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***“Toward a Sustainable Low Carbon Society”***

***How are we prepared for  
emerging zoonoses ?***

**Ayato Takada**

**Hokkaido University  
Research Center for Zoonosis Control  
Sapporo, Japan**

**Zoonosis is any infectious disease that may be transmitted from other animals, both wild and domestic, to humans or from humans to animals.**

**The word is derived from the Greek words zoon (animal) (pronounced as zoo-on) and nosos (disease). Many serious diseases fall under this category.**

**Bacteria, viruses, parasite, protozoa, prion ....**

- **Anthrax, Brucellosis, Leptospirosis, Listeriosis, MRSA,**
- **Influenza, Ebola fever, SARS, Rabies,**
- **Echinococcosis, Trypanosomiasis, Toxoplasmosis,**
- **BSE**

# Emerging Zoonoses

Year	Disease	Causative agent	Country	Human cases
1977	Ebola hemorrhagic fever	Ebola virus of <i>Filoviridae</i>	Zaire (DRC)	318 (279 deaths)
	Hemorrhagic fever with renal syndrome Bloody diarrhea, Hemolytic uremic syndrome	Hantavirus of <i>Bunyaviridae</i>	Korea	388
1982		<i>Escherichia coli</i> 0157:H7	USA	73,000 (61 deaths)
	Lyme disease	<i>Borrelia burgdorferi</i>	USA	9,000
1983	AIDS	HIV of <i>Retroviridae</i>		
1986	BSE	Prion	UK	113 (2001)
1989	Ehrlichiosis	<i>Ehrlichia chaffeensis</i> , <i>E. phagocytophila</i>	USA	1,200
1991	Venezuelan hemorrhagic fever	Guanarito virus of <i>Arenaviridae</i>	Venezuela	105 (35 deaths)
1992	Cat scratch disease	<i>Bartonella henselae</i>	USA	22,000
1993	Hantavirus pulmonary syndrome	Sin Nombre virus of <i>Bunyaviridae</i>	USA	80 (50 deaths)
1994	Brazilian hemorrhagic fever	Sabia virus of <i>Arenaviridae</i>	Brazil	26 (10 deaths)
	Morbillivirus infection from horses	Hendra virus of <i>Paramyxoviridae</i>	Australia	2 (1 death)
1995	Hantavirus pulmonary syndrome	<i>Hantavirus of bunyaviridae</i>	South American countries	239 (30% deaths)
	Ebola hemorrhagic fever	Ebola virus of <i>Filoviridae</i>	Zaire	318 (249 deaths)
1996	Rabies from bat	Lyssavirus type 7 of <i>Rhabdoviridae</i>	Australia	2 deaths
1997	Avian influenza (H5N1) virus infection	Highly pathogenic avian influenza virus	Hong Kong	18 (6 deaths)
1998	Pneumonic plague	<i>Yersinia pestis</i>	India	16 (4 deaths)
1999	Nipah virus infection	Morbillivirus of <i>Paramyxoviridae</i>	Malaysia	258 (100 deaths)
	Leptospirosis (present)	<i>Leptospira interrogans</i>	Thai, Philippines, Asia	>30,000 (>700 deaths)
2000	Rift Valley fever	Rift Valley fever virus of <i>Bunyaviridae</i>	Saudi Arabia, Yemen	884 (124 death)
2001 - 2007	West Nile fever	West Nile virus of <i>Flaviviridae</i>	USA, Canada, Mexico	17,000 (>600 deaths)
2001 ~ 2004	Ebola hemorrhagic fever	Ebola virus of <i>Filoviridae</i>	Congo	210 (175 deaths)
2003	SARS	Coronavirus	Hong Kong, China, worldwide	8,437 (813 deaths)
	Avian influenza virus (H7N7) infection	Highly pathogenic avian influenza virus	Netherlands, Belgium, Germany	86 (1 death)
2004 ~ 2008	Avian influenza virus (H5N1) infection	Highly pathogenic avian influenza virus	China and 11 countries of Asia, Far East, and Africa	331 (204 deaths)
2004 ~ 2005	Marburg hemorrhagic fever	Marburg virus of <i>Filoviridae</i>	Angola	424 (363 deaths)
2005	Ebola hemorrhagic fever	Ebola virus of <i>Filoviridae</i>	Congo	12 (10 deaths)



# Emerging Zoonoses

- **Many of the agents responsible for epidemics throughout human history have their origins in animals.**
- **Nearly all emerging disease episodes of the past 20 years have involved zoonotic infectious agents.**
- **Episodes of zoonoses are increasing around the globe.**

# Causative factors resulting in the increase of zoonosis outbreaks

- **Climate, weather, rainfall, temperature (global warming)**
- **Population movements and the intrusion of humans and domestic animals into arthropod habitats**
- **Deforestation and settlement of new tropical forest/farm margins**
- **Expanding primitive irrigation systems**
- **The opening up of isolated ecosystems such as islands**
- **Increased long-distance air travel**
- **Increased long-distance livestock transportation**
- **New routings of long-distance bird migrations**
- **Uncontrolled urbanization and environmental pollution**

# Zoonotic factors favoring new, emerging and re-emerging infections

- **Zoonoses must be dealt with at the interface between medical, veterinary, and environmental sciences.**
- **The research base involves the interface between:**  
**virology (biologic and molecular biologic), immunology, pathology, ecology, animal biology, wildlife biology, mammology, ornithology, entomology, meteorology, climatology, geography, sciences pertaining to societal and commercial risk factors, economics, government, biodefense, etc., and the medical sciences and veterinary sciences.**

# Control and Prevention of Zoonoses

## Veterinary Medicine

Prevention and therapeutics of diseases in livestock and pet animals



Ministry of Agriculture, Forestry and Fisheries

OIE

## Research Center for Zoonosis Control

Ecology of zoonotic pathogens



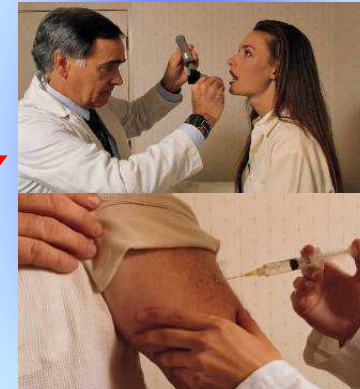
Prevention and Control of Zoonoses

Ministry of the Environment

Species conservation of wild animals

## Medicine

Maintenance and improvement of human and public health



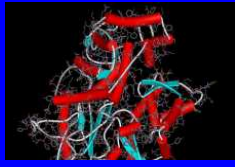
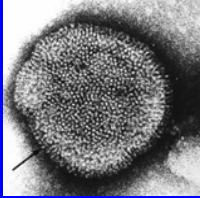
Ministry of Health and Welfare

WHO



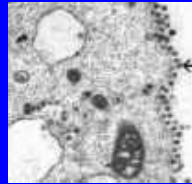
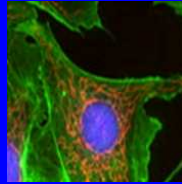
### Department of Global Epidemiology

- Identification of natural host animals of zoonotic pathogens



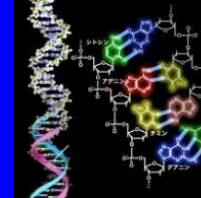
### Department of Molecular Pathobiology

- Diagnosis of zoonotic diseases and development of detection methods



### Department of Bioresources

- Preservation and supply of pathogens, cells, genes and animal strains



### Department of Collaboration and Education

- Coordination of collaboration programs with international and domestic organizations



## Hokkaido University Research Center for Zoonosis Control

### Hokudai Center for Zoonosis Control in Zambia

- Identification of natural host animals and transmission routes of zoonotic pathogens



### Global Surveillance

### International Collaboration

World Health Organization (WHO)  
World Organization for Animal Health (OIE)  
Food and Agriculture Organization (FAO)  
Centers for Disease Control and Prevention (CDC)

**Influenza A virus**

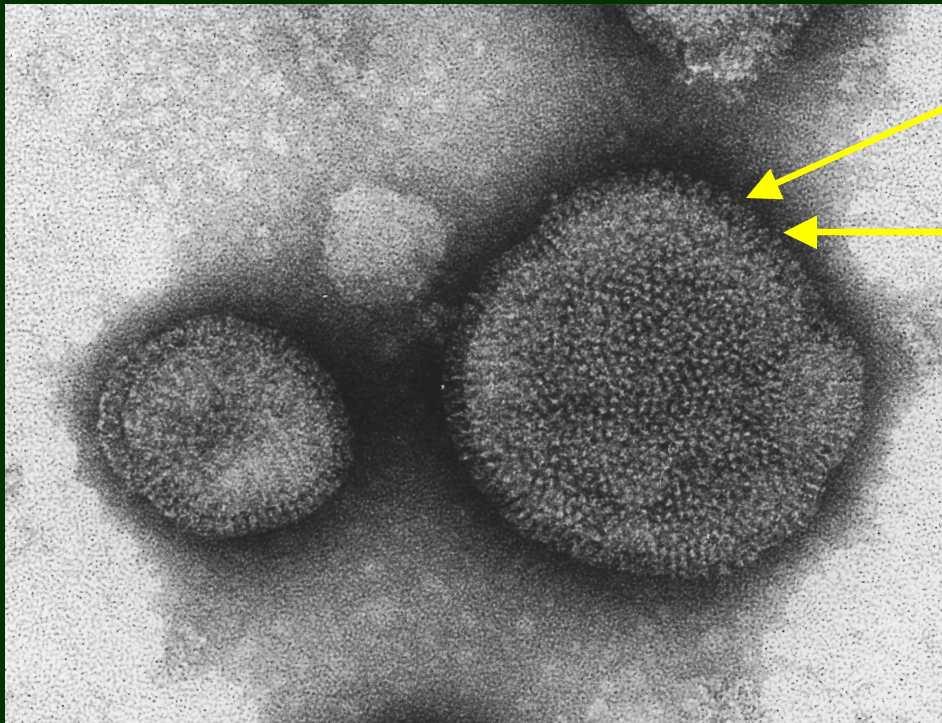
**Filovirus**

# The Ecology of influenza A viruses

# Influenza virus

## *Orthomyxoviridae*

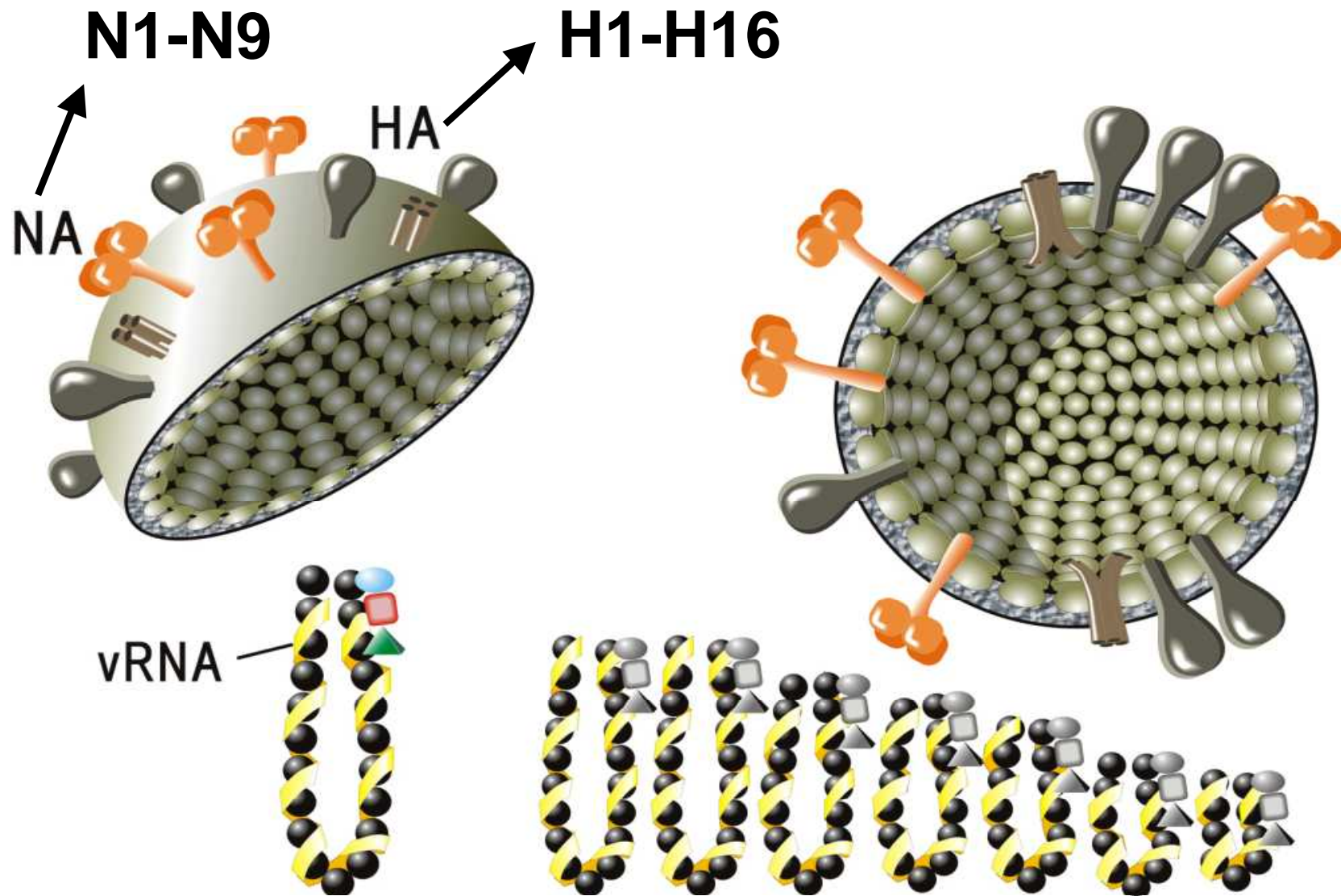
Envepoled, negative-stranded RNA virus  
Segmented RNA genome



**Hemagglutinin, HA**

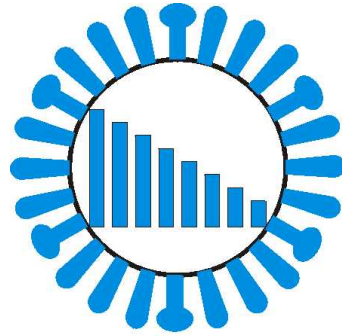
**Neuraminidase, NA**



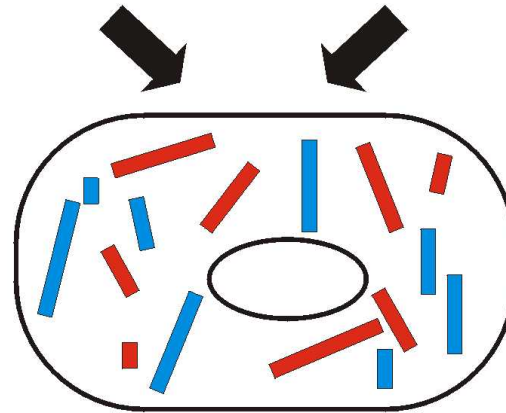
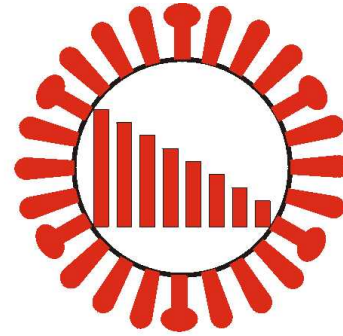


**Genetic Reassortment**

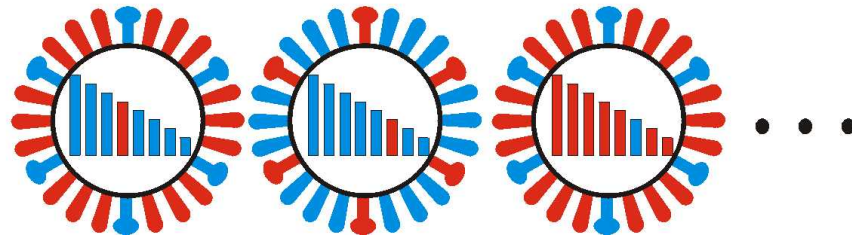
**H1N1**



**H2N2**



**Gene Exchange  
Genetic Reassortment**



**H2N1**

**H1N2**

**H2N1**



**Wild aquatic bird**

**Natural reservoir**

**No disease**

**Non-pathogenic virus**

**H1-16、N1-9**



# The Ecology of Influenza Viruses

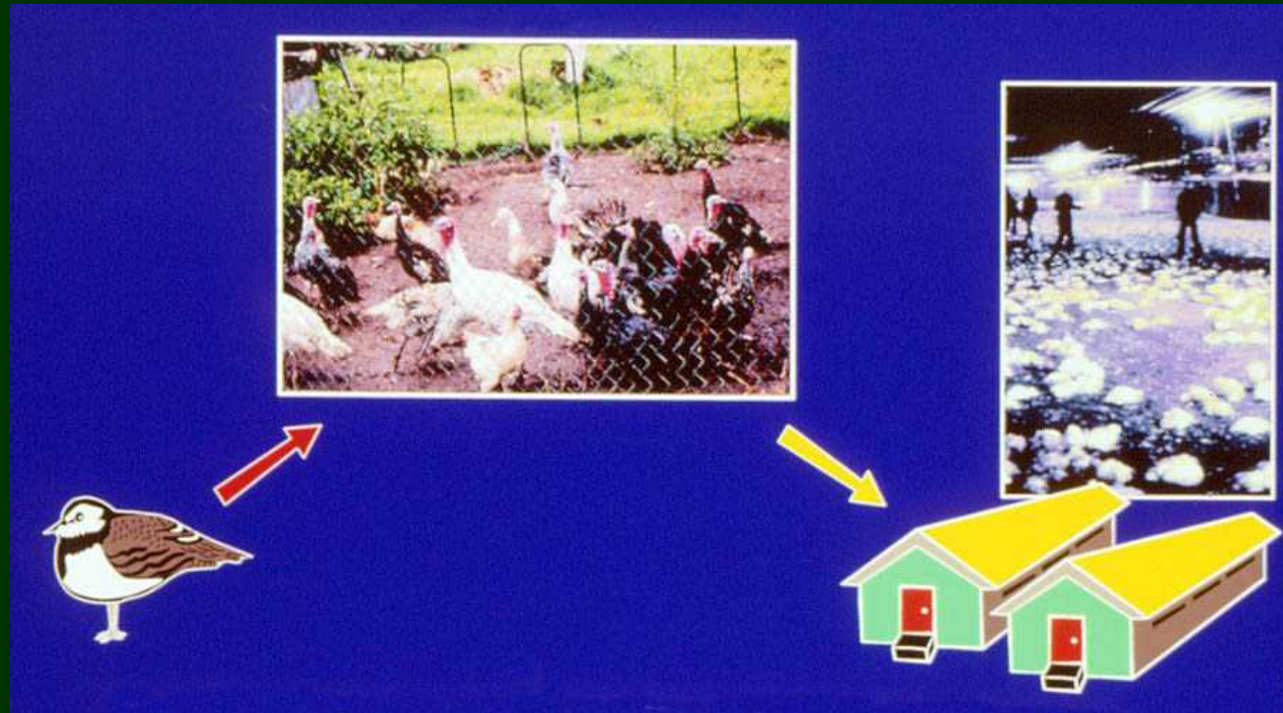
- Wild aquatic birds are the natural reservoirs of all influenza A viruses in other species
- In wild aquatic birds, influenza viruses replicate predominately in the intestinal tract and are shed by fecal oral transmission often through water



