H5N1/N8)
Exps	Mammal ¹ Positry	2.3.4.4b (B5N8) 2.3.4.4b (B5N1/N8)
Estenia		
	Wild Birds	2.3.4.4b (H5NUN8)
	Mammali	2.3.4.4b (H5N1)
Faroe Islands	Wild Birds	unknown (H5N1). 2.3.4.4b (H5N1); unknown (H5N8) 2.3.4.4b (H5N1) 2.3.4.4b (H5N1)N8)
Finland	Wild Birds Mormal ²	2.3.4.4b (H5N1); unknown (H5N8) 2.3.4.4b (H5N1)
France		2.3.4.4b (B5N1/N8)
	Wild Birds	2.3.4.4b (H5N1) 2.3.4.4b (H5N1)
Germany	Poultry	2.3.4.4b (H5N1)
Ghana	Wild Birds	2.3.4.4b (H5N1); unknown (H5N2/N3)
Greece	Poultry Wild Birds	unknown (H5N1) unknown (H5N1)
China, Hong Kong SAR	Wild Birds	unknown (H5N1)
Hungary	Poultry	
Isdia	Wild Birds	unknown (H5N1)
India	Poultry Wild Birds	2.3.4.4b (H5N1) 2.3.4.4b (H5N1/N8)
Iran (The Islamic Republic of)	Poultry	unknown (H5N5)
beland	Poultry	unkroan (HSN1)
	Wild Hirds	unknown (H5N1) 2.3.4.4b (H5N1)
Isle of Man	Poultry	
Israel	Wild Birds Poultry	unknown (H5N1) unknown (H5N1)
Betael	Wild Birds	unknown (H5N1)
Italy	Poultry Wild Birds	2.3.4.4b (H5N1) 2.3.4.4b (H5N1)
	Wild Birds	2.3.4.4b (H5N1)
Japan	Poultry Wild Birds	2.3.4.4b (H5N1/N8) 2.3.4.4b (H5N8)
	Positry	2.3.4.4b (HSN1) 2.3.2.1c (HSN1); 2.3.4.4b (HSN6/N8) Page 2 of 11
	Postto	2.3.2.1c (HSN1); 2.3.4.4b (HSN6/N8)
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66 countries/regions

Feb 2023

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able 1. NS authory reported ountry, near or territory	to international agencies since Se	tember 1022
	Host Yorkry	Genetic clode tarknown* (HSNI)
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	Wild Birds Kodry	2.3.4.46 (ENI) 2.3.2.16 (ENI) 2.3.4.46 (ENI)
Sanghalosh Salgiran	Nukry	23446/(988)
	Mararule (fema), fox)	2.3.4.4b(25N1)
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wate	Wild Birds Foultry	urknown (1854.) 2.3.4.46(1850)
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	Marwale (dolphin, fire, Bacoon, skunk) Wild Hinds Foolbry Marwale (sea lion)	
344	Positry	2.3.4.4b (PENI) taknova (PENI)
	Marrirol (sea lion)	rankmonum (ERENE)
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Sira, Way Kong SAR	Positry findenument	2.3.4.46((BN1)) 2.3.4.46((BN1))
	WildTitals	
Darwon, China	Wild Hinds Number	2.1446(BNI); urknown(BN23)
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	Wild Birds Foultry	2.3446(BNI) 2.3446(BNI)
ckerks		2.3449(PSNI) 2.3449(PSNI)
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эны Эрти	Wiki Birds Number	188000 (1831) 512309800
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	Mararal (fee)	2.3.4.46 (HSNI)
conter	House (1)	2.3446(BNI) 2.3446(BNI)
	Poukry	2.3.4.4h(PBNI)
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errury	Mild Helds Reality Married (cont.) Wild Helds	23.446(#BNI) 23.446(#BNI)
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Vederas Vengery	Wild Hole	23446(BN) 23446(BN)
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octond idda d February 2023	Wild Birds Fookry	443359800
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námota relate	Wild Wells Acadesy Acadesy Manual Ohio	ukuwe (EM) ukuwe (EM) 2.1446(EM)
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ole of Man	Poskry Marrani (bro) Wild Brite Poskry Wild Brite Poskry Wild Brite Poskry Wild Brite Poskry Poskry	23.446 (BNI) 23.446 (BNI) 23.446 (BNI) uskuwa (BNI)
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uly	Positry Well (1964)	23.446((1981))
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ao Neogla's Democratic	Wild Heds Foolity Wild Heds Foolity	2.14.46 (HIN100); 23.212 (HIN1)
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	Notice to	23.4.46(MSNI)
dokkera, Republic of sepal	Wild Birds Numbry Numbry Numbry	214-6 (BNI) 214-6 (BNI) 214-6 (BNI) 214-6 (BNI)
Sepul Sethertande	Poultry	23.446(HSN)
	Wild Hirds	2.3.4.46 (MSNI)
Vacro	Wild Hinds Nodery Nodery	2.3.4.46 (EN1) taksova (EN1) 2.3.4.46 (EN1)
	Wild Birds	takawa (1981)
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65 countries/regions



