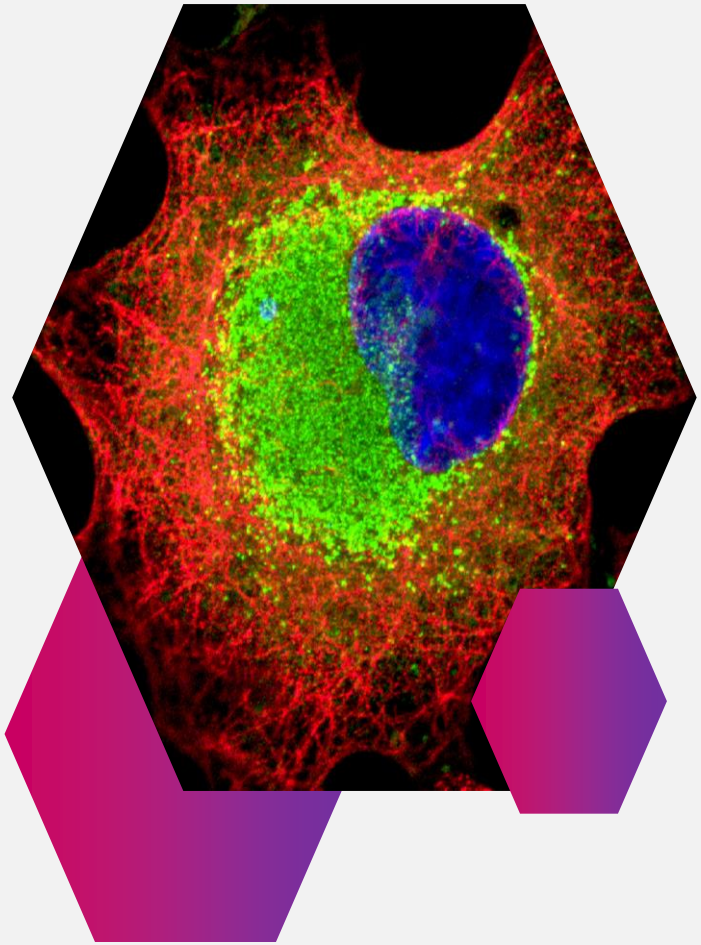


Overview of HPAI spillover events – quo vadis?

Ian Brown

Pirbright Institute

FVE webinar 27/2/25

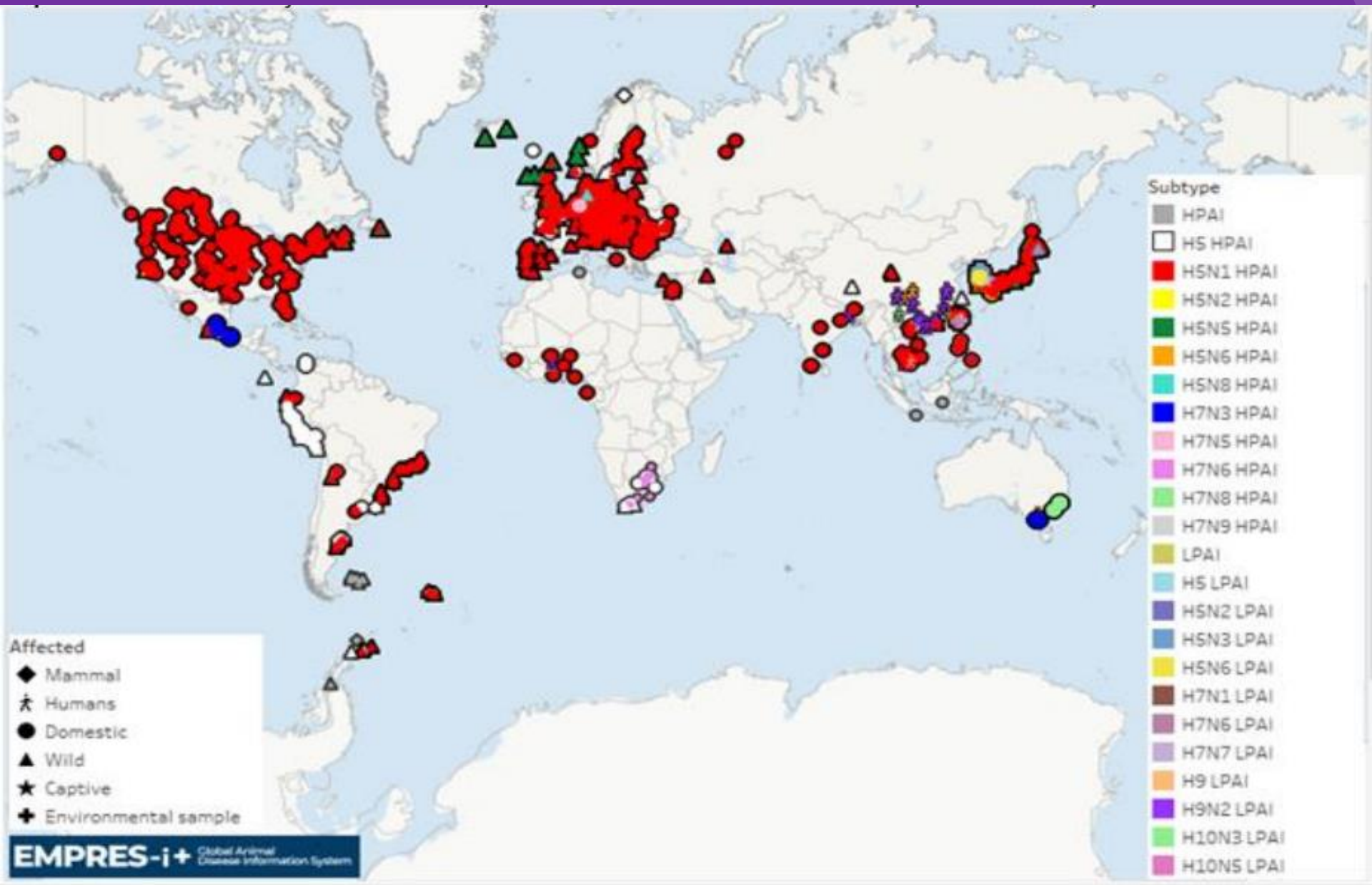
Biotechnology and Biological Sciences Research Council

Pirbright receives strategic funding from BBSRC UKRI

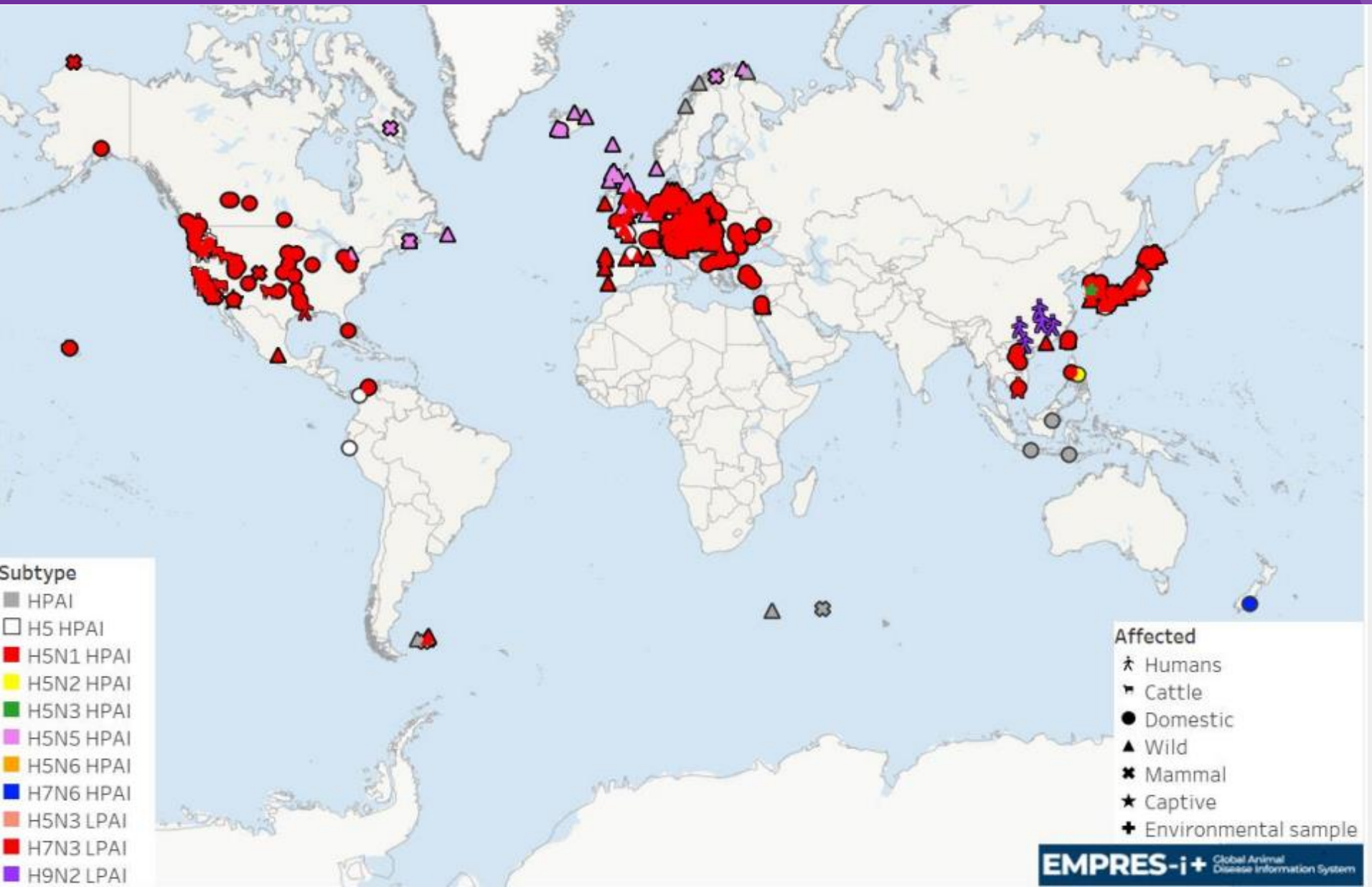
Key new developments in HPAI epidemiology

- Exceptional global spread; panzootic most continents affected
- High infection pressure
  - Increased spread to domestic birds
  - High environmental contamination
  - Exposure to greater range of species of wild bird
- Mammalian infections: spillover to scavengers, some M2M transmission
- Dairy cattle infection in USA: sustained transmission non respiratory, back spill to domestic birds
- H5 HPAI virus evolving with high fitness traits
- Antigenically HA clade 2.3.4.4b moderately stable

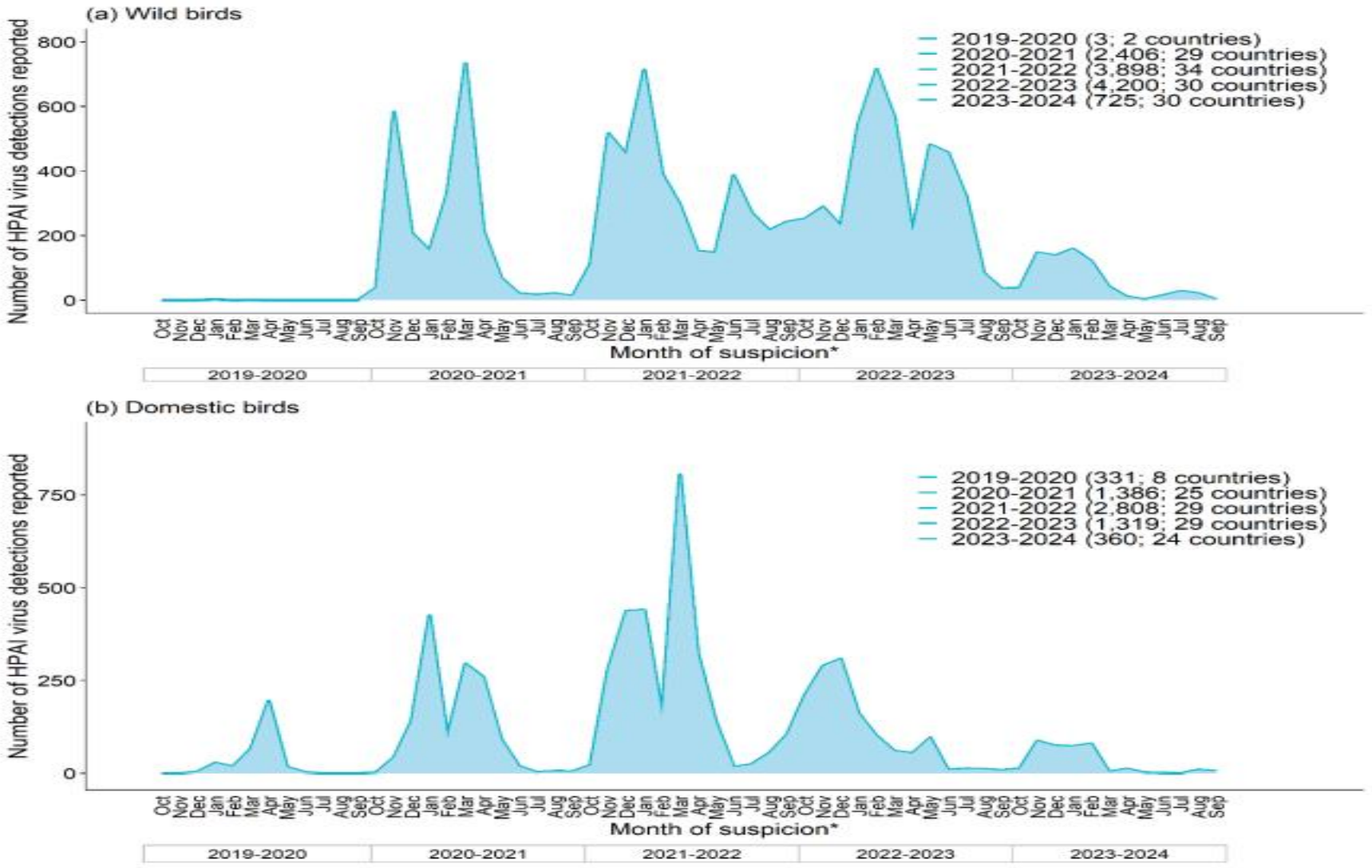
Global distribution of Avian Influenza
1st October 2023- 26th September 2024



