

AIV - Wild bird host ecology

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GRIPAVI

General understanding: HPAI host ecology



- ✓ AIV with pathogenic potential: **H5, H7, H9**

- ✓ Until recently, HPAI viruses had been **isolated rarely from wild birds**
 - apart from tern/S. Africa/61: HPAI H5N3

- ✓ Highly pathogenic H5, H7 influenza viruses from 1970s to 2003 were not pathogenic in aquatic birds:
 - HPAI H5N1 represent the first significant AIV **mortality in free-living wild bird** since Terns/SA
 - **different pathogenicity** of different Asian-origin H5N1 strains (severe lesion and mortality to no clinical signs)

General understanding: HPAI host ecology



- ✓ Isolations of HPAI H5N1 from over **90 species** of wild birds:
 - usually found in dead or sick wild birds

- ✓ Surveillance in wild birds (>350,000 free ranging healthy bird samples in over 40 countries) → **only very few rare samples** were positives for H5N1 HPAIV:
 - 6 wild ducks in China in Jan. 2005 (n> 4600, Chen et al. 2006)
 - 1 grebe (+ 2 wild ducks) in Siberia in July 2005 (Lvov et al. 2006)
 - 1 wild duck in Egypt in Oct. 2005 (n> 1300, Saad et al. 2007)

→ **No wild reservoir has been yet identified for H5N1 HPAI viruses**

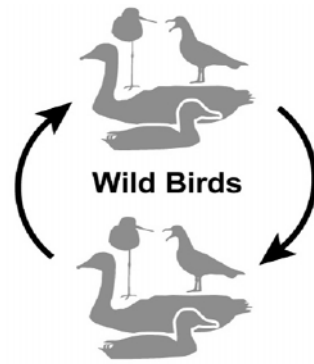
Bridge species



- ✓ H5N1 HPAI have been isolated in **several peri-domestic species**: dead pigeons, crows, mynah, and sparrows (e.g. Ellis et al., 2004)
- ✓ **Experimental infections** on starlings and house sparrows with Hong Kong–origin H5N1 showed relative resistance (Perkins & Swayne 2003)
- ✓ **Healthy tree sparrows** in China harbored and excreted H5N1 HPAI: highly pathogenic for chickens but not for domestic ducks (Kou et al., 2005)
- ✓ Chinese scientists reported H5N1 HPAI in **healthy house sparrows**
- ✓ **Hooded vultures** in Burkina Faso (2006) dead/sick - positive H5N1 HPAI (n=17) (Ducatez et al., 2007)
- ✓ **Daurian Starling** (bird market HK, 2007) droppings tested positive - asymptomatic

→ **Role of bridge species in virus transmission unclear**

AIV host ecology



✓ **Large diversity of host:** LPAI isolated from >100 wild birds species (26 bird families)

✓ **Wildfowl** (ducks, swans and geese) and **shorebirds** (gulls, terns and waders) = major natural reservoirs of AIV:

→ Prevalence LPAI: ducks > swans > gulls > waders > other waterbirds > other birds

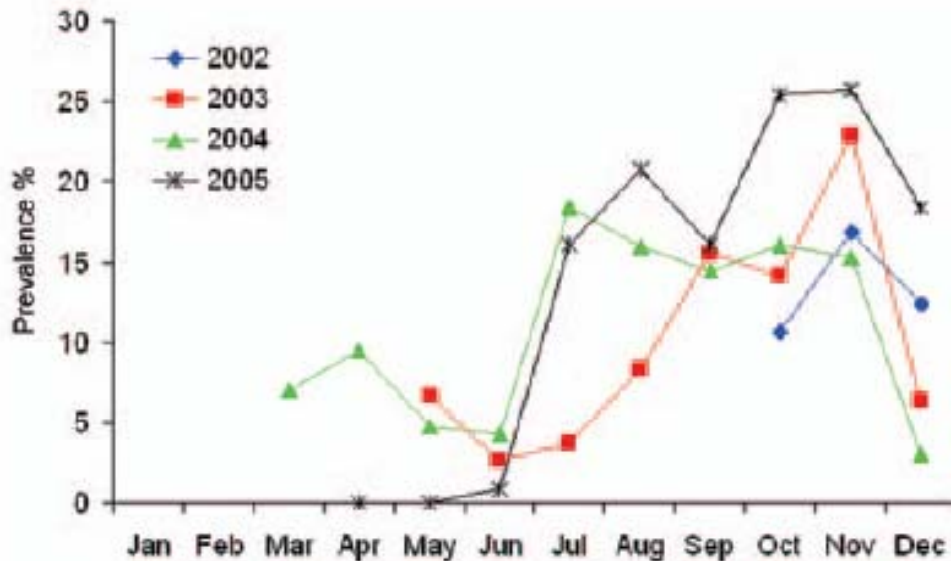


✓ Simultaneous occurrence of various AIV within groups of birds or within single bird