New hosts





The New York Times

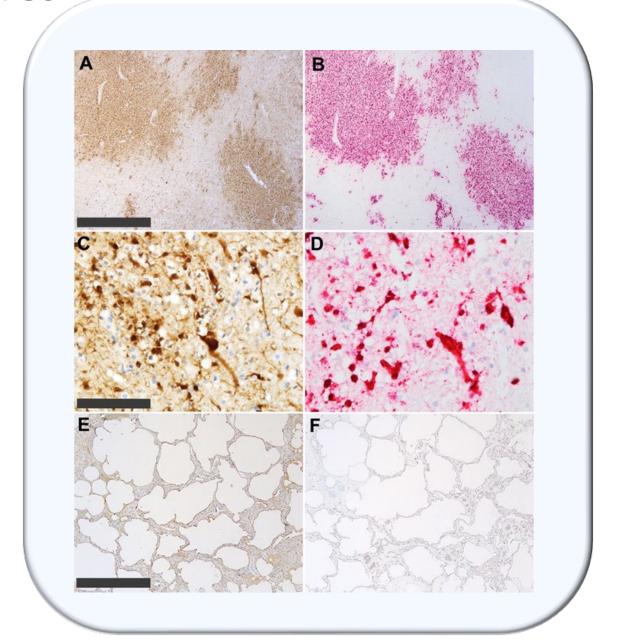
Bird Flu Found in Dolphin in Florida and Porpoise in Sweden

The findings represent the first time a highly pathogenic form of the virus, which has devastated bird populations this year, has been detected in cetaceans.





New features





Current numbers US



Wild Birds Detected

7,098

as of 6/21/2023 | Full Report >

www.cdc.gov



Poultry Affected

58,789,591 as of 6/7/2023 | Full Report >



Reported Human Cases in the U.S.