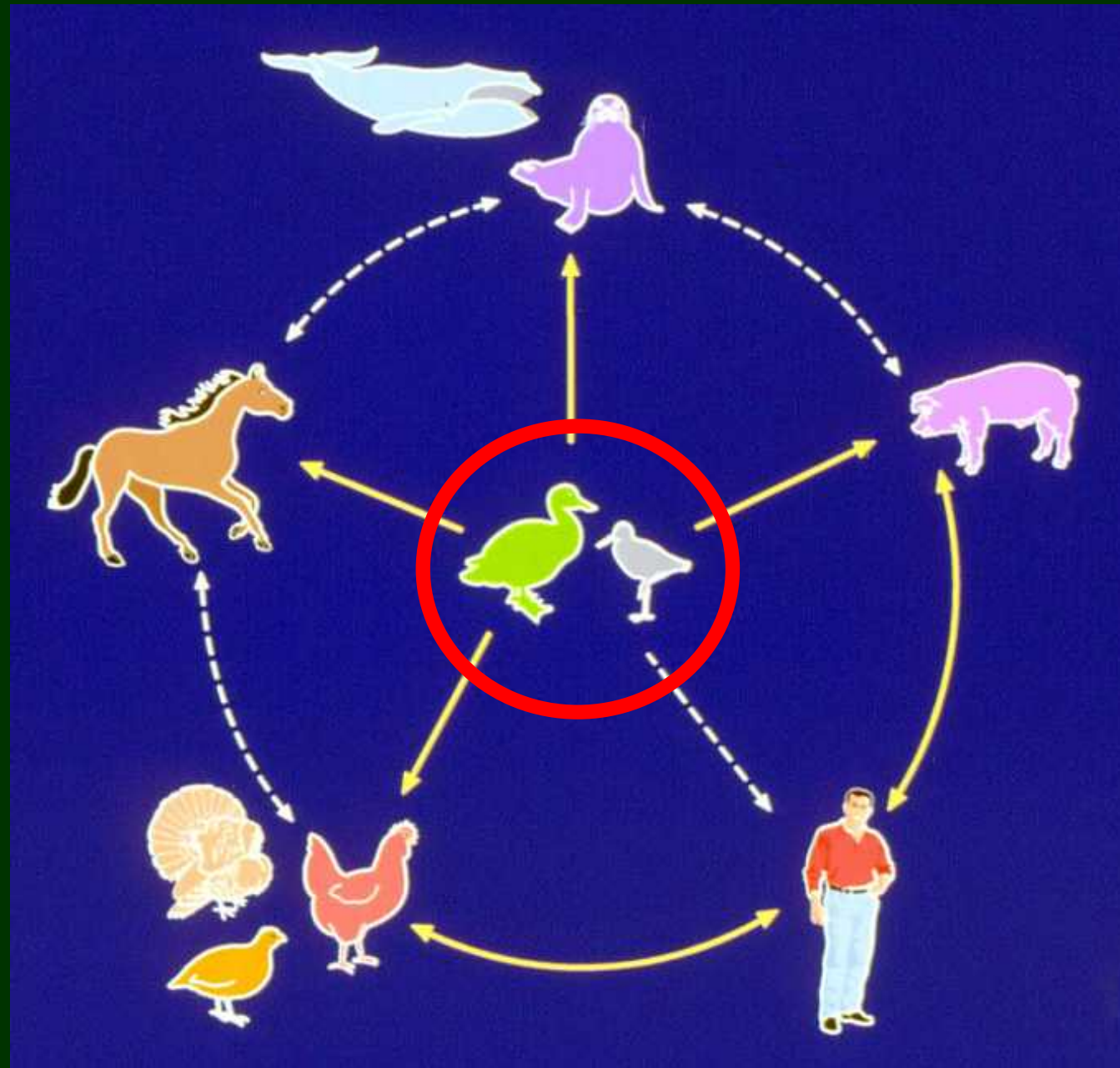


# The Ecology of Influenza A Viruses

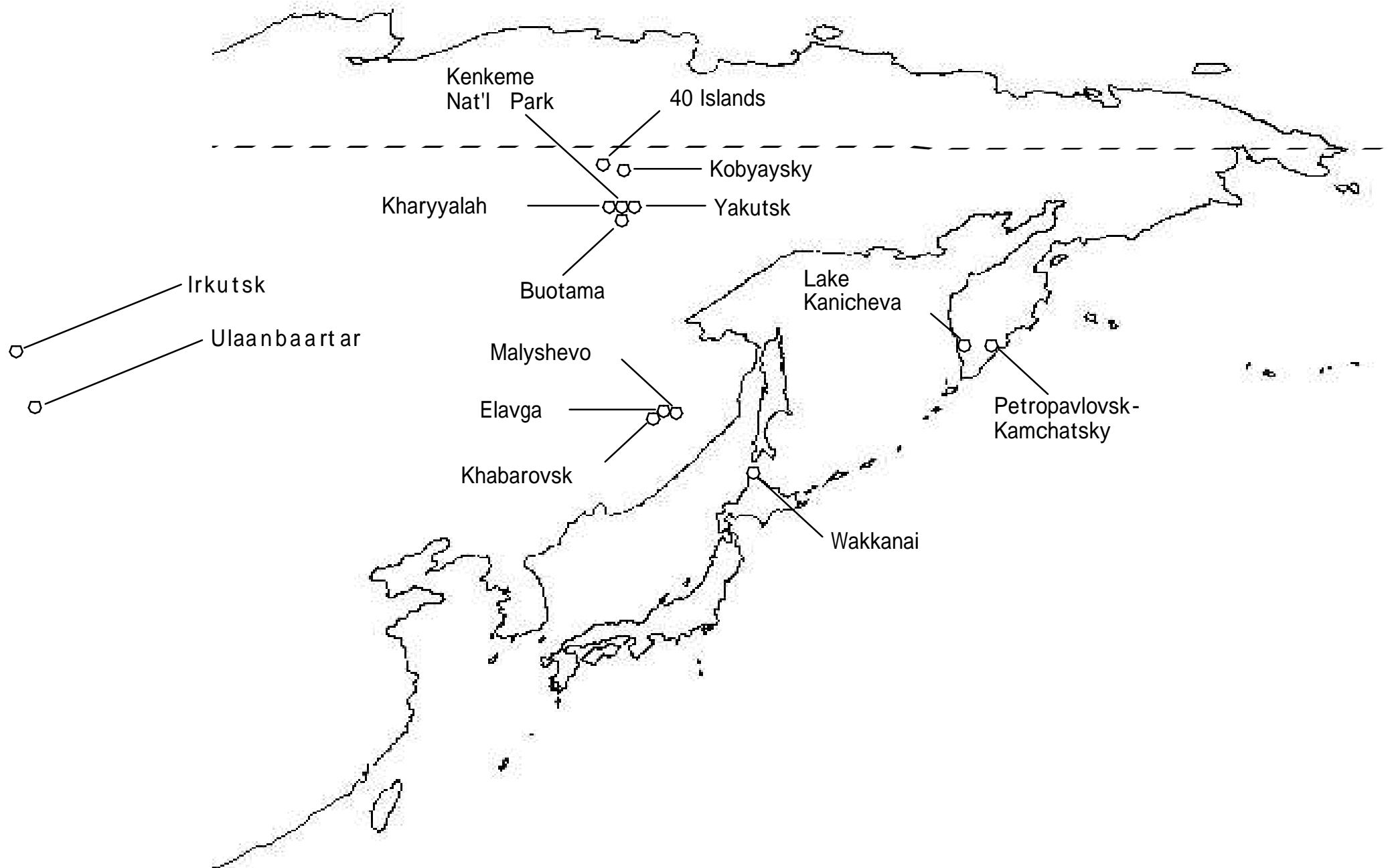
- Influenza viruses in their natural reservoirs are in evolutionary stasis
- Rapid evolution occurs after transfer to new hosts



# The Ecology of Influenza A Viruses

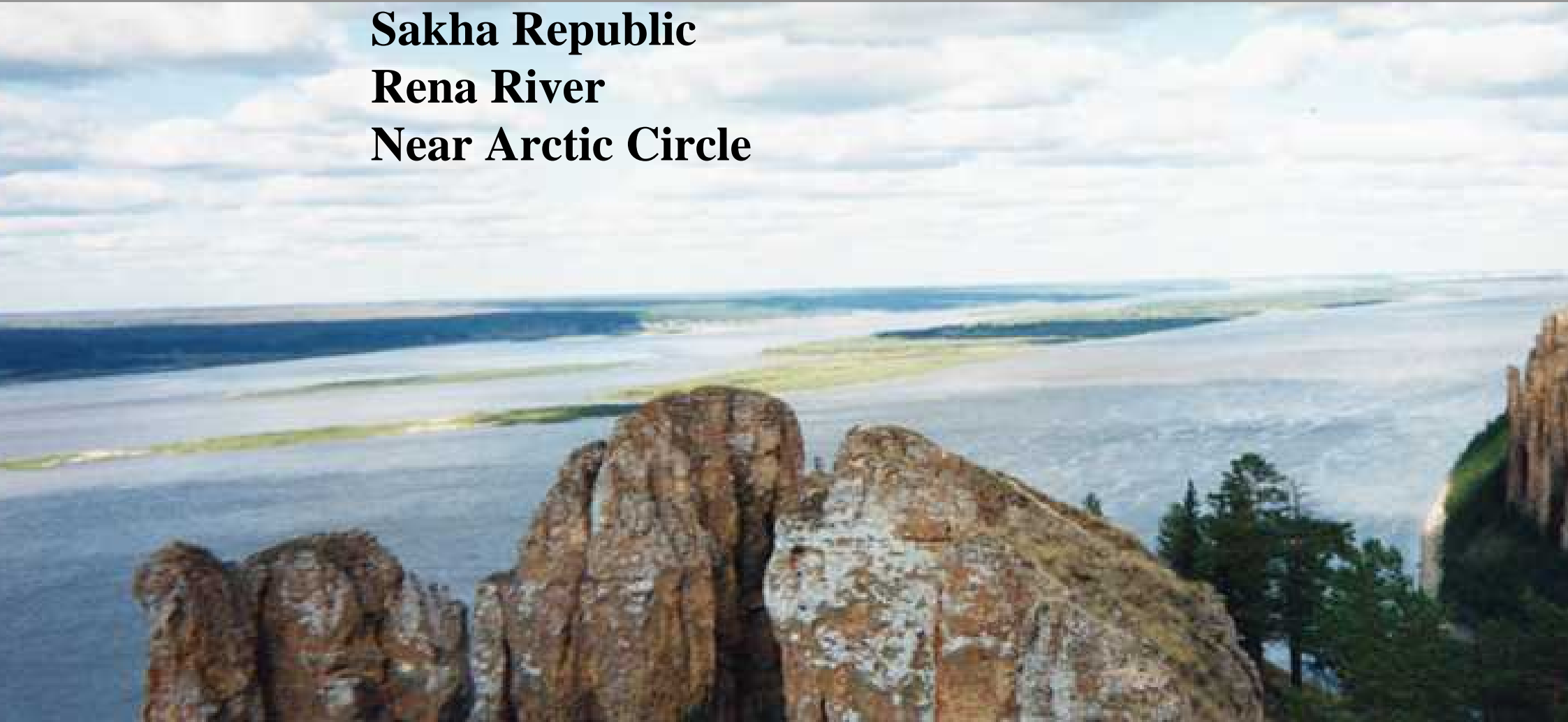


# Surveillance of avian influenza in Japan, Siberia, and Mongolia





**Sakha Republic**  
**Rena River**  
**Near Arctic Circle**







with a bird's-eye view

**A lot of lakes and ponds**  
**Nesting area for wild ducks**  
**Viruses are perpetuated in winter**



## Evidence of Influenza A Virus RNA in Siberian Lake Ice

Gang Zhang,<sup>1</sup> Dany Shoham,<sup>2</sup> David Gilichinsky,<sup>3</sup> Sergei Davydov,<sup>4</sup> John D. Castello,<sup>5</sup> and Scott O. Rogers<sup>1\*</sup>



Influenza A virus infects a large proportion of the human population annually, sometimes leading to the deaths of millions. The biotic cycles of infection are well characterized in the literature, including in studies of populations of humans, poultry, swine, and migratory waterfowl. However, there are few studies of abiotic reservoirs for this virus. Here, we report the preservation of influenza A virus genes in ice and water from high-latitude lakes that are visited by large numbers of migratory birds. The lakes are along the migratory flight paths of birds flying into Asia, North America, Europe, and Africa. The data suggest that influenza A virus, deposited as the birds begin their autumn migration, can be preserved in lake ice. As birds return in the spring, the ice melts, releasing the viruses. Therefore, temporal gene flow is facilitated between the viruses shed during the previous year and the viruses newly acquired by birds during winter months spent in the south. Above the Arctic Circle, the cycles of entrapment in the ice and release by melting can be variable in length, because some ice persists for several years, decades, or longer. This type of temporal gene flow might be a feature common to viruses that can survive entrapment in environmental ice and snow.