→ **Ideal situation for reassortment & formation of novel virus**

Seasonal AIV prevalence

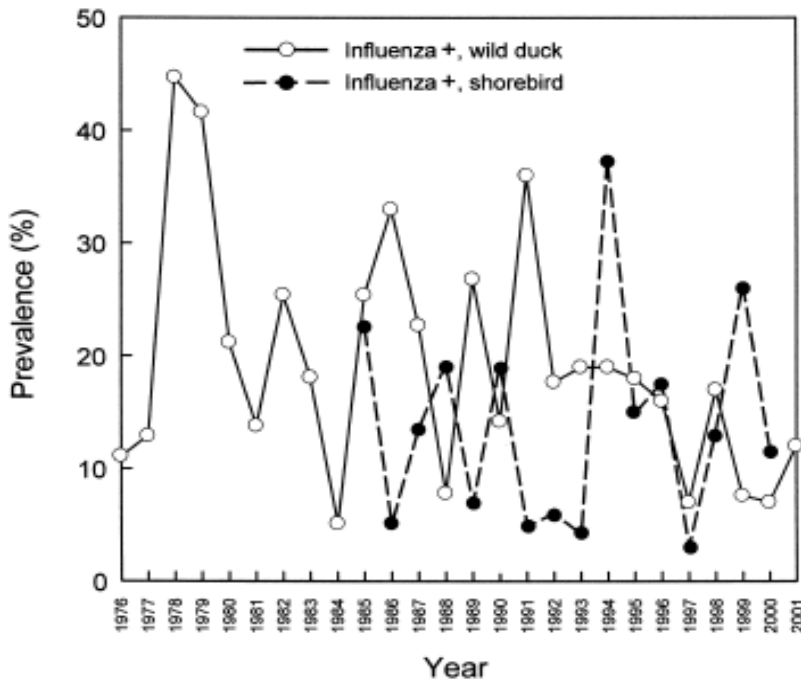
- AIV prevalence in ducks peaks in late summer and fall:
 - in North America (35%, Stallknecht and Brown 2007)
 - in Europe (>25%, Wallensten et al. 2007)attributed to increased concentrations of susceptible hatching-year birds
- Prevalence in juvenile ducks > adults (immunological naïve birds)



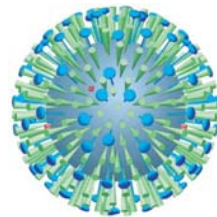
Mallards in Sweden (n= 4,106;
Wallensten et al. 2007)

Yearly AIV prevalence

- ✓ Similar cyclic patterns in duck and shorebirds, but asynchrony
→ Periodicity: short term immunity? Population turn over?
- ✓ Annual variation in subtype diversity (2-yr cycle in predominant subtypes; Krauss et al., 2004)



Ducks and shorebirds in North America from 1976-2001 (Krauss et al. 2004)



Mechanisms for perpetuations in wild birds?

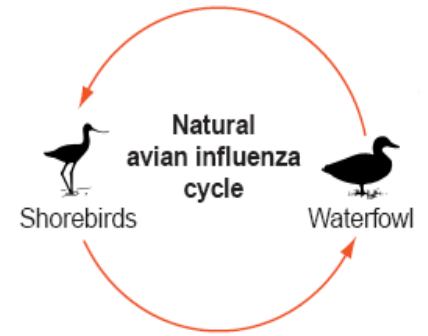
- ✓ **Persistence in frozen wetlands** where migratory birds nest?
 - isolates from water in Siberia and Alaska (Zhang et al., 2006)

- ✓ **Continuous circulation in subtropical and tropical regions?**
 - isolates from African ducks in northern winter (Gaidet et al., 2007)

- ✓ **Persistence in migratory ducks alone** (continuous circulation)?
 - isolates in all seasons in Europe (Wallensten et al. 2007, De Marco et al. 2003), but very low isolates in spring in North America (Krauss et al. 2004)

- ✓ Perpetuation through **transmission among different birds families** sharing wetlands?

Complementary role of different birds species in the perpetuation of AIV?



- AIV isolated in various waterbird groups in the same ecosystem
- Prevalence in dabbling ducks > diving ducks (surface feeding)
- Wider spectrum of AIV subtypes in waders/ducks in North America, some HA/NA subtypes absent in wild ducks in North America (Krauss et al., 2004) and Europe (Wallensten et al. 2007)
- Difference in seasonal prevalence between shorebirds and duck in North America → **shorebirds - duck link** hypothesis?
- Limited genetic differentiation → **inter species transmission** ?