Global distribution of AIV since 1 October 2024 (i.e. current wave) ; H5 HPAI predominant



European epidemic waves with H5 HPAI

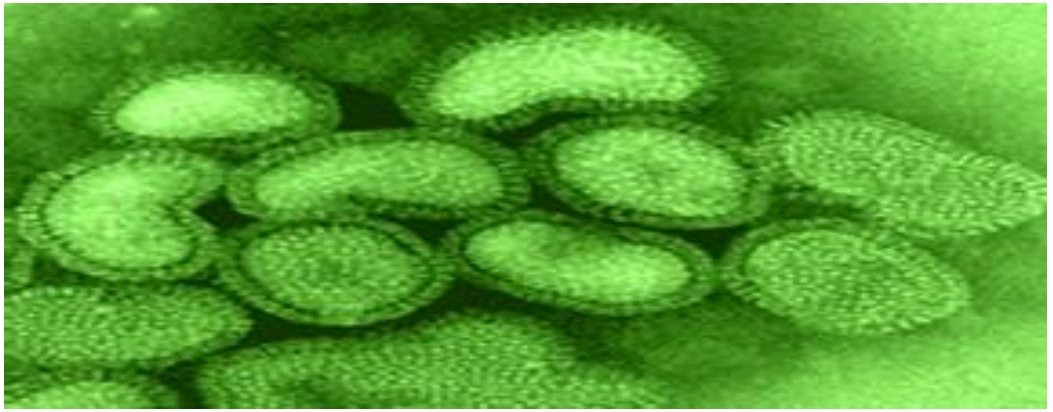


doi: 10.2903/j.efsa.2024.9057

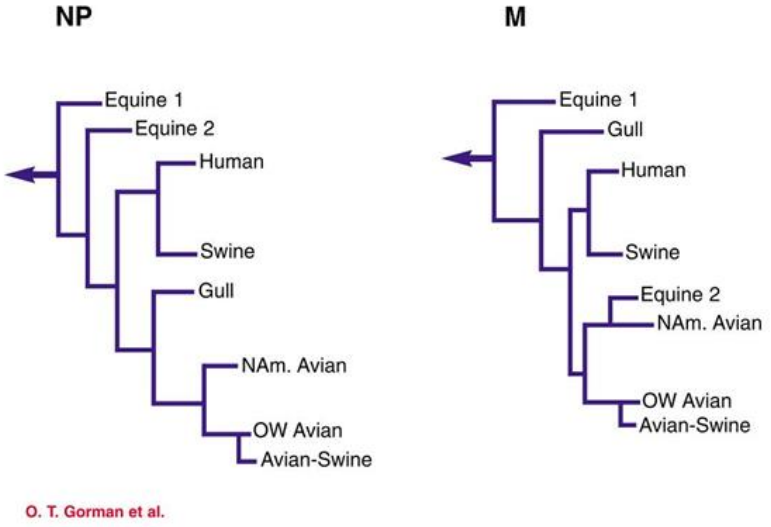
How do avian influenza viruses change in nature?

Segmented genome: shift

Point mutations in HA/NA: drift

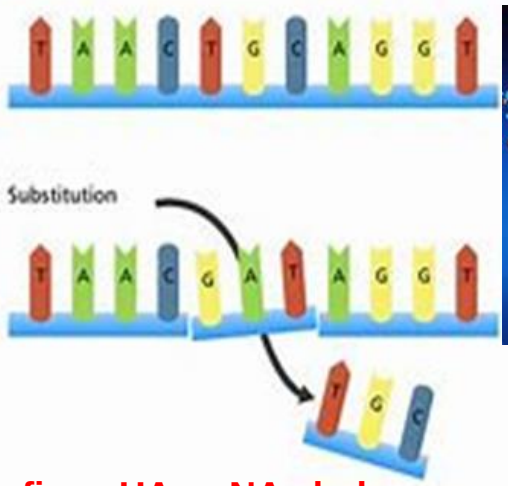


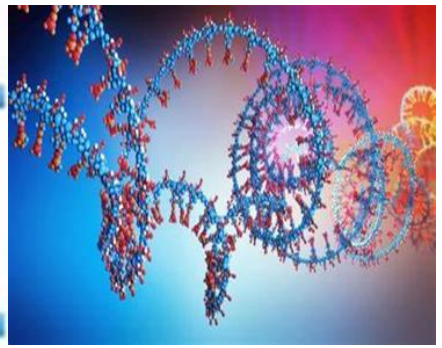
Gene signatures carry host of origin traits
Useful for tracking virus change – genetic reassortment or SHIFT