# On the Rena River





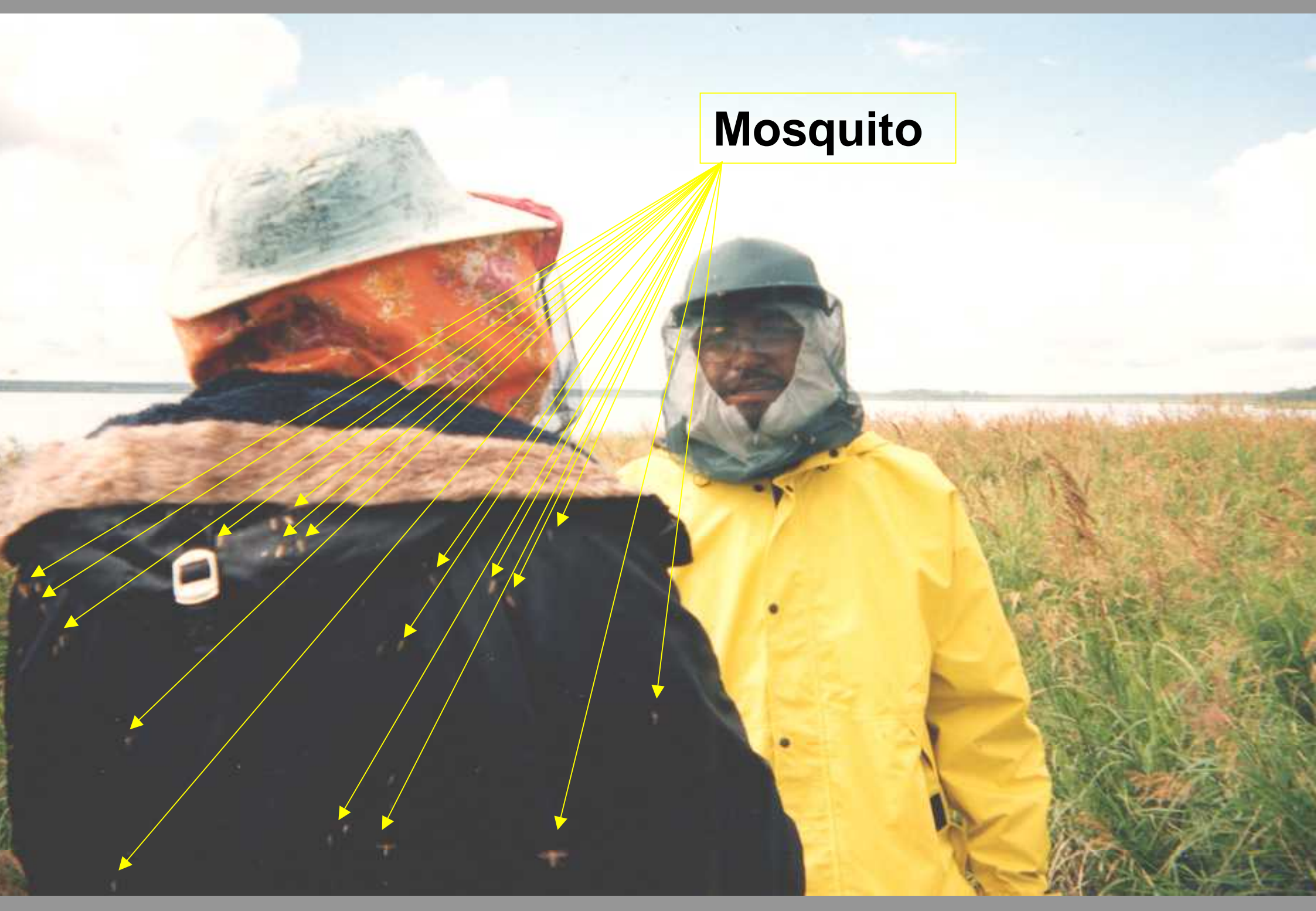








**Mosquito**



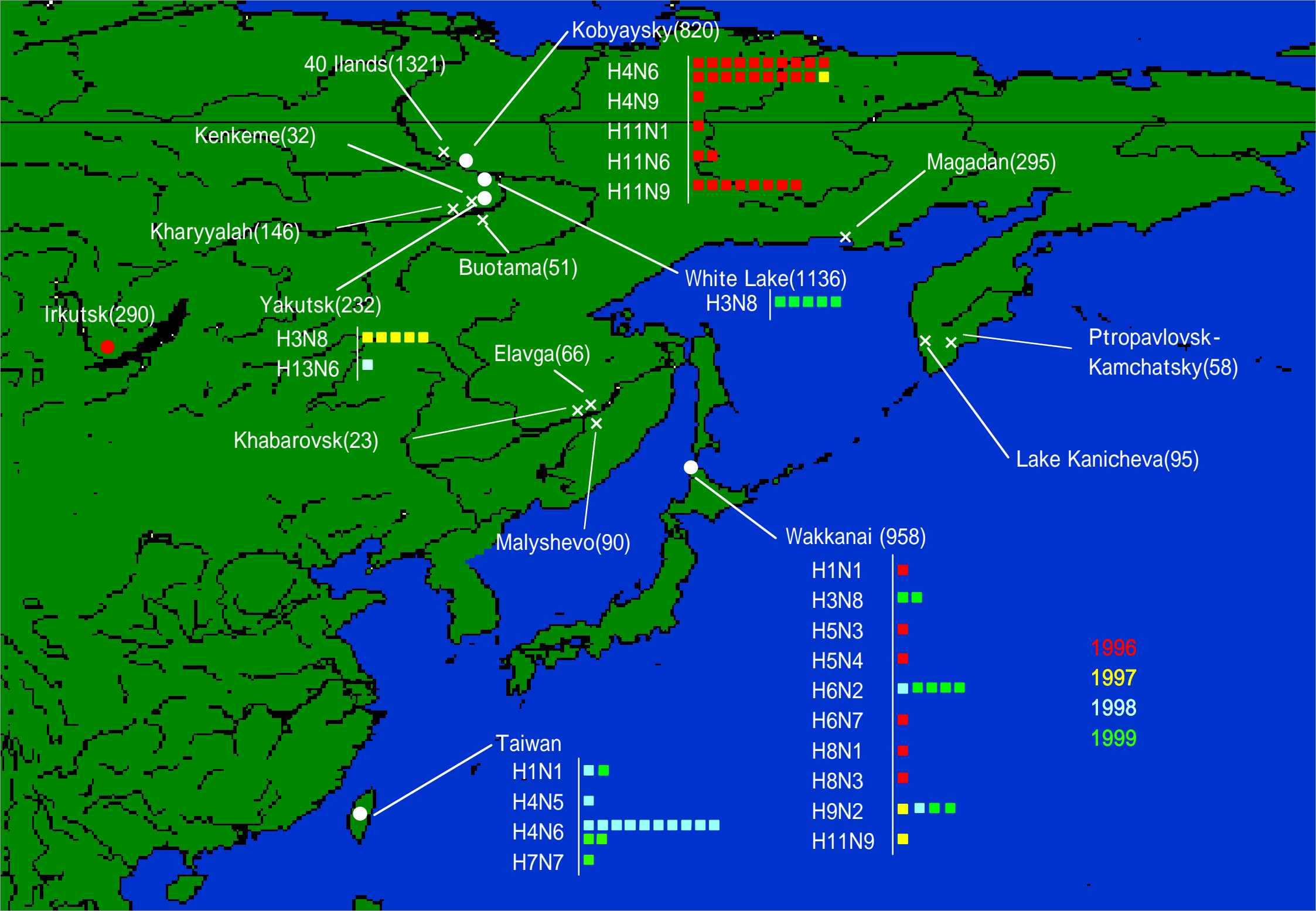




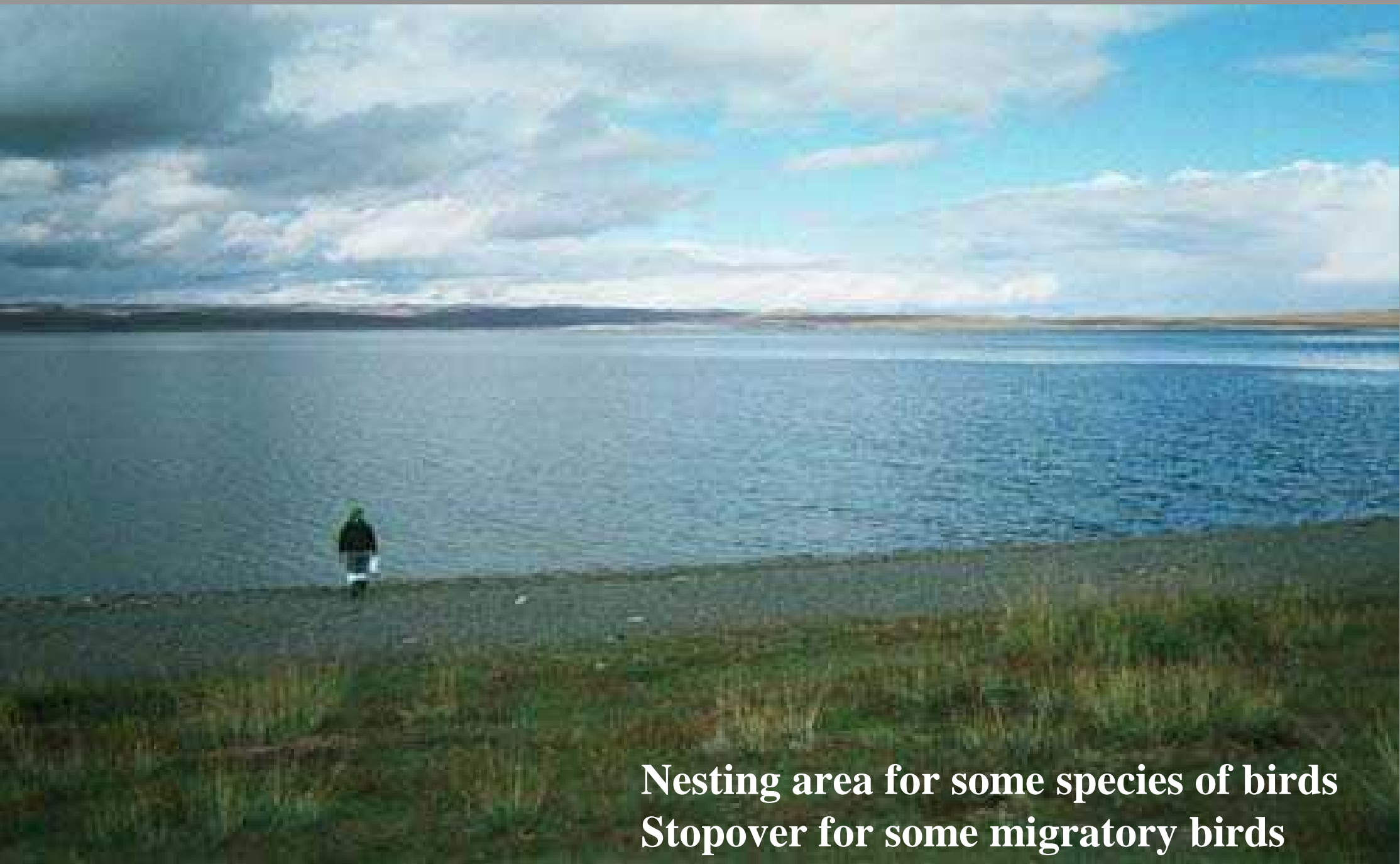




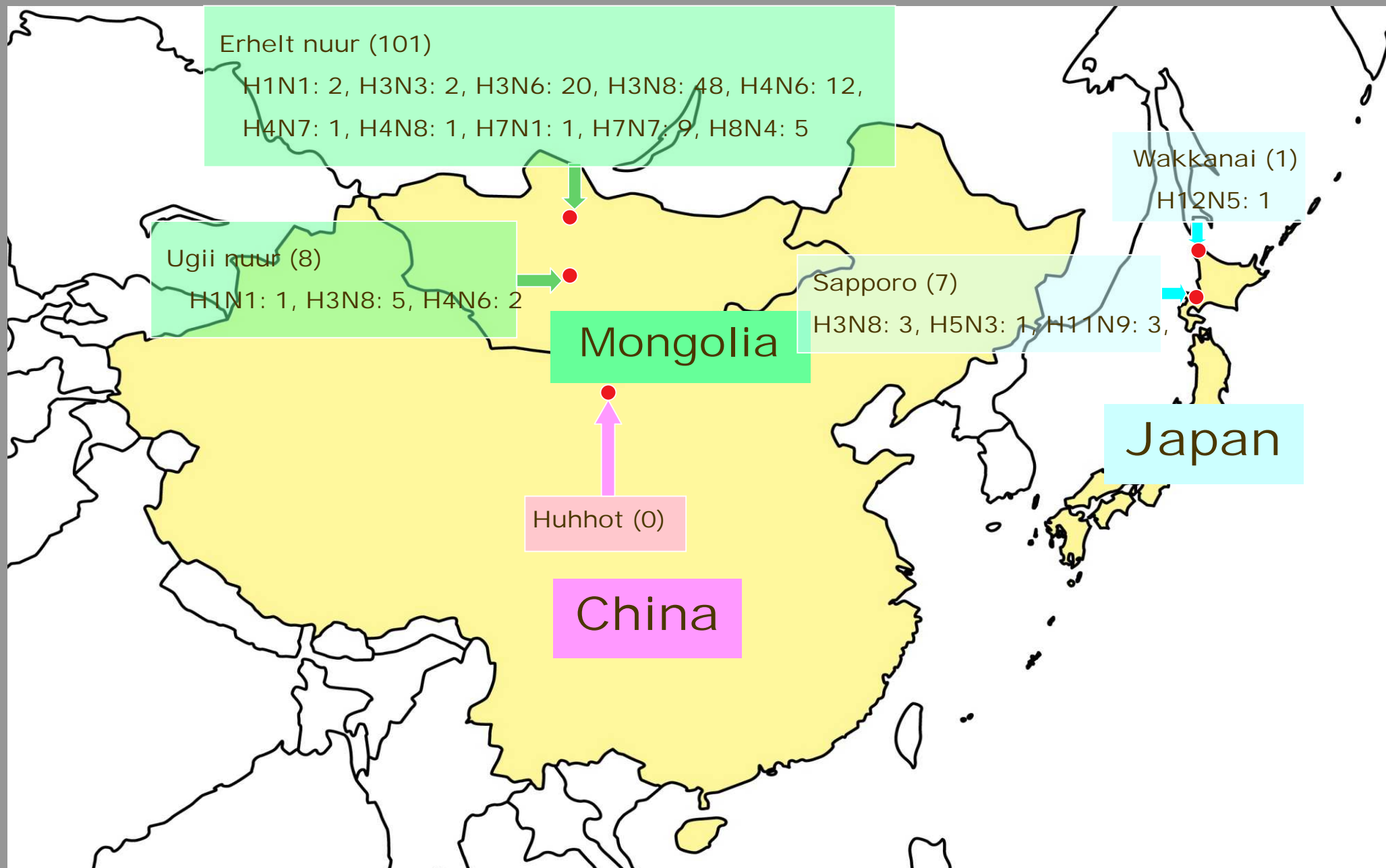






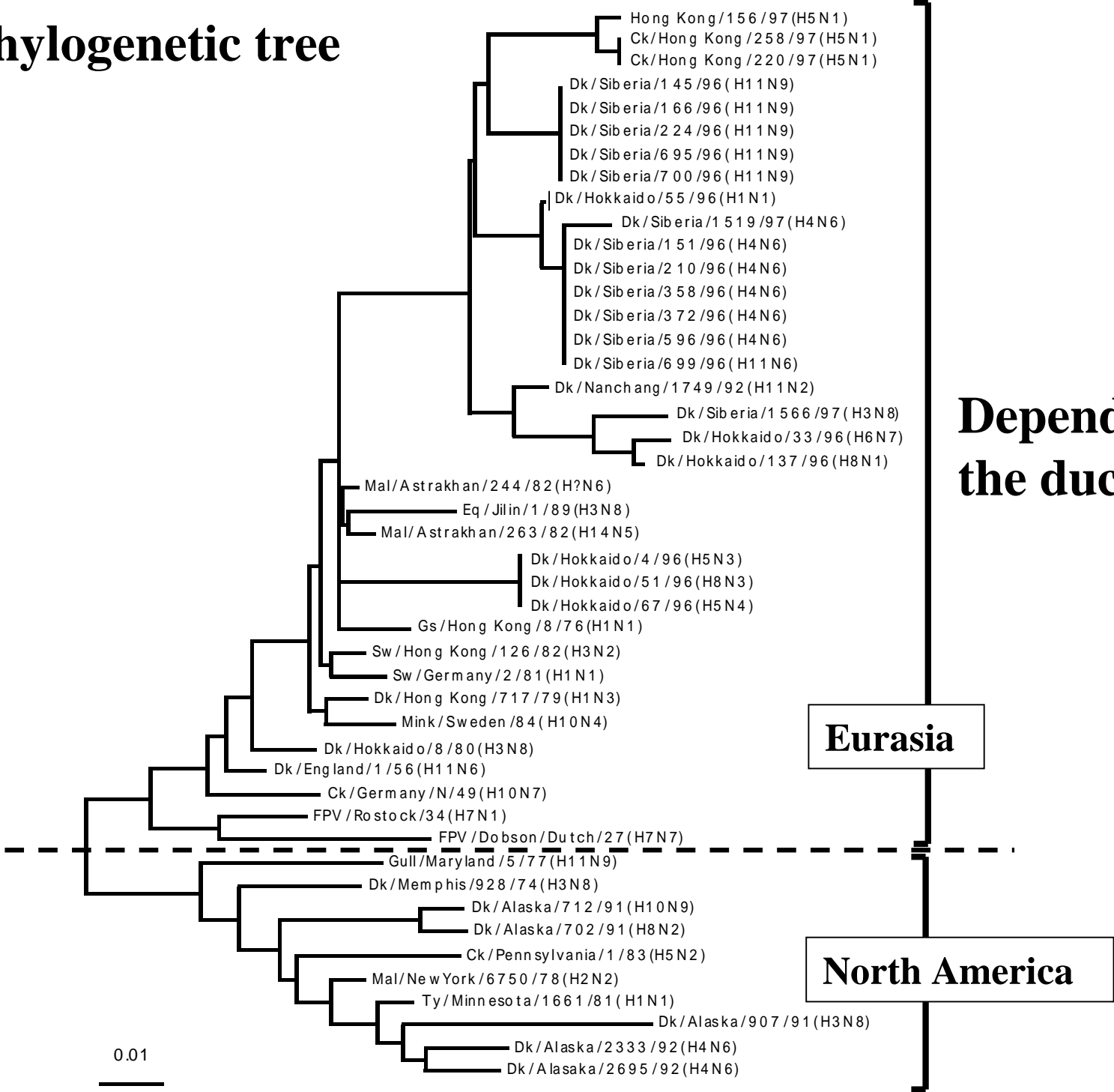


**Nesting area for some species of birds**  
**Stopover for some migratory birds**



Isolation of influenza virus in 2002 (117 isolates)

# Phylogenetic tree



Depending on the flyway of the duck





**Global warming may affect the route of migration, and may change the ecology of influenza viruses.**

# H5N1 influenza virus

A highly pathogenic avian influenza virus

## Outbreaks of highly pathogenic avian influenza

Country	Year	Subtype	Species of birds
Italy	1902	H7N7	Chicken
Japan	1924-5	H7N7	Chicken
Netherlands	1927	H7N1	?
Germany	1934	H7N1	?
Egypt	1945	H7N3	?
England	1959	H5N1	Chicken
South Africa	1961	H5N3	Tern
England	1963	H7N3	Turkey
Canada	1966	H5N9	Turkey
Australia	1975-6	H7N7	Chicken
Germany	1979	H7N7	Goose
USA	1983	H5N2	Chicken
Australia	1985	H7N7	Chicken
Ireland	1985	H5N8	Turkey
England	1991	H5N1	Turkey
Australia	1992	H7N3	Chicken
Australia	1994	H7N3	Chicken
Pakistan	1996	H7N2	Chicken
Mexico	1994-5	H5N2	Chicken
Pakistan	1996	H7N3	Chicken
Italy	1997	H5N2	Chicken
Australia	1997	H7N4	Chicken
Hong Kong	1997	H5N1	Chicken
Hong Kong	2003	H5N1	Chicken
Netherlands	2003	H7N7	Chicken
Eurasia	2003-	H5N1	Chicken

Only H5 and H7  
HA subtypes

No report of human  
disease





**Wild aquatic birds**

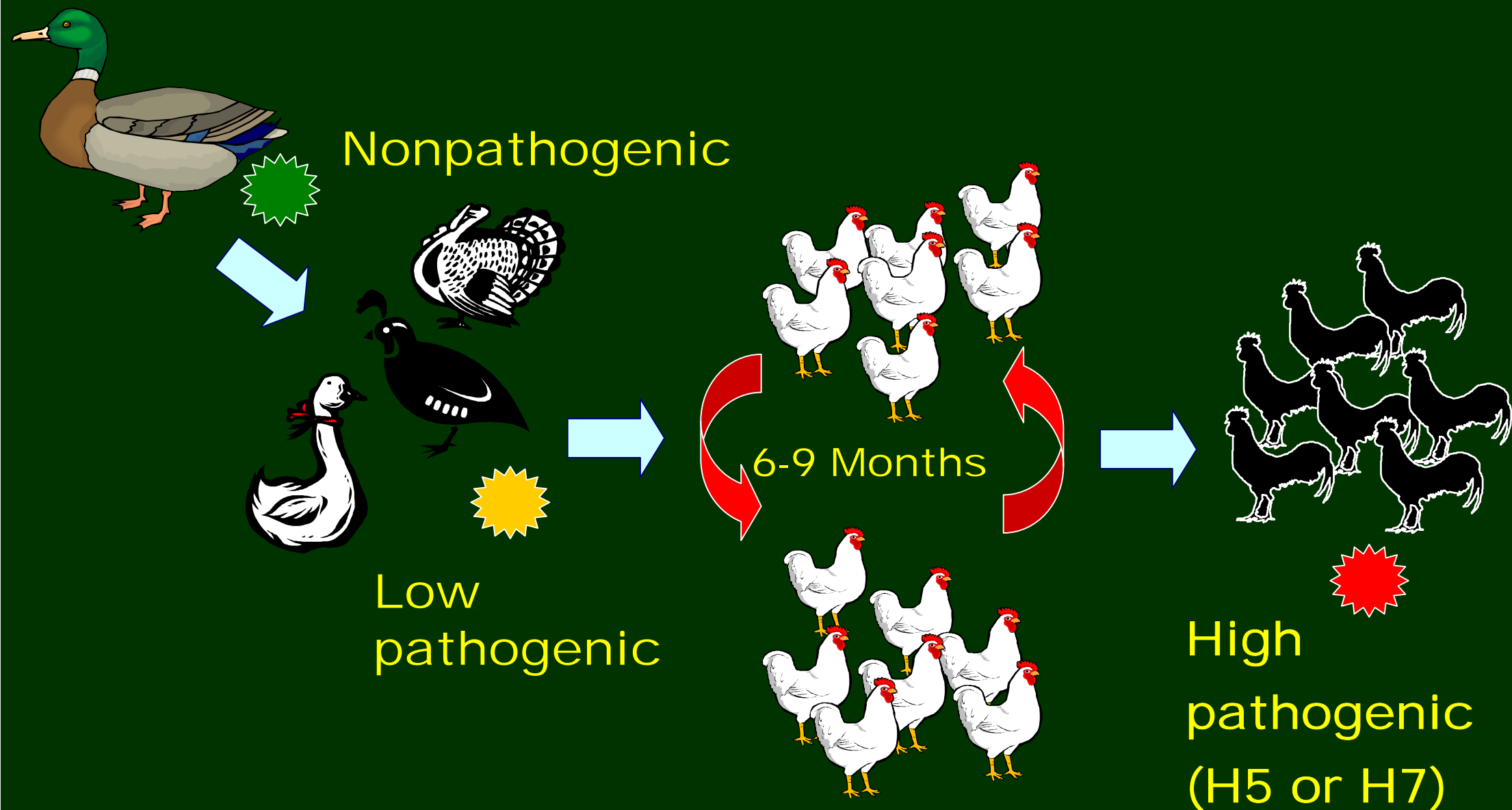
**Natural host (reservoir)**

**No disease**

**Nonpathogenic**

**H1-16、 N1-9**

# Emergence of HPAI virus

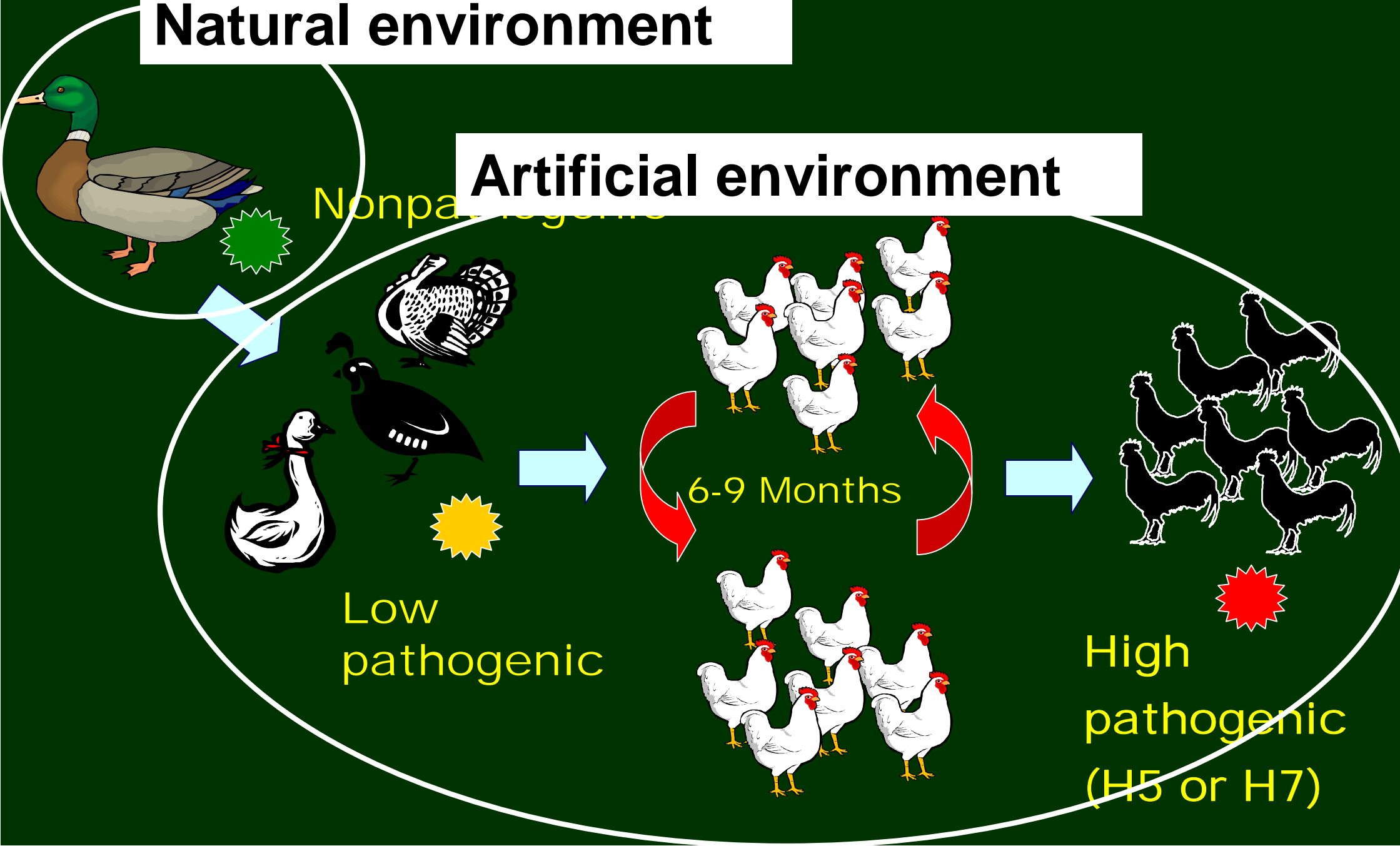




# Emergence of HPAI virus

Natural environment

Artificial environment



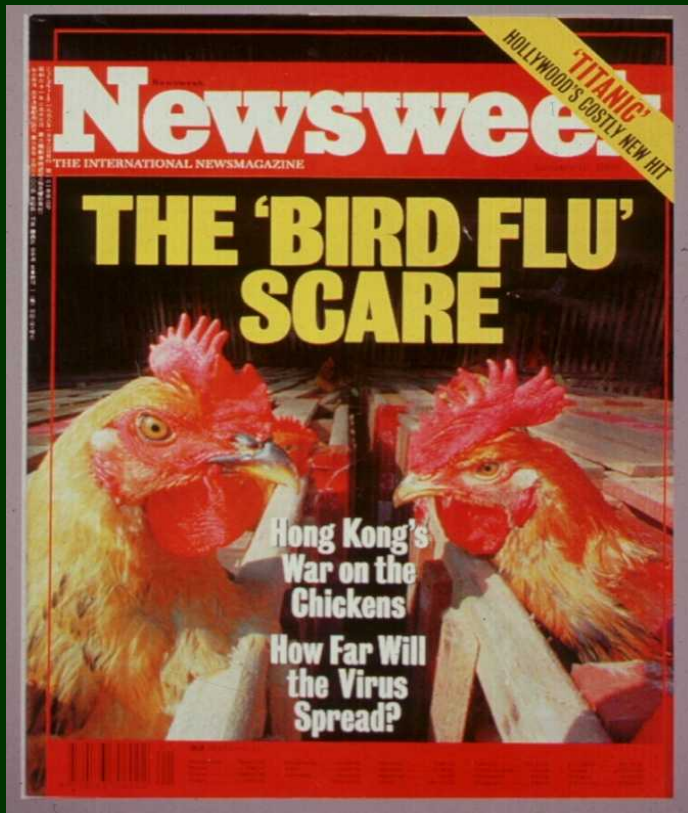
# **Transmission of HPAI to humans**

**1997**

**H5N1 incident in Hong Kong**

**18 infected, 6 died**

# The H5N1 incident in 1997



- Outbreaks of avian flu in chicken farms in Hong Kong in March / April 1997
- May 1997: Child with flu like illness
- Died of complications
- Virus was H5N1

# The H5N1 incident in 1997

- Human H5N1 viruses were genetically identical to the virus causing disease in the chicken farms

*Subbarao et al 1998*

*Claas et al 1998*





Young at risk from infection through faeces, warns scientist

# Bird flu 'most likely to strike children'

YOUNG children are the greatest risk from bird flu, scientists warned yesterday, as an eight-year-old girl was suspected of having contracted the deadly virus.

The chance of the virus passing directly from birds to humans was again highlighted after a doctor who treated the first victim was himself infected.

Eight of the 11 confirmed cases have involved children under 13, two of whom have died. A further six of nine suspected cases are aged seven or under. A one-year-old boy and a 72-year-old man yesterday became the latest suspected victims.

Dr Keiji Fukuda of the Centres for Disease Control and Pre-

vention analysis was needed to trace the source of each individual case.

"The number of cases of young people being infected are very striking to us ... there is something about young children which is putting them at a lot of risk," Dr Fukuda said.

Things like hepatitis A, which is a faecal-orally transmitted virus, can be common among

Five out of 29 retailers tested had antibodies for H5N1 but had developed no illness, suggesting they had become infected but their bodies had been able to fight the disease.

Dr Fukuda said as H5N1 was an intestinal virus among poultry, it would be excreted in faeces and the workers or children likely came into contact with that.

found positive for antibodies.

Director of Health Dr Margaret Chan Fung Fu-chun said it was possible the doctor may have come into contact with bodily fluids of the child and investigations were continuing.

Dr Fukuda said the virus may "episodically" enter the human population, circulate, disappear "and never get noticed".

A one-year-old girl died this morning from complications of the virus.

Two latest suspected victims are in satisfactory condition in United Christian and Sun hospitals. Three women remain critically ill.

Measures are being stepped up to cull inland and local chickens and the World Health Organisation

is sending a team to Guangdong to try to trace the virus source.