as of 04/28/2022 | Full Report >

www.usda.gov



Mammals Detected

196

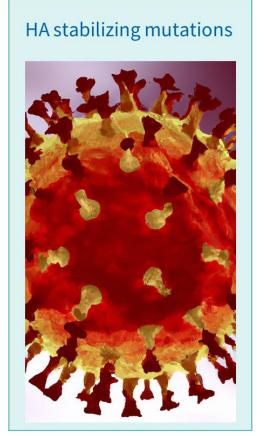
as of 06/23/2023

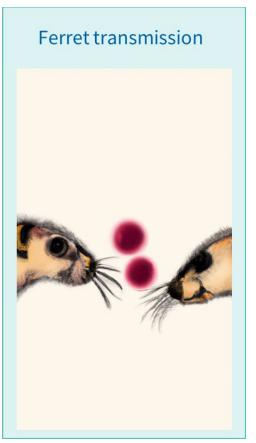


The good news, these are still very much bird viruses









Single amino acid changes can switch these



New hosts





The New York Times

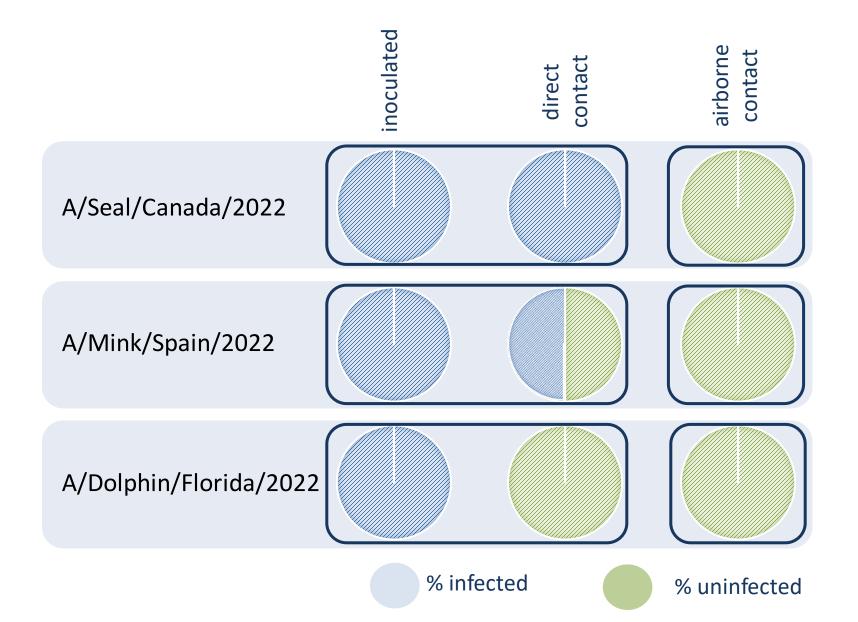
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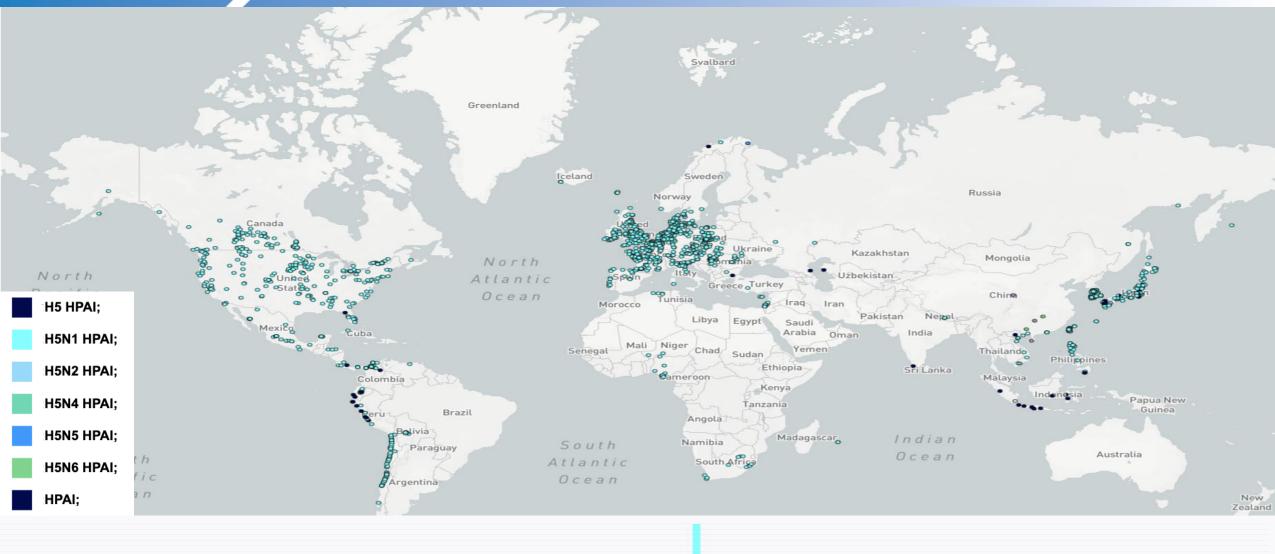