Defines genotypes on whole genome characteristics

Point mutations in each gene segment; HA gene most relevant – genetic DRIFT

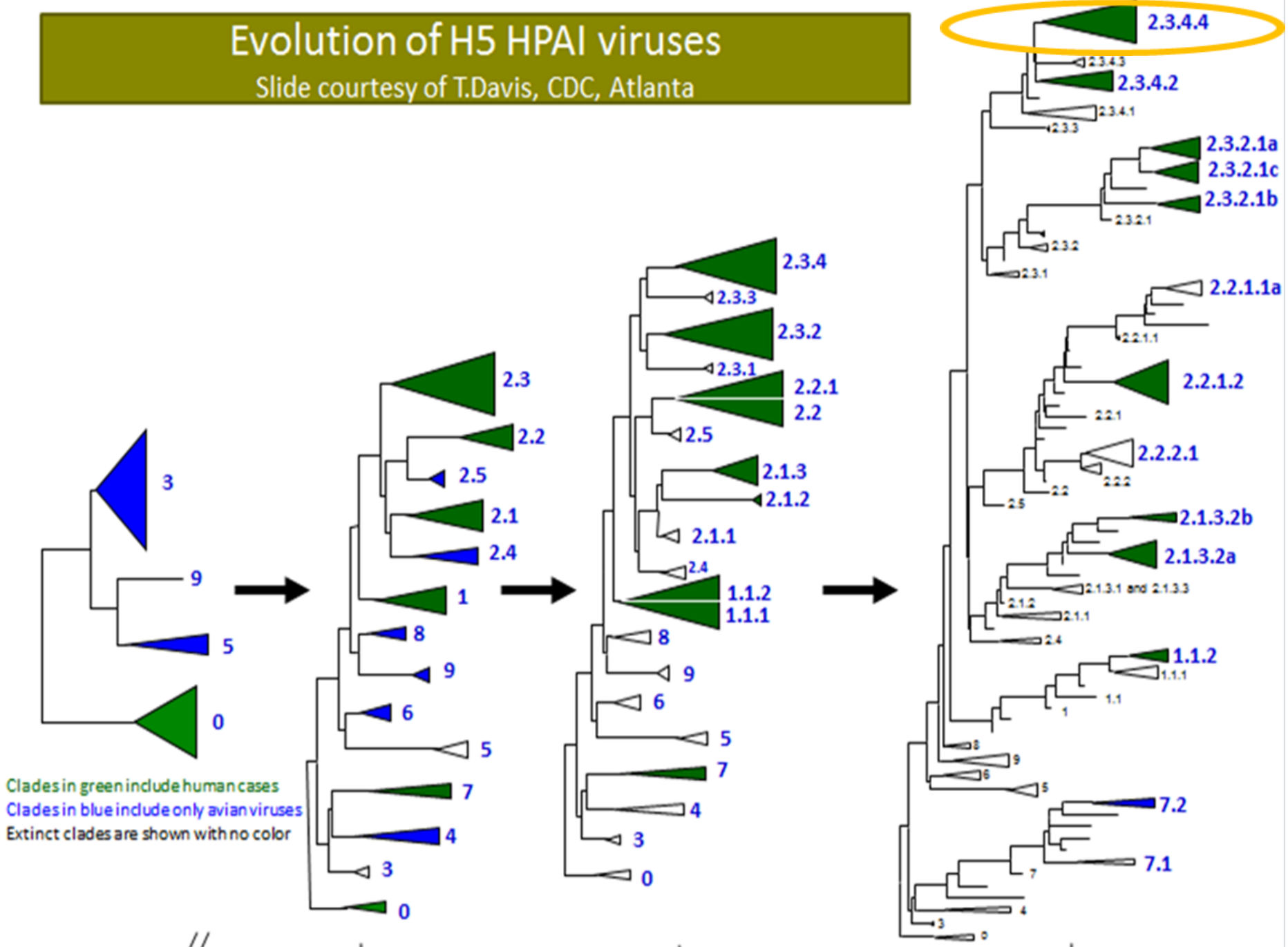




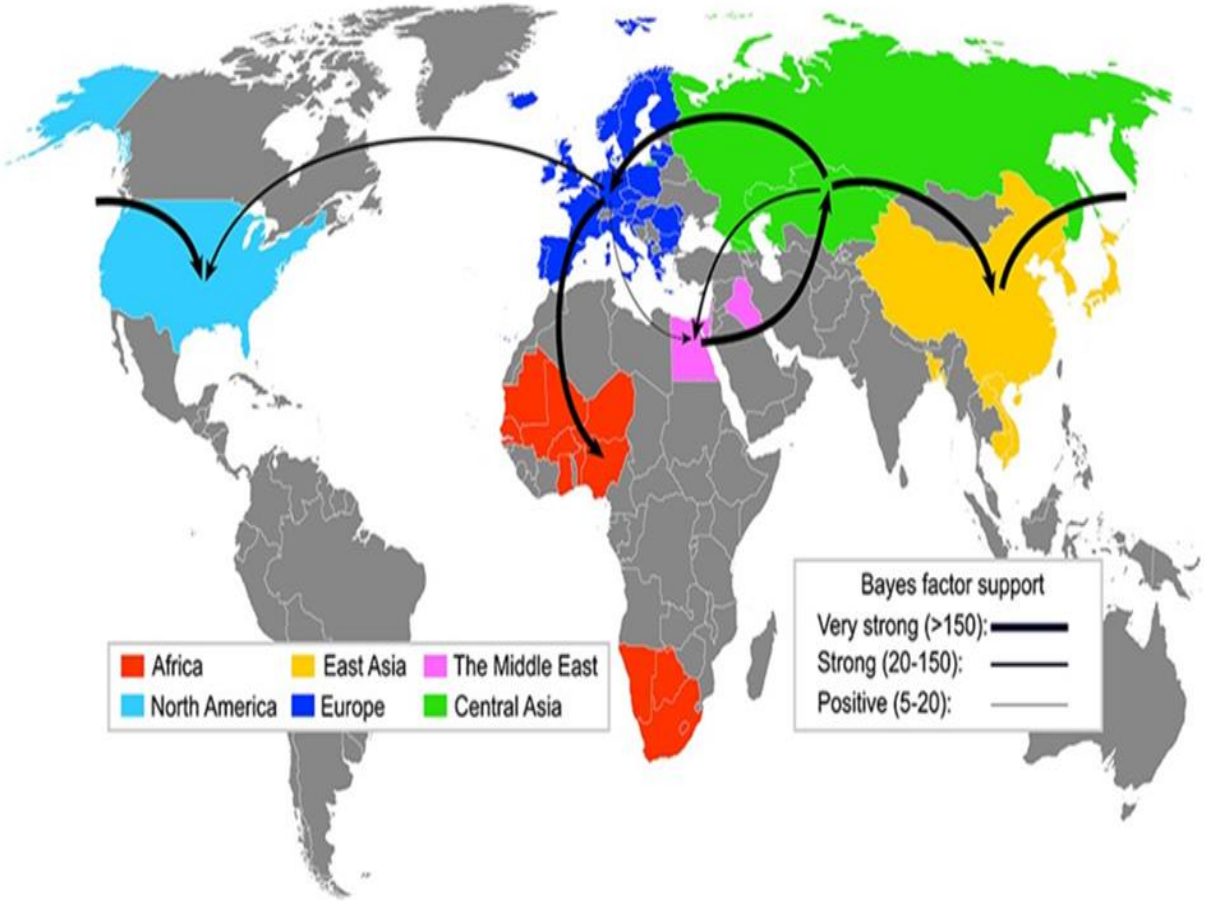
Defines HA or NA clades

Evolution of H5 HPAI viruses

Slide courtesy of T.Davis, CDC, Atlanta



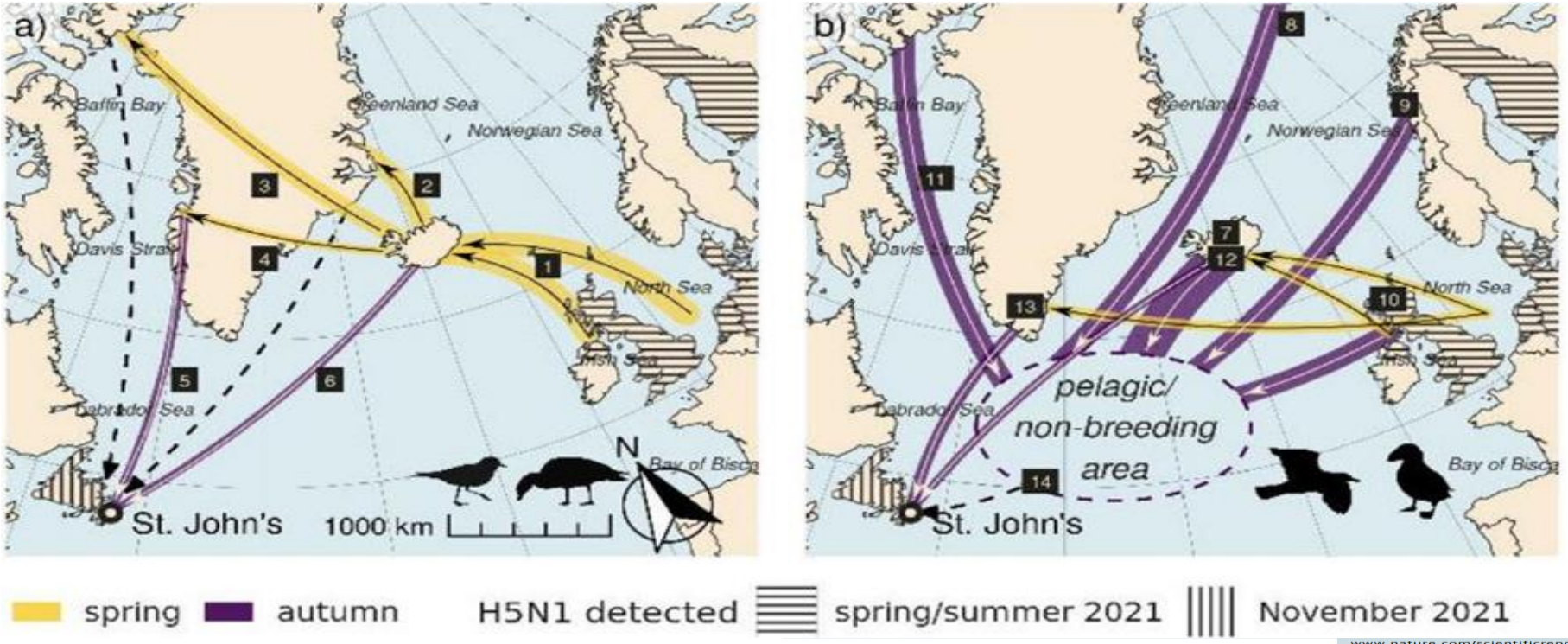
Global migration rates among the geographic regions of clade 2.3.4.4b (2020-2022)



Fusaro et al High pathogenic avian influenza A(H5) viruses of clade 2.3.4.4b in Europe—Why trends of virus evolution are more difficult to predict, Virus Evolution, Volume 10, Issue 1, 2024, veae027, https://doi.org/10.1093/ve/veae027

Transatlantic transmission

Putative transmission pathways between Europe and Newfoundland via migratory waterfowls/shorebirds



viruses
MDPI

Communication

Recurring Trans-Atlantic Incursion of Clade 2.3.4.4b H5N1 Viruses by Long Distance Migratory Birds from Northern Europe to Canada in 2022/2023

Tamiru N. Alkie [1,†], Alexander M. P. Byrne [2,†], Megan E. B. Jones [3,4], Benjamin C. Mollett [2], Laura Bourque [3], Oliver Lung [1], Joe James [2,5], Carmencita Yason [4], Ashley C. Banyard [2,5], Daniel Sullivan [1], Anthony V. Signore [1], Andrew S. Lang [6], Meghan Baker [7], Beverly Dawe [7], Ian H. Brown [2,5,*] and Yohannes Berhane [1,8,9,*]

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OPEN

Transatlantic spread of highly pathogenic avian influenza H5N1 by wild birds from Europe to North America in 2021

V. Caliendo[1,16], N. S. Lewis[2,4,16], A. Pohlmann[3,16], S. R. Baillie[11,15], A. C. Banyard[4], M. Beer[3], I. H. Brown[5], R. A. M. Fouchier[6], R. D. E. Hansen[4], T. K. Lameris[12], A. S. Lang[6], S. Laurendeau[7], O. Lung[7], G. Robertson[8], H. van der Jeugd[5], T. N. Alkie[7], K. Thorup[12,13], M. L. van Toor[4], J. Waldenström[9], C. Yason[10], T. Kuiken[1,17]✉ & Y. Berhane[7,17]

Wild bird species affected: >300 species/25+orders

Wild bird orders affected by Gs/Gd H5Nx HPAI

	Since 2021	
Accipitriformes (n=51)	Galliformes (n=19)	Psittaciformes (n=25)
Anseriformes (n=94)	Gaviiformes (n=3)	Rheiformes (n=1)
Caprimulgiformes (n=1)	Gruiformes (n=16)	Sphenisciformes (n=4)
Casuariiformes (n=1)	Passeriformes (n=49)	Strigiformes (n=18)
Cathartiformes (n=2)	Pelecaniformes (n=31)	Struthioniformes (n=1)
Charadriiformes (n=111)	Phoenicopteriformes (n=4)	Suliformes (n=25)
Ciconiiformes (n=6)	Piciformes (n=3)	Trogoniformes (n=1)
Columbiformes (n=7)	Podicipediformes (n=8)	
Falconiformes (n=13)	Procellariiformes (n=14)	