A spokesman for the Hong Kong Medical Association yesterday suggested mass destruction of fowl to see if the virus spread in a "chicken-free" environment.

**Poultry curbs – Page 2**  
**Editorial – Page 8**

**This overturned the idea that avian influenza can not directly transmitted to humans.**



**Where did H5N1 virus come from?**

**Beginning of AI surveillance in live  
poultry market in Hong Kong**

**Sampling from any species of birds**







Taking cloacal swab

**H5, H9, H6 viruses and NDV**



# HABIBIE NO.2? ♦ CHINA'S DOPED SWIMMERS

# ASIaweek

JANUARY 30, 1998



## THE FLU FIGHTERS

On the Frontlines  
in a World War  
Against the Bird Virus

Australia \$45.00	China RMB15.00	India \$45.00	Laos \$45.00	Nepal \$45.00	Portugal \$120.00	Thailand \$45.00
Bangladesh \$45.00	Denmark \$45.00	Indonesia \$45.00	Malaysia \$45.00	New Zealand \$45.00	Saudi Arabia \$45.00	U.S.A. \$45.00
Bhutan \$45.00	France \$45.00	Italy \$45.00	Maldives \$45.00	Norway \$45.00	Singapore \$45.00	U.S.A. \$45.00
Brunei \$45.00	Germany \$45.00	Japan \$45.00	Mongolia \$45.00	Pakistan \$45.00	South Korea \$45.00	U.S.A. \$45.00
Canada \$45.00	Hong Kong \$45.00	Korea \$45.00	Myanmar \$45.00	Papua N.G. \$45.00	Sweden \$45.00	Vietnam \$45.00
		Kuwait \$45.00		Philippines \$45.00	Taiwan \$45.00	Rest of the World \$45.00





# South China Morning Post

General: 2565 2222 News: 2565 2252 Classified: 2565 8822 Subscriptions: 2880 8882 Web Site: <http://www.scmp.com>

南華早報

Hong Kong Monday December 29 1997

Vol. LIII No. 360 ★★ Price \$7.00

## Virus fears spark massive 24-hour operation to kill all local chickens

# 1.2m birds to be slaughtered

STAFF REPORTERS

All Hong Kong's estimated 1.2 million chickens are to be slaughtered in a radical attempt to rid the SAR of the deadly bird flu virus that has killed four people.

Poultry in retail markets – including geese and ducks kept near chickens – will also be destroyed in the massive 24-hour operation beginning today.

Government officials announced the move, sanctioned by Chief Executive Tung Chee-hwa, after a New Territories farm and part of a Kowloon wholesale market were found to be infected with the killer H5N1 virus.

"The Government has decided, in public health interests, to kill birds in local farms," said Director of Health Margaret Chan.

Compensation for farmers may top \$40 million and 2,200 government workers will be needed to arrange the slaughter.

Teams of five Agriculture and Fisheries Department staff will visit each of Hong Kong's 160 chicken and 39 mixed poultry farms. They will place groups of birds into plastic containers and then gas them to death with carbon dioxide.

The operation is expected to

The Environmental Protection Department expects to deal with about 6,500 cubic metres of waste generated by the blitz.

Officials will make a count at each location to help with compensation assessments.

Farmers can expect up to \$30 for each bird if provisional legislators approve a finance package outlined by the Government during their sitting on January 9.

Farmers supported the slaughter but called for the rapid payment of compensation claims.

With wholesale prices having fallen from \$12 to \$2 per catty in recent weeks, a Hong Kong Chicken Farmers' Association spokesman said: "We support any move to restore public confidence. But the Government has to give us compensation quickly so that we can start our business again."

The mass slaughter was a "short-term measure", according to Mr Ip, and another cleaning operation of markets and stalls would follow.

Another factor behind the decision to kill all poultry was the "huge number" of chickens imported before the winter solstice festival, said Agriculture and Fisheries Department assistant



## No human case after slaughtering in Hong Kong

# The source of human infection was infected poultry

- ~ 20% of chicken in live poultry markets had H5N1 virus

– *Shortridge et al 1999*

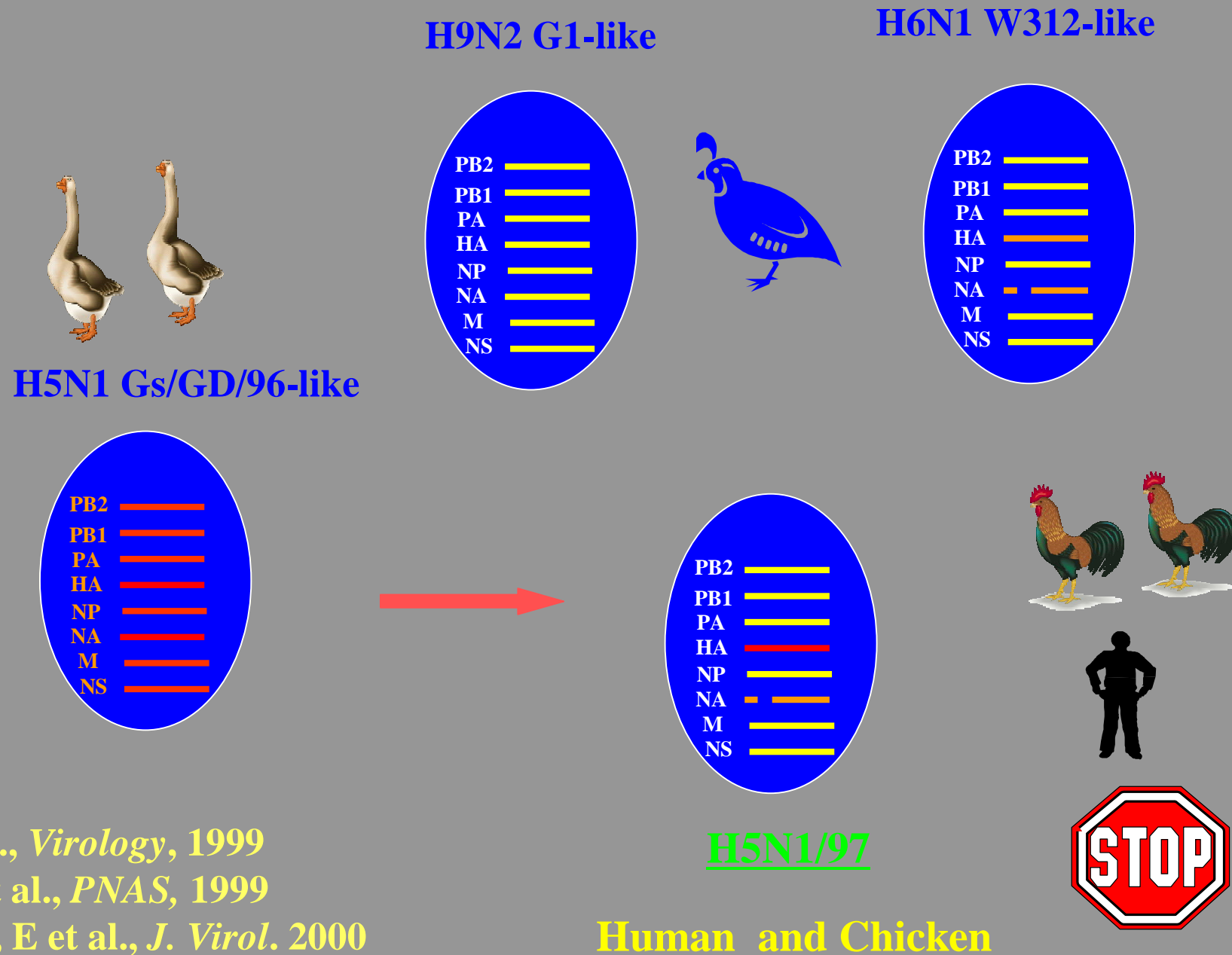
- patients with H5N1 disease had contact with live poultry markets

– *Mounts et al 1999*



# 1997

## H5N1 incident of HK



Xu, X et al., *Virology*, 1999  
Guan, Y et al., *PNAS*, 1999  
Hoffmann, E et al., *J. Virol.* 2000

H5N1/97  
Human and Chicken



## Outbreaks of highly pathogenic avian influenza

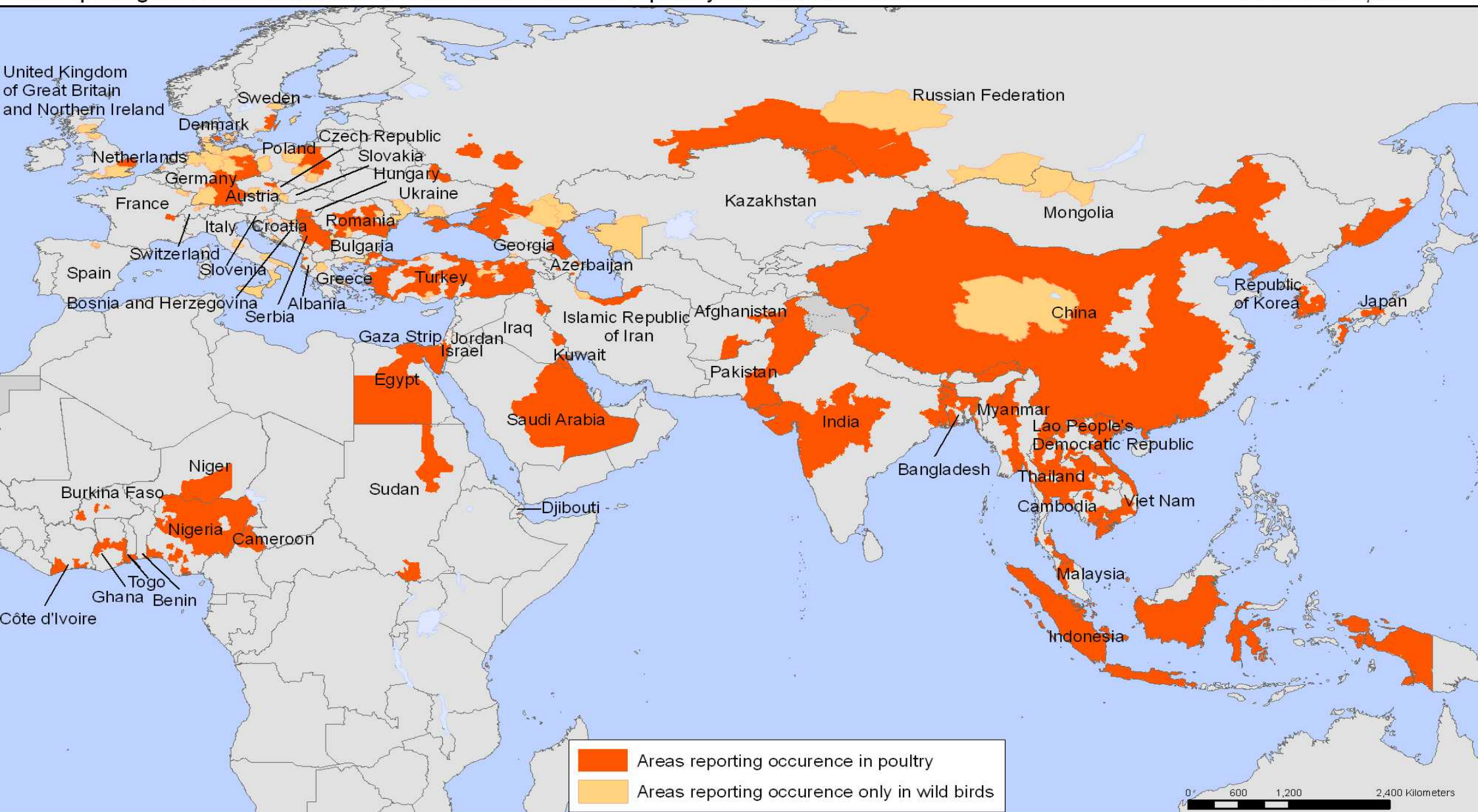
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Netherlands	1927	H7N1	?
Germany	1934	H7N1	?
Egypt	1945	H7N3	?
England	1959	H5N1	Chicken
South Africa	1961	H5N3	Tern
England	1963	H7N3	Turkey
Canada	1966	H5N9	Turkey
Australia	1975-6	H7N7	Chicken
Germany	1979	H7N7	Goose
USA	1983	H5N2	Chicken
Australia	1985	H7N7	Chicken
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Australia	1992	H7N3	Chicken
Australia	1994	H7N3	Chicken
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Mexico	1994-5	H5N2	Chicken
Pakistan	1996	H7N3	Chicken
Italy	1997	H5N2	Chicken
Australia	1997	H7N4	Chicken
<b>Hong Kong</b>	<b>1997</b>	<b>H5N1</b>	<b>Chicken</b>

Humans, cats, tigers,  
wild birds



# Areas reporting confirmed occurrence of H5N1 avian influenza in poultry and wild birds since 2003

Status as of 14 April 2008  
Latest available update





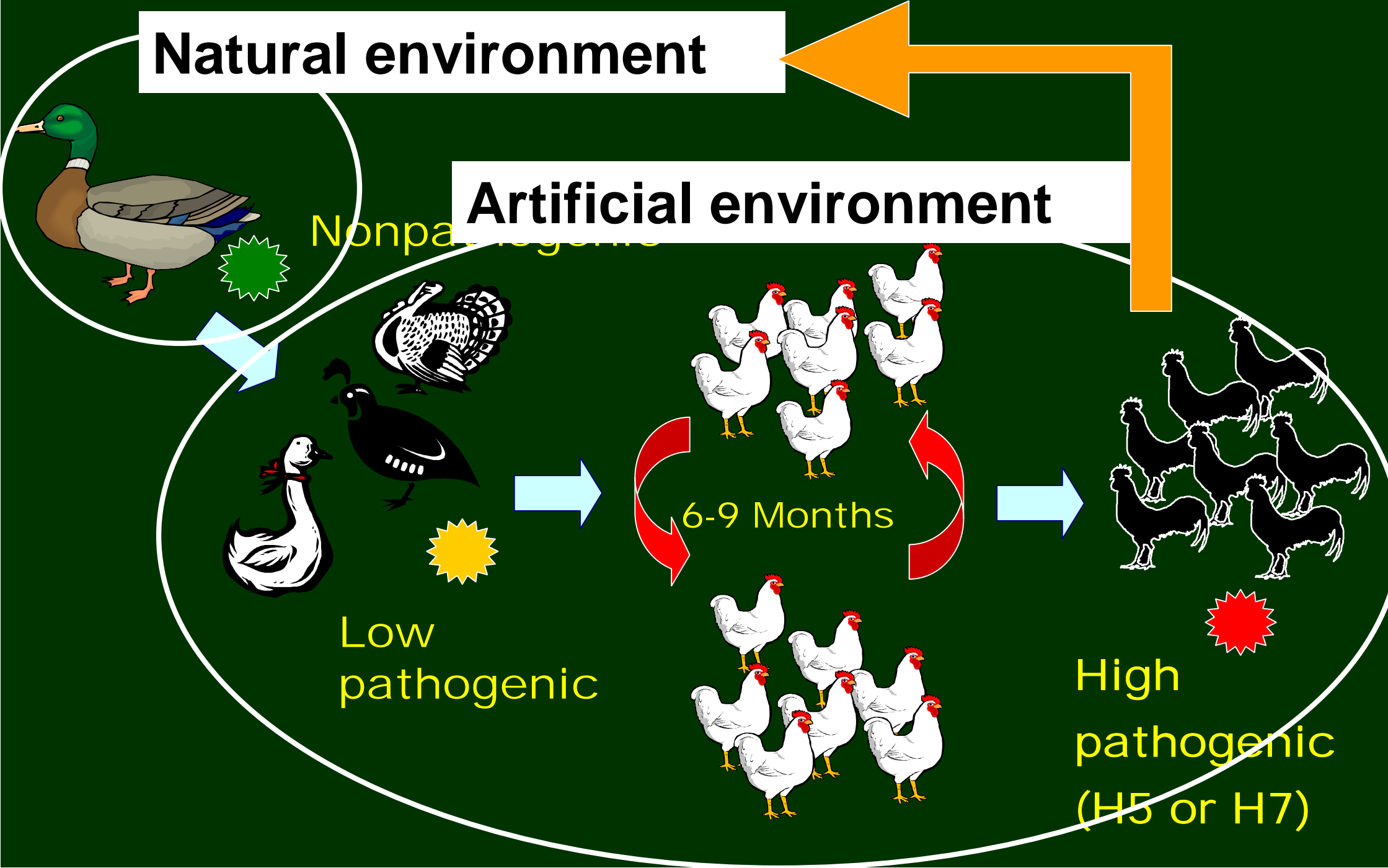
# **The Spread of H5N1 to wild aquatic bird**



# Emergence of HPAI virus

Natural environment

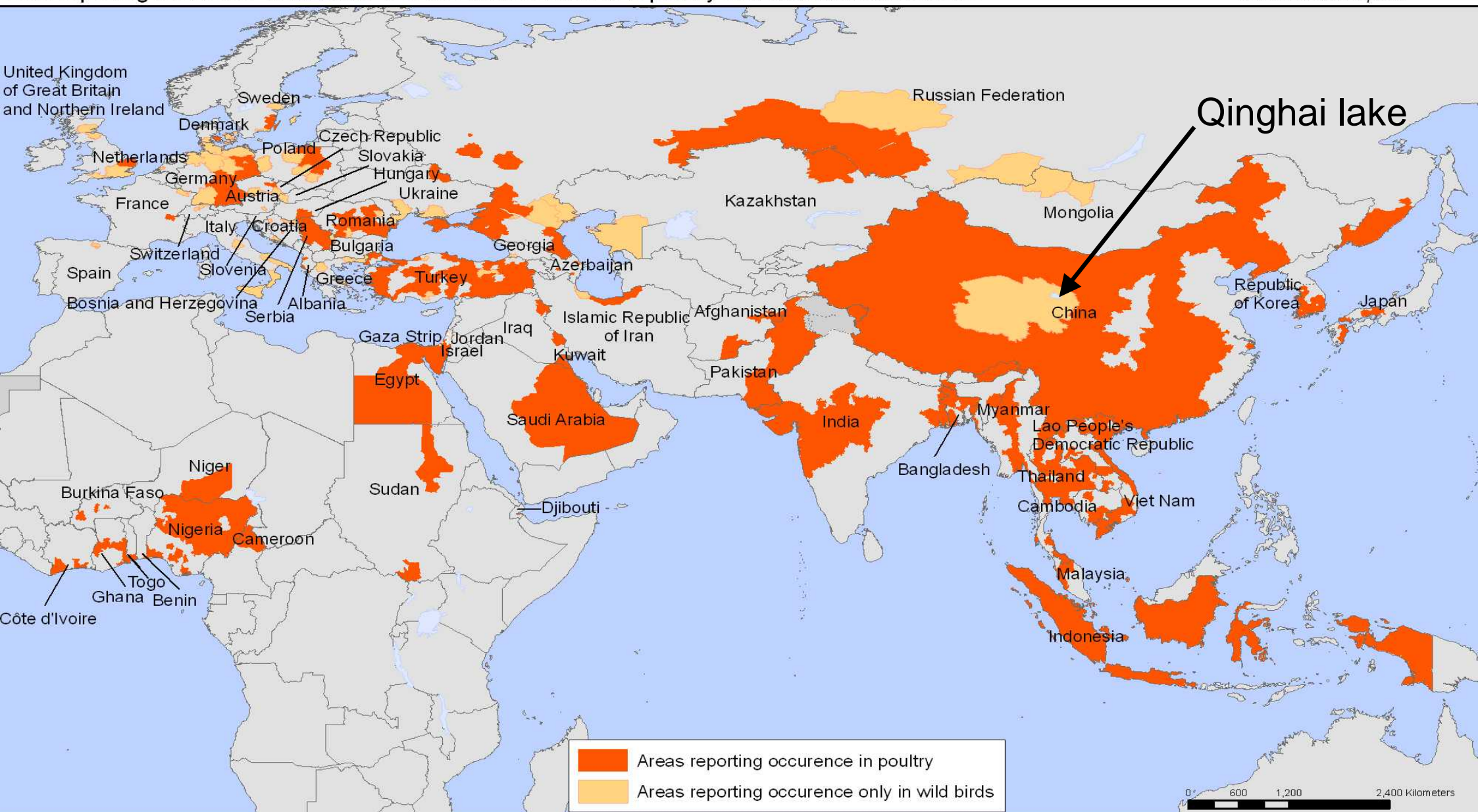
Artificial environment





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Status as of 14 April 2008  
Latest available update



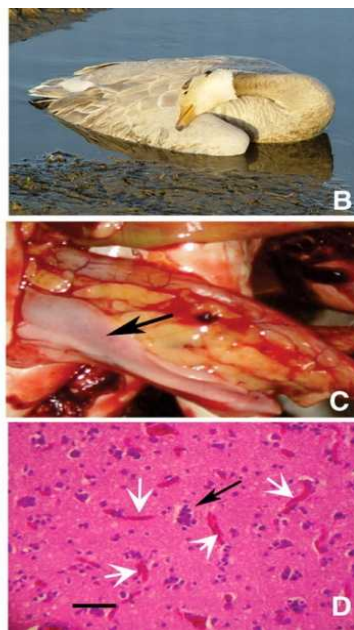


Science 309, 1206 (19 August 2005)

## Highly Pathogenic H5N1 Influenza Virus Infection in Migratory Birds

J. Liu, H. Xiao, F. Lei, Q. Zhu, K. Qin, X.-w. Zhang, X.-I. Zhang, D. Zhao, G. Wang, Y. Feng, J. Ma, W. Liu, J. Wang, G.F. Gao

H5N1 avian influenza virus (AIV) has emerged as a pathogenic entity for a variety of species, including humans, in recent years. Here we report an outbreak among migratory birds on Lake Qinghaihu, China, in May and June 2005, in which more than a thousand birds were affected. Pancreatic necrosis and abnormal neurological symptoms were the major clinical features. Sequencing of the complete genomes of four H5N1 AIV strains revealed them to be reassortants related to a peregrine falcon isolate from Hong Kong and to have known highly pathogenic characteristics. Experimental animal infections reproduced typical highly pathogenic AIV infection symptoms and pathology.