Ferret transmission of mammalian A(H5N1) viruses



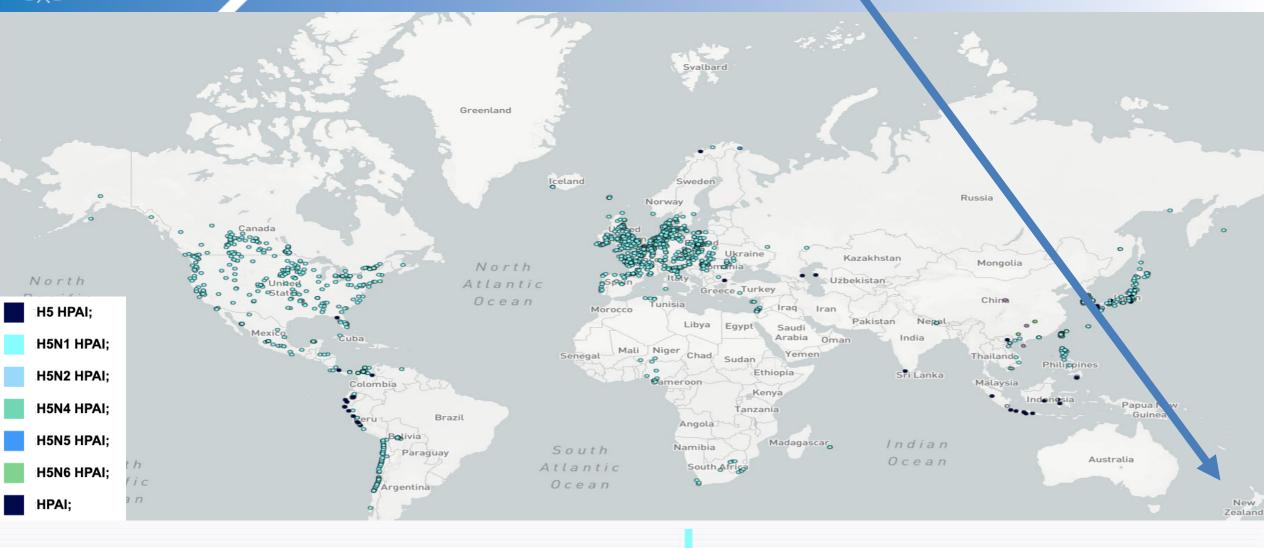


New Countries (many likely now endemic)





What about this Country?



معروبان والطواحية والمراجعة



AIV in Australia/NZ is unique

Lack of migratory ducks drives uniqueness

PLOS PATHOGENS RESEARCH ARTICLE Australia as a global sink for the genetic diversity of avian influenza A virus Michelle Wille 1,23*, Victoria Grillo4, Silvia Ban de Gouvea Pedroso4, Graham W. Burgess5, Allison Crawley6, Celia Dickason6, Philip M. Hansbro7, Md. Ahasanul Hoque8, Paul F. Horwood5, Peter D. Kirkland9, Nina Yu-Hsin Kung10, Stacey E. Lynch11, Sue Martin12, Michaela McArthur13, Kim O'Riley11, Andrew J. Read9, Simone Warner11, Bethany J. Hoye14, Simeon Lisovski14, Trent Leen 15,16, Aeron C. Hurt1, Jeff Butler17, Ivano Broz17, Kelly R. Davies17, Patrick Mileto17, Matthew J. Neave17,

Vicky Stevens¹⁷, Andrew C. Breed^{18,19}, Tommy T. Y. Lam²⁰, Edward C. Holmes²,

• The H5 virus isn't sticking to the rules (e.g., introductions into Americas)

Marcel Klaassen 14, Frank Y. K. Wong 6 17*



Summary

- Flu is bad
- Pandemics are bad
- H5 bird flu viruses are bad
- Not having migratory waterfowl isn't so bad

Fukuda gives the auditory equivalent of a shrug. "Anyone who tries to predict anything about influenza is a bit foolish and hasn't been in the field very long," he said.

• The H5 virus is teaching us new things



Acknowledgments

Rob Webster/St. Jude Children's Research Hospital/ALSAC
Sue and the SHIVERS team and participants
Wlodek Stanislawek, Biosecurity New Zealand
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Mia Torchetti, USDA

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