Wild bird species affected by Gs/Gd H5Nx HPAI Since 2021

Anseriformes (n=40)	Galliformes (n=8)	Phoenicopteriformes (n=2)
Amazonetta brasiliensis (Brazilian Teal)*	Alectoris rufa (Red legged partridge)	Phoenicopterus chilensis (Chilean flamingo)*
Anas cyanoptera (Cinnamon Teal)	Bonasa umbellus (Ruffed grouse)	Phoenicopterus ruber (American Flamingo)*
Anas discors (Blue-winged Teal)	Callipepla californica (California Quail)	Gruiformes (n=7)
Anas flavirostris (Andean Teal)	Centrocercus urophasianus (Greater sage-grouse)	Anthropoides virgo (Demoiselle Crane)
Anas formosa (Baikal Teal)*	Coturnix coturnix (Common Quail)*	Balearica regulorum (Crowned crane)
Anas fulvigula (Mottled Duck)	Cracidae (incognita)*	Fulica americana (American coot)
Anas rhynchotis (Australasian Shoveler)	Lagopus lagopus (Willow Grouse)	Fulica armillata (Red-gartered Coot)
Anas rubripes (American Black Duck)	Perdix perdix (Grey Partridge)*	Grus canadensis (Sandhill Crane)
Anser cygnoides (Swan Goose)*	Charadriiformes (n=78)	Grus leucogeranus (Siberian crane)*
Anser rossii (Ross's Goose)	Alca torda (Razorbill)	Rallus aquaticus (Water Rail)
Aythya affinis (Lesser Scaup)	Alle alle (Little auk)	Psittaciformes (n=10)
Aythya americana (Redhead Duck)	Arenaria interpres (Ruddy Turnstone)	Amazona farinosa (Southern mealy amazon)*
Aythya baeri (Baer's pochard)*	Arenaria melanocephala (Black turnstone)	Amazona ochrocephala (Yellow-crowned Parrot)*
Aythya valisineria (Canvasback)	Calidris alba (Sanderling)	Amazona oratrix (Yellow-headed amazon)*
Branta ruficollis (Red breasted goose)	Calidris alpina (Dunlin)	Ara militaris (Military macaw)*
Branta sandvicensis (Nene)*	Calidris fuscicollis (White-rumped Sandpiper)	Brotogeris versicolurus (White-winged Parakeet)*
Bucephala albeola (Bufflehead)	Calidris maritima (Purple sandpiper)	Cyanoliseus patagonus (Burrowing Parrot)
Bucephala islandica (Barrow's goldeneye)*	Calidris pusilla (Semipalmated sandpiper)	Enicognathus ferrugineus (Austral Parakeet)
Chloephaga melanoptera (Andean Goose)	Cepphus grylle (Black Guillemot)	Enicognathus leptorhynchus (Slender-billed Parakeet)
Chloephaga picta (Upland Goose)	Charadrius hiaticula (Common ringed plover)	Loriculus spp. (Hanging Parrot)*
Cygnus bewickii (Tundra swan)	Charadrius mongolus (Lesser Sand Plover)	Pycnonotus zeylanicus (Straw-headed bulbul)*
Cygnus buccinator (Trumpeter Swan)	Charadrius nivosus (Snowy plover)	Falconiformes (n=8)
Cygnus melancoryphus (black-necked swan)	Chlidonias hybrida (Whiskered Tern)	Caracara cheriway (Northern Crested Caracara)
Dendrocygna bicolor (Fulvous whistling Duck)	Chroicocephalus maculipennis (Brown-hooded gull)	Caracara plancus (Southern Caracara)
Dendrocygna viduata (White-faced Whistling-Duck)	Chroicocephalus ridibundus (Black-headed Gull)	Falco biarmicus (Lanner Falcon)
Lophodytes cucullatus (Hooded Merganser)	Fratercula arctica (Atlantic Puffin)	Falco columbarius (Merlin)
Mareca falcata (Falcated Duck)	Gallinago gallinago (Common Snipe)	Falco mexicanus (Prairie falcon)
Marmaronetta angustirostris (Marbled Teal)	Gallinago stenura (Pin-tailed Snipe)	Falco sparverius (American Kestrel)
Melanitta fusca (Velvet Scoter)	Gelochelidon nilotica (Common Gull-billed Tern)	Falco vespertinus (Red-footed Falcon)
Melanitta nigra (Common Scoter)	Haematopus ater (Blackish Oystercatcher)	Milvago chimango (Chimango Caracara)
Melanitta perspicillata (Surf Scoter)	Haematopus ostralegus (Eurasian oystercatcher)	Accipitriformes (n=30)
Mergellus albellus (Smew)*	Haematopus palliatus (American oystercatcher)	Accipiter brachyurus (New Britain Sparrowhawk)
Mergus serrator (Red-breasted merganser)	Hydroprogne caspia (Caspian Tern)	Accipiter gularis (Japanese Sparrowhawk)
Mergus squamatus (Scaly-sided merganser)*	Ichthyaetus melanocephalus (Mediterranean Gull)	Accipiter striatus (Sharp-shinned Hawk)
Oxyura jamaicensis (Ruddy Duck)	Larosterna inca (Inca tern)	Aquila audax (Wedge-tailed Eagle)
Spatula cyanoptera (Cinnamon Teal)	Larus atricilla (Laughing Gull)	Aquila chrysaetos (Golden Eagle)
Spatula puna (Puna Teal)*	Larus audouinii (Audouin's Gull)	Aquila fasciata (Bonelli's eagle)
Spatula querquedula (Garganey)	Larus belcheri (Belcher's Gull)	Aquila rapax (Tawny Eagle)*
Tachyeres pteneres (Magellanic Steamerduck)	Larus brachyrhynchus (Short-billed Gull)	Buteo lagopus (Rough-legged Hawk)
Tadorna ferruginea (Ruddy Shelduck)	Larus brunnicephalus (Brown-headed Gull)	Buteo lineatus (Red-shouldered Hawk)
Gaviiformes (n=3)	Larus cachinnans (Caspian Gull)	Buteo magnirostris (Roadside Hawk)
Gavia immer (Common Loon)	Larus californicus (California Gull)	Buteo platypterus (Broad-winged Hawk)
Gavia pacifica (Pacific Loon)	Larus crassirostris (Black-tailed Gull)	Buteo polyosoma (Red-backed Hawk)*
Gavia stellata (Red-throated Loon)	Larus delawarensis (Ring-billed Gull)	Buteo regalis (Ferruginous Hawk)
Sphenisciformes (n=3)	Larus dominicanus (Kelp Gull)	Buteo swainsoni (Swainson's Hawk)
Eudyptes chrysocome (Southern Rockhopper Penguin)	Larus genei (Slender-billed Gull)	Buteogallus urubitinga (Great Black Hawk)
Spheniscus humboldti (Humboldt Penguin)	Larus glaucescens (Glaucous-winged Gull)	Cathartes aura (Turkey Vulture)
Spheniscus magellanicus (Magellanic Penguin)	Larus glaucoides (Iceland Gull)	Circus assimilis (Spotted Harrier)
Ciconiiformes (n=3)	Larus hyperboreus (Glaucous Gull)	Circus cyaneus (Hen Harrier)
Ciconia boyciana (Oriental Stork)	Larus michahellis (Yellow-legged Gull)	Circus pygargus (Montagu's Harrier)
Ciconia nigra (Black Stork)	Larus novaehollandiae (Silver Gull)	Coragyps atratus (Black Vulture)
Mycteria americana (American Wood Stork)	Larus occidentalis (Western Gull)	Geranoaetus melanoleucus (Black-chested buzzard-eagle)
Procellariiformes (n=13)	Larus philadelphia (Bonaparte's Gull)	Gypaetus barbatus (Bearded vulture)
Ardenna gravis (Great Shearwater)	Larus pipixcan (Franklin's Gull)	Gyps africanus (White-backed vulture)*
Ardenna grisea (Sooty Shearwater)	Larus schistisagus (Slaty-backed Gull)	Haliaeetus pelagicus (Steller's Sea Eagle)
Ardenna tenuirostris (Short-tailed Shearwater)	Larus scopulinus (Silver Gull)	Haliaeetus vocifer (African Fish Eagle)
Fulmarus glacialis (Northern Fulmar)	Larus smithsonianus (Arctic Herring Gull)	Milvus migrans (Black Kite)
Fulmarus glacialoides (Southern Fulmar)	Larus thayeri (Thayer's gull)	Milvus milvus (Red Kite)
Macronectes giganteus (Southern Giant Petrel)	Leucophaeus modestus (Grey gull)	Pandion haliaetus (Osprey)
Macronectes halli (Northern Giant Petrel)	Numenius phaeopus (Whimbrel)	Parabuteo unicinctus (Harris's Hawk)
Pachyptila desolata (Antarctic Prion)	Phalaropus lobatus (Red-necked phalarope)	Sagittarius serpentarius (Secretary Bird)
Phoebastria irrorata (Waved Albatross)	Pluvialis dominica (American Golden Plover)	Strigiformes (n=6)
Procellaria aequinoctialis (White-chinned Petrel)	Pluvialis squatarola (Grey Plover/Black-bellied Plover)	Aegolius acadicus (Northern Saw-whet Owl)
Pterodroma macroptera (Great-winged Petrel)	Rissa tridactyla (Black-legged Kittiwake)	Megascops asio (Eastern Screech Owl)
Puffinus puffinus (Manx Shearwater)	Rynchops niger (Black skimmer)	Megascops choliba (Tropical Screech-owl)
Thalassarche melanophris (Black-browed Albatross)	Scolopax rusticola (Eurasian Woodcock)	Megascops kennicottii (Western Screech-Owl)
Suliformes (n=18)	Stercorarius antarcticus (Brown skua)	Strix nebulosa (Great grey owl)
Fregata magnificens (Magnificent Frigatebird)	Stercorarius chilensis (Chilean Skua)	Strix varia (Barred owl)
Fregata minor (Great Frigatebird)	Stercorarius parasiticus (Arctic Skua)	Caprimulgiformes (n=1)
Leucocarbo atriceps (Imperial Shag)	Stercorarius skua (Great Skua)	Caprimulgus fossii (Mozambique Nightjar)
Morus capensis (Cape Gannet)	Sterna dougallii (Roseate Tern)	Columbiformes (n=2)
Nannopterum brasilianum (Neotropic Cormorant)	Sterna forsteri (Forster's Tern)	Columbina inca (Inca Dove)
Phalacrocorax auritus (Double-crested Cormorant)	Sterna hirundinacea (South American Tern)	Streptopelia turtur (European Turtle-dove)
Phalacrocorax bougainvillii (Guanay Cormorant)	Sterna paradisaea (Arctic Tern)	Piciformes (n=3)
Phalacrocorax brasilianus (Neotropical Cormorant)	Sternula albifrons (Little Tern)	Dendrocopos major (Great spotted woodpecker)
Phalacrocorax gaimardi (Red-legged Cormorant)	Thalasseus acuflavidus (Cabot's Tern)	Pteroglossus castanotis (Chestnut-eared aracari)*
Phalacrocorax lucidus (White-breasted Cormorant)	Thalasseus elegans (Elegant Tern)	Ramphastos cuvieri (white-throated toucan)*
Phalacrocorax magellanicus (Rock Shag)	Thalasseus maximus (Royal Tern)	Trogoniformes (n=1)
Phalacrocorax neglectus (Bank Cormorant)	Tringa flavipes (Lesser Yellowlegs)	Harpactes erythrocephalus (Red-headed Trogon)
Phalacrocorax punctatus (Spotted Shag	Tringa melanoleuca (Greater Yellowlegs)	Passeriformes (n=22)
Sula leucogaster (Brown Booby)	Tringa semipalmata (Willet)	Agelaius phoeniceus (Red-winged Blackbird)
Sula nebouxii (Blue-footed Booby)	Tringa totanus (Common Redshank)	Carduelis carduelis (European goldfinch)
Sula sula (Red-footed Booby)	Uria aalge (Common Murre)	Carduelis chloris (European Greenfinch)
Sula variegata (Peruvian Booby)	Uria lomvia (Thick-billed Murre)	Corvus brachyrhynchos (American Crow)
Urile penicillatus (Brandt's Cormorant)	Vanellus chilensis (Southern Lapwing)	Corvus caurinus (Northwestern Crow)
Pelecaniformes (n=13)	Vanellus vanellus (Northern Lapwing)	Corvus corone (Carrion Crow)
Ajaia ajaja (Roseate Spoonbill)	Xema sabini (Sabine's Gull)	Corvus monedula (Western Jackdaw)
Ardea herodias (Great Blue Heron)	Podicipediformes (n=8)	Corvus ossifragus (Fish Crow)
Bostrychia hagedash (Hadada Ibis)	Aechmophorus occidentalis (Western Grebe)	Cyanocitta cristata (Blue Jay)
Egretta caerulea (Little Blue Heron)	Podiceps auritus (Horned Grebe)	Cyanocorax chrysops (Plush-crested Jay)
Egretta intermedia (Intermediate Egret)	Podiceps grisegena (Red-necked Grebe)	Garrulus glandarius (Eurasian Jay)
Egretta thula (Snowy Egret)	Podiceps major (Great Grebe)	Junco hyemalis (Dark-eyed Junco)
Eudocimus ruber (Scarlet Ibis)*	Podilymbus podiceps (Pied-billed Grebe)	Passer montanus (Eurasian Tree Sparrow)
Geronticus eremita (Northern Bald Ibis)	Spilornis cheela (Crested Serpent Eagle)	Phylloscopus trochilus (Willow warbler)
Pelecanus erythrorhynchos (American White Pelican)	Spizaetus nipalensis (Mountain hawk-eagle)	Pica hudsonia (Black-billed Magpie)
Pelecanus occidentalis (Brown Pelican)	Vultur gryphus (Andean condor)*	Pygochelidon cyanoleuca (Blue-and-white Swallow)
Pelecanus rufescens (Pink-backed Pelican)	Cathartiformes (n=2)	Pyrrhula pyrrhula (Eurasian Bullfinch)
Pelecanus thagus (Peruvian Pelican)	Gymnogyps californianus (California Condor)	Quiscalus mexicanus (Great-tailed grackle)
Plegadis chihi (White-faced Ibis)*	Sarcoramphus papa (King Vulture)	Quiscalus quiscula (Common Grackle)
		Tachycineta bicolor (Tree Swallow)
		Turdus iliacus (Redwing)
		Turdus migratorius (American Robin)

Expansion in wild bird host range:susceptibility?

Primary hosts: Often highly susceptible

- Many long distance migratory species may be tolerant to infection with HPAIV in the absence of disease

Secondary hosts: Differential susceptibility

Expansion in wild bird host range:susceptibility

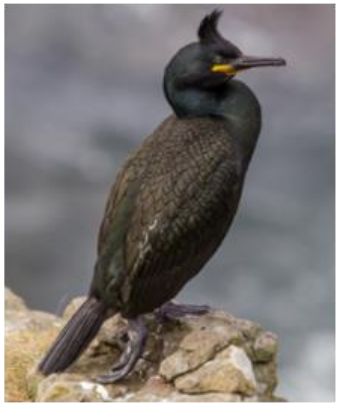
Tertiary: Medium-Low Susceptibility




Occasionally seen to succumb to infection.

Quaternary: Resistant?

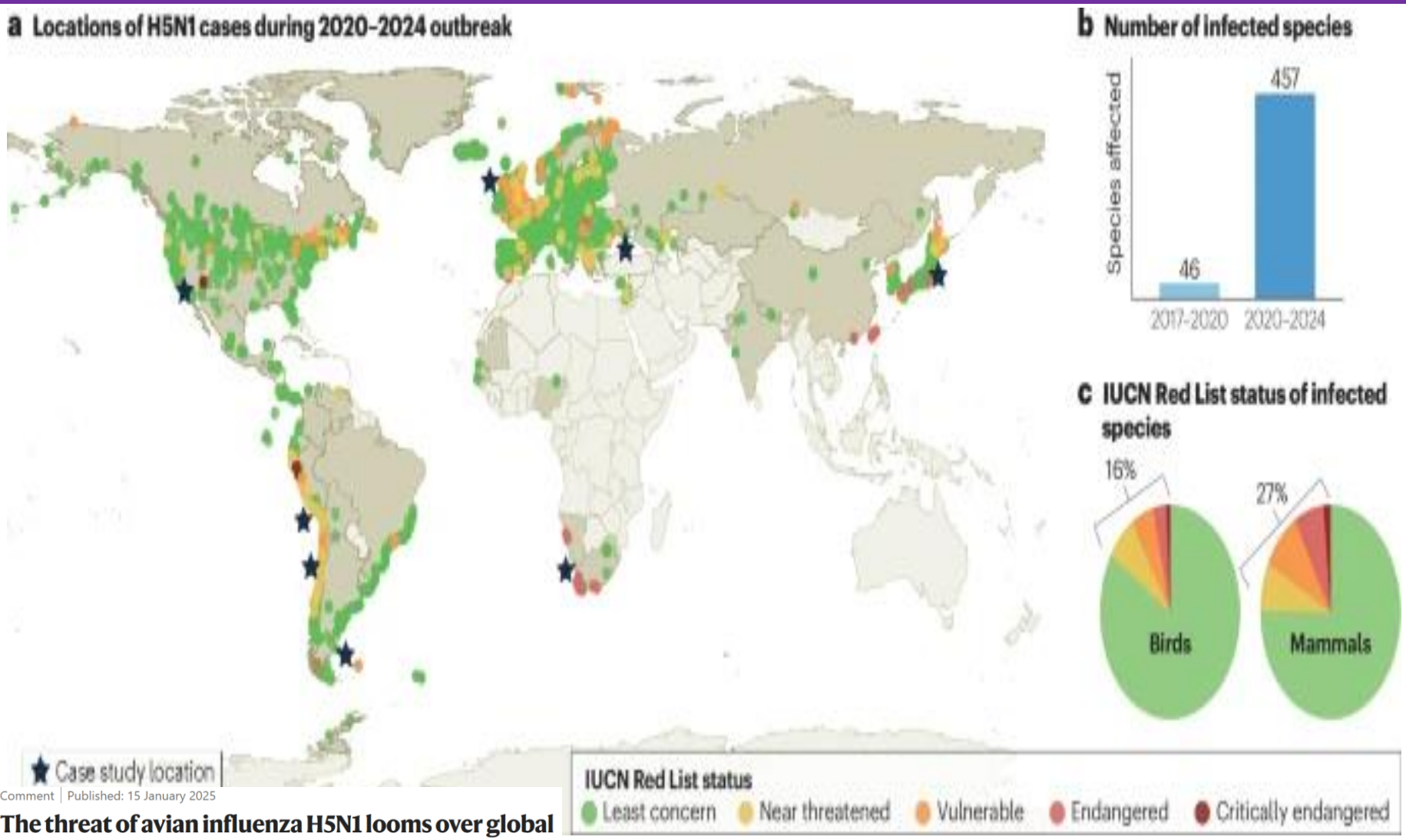
Dalmatian pelican

European shag

Impacts on biodiversity

Impacts of H5 HPAI on biodiversity



Comment | Published: 15 January 2025

The threat of avian influenza H5N1 looms over global biodiversity

Sergio A. Lambertucci, Andrea Santangeli & Pablo I. Plaza

Nature Reviews Biodiversity **1**, 7–9 (2025) | Cite this article

Increased infectivity in effective bridging species?