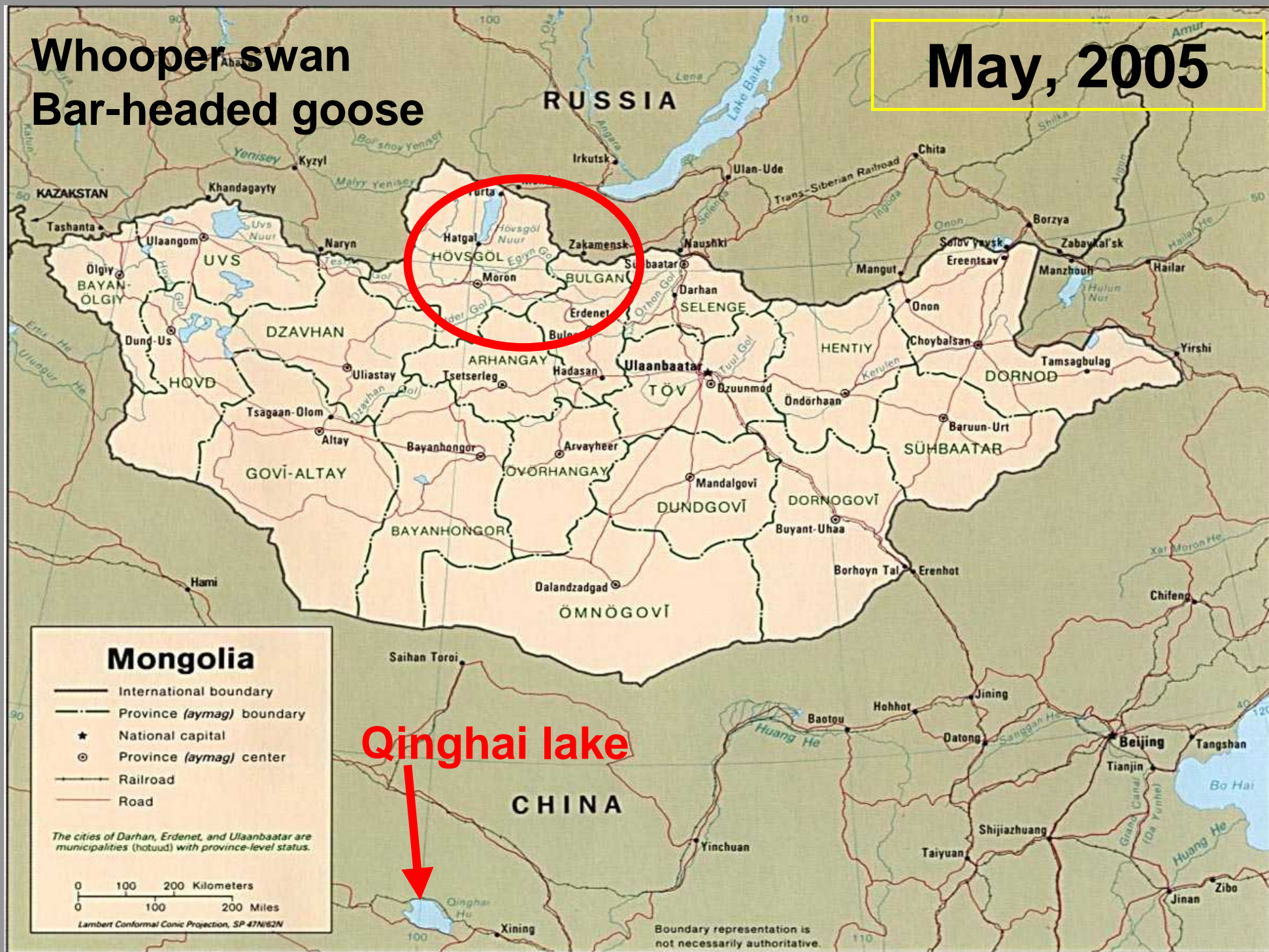


Areas reporting occurrence in poultry  
Areas reporting occurrence only in wild birds