Host ecology, life history and behavior



✓ Bird' species or groups specific behavior in:

- spatial and seasonal distribution
- habitat utilization
- foraging behaviour
- migration timing
- reproductive cycle

all potentially influence a **species' role in AIV epidemiology**

✓ **Community structure** (species composition, mixing, turn over, gregariousness) and **population structure** (age/sex classes) are important factors to consider in AIV maintenance, transmission, and possibly long-distance movement

A knowledge gap in the host ecology of IAV in tropical regions

- ✓ Few multi-year studies available, none in tropical areas
- ✓ Conditions and patterns of AIV circulation in tropical regions?
 - Can AIV persists in tropical ecosystem ? in wild bird populations ?
 - How is it maintained in tropical ecosystem ?
 - How is it transmitted between wild and domestic birds ?



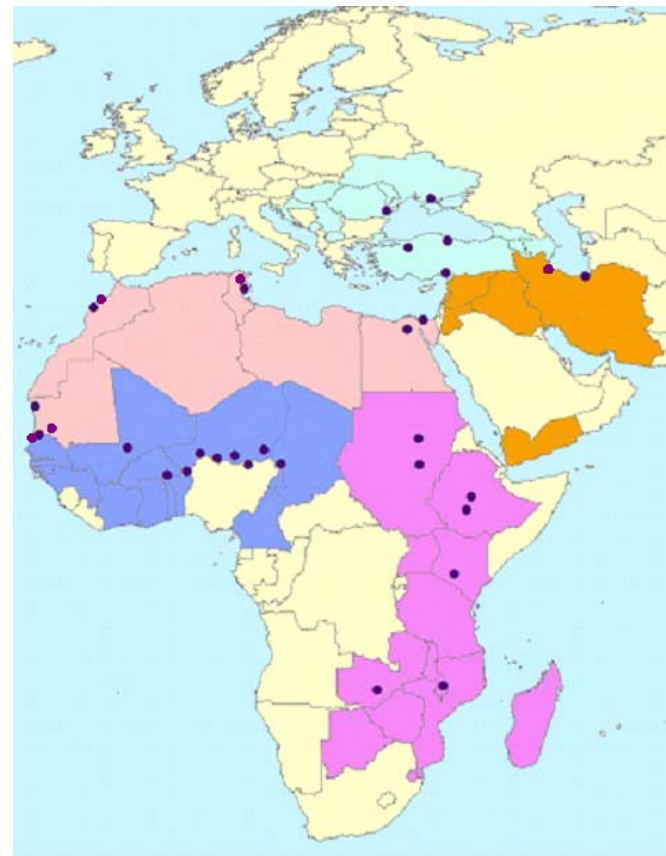
Large-scale wild bird surveillance program in Africa

TCP FAO: 2006-2007

Evaluate the AIV carriage, in particular HPAI, among wild bird populations

17,500 samples collected in 19 countries, >12,000 birds tested

Mostly from December to March



New insights on the host ecology of AI virus in tropical regions

✓ no positivity for HPAI H5N1 has been detected

✓ LPAI virus have been detected and isolated in wild birds in several major wetlands of Northern, Western and Eastern Africa

→ Environmental conditions in Afro-tropical ecosystems are favourable to the persistence and transmission of AIV (northern winter)

In Eurasian migratory birds:

→ potential for introduction and transmission in the tropics

→ new detection in waders: specific role in the perpetuation of IAV across continents?

In Afro-tropical species:

→ potential persistence in the African ecosystems within resident waterbirds

→ potential dissemination over Africa through intra-African migratory birds



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6 observatories

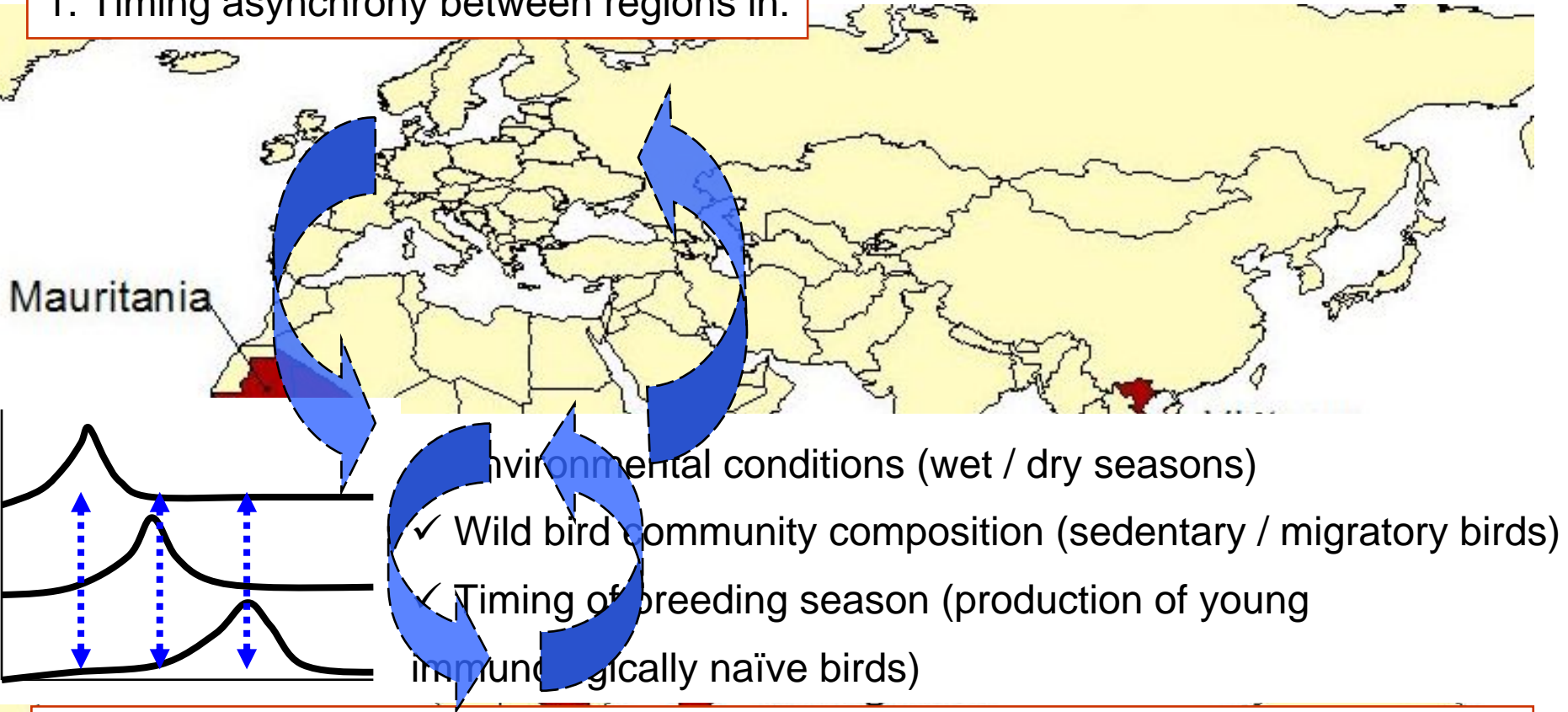


→ Specific protocols for specific questions in each observatory according to the local context

→ Shared protocols for generic questions through comparison between observatories