Charadriiformes: diverse order live near water

Sub group Laridae (gulls, terns, noddies, skimmers, kittiwakes);ubiquitous

100 species from 22 genera many of which have become infected with H5N1

Genetic changes in virus

High susceptibility and virus shedding

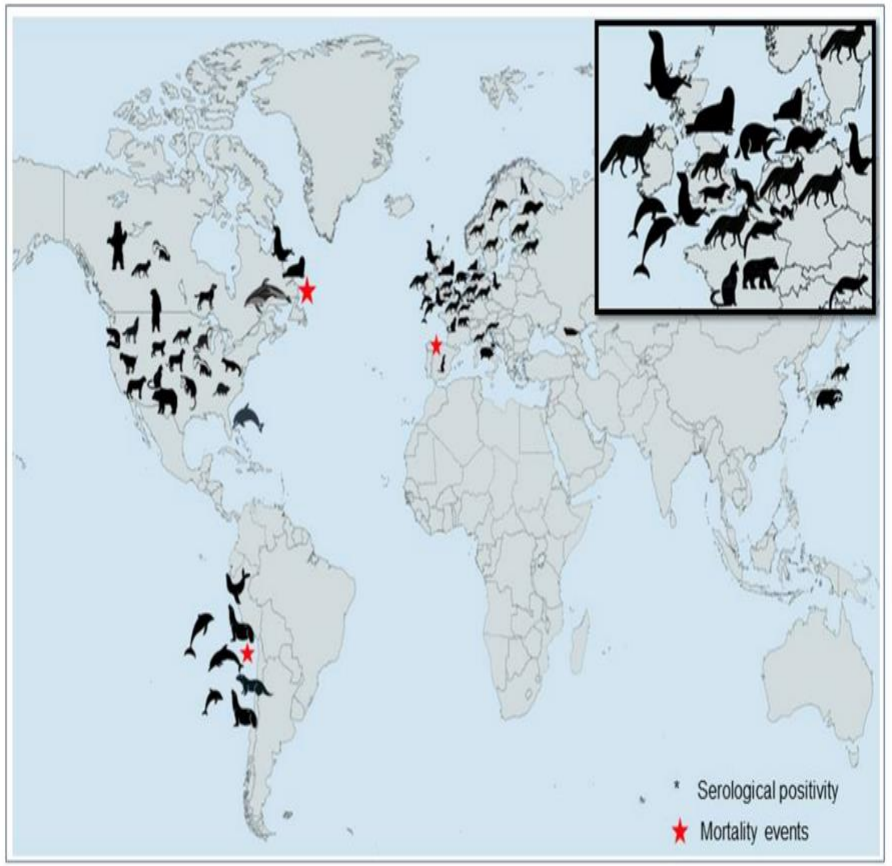
Behavioural; move between habitats (land, sea, remote land masses)

Increasing environmental contamination/exposure (naïve populations)

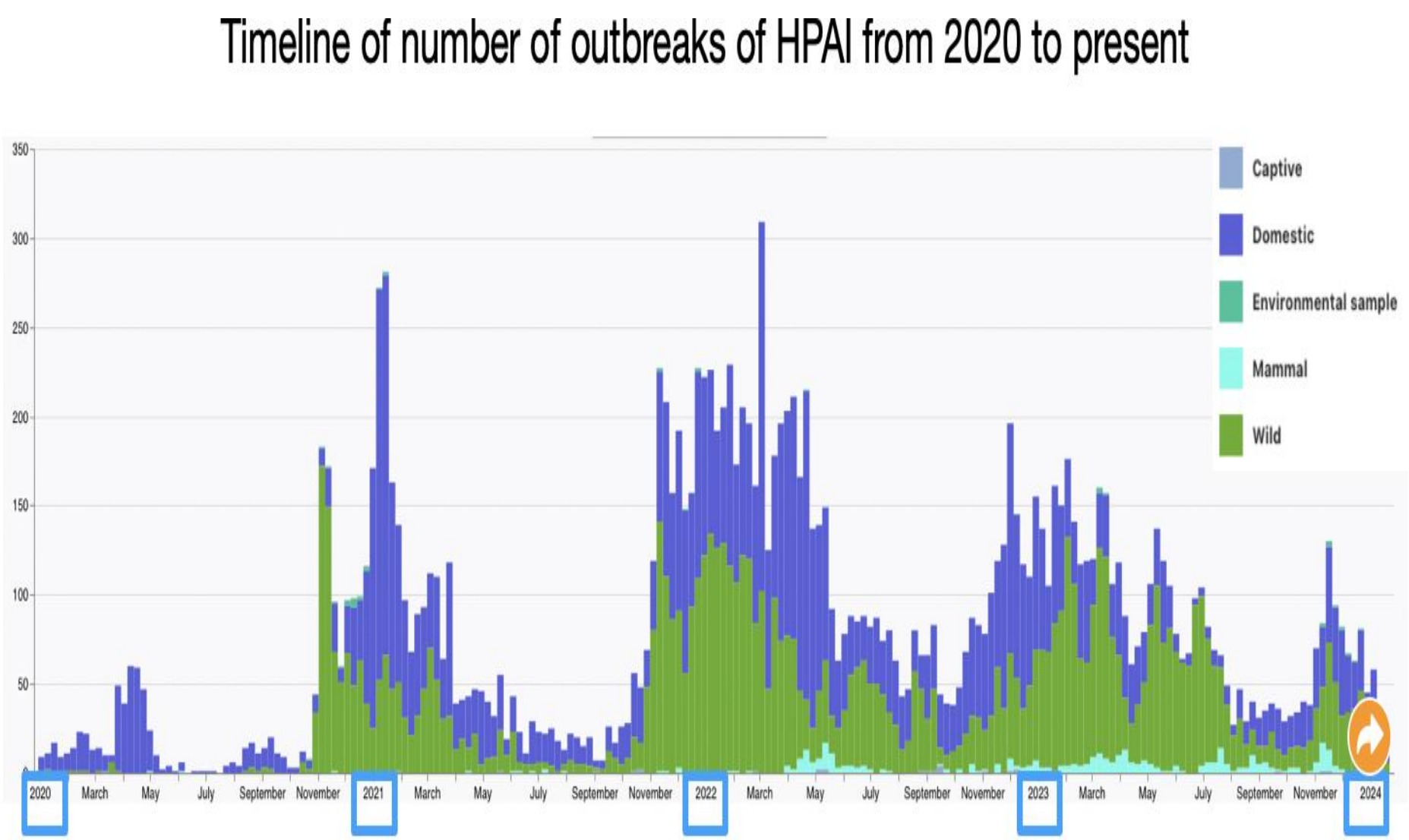
Spread to mammals

- Captive bred animals: mink, foxes
- Wild Scavengers; ie foxes, seals, stoat, otter
- Domestic ; cats

ecdc izsve efsa JOURNAL



H5 detections: Expanded host range



Semi-aquatic mammals in South America
Mammal to mammal transmission

nature communications

Article

https://doi.org/10.1038/s41467-024-53766-5

Epidemiological data of an influenza A/H5N1 outbreak in elephant seals in Argentina indicates mammal-to-mammal transmission

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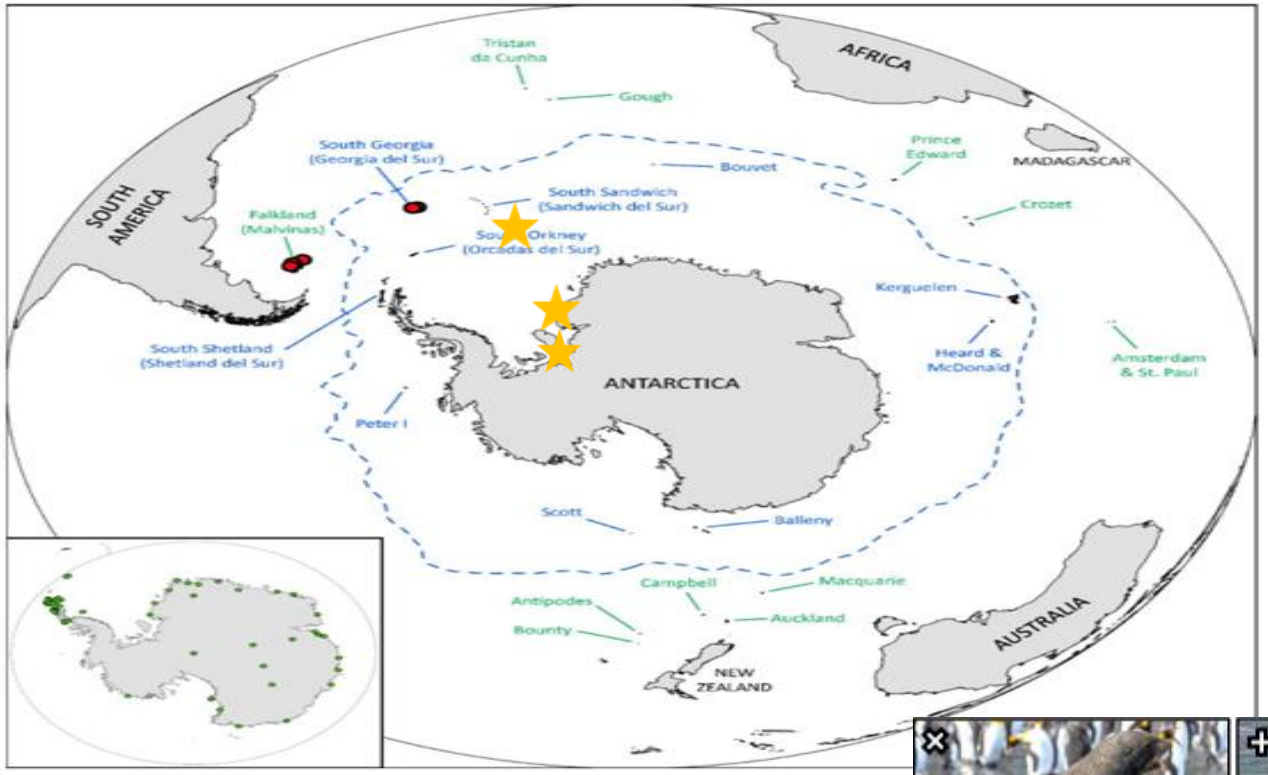
Marcela M. Uhart[1,2], Ralph E. T. Vanstreels[3], Martha I. Nelson[3], Valeria Olivera[4], Julieta Campagna[5], Victoria Zavattieri[5], Philippe Lemey[6], Claudio Campagna[5], Valeria Falabella[5] & Agustina Rimondi[4,7]

Spread to Antarctica

OFFLU ad-hoc group on HPAI H5 in wildlife of South America and Antarctica (2023) Continued expansion of high pathogenicity avian influenza H5 in wildlife in South America and incursion into the Antarctic region.



Separate introductions into South Georgia, South Sandwich Islands and Falkland islands; spread to shelf

nature communications

Article https://doi.org/10.1038/s41467-024-51490-8

Detection and spread of high pathogenicity avian influenza virus H5N1 in the Antarctic Region

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Accepted: 8 August 2024
Published online: 03 September 2024

Ashley C. Banyard[1,2], Ashley Bennison[3], Alexander M. P. Byrne[1,4], Scott M. Reid[1], Joshua G. Lynton-Jenkins[1,2], Benjamin Mollett[1], Dilhani De Silva[1], Jacob Peers-Dent[1], Kim Finlayson[5], Rosamund Hall[3], Freya Blockley[3], Marcia Blyth[3], Marco Falchieri[1], Zoe Fowler[6], Elaine M. Fitzcharles[3], Ian H. Brown[1,2] & Joe James[1,2]

Highly Pathogenic Avian Influenza A (H5N1) Suspected in penguins and shags on the Antarctic Peninsula and West Antarctic Coast

Fabiola León, Céline Le Bohec, Eduardo J. Pizarro, Loïcka Baille, Robin Cristofari, Aymeric Houstin, Daniel P. Zitterbart, Gonzalo Barriga, Elie Poulin, Juliana A. Vianna

doi: https://doi.org/10.1101/2024.03.16.585360

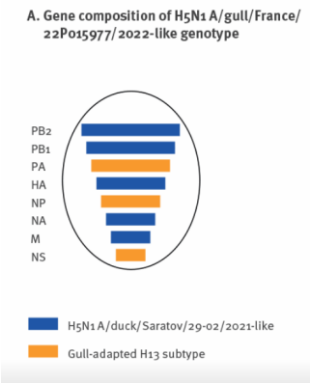
This article is a preprint and has not been certified by peer review [what does this mean?].