# Whooper swan Bar-headed goose

May, 2005





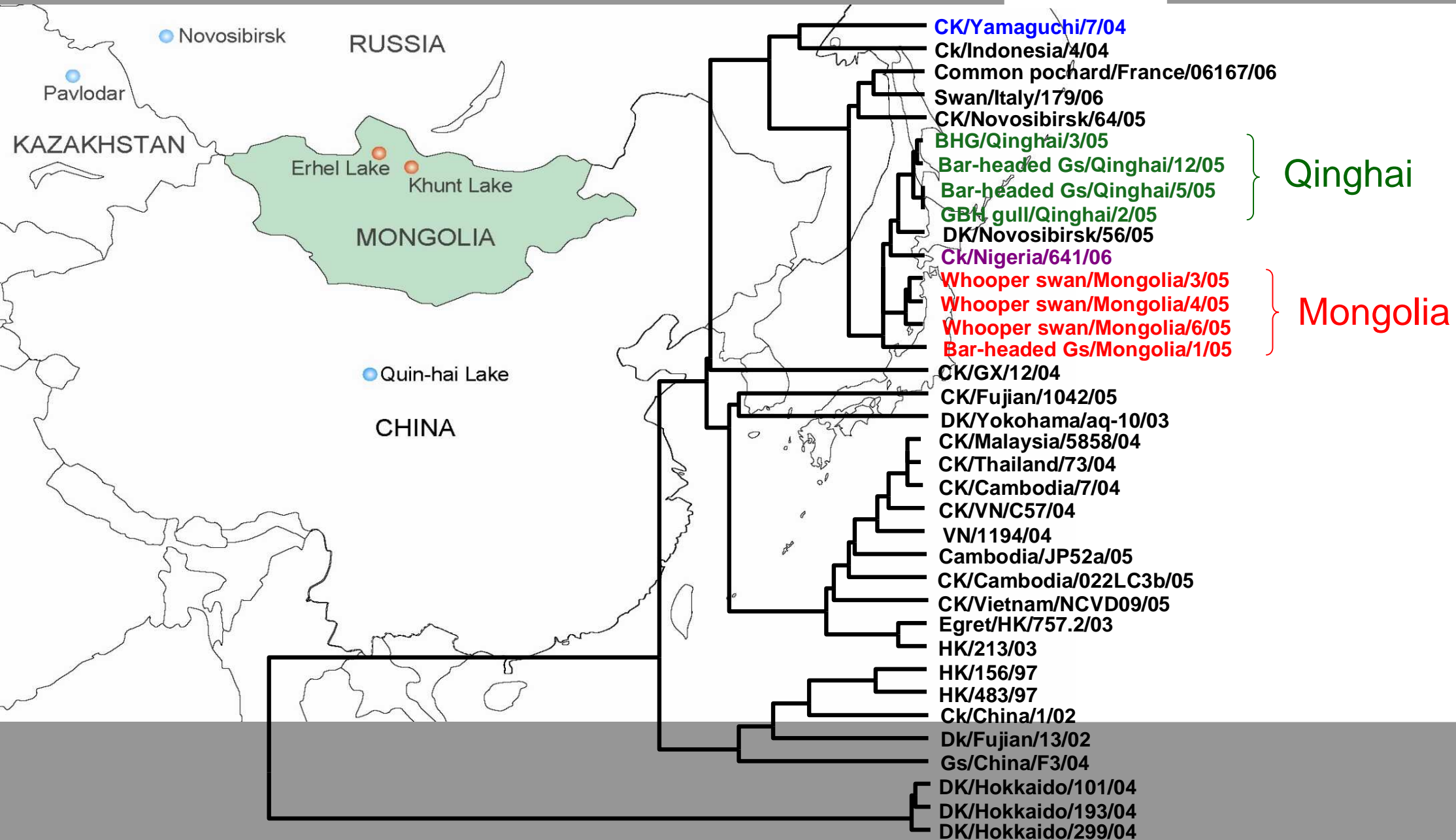


**A : Bar-headed goose**

**B : Whooper swan**

**H5N1 virus was isolated**

HA





# H5N1 virus from dead swan

May, 2006





# H5N1 virus from dead crested grebe

June, 2006



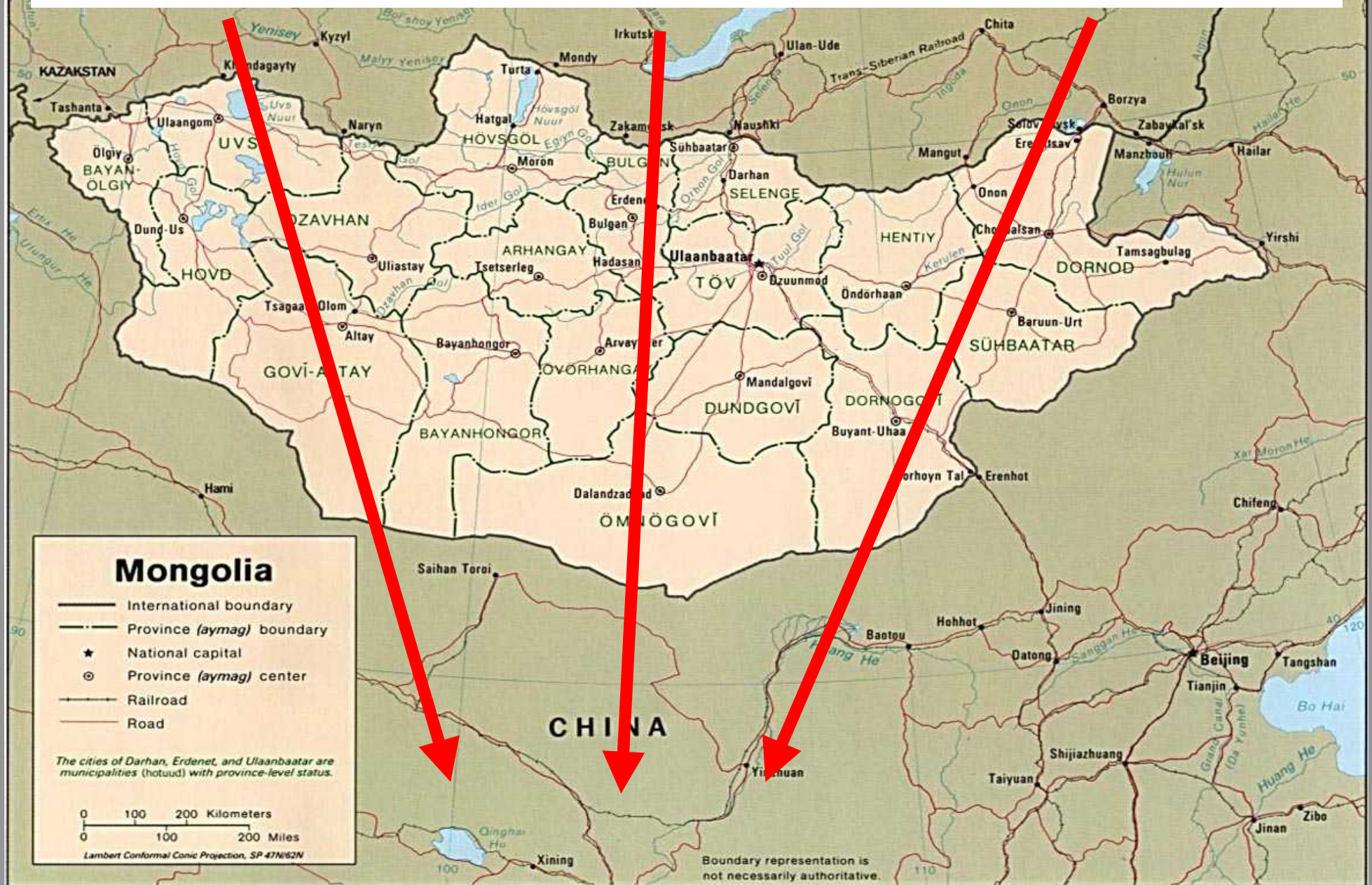


# In May and June, birds are coming from China





# In August and September, birds are going to China





# Mongolia, August, 2005 and 2006

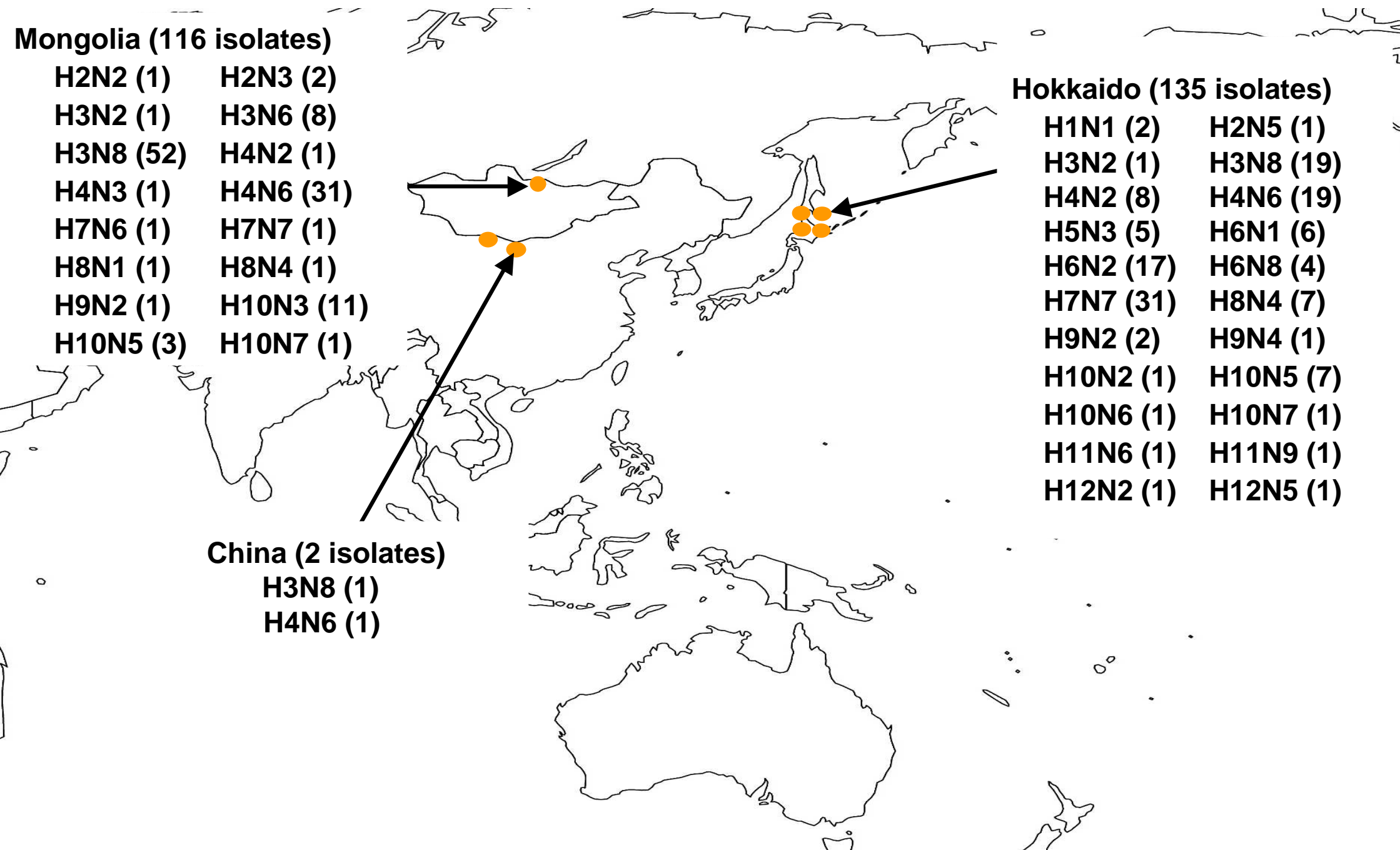




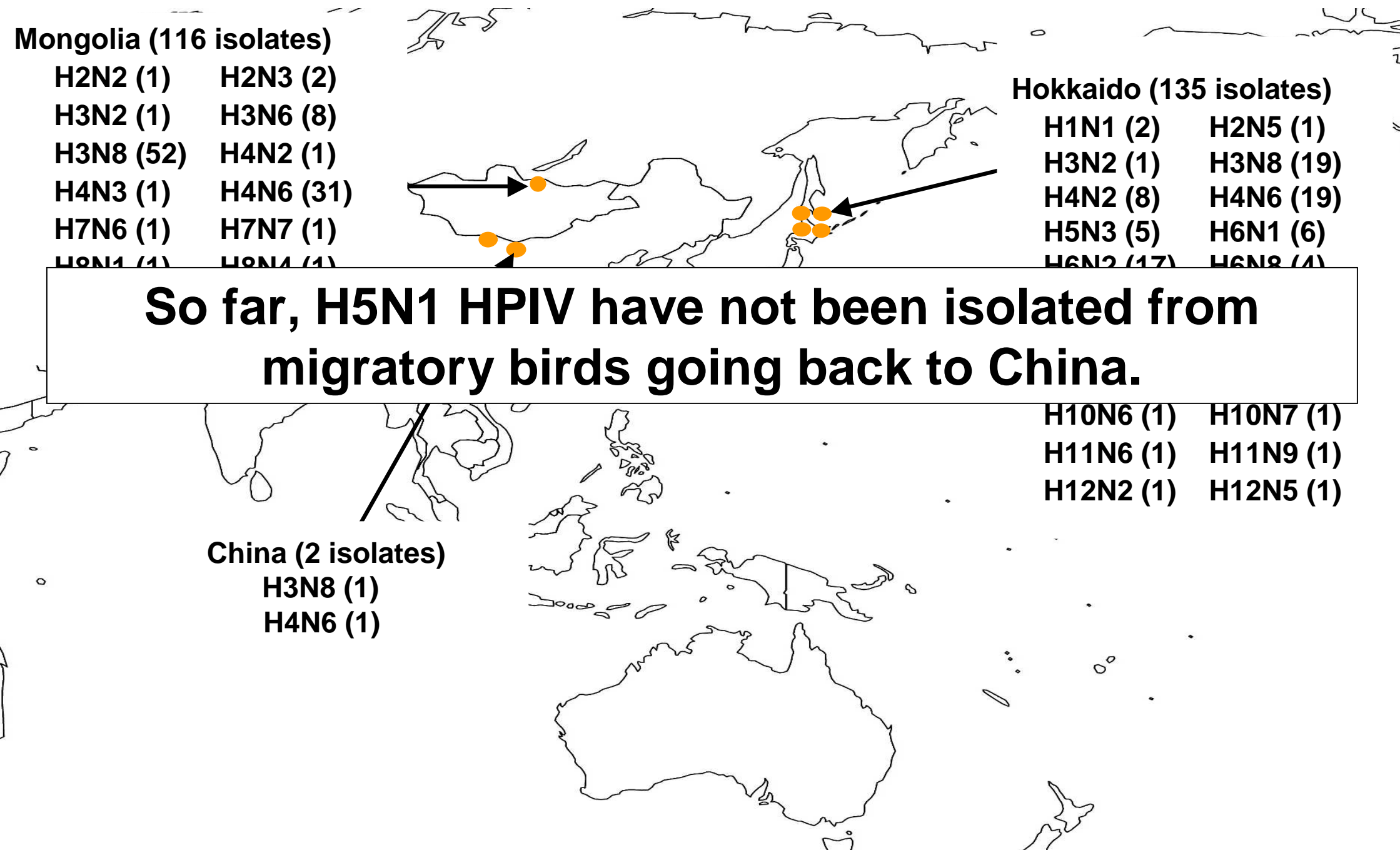




# Surveillance of avian influenza in migratory ducks in 2004-2007

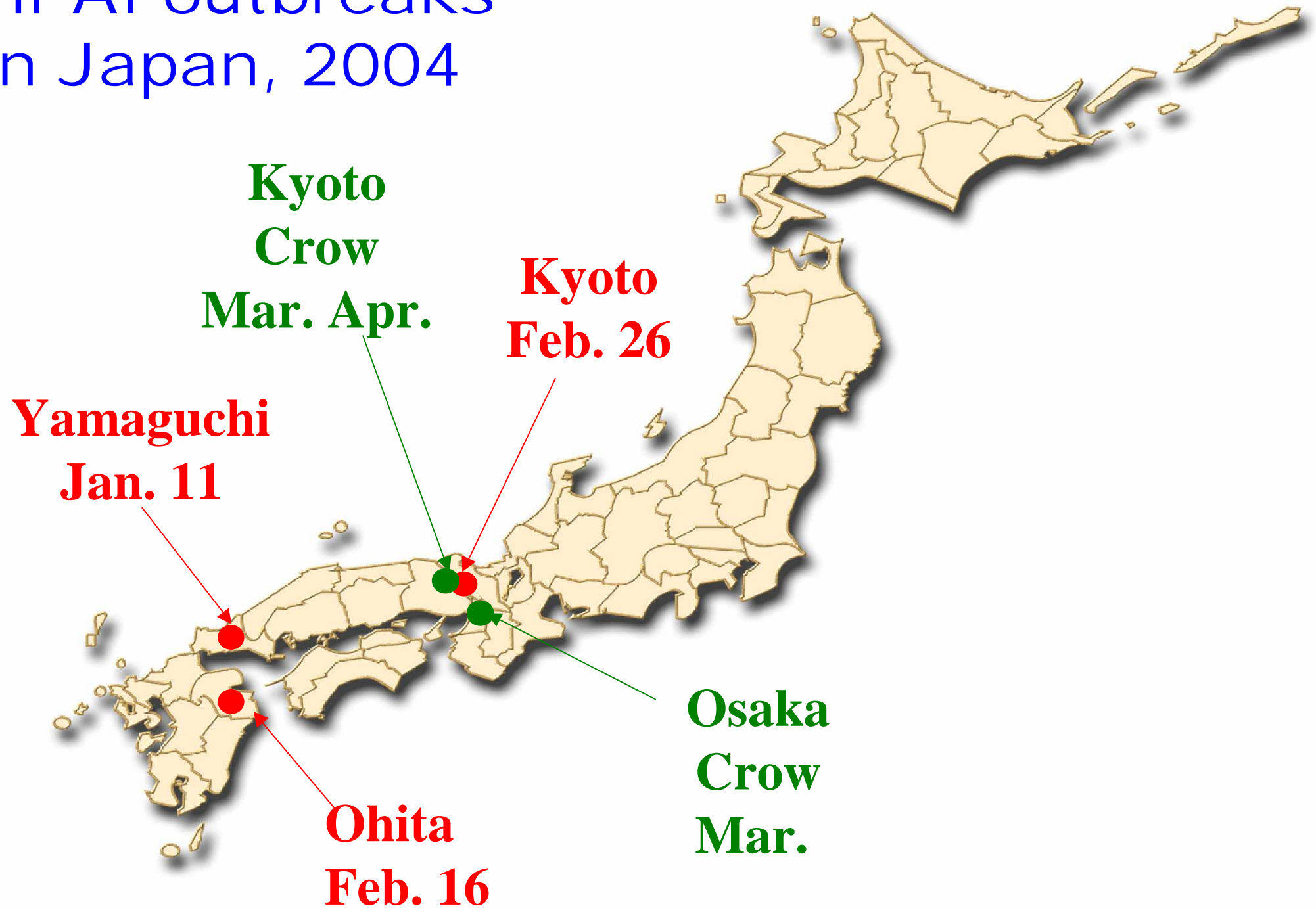


# Surveillance of avian influenza in migratory ducks in 2004-2007





# HPAI outbreaks in Japan, 2004



# HPAI outbreaks in Japan, 2007

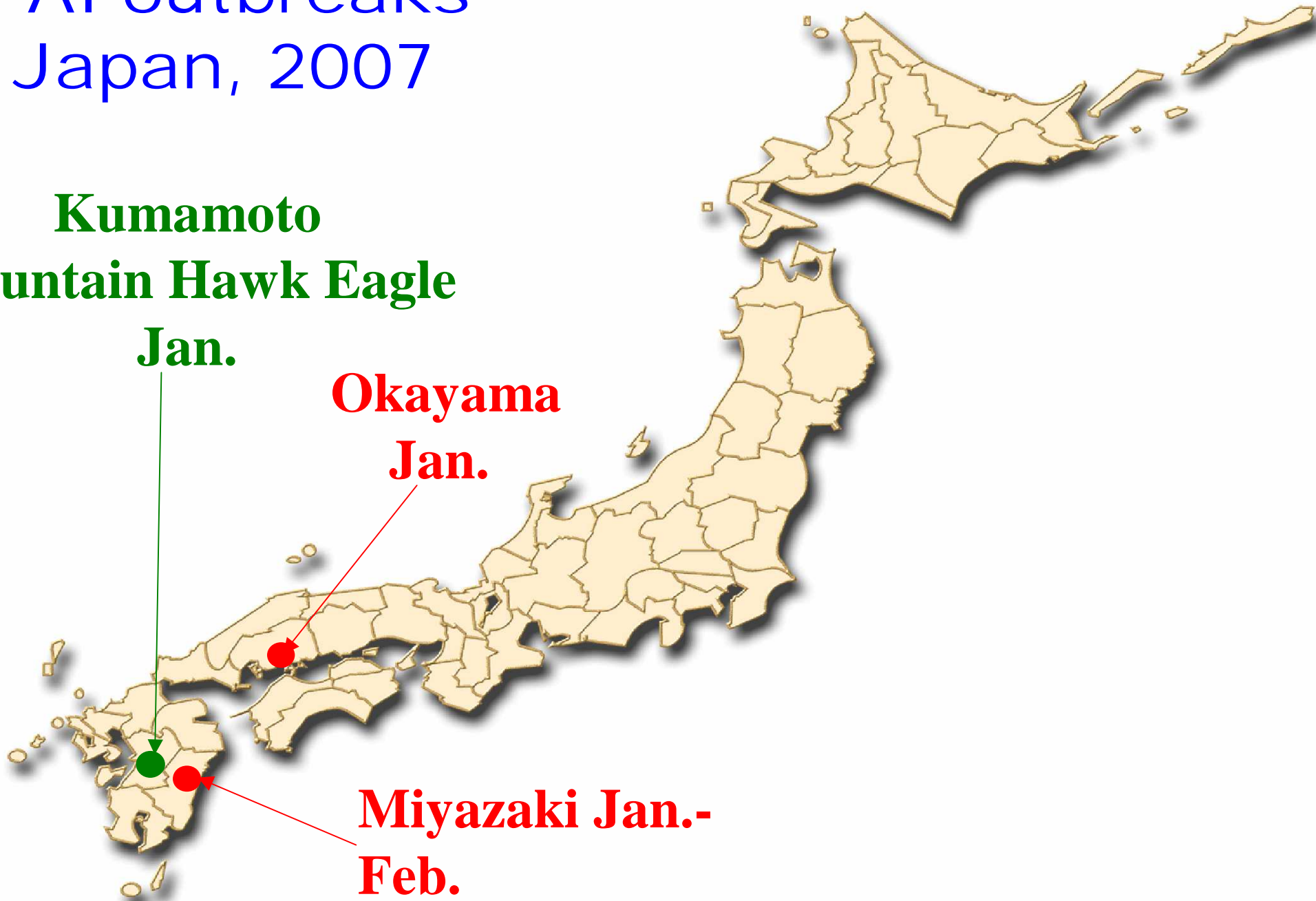
**Kumamoto**  
**Mountain Hawk Eagle**

**Jan.**

**Okayama**

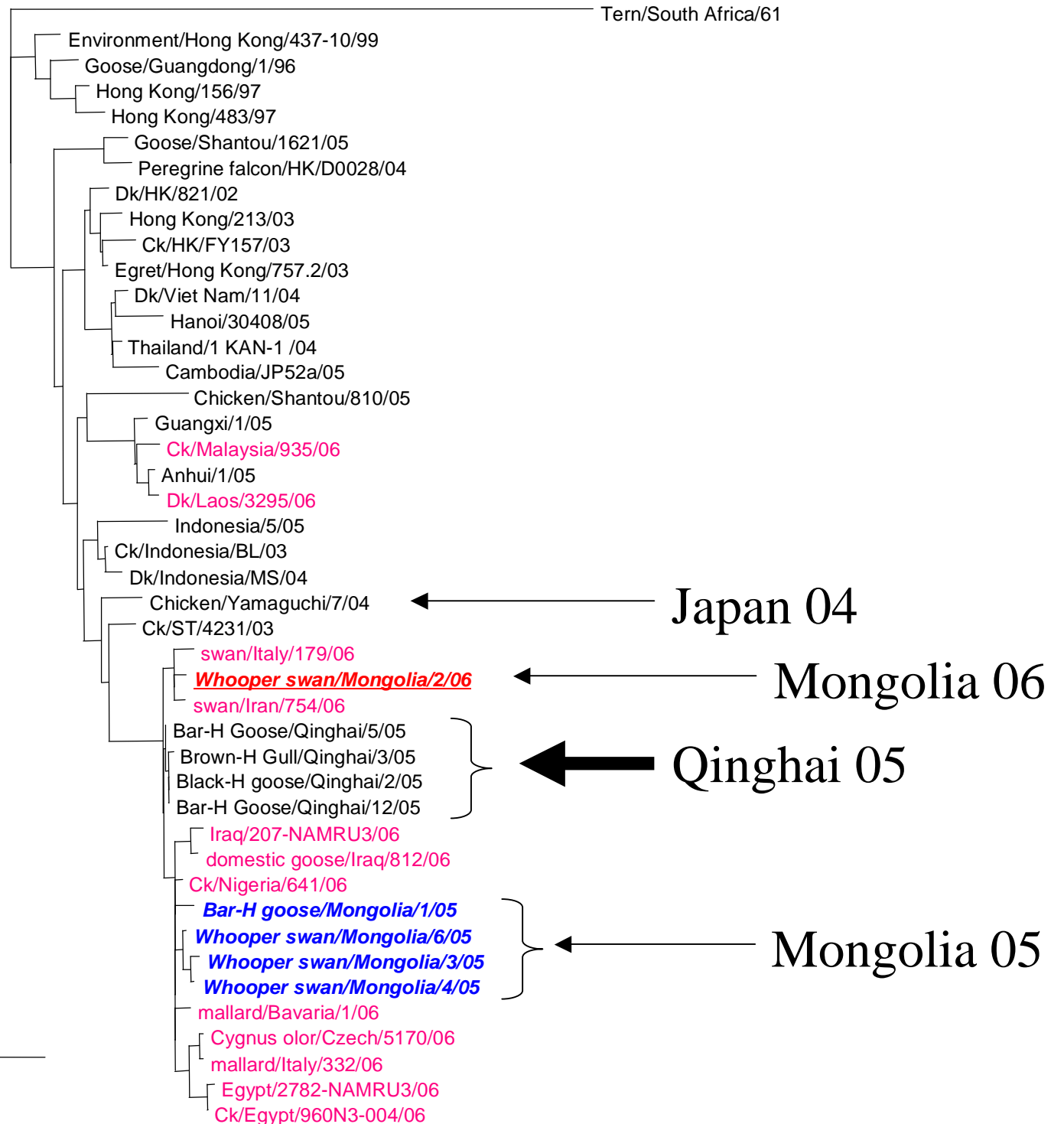
**Jan.**

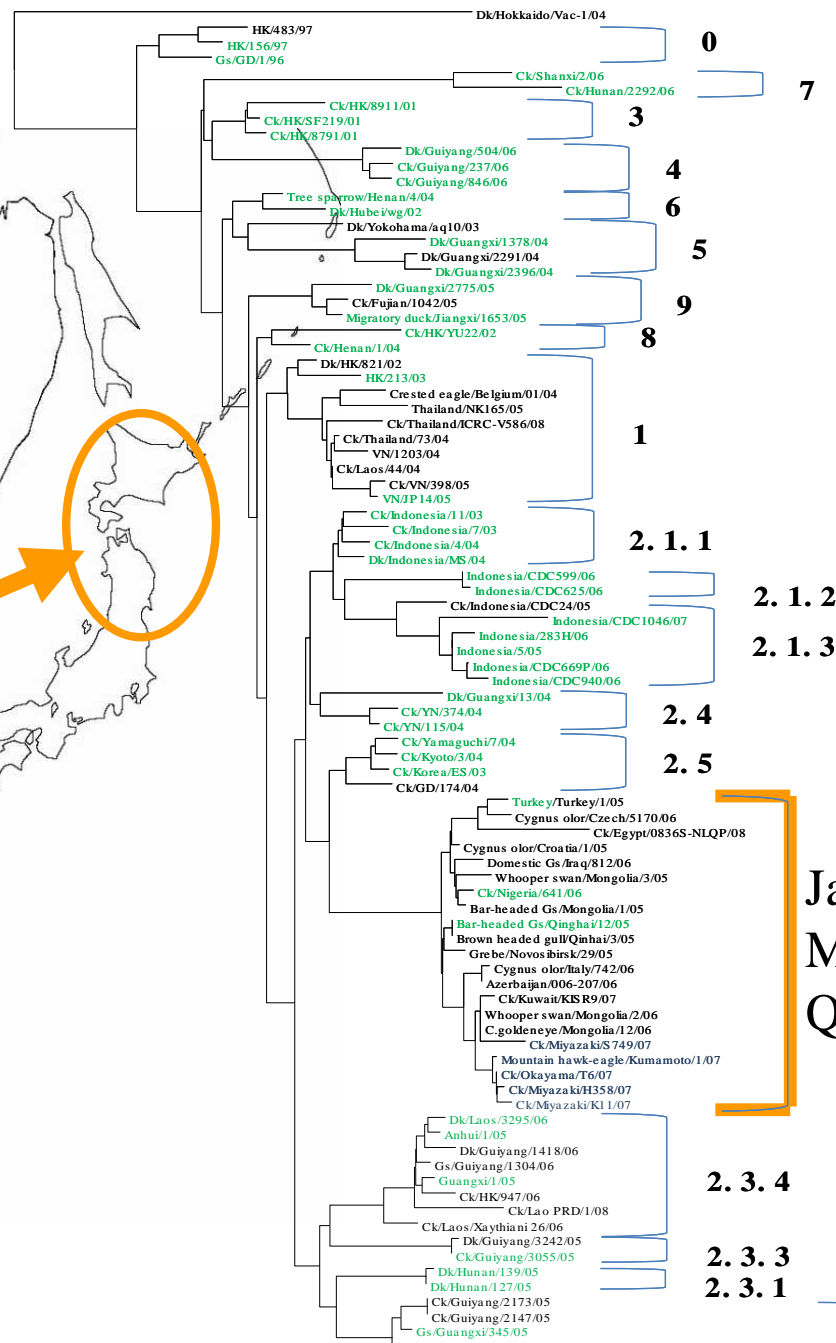
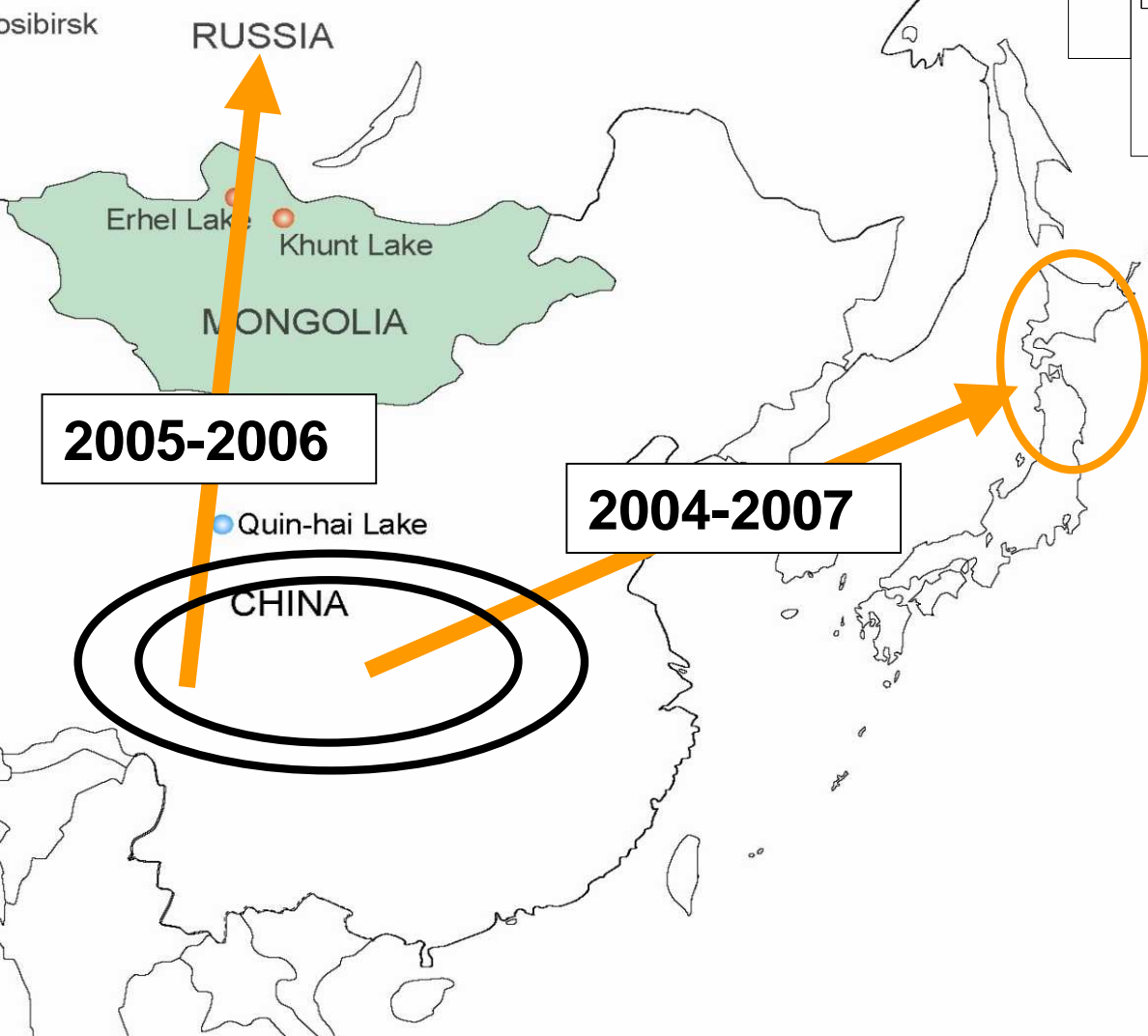
**Miyazaki Jan.-  
Feb.**





# Phylogenetic tree analysis (HA gene, partial sequence)





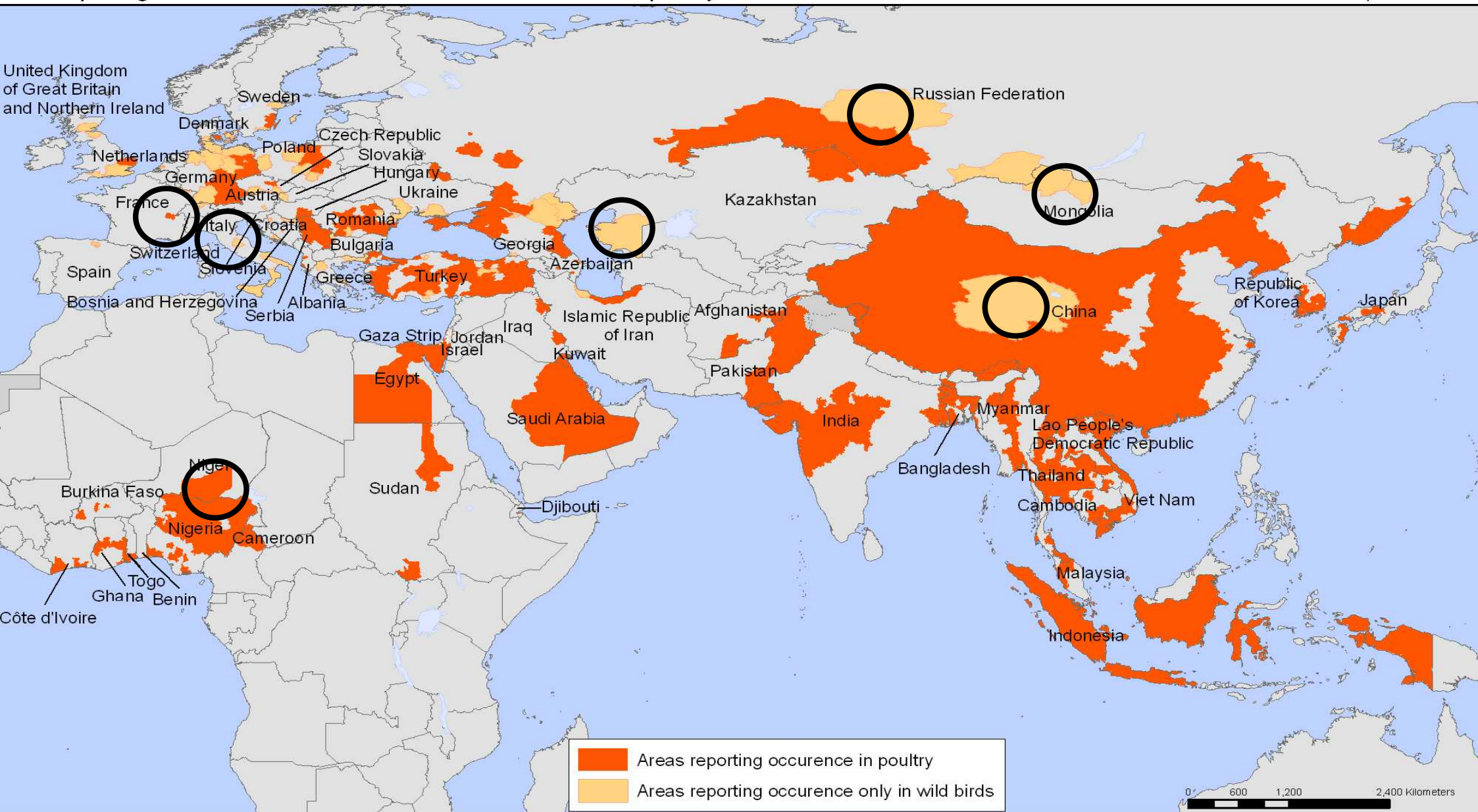
Japan 04 and 07  
Mongolia 05 and 06  
Qinghai 05