A network of complementary regions

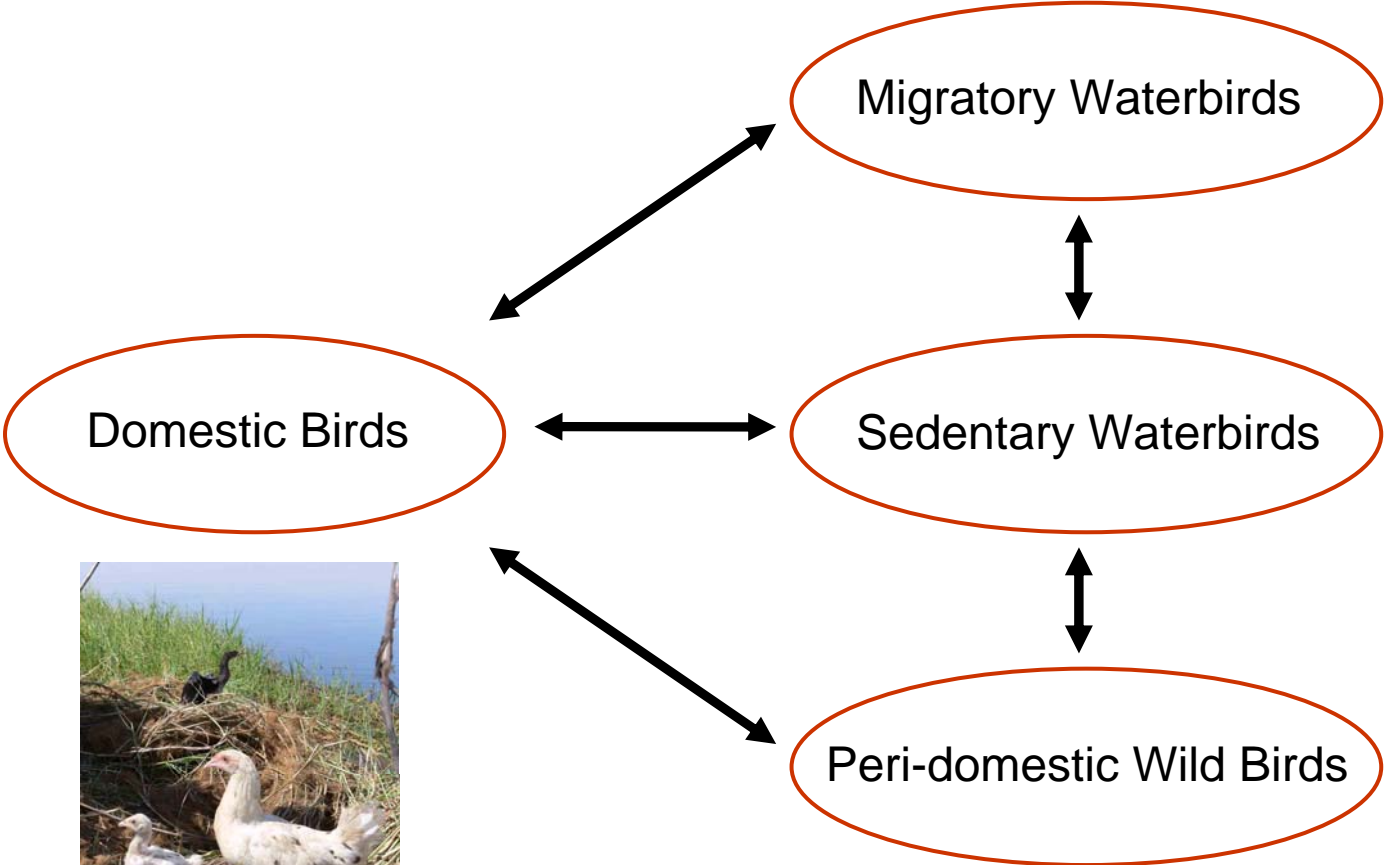
1. Timing asynchrony between regions in:



2. Connections between regions and continents through waterbirds migration

→ Mechanism of maintenance, dissemination and reassortment of AIV in nature?

A bird reservoir community



Conditions and patterns of AIV circulation in tropical regions?

✓ What are the seasonal and geographical patterns in prevalence of AIV in wild birds in tropical ecosystems?

→ Similar longitudinal survey in waterbirds in various regions:
seasonal profile of AIV circulation

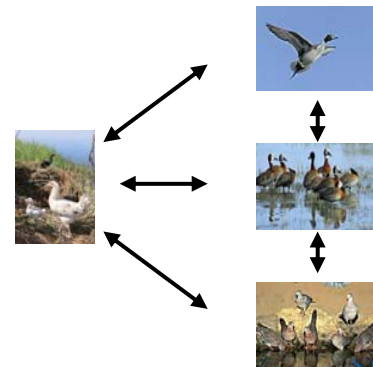
→ Comparison of seasonal profiles between regions

✓ Is the contact between different wild bird species contribute to maintenance and dissemination of AIV in wild bird community?

→ Describe bird community structure and dynamic (wild bird species assemblage)

→ Measure AIV prevalence in different wild birds groups

→ Relation among strains circulating within various wild bird groups



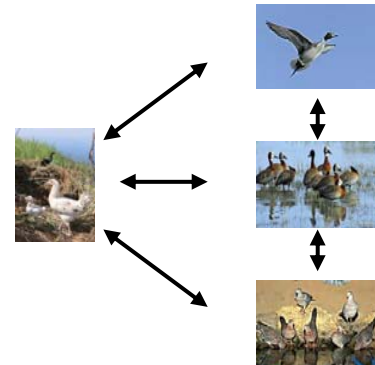
Conditions and patterns of AIV circulation in tropical regions?

- ✓ What are the relations between AIV circulating wild and domestic birds?
 - investigate the role of the interactions between wild and domestic birds in the maintenance of AIV

- ✓ Are there any bridge species that allows the maintenance and dissemination of AIV (and in particular HPAI H5N1) between wild and domestic birds?

→ In parallel measure of AIV prevalence in the 4 compartments (including peri-domestic wild bird species)

→ Relation among strains circulating within the 4 compartments





Thank you