Abstract Full Text Info/History Metrics Preview PDF

www.pirbright.ac.uk

Outbreaks in captive bred mammals

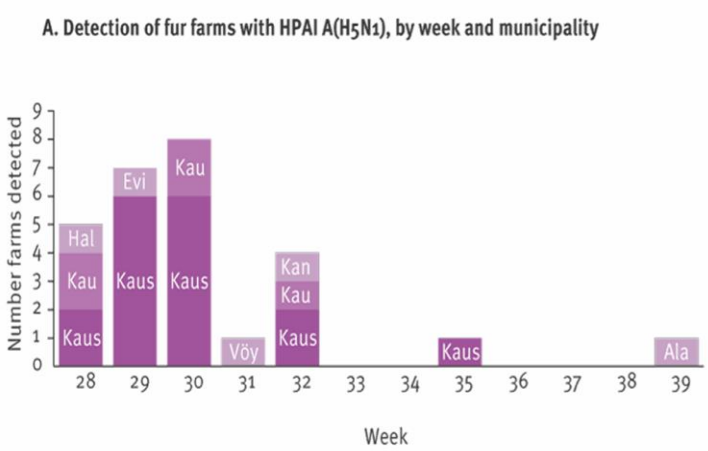
Spain ; Oct 22 outbreak in mink farm (52k)

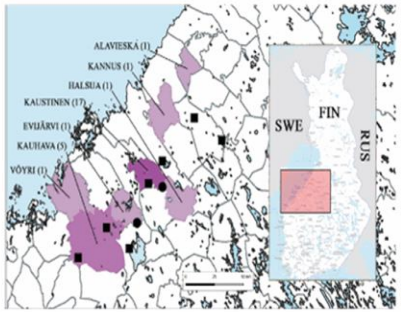


Limited adaptive changes in the virus (T271A) in the PB2 gene

Montserrat et al (https://doi.org/10.2807/1560-7917.ES.2023.28.3.2300001)

H5N1 HPAI in fur farms in Finland July-Oct 2023

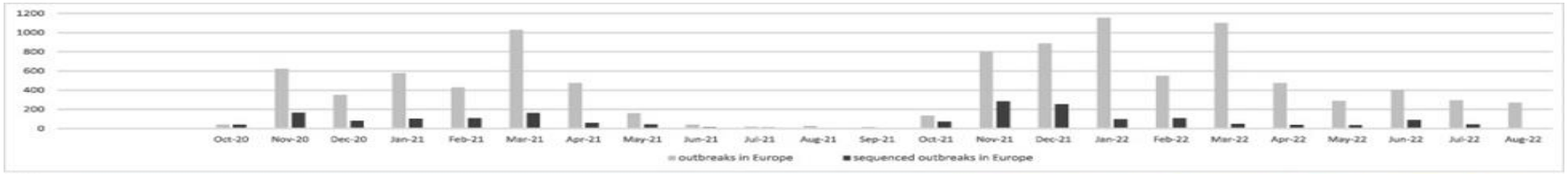


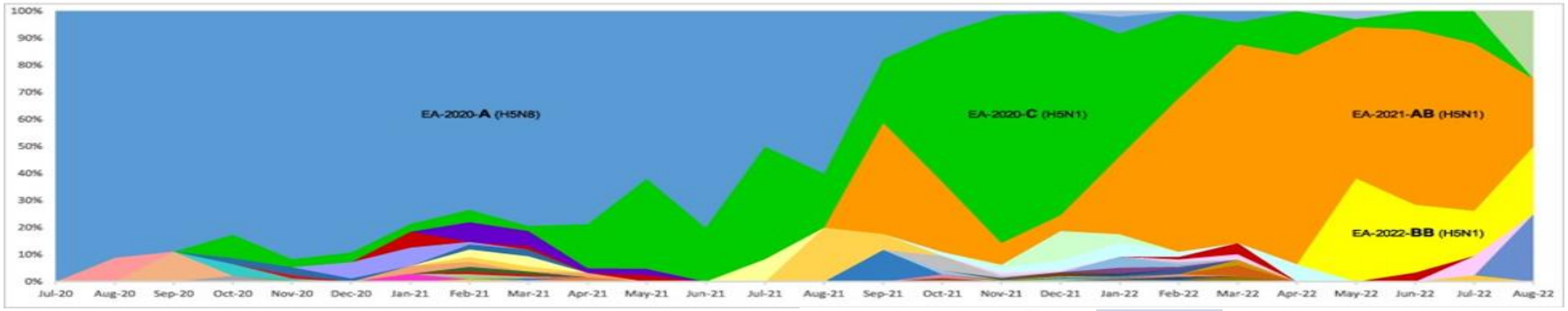


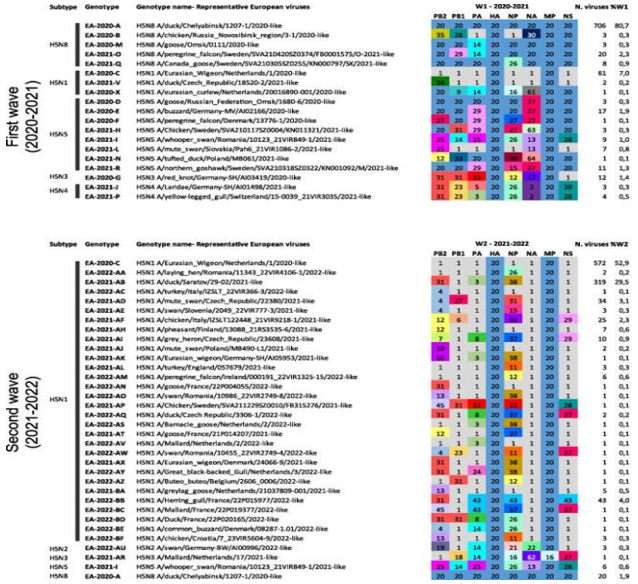
- Initial point introductions from wild birds
- Secondary spread between fur farms
- Up to 7 genetic changes associated with mammalian adaptation but not all viruses

- Depopulation and other control measures
- Prophylactic vaccination of fur farms workers now offered

Extensive genetic heterogeneity: large genotype diversity in Europe







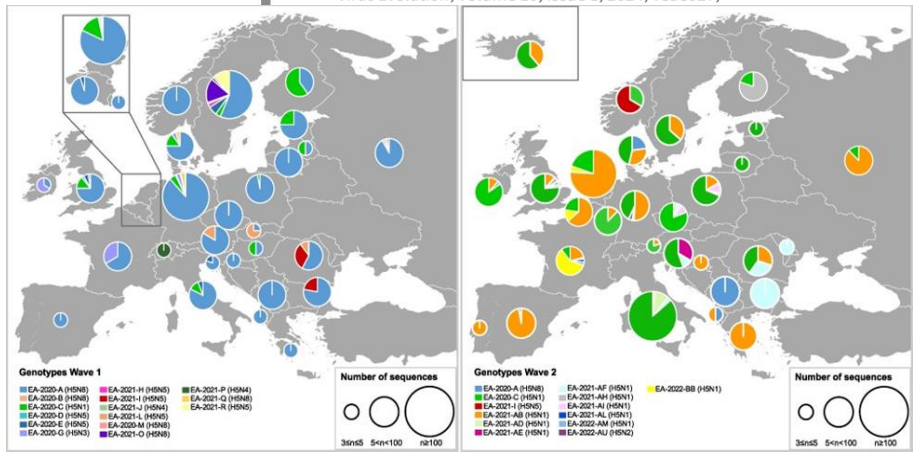
JOURNAL ARTICLE

High pathogenic avian influenza A(H5) viruses of clade 2.3.4.4b in Europe—Why trends of virus evolution are more difficult to predict

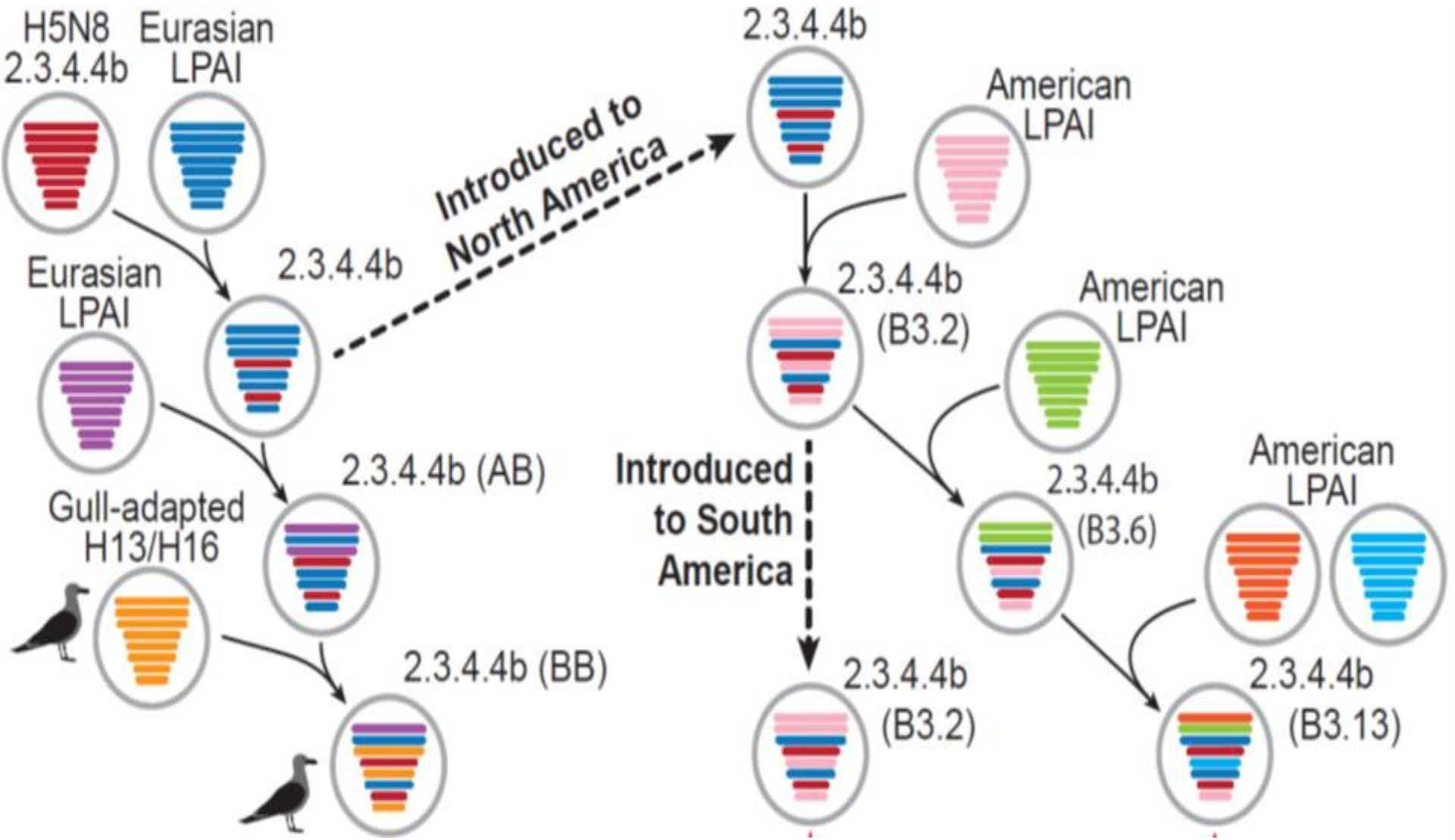
Alice Fusaro ✉, Bianca Zecchin, Edoardo Giussani, Elisa Palumbo, Montserrat Agüero-García, Claudia Bachofen, Ádám Bálint, Fereshteh Banihashem, Ashley C Banyard, Nancy Beerens ... Show more
Author Notes

Volume 10, Issue 1
2024
(In Progress)

Virus Evolution, Volume 10, Issue 1, 2024, veae027,

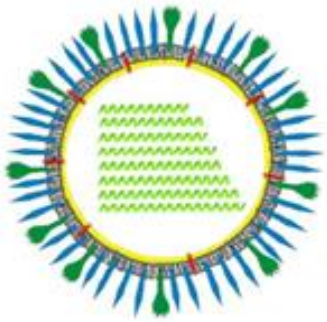


Iterative reassortment drove the emergence and propagation of the H5N1 panzootic



Peacock et al, 2024 (Figure credit Martha Nelson and David VanInsberghe)

The virus driving the impact!