HA



# Areas reporting confirmed occurrence of H5N1 avian influenza in poultry and wild birds since 2003

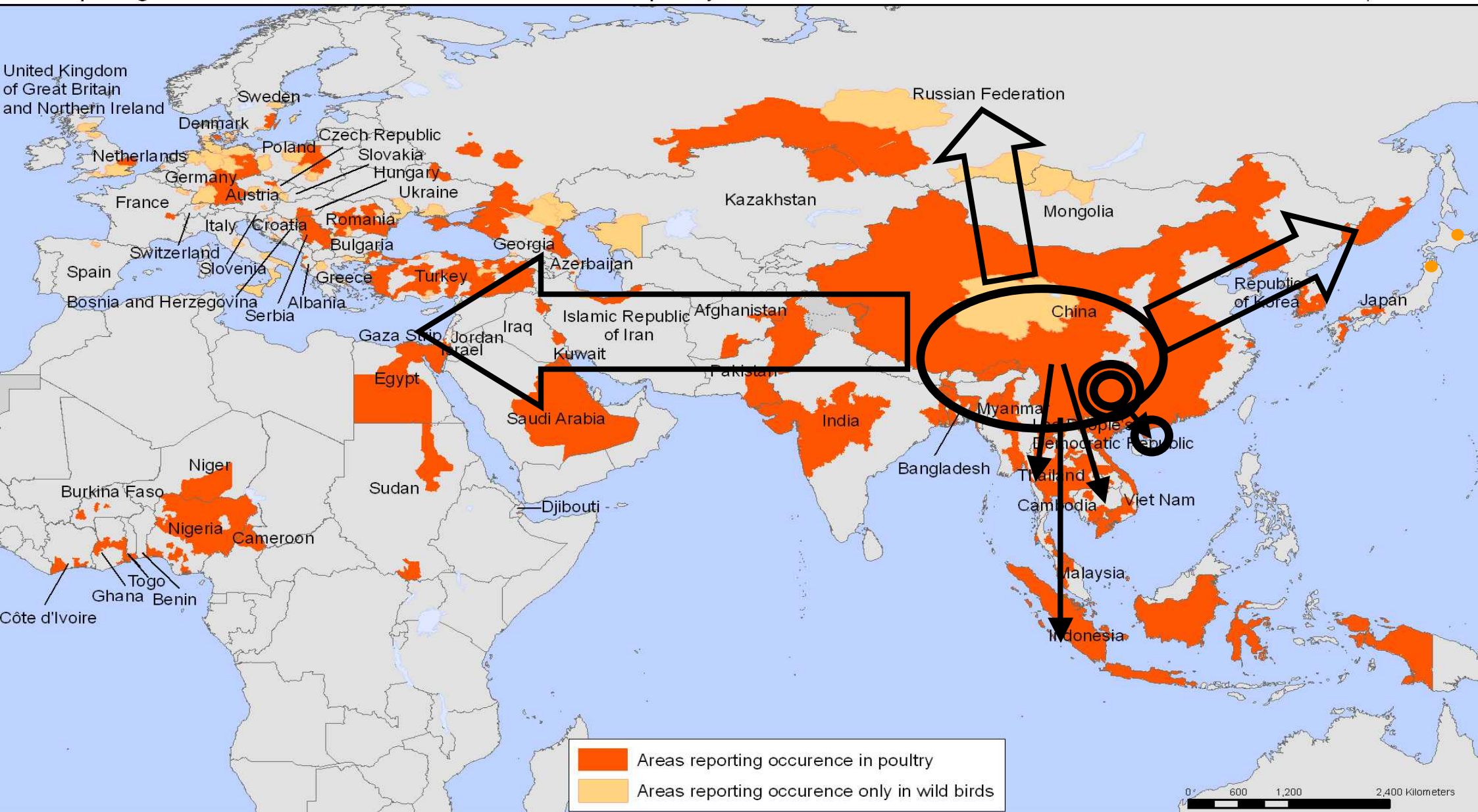
Status as of 14 April 2008  
Latest available update



# HPAI isolation in Japan, 2008







# Changing Patterns of Asian HP H5N1?

- Transmission to humans ..... 1997
- Inapparent infection of ducks (HPAI) ..... 1997
- Lethality for waterfowl ..... 2002
- Introduction of distinguishable lineages to  
Thailand/Vietnam versus Indonesia ..... 2003
- Emergence of Qinghai H5N1 strain ..... 2005
- HPAI endemic of H5N1 viruses in migratory  
birds ..... 2005
- Inapparent infection of vaccinated chickens  
(HPAI) ..... 2006-?
- Frequent (multiple) introduction of H5N1  
viruses into wild birds? ..... 2008-?



# Generation of pandemic influenza virus

# Pandemic Flu – Worldwide Outbreak

- 1918      H1N1
- 1957      H2N2
- 1968      H3N2

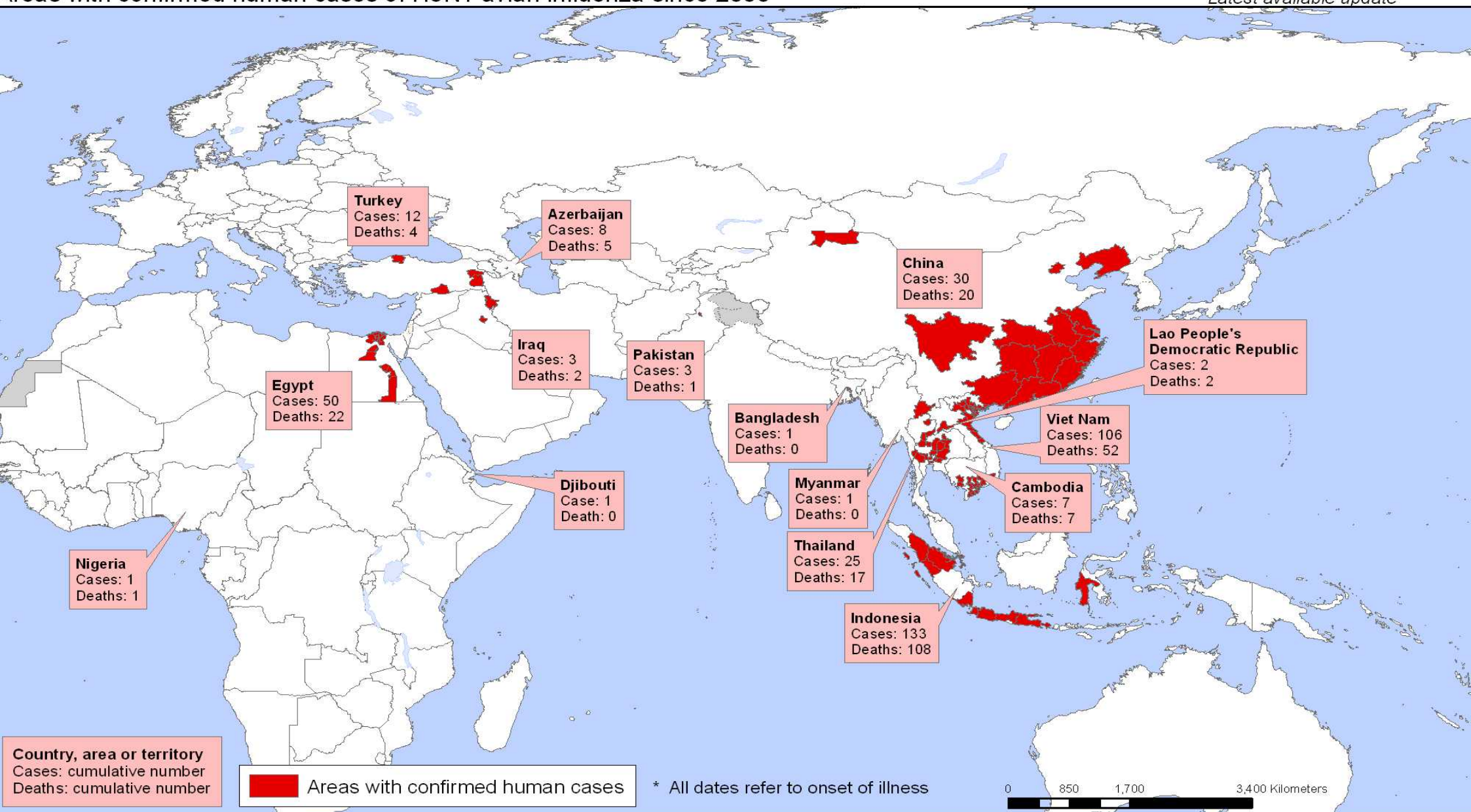


# **Pandemic Flu – Worldwide Outbreak**

- **Emergence of influenza virus with NEW subtype of HA**
- **Infect all age-group people**
- **Worldwide outbreak within one year**

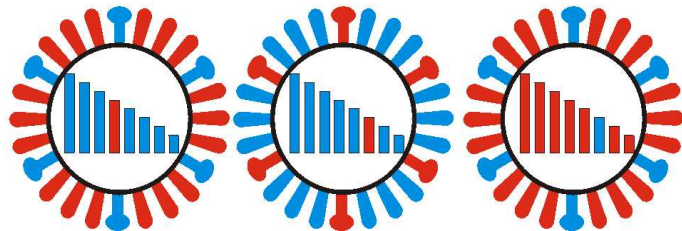
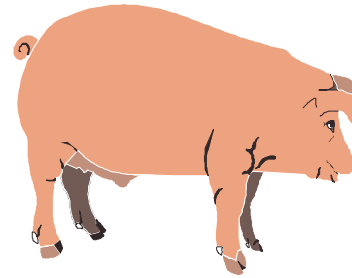
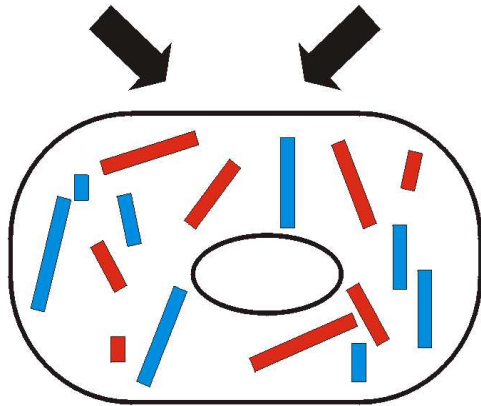
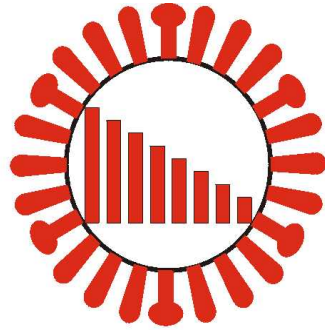
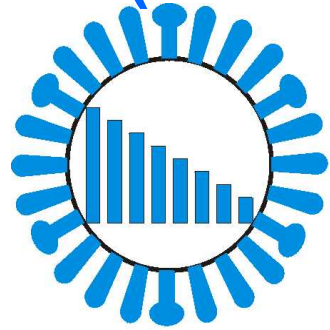
# Areas with confirmed human cases of H5N1 avian influenza since 2003 \*

Status as of 28 May 2008  
Latest available update



H3N2(human)  
H1N1(human)

H5N1(avian)



H3N1

H5N2

H3N2,

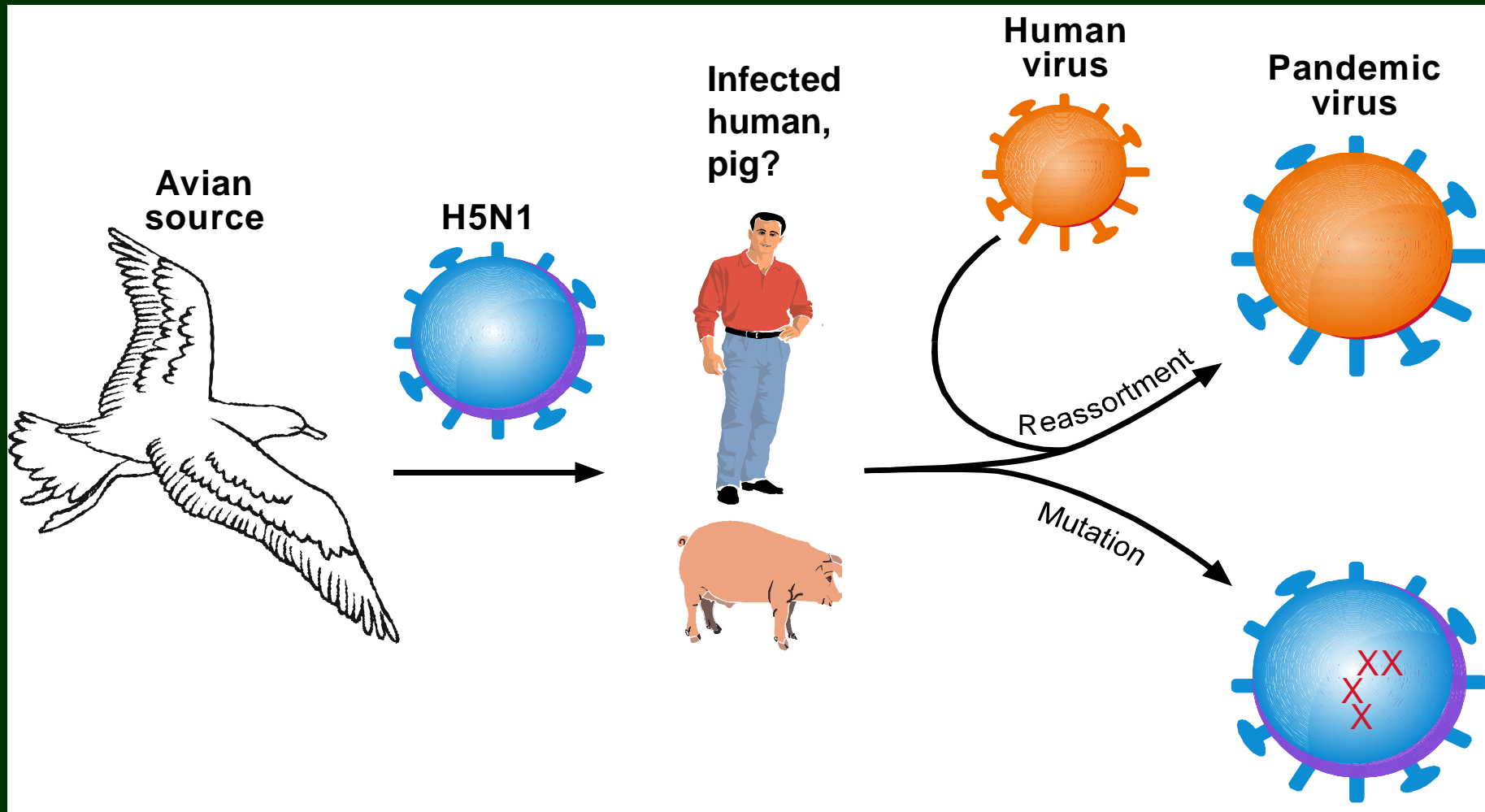
H5N1

H1N1,

H5N1



# Will H5N1 Acquire Transmissibility?



**Many factors required.**  
**Ten years have already passed since the first H5N1 case of chicken to human transmission was reported.**

# Recent Human Infections by Avian Influenza

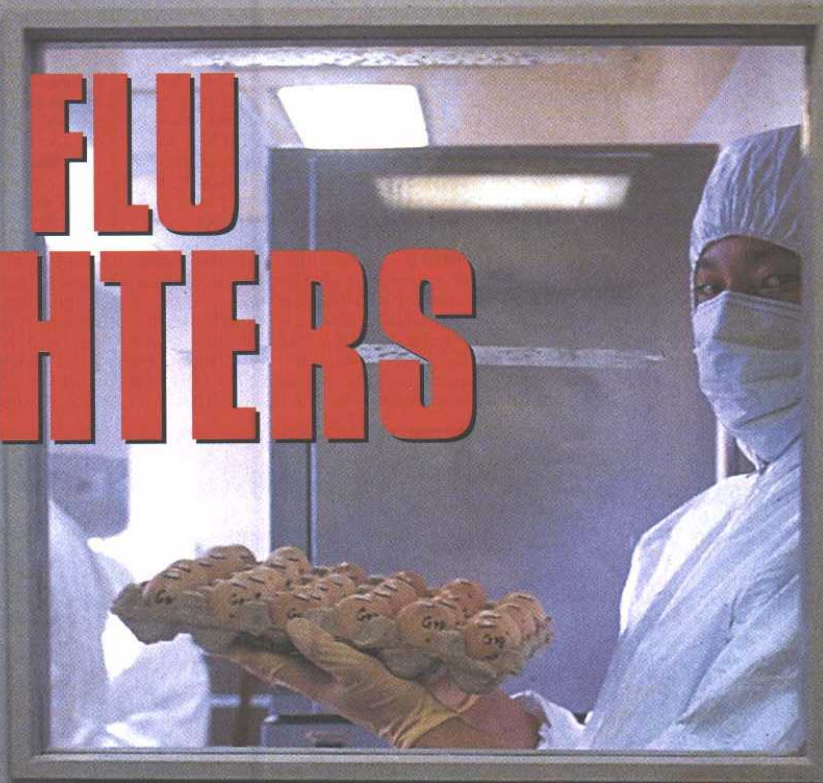
Year	Place	Subtype	Cases	Deaths	H to H
1997	Hong Kong	H5N1	18	6	Limited
1999	Hong Kong	H9N2	2	0	No
2003	Netherlands	H7N7	83	1	Limited
2003	Hong Kong	H9N2	1	0	No
2003-	Eurasia and Africa	H5N1	244	143	Limited

**Adaptation to humans?**

**New Pandemic?**

# THE FLU FIGHTERS

How the people on the front-lines battled H5N1 to a stalemate. Not that the war is over



Potential infective area

No unauthorized entry

閒人免進

**BIBBAZAH** A technician at a University of Hong Kong lab with eggs used to grow the H5N1 "bird flu" virus



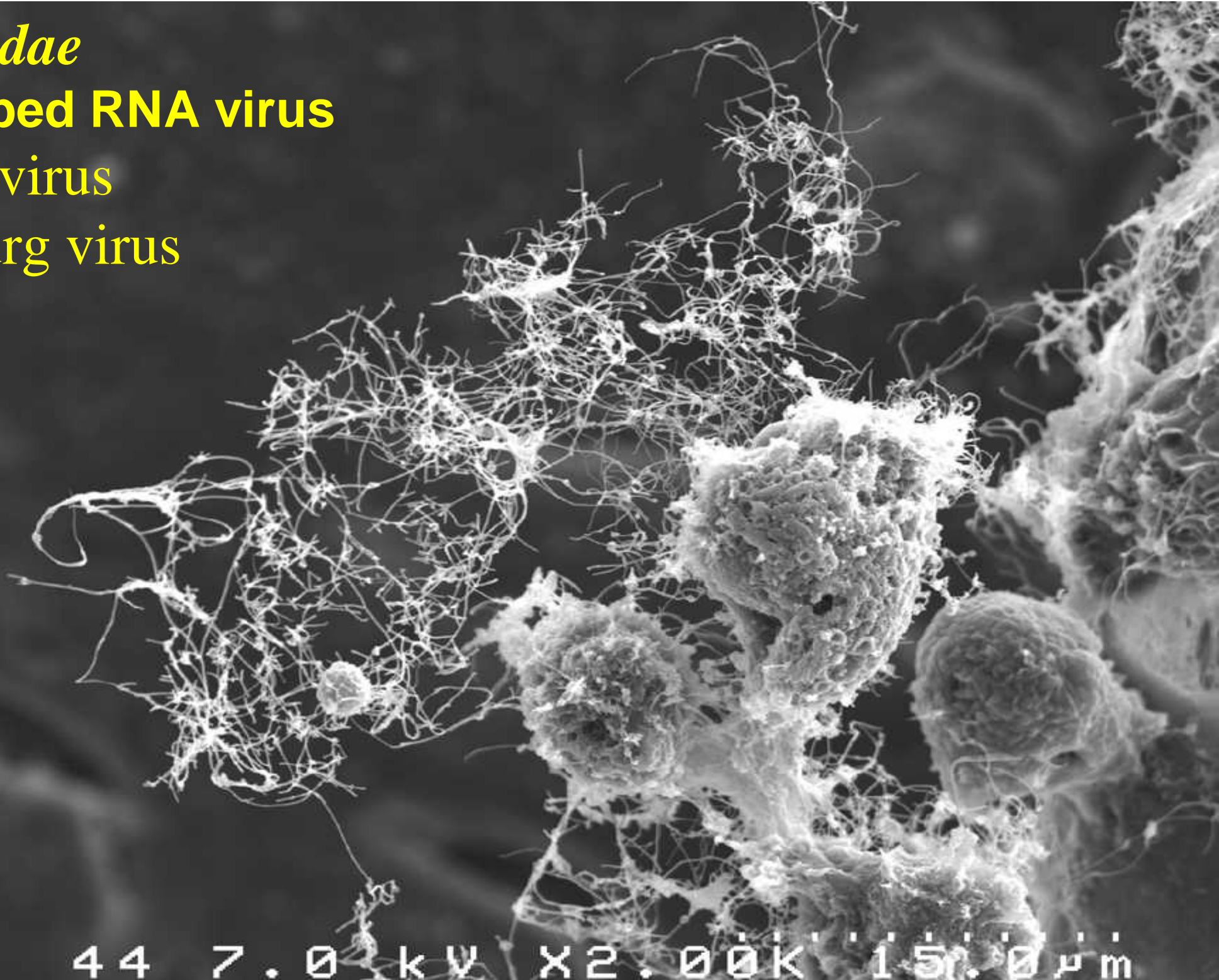
# **The Ecology of Filoviruses**

*Filoviridae*

**Enveloped RNA virus**

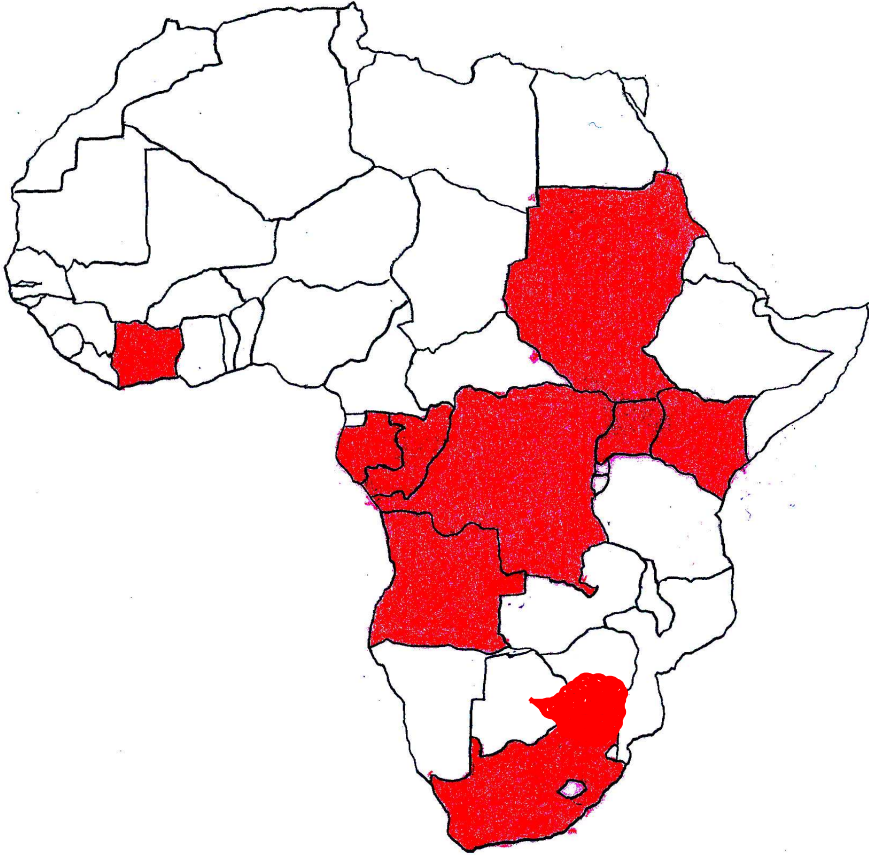
Ebola virus

Marburg virus



44 7.0 kV X2.00K 15.0 μm

# Filoviruses



- Sporadic outbreaks of lethal hemorrhagic disease in central Africa
- No effective vaccine or antiviral treatment is currently available.
- Biosafety Level 4 facility is required.