The 2021-24 H5N1 HPAI is the most infectious and dangerous of strains to date

Multiple evolved traits

Spread of H5N1 HPAI to dairy cattle

H5N1 HPAI dairy cattle outbreak 10th March 2024 to present

Choose time period: Total Outbreak

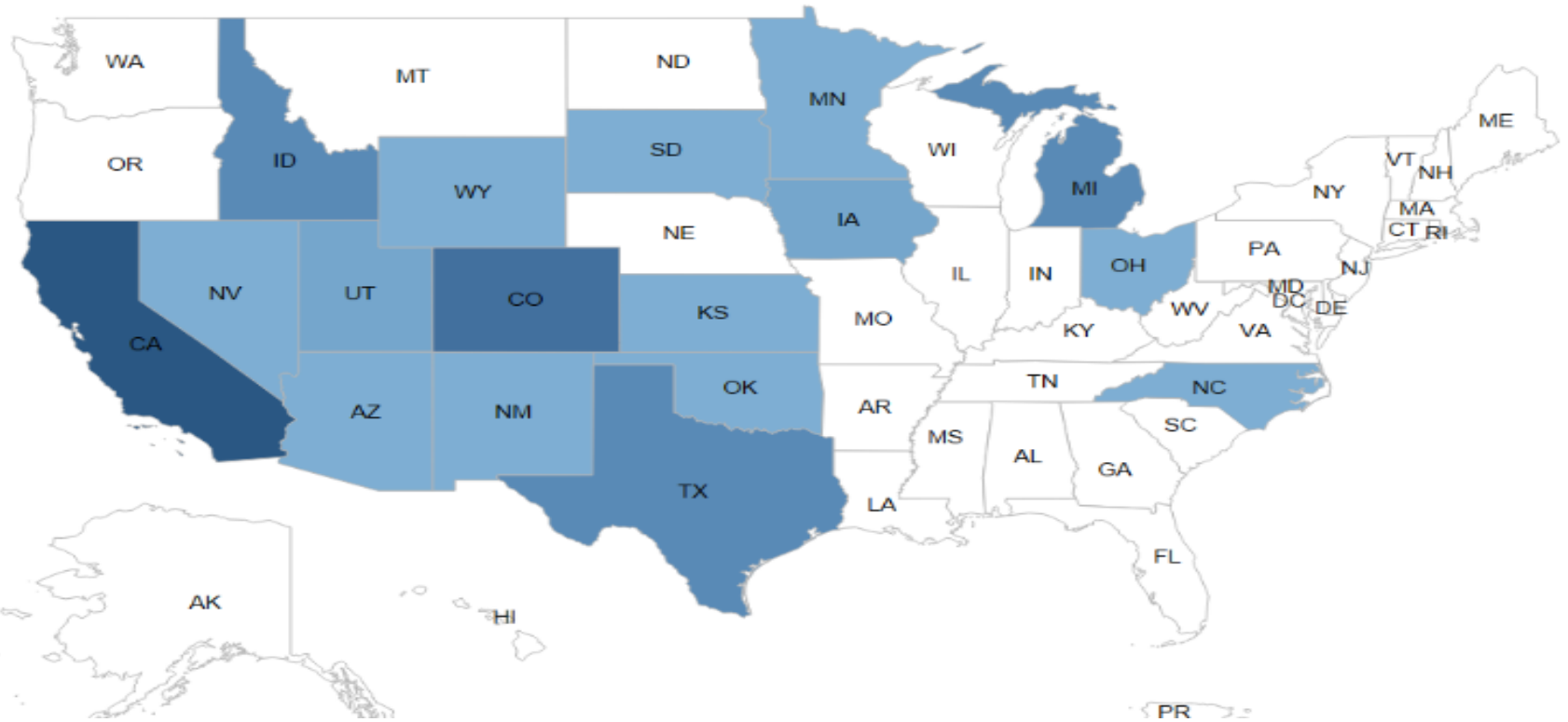
Choose species: Cattle

Click for International Exports

Situational Update

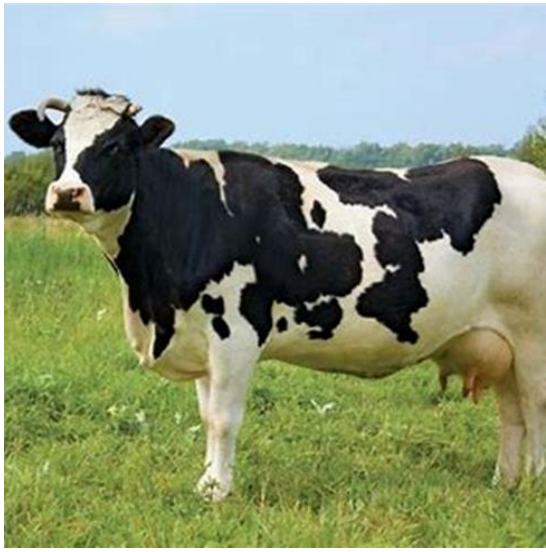
In the Total Outbreak, in Cattle, there were:
973 Confirmed Cases in **17** States

Number of Confirmed Cases in Cattle by State, Total Outbreak



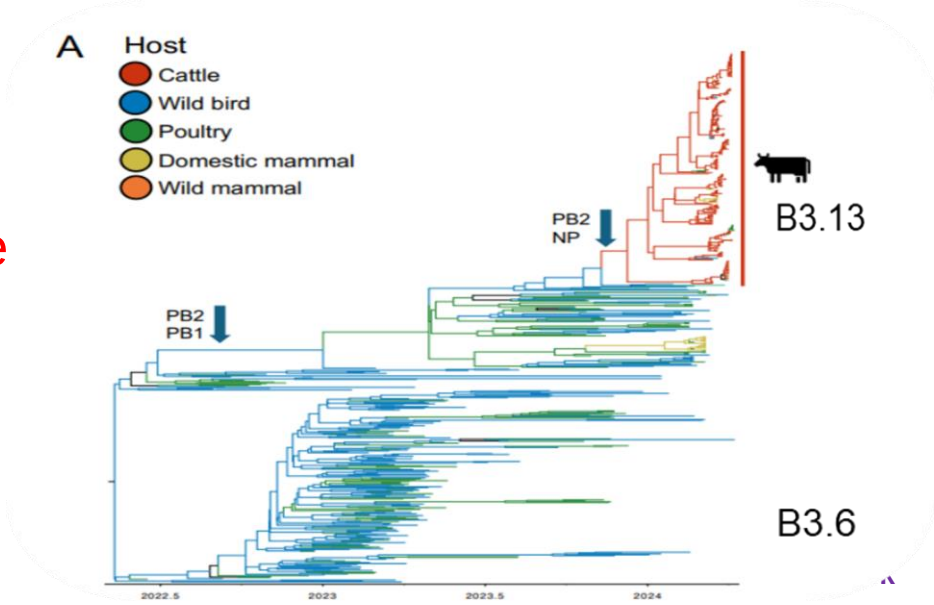
Dairy cattle; infection and epidemiology

- 3 spill overs of H5N1 HPAI (B3.13 genotype dominant)
- Initial signs are drop in feed intake and milk output
- Mastitis
- Symptoms range from asymptomatic to lethal
- Viral load in milk can be very high
- Almost exclusively lactating cows

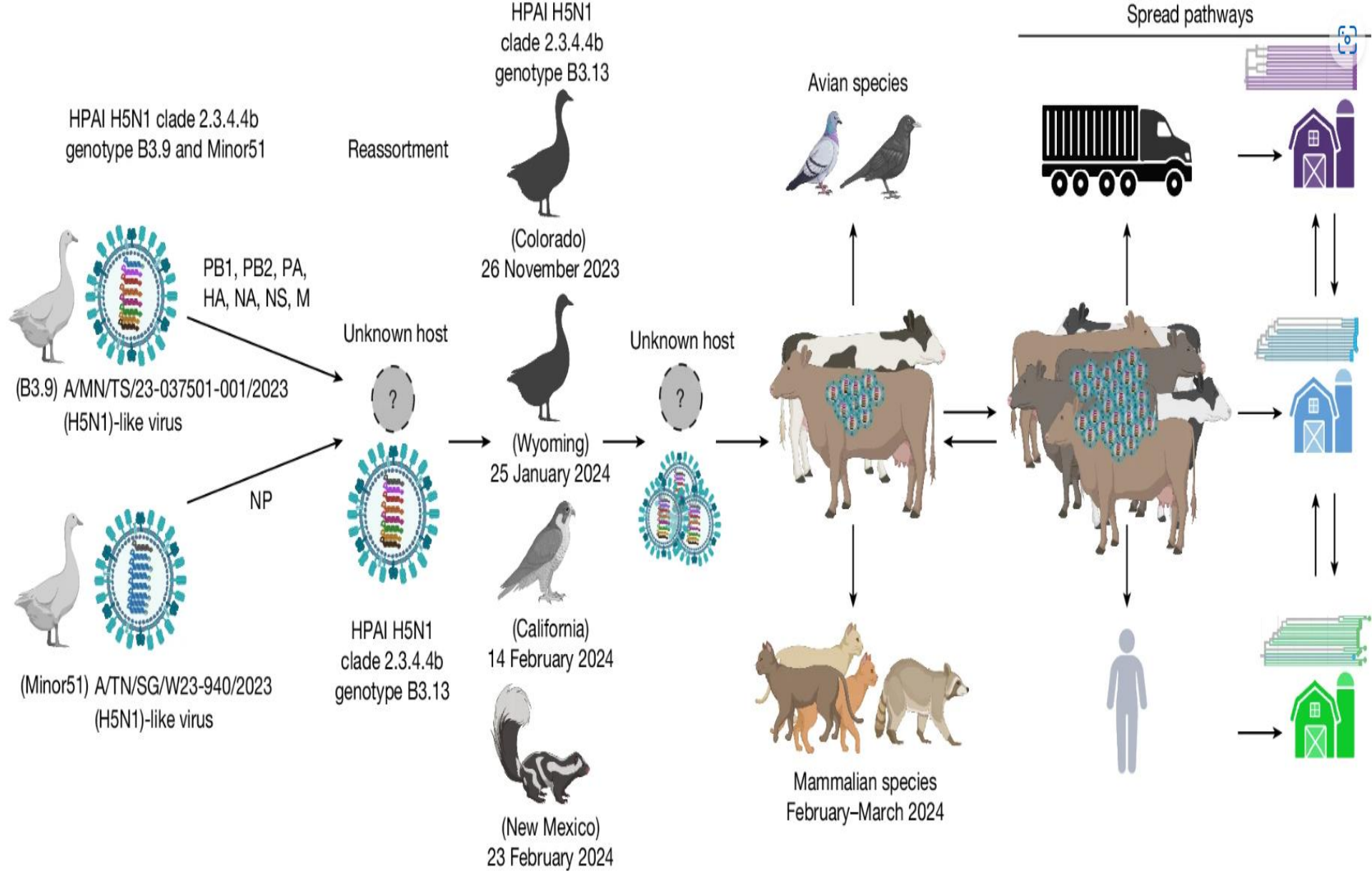


- Replication largely in mammary gland
- Respiratory infection at best transient

- Spread via movement of infected cattle
- Fomite : equipment, people etc



Nguyen et al bioRxiv
https://doi.org/10.1101/2024.05.01.591751



Caserta, L.C., Frye, E.A., Butt, S.L. et al. Spillover of highly pathogenic avian influenza H5N1 virus to dairy cattle. Nature (2024). https://doi.org/10.1038/s41586-024-07849-4

Human case summary associated with dairy cattle epidemic (24/2/25)

National Total Cases: 70

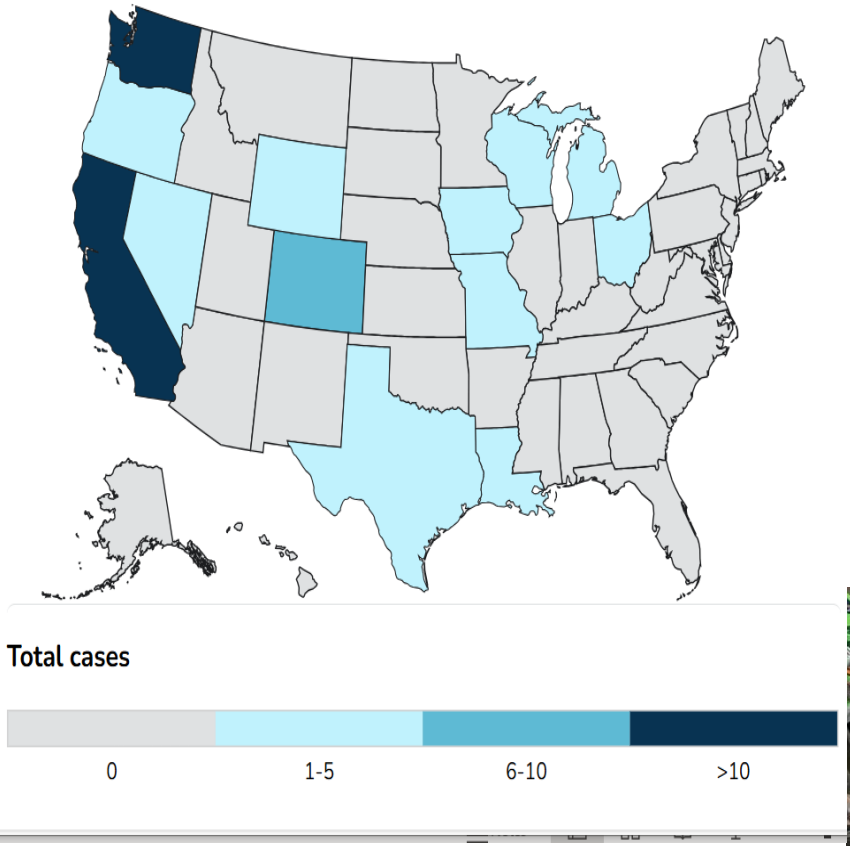
Cases	Exposure Source
41	Dairy Herds (Cattle)*
24	Poultry Farms and Culling Operations*
2	Other Animal Exposure†
3	Exposure Source Unknown‡

NOTE: One additional case was previously detected in a poultry worker in Colorado in 2022. Louisiana reported the first H5 bird flu death in the U.S.

*Exposure Associated with Commercial Agriculture and Related Operations

†Exposure was related to other animals such as backyard flocks, wild birds, or other mammals

‡Exposure source was not able to be identified

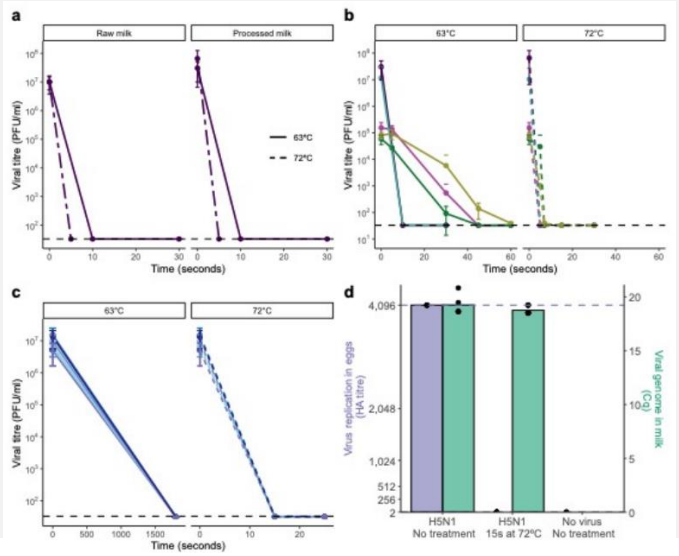


Pasteurisation kills live virus in the milk

https://www.cdc.gov/bird-flu/situation-summary/index.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fbird-flu%2Fphp%2Favian-flu-summary%2Findex.html

Virus survival in milk?

Pasteurisation



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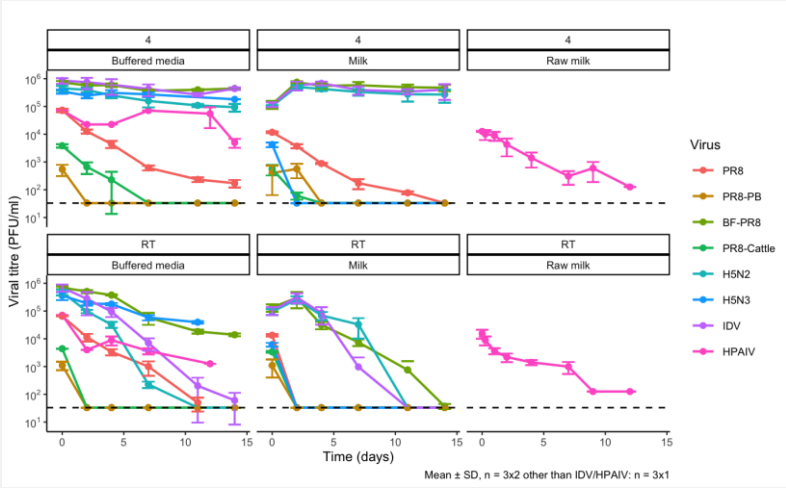
Pasteurisation temperatures effectively inactivate influenza A viruses in milk

Jenna Schafers, Caroline J. Warren, Jiayun Yang, Junsen Zhang, Sarah J. Cole, Jayne Cooper, Karolina Drewek, B Reddy Kolli, Natalie McGinn, Mehnaz Qureshi, Scott M. Reid, Thomas P. Peacock, Ian Brown, Joe James, Ashley C. Banyard, Munir Iqbal, Paul Digard, Ed Hutchinson

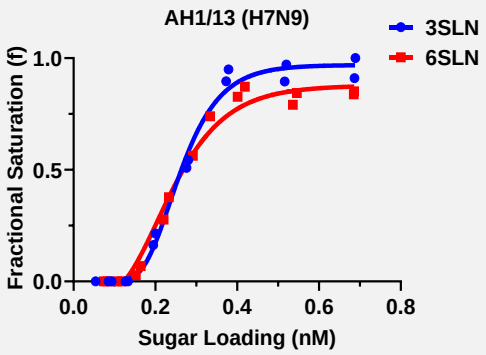
doi: https://doi.org/10.1101/2024.05.30.24308212

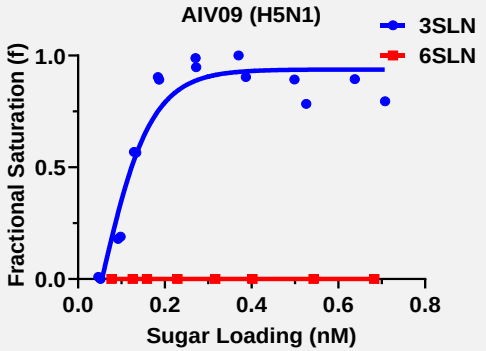


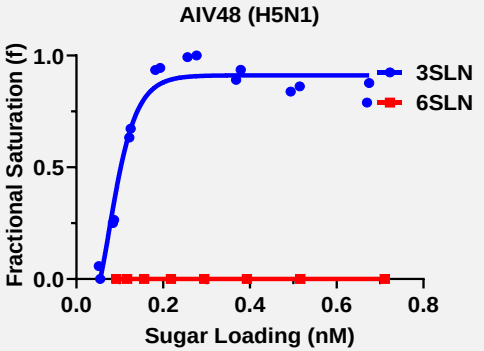
Raw milk an unsafe commodity!

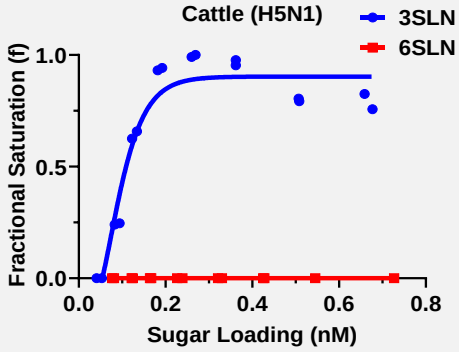
Do the cattle and goat H5N1 viruses pose risk to humans?

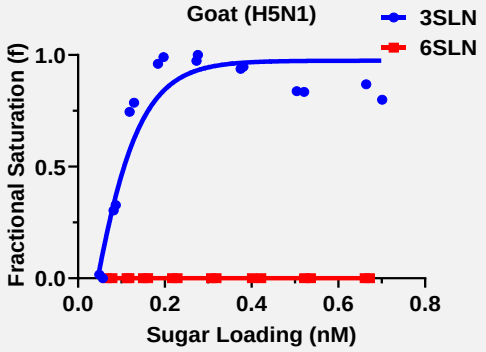
Receptor Binding studies

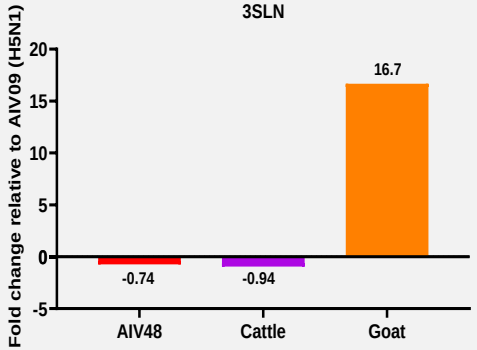










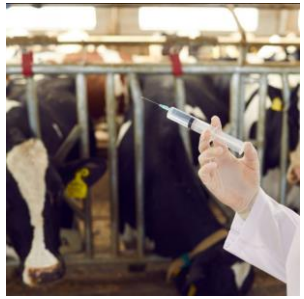


Cattle and goat H5N1 viruses retain affinity for avian-like receptor analogue 3SLN.

Munir Iqbal and Jiayun Yang & team

Dairy cattle epidemic; implications for poultry?

- Dairy farms often close proximity to poultry
- Poorer biosecurity practices
- Shared personnel/household contacts between sectors
- Cattle virus whilst replicating in mammary gland phenotypically avian
- Fully infectious for domestic birds
  - Human cases; mild
- No evidence to date for spill over into wild birds of diary cattle B3.13 virus
- Infection confined to USA



- Reduction of threat from cattle via vaccination?
- Field Studies with Nonviable, Non-replicating Veterinary Vaccines Targeting Highly Pathogenic Avian Influenza in Livestock
  https://www.aphis.usda.gov/news/program-update/cvb-notice-24-13-field-studies-nonviable-non-replicating-veterinary-vaccines

Companion animals: H5 HPAI

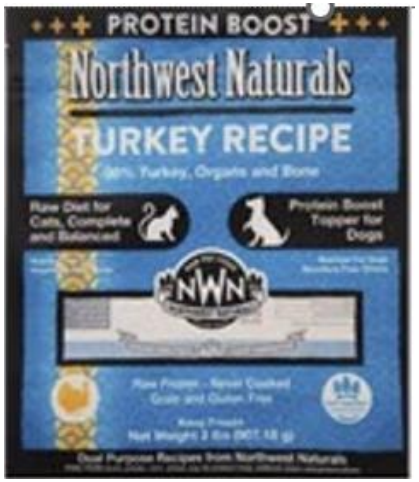
- H5N1 HPAI infections in cats have been widely reported
- Variable clinical manifestations, including respiratory and neurological signs, often fatal outcomes.
- Infection via exposure to infected birds, other animals, raw or contaminated feed or in the milking parlour!
- Multiple independent cases in Poland; feed?
- Captivity die offs ie Large cats in zoos

RESEARCH

Outbreak of highly pathogenic avian influenza A(H5N1) clade 2.3.4.4b virus in cats, Poland, June to July 2023

Katarzyna Domańska-Blicharz[1], Edyta Świętoń[2], Agnieszka Świątalska[3], Isabella Monne[4], Alice Fusaro[4], Karolina Tarasiuk[1], Krzysztof Wyrostek[1], Natalia Styś-Fijoł[1], Aleksandra Giza[2], Marta Pietruk[2], Bianca Zecchin[4], Ambra Pastori[4], Łukasz Adaszek[5], Małgorzata Pomorska-Mól[6], Grzegorz Tomczyk[1], Calogero Terregino[4], Stanisław Winiarczyk[5-7]

- Dogs susceptible
- Very infrequent reports



Could vaccination solve the problem?

Vaccination will only work when applied in combination with other measures

Vaccination is not a substitute for weak farm biosecurity

Considering vaccination as part of available avian influenza control measures

- **Prevention and control of outbreaks in vaccinated domestic bird populations** resulting in reduced virus circulation within and between flocks and lower risk of spillover to wildlife

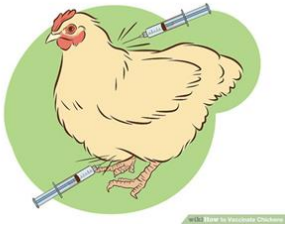
- **Reduced economic losses**, both direct (e.g. bird deaths) and indirect (e.g. mass culling and trade disruption). When properly implemented, avian influenza vaccination is compatible with safe trade, according to WOAH international standards

- **Lower risk of human exposure to avian influenza viruses**, and thus of a potential pandemic, in line with the One Health

- **Minimised environmental impact** by reducing the risk of spill over to wild animals

- **Protecting food security**

- **Incentives for innovative research**



Key Conclusions

- Exceptional global spread; panzootic most continents affected
  - Continues to be a significant threat to biodiversity
- High infection pressure resulting in increased wild bird host range and continuing if not declining cases in domestic birds
- Mammalian infections: spillover to scavengers, some M2M transmission
- Dairy cattle infection in USA: continuing outbreak with spread (17 states); vaccination in future?
- H5 HPAI virus evolving with high fitness traits
- Antigenically dominant clade 2.3.4.4b moderately stable

- Vaccination remains an important tool for prevention/control in some countries/regions


Animal & Plant Health Agency
Ash Banyard
Joe James
Marek Slomka
Cecilia Di Genova
Lizzie Billington
Sofia Riccio
Kajal Ralh
Jafar Hassan
Caroline Warren
DES, Animal Sciences, Pathology
RVC Royal Veterinary College University of London
Pablo Alarcon
Guillaume Fournie
Javier Guitan
Stephen Vickers
Sarah Hill
THE FRANCIS CRICK INSTITUTE
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rspb
THE Pirbright INSTITUTE
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