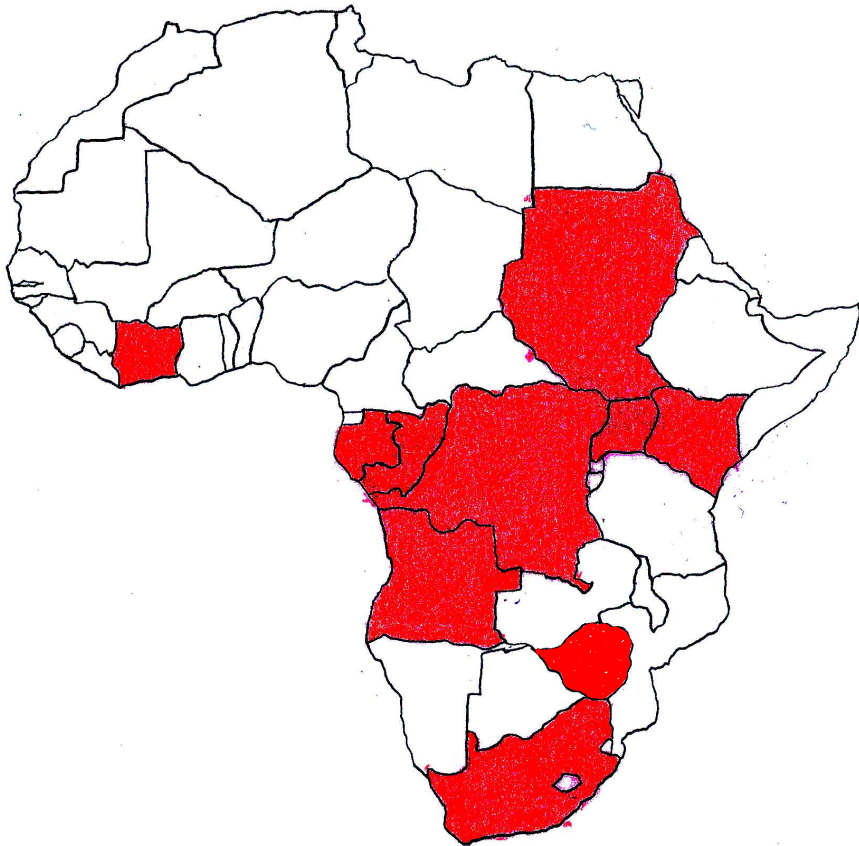
# Outbreaks of filovirus Diseases

Species	Year	Location	Human cases (%mortality)
Marburg	1967	Germany, Yugoslavia	32 (23)
	1975	South Africa, Zimbabwe	3 (33)
	1980	Kenya	2 (50)
	1987	Kenya	1 (100)
	1999-2000	DR Congo (Zaire)	?
	2005	Angola	374 (88)
Ebola Zaire	1976	DR Congo (Zaire)	318 (88)
	1977	DR Congo (Zaire)	1 (100)
	1994	Gabon	49 (59)
	1995	DR Congo (Zaire)	315 (77)
	1996	Gabon	31 (68)
	1996	Gabon, South Africa	60 (75)
	2001-2002	Gabon	60 (83)
	2001-2002	DR Congo	32 (59)
	2003	R Congo	143 (89)
	2003-2004	DR Congo	35 (83)
Ebola Sudan	1976	Sudan	284 (53)
	1979	Sudan	34 (65)
	2001-2002	Uganda	423 (40)
	2004	Sudan	18<?
Ebola Ivory Coast	1994	Ivory Coast	1 (0)
Ebola Reston	1989	USA	1?
	1992	Italy	0
	1996	USA	0
Ebola new species?	2007	Uganda	93< (?)

# Ebola · Marburg hemorrhagic fever

## — Filovirus infections —

have been emerging every year  
in Africa in this century.  
Natural host is not known.

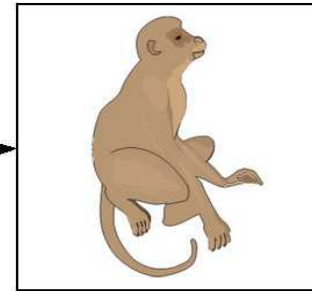


**Natural host**

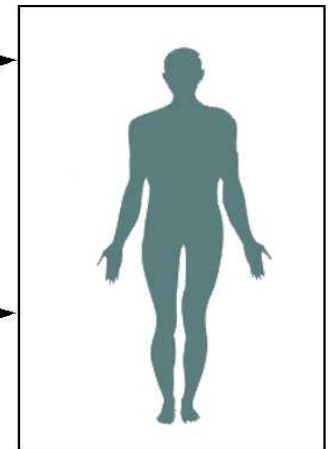


Bats ?

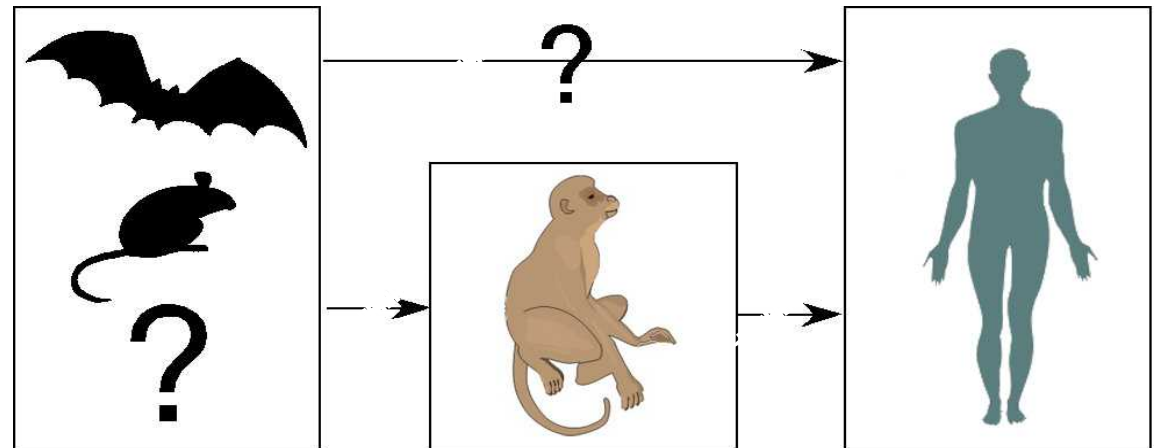
Rodents ?



**Lethal**



**Lethal**



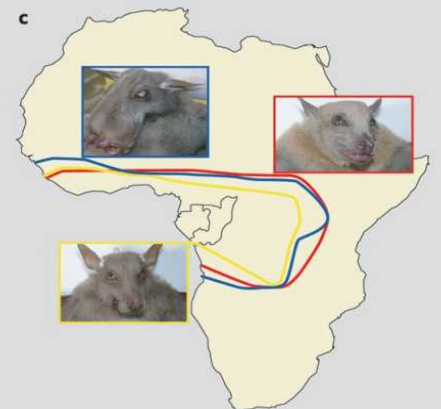
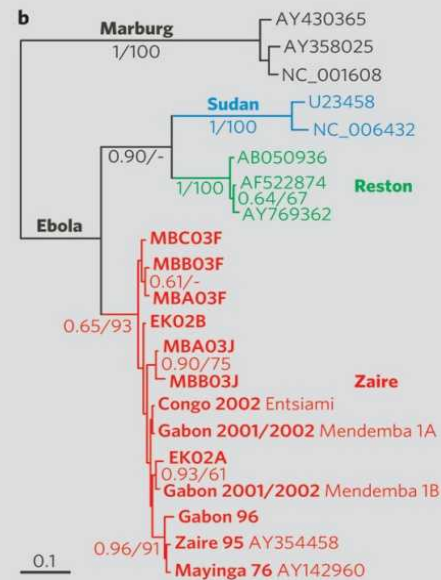
*Nature* **438**, 575-576 (1 December 2005)

## Fruit bats as reservoirs of Ebola virus

Eric M. Leroy, Brice Kumulungui, Xavier Pourrut, Pierre Rouquet, Alexandre Hassanin, Philippe Yaba, André Délicat, Janusz T. Paweska, Jean-Paul Gonzalez and Robert Swanepoel

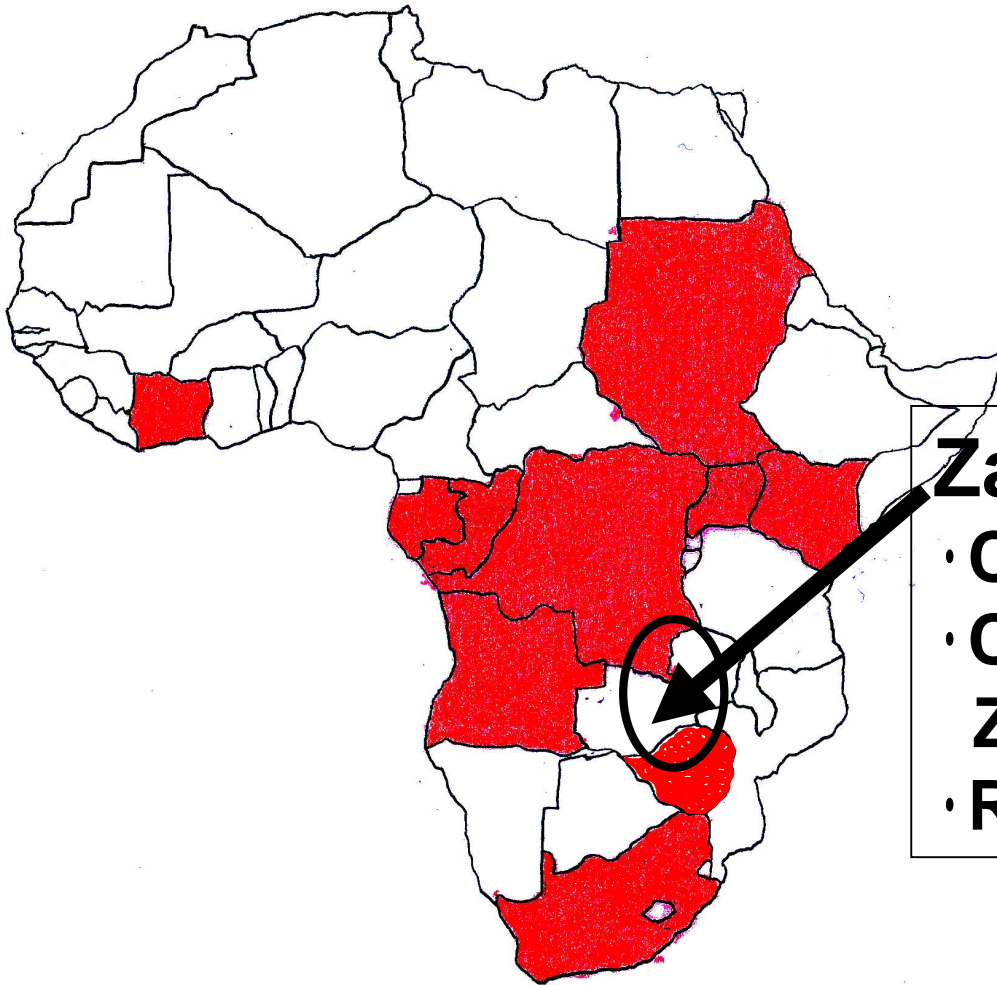
Bat species eaten by people in central Africa show evidence of symptomless Ebola infection.

The first recorded human outbreak of Ebola virus was in 1976, but the wild reservoir of this virus is still unknown. Here we test for Ebola in more than a thousand small vertebrates that were collected during Ebola outbreaks in humans and great apes between 2001 and 2003 in Gabon and the Republic of the Congo. We find evidence of asymptomatic infection by Ebola virus in three species of fruit bat, indicating that these animals may be acting as a reservoir for this deadly virus.





# Natural reservoir of filoviruses ?

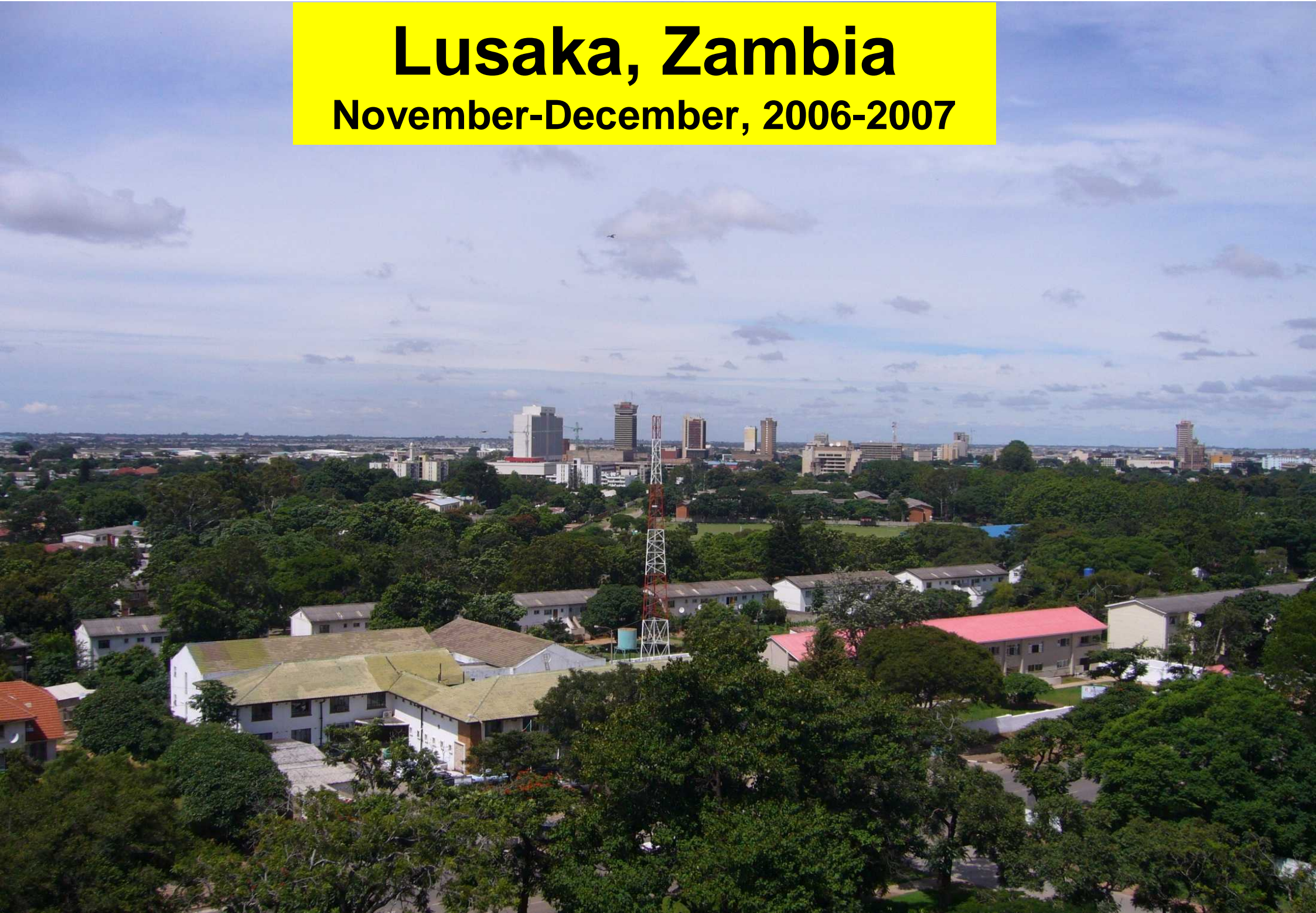


## **Zambia**

- **Close to DR Congo and Angola**
- **Collaboration with University of Zambia**
- **Relation through JICA**

# **Lusaka, Zambia**

**November-December, 2006-2007**



















***Eidolon helvum***









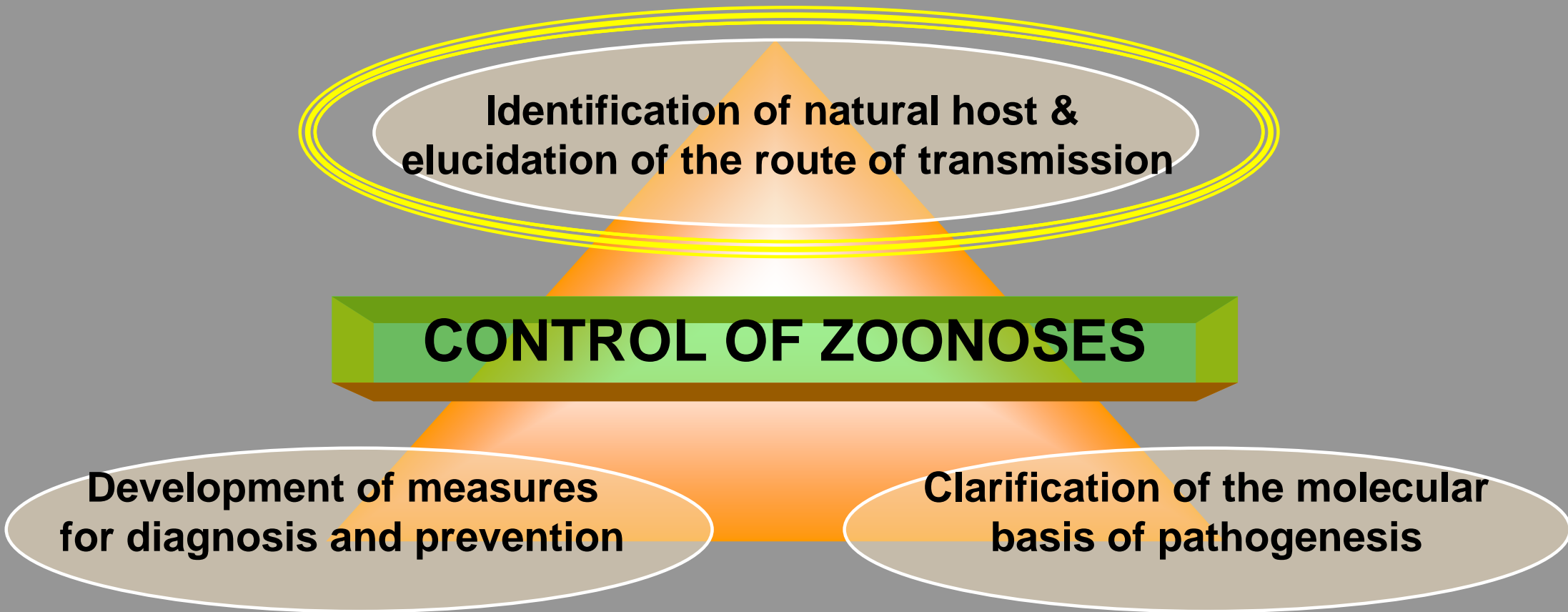




**Now being investigated.  
But, I may not be the only candidate . . .**



# Sustainable strategy for the control of zoonoses



**Changes in the global environment and human behavior affect the ecology of wildlife and hence contribute to the emergence of new diseases (Changing transmission dynamics and bringing people into closer and more frequent contact with potential pathogens).**



***“Toward a Sustainable Low **Urban** Society”***

***“Toward a Sustainable Low Carbon Society”***

***Equipollent?***