



# **Newcastle Disease: Global Situation and Effective Control Strategies**

Dr. Liu Hualei

China Animal Health and Epidemiology Center  
OIE Reference Laboratory for Newcastle Disease

# Avian Diseases Surveillance Laboratory

- Newcastle disease
  - OIE/National Reference Laboratory
- Avian influenza
  - National Para-reference Laboratory (Qingdao)
- New emerging avian diseases

# National Roles

- Diagnosis
- Surveillance
- Evaluation of Vaccination and Diagnostic
- Technical Training
- Research
  - Diagnostic technologies
  - Molecular Epidemiology
  - Development of New Vaccine
  - Reverse Genetics
  - .....



# International Roles

- Virus sharing
- Evaluation of diagnostic kits
- Regional Training
- International cooperation
- Technical support



# Outline

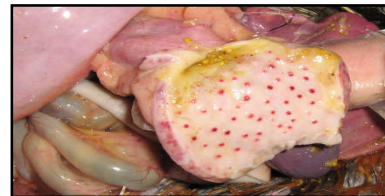
- Overview of Newcastle disease
- Global situation of Newcastle disease
- Control strategies and challenges for ND
- Current situation and control experiences in China

# Outline

- Overview of Newcastle disease
- Global situation of Newcastle disease
- Control strategies and challenges for ND
- Current situation and control experiences in China

# Newcastle Disease

- One of the most important diseases in poultry worldwide
- OIE Notifiable disease (List A)
- More than 200 species of bird can be infected
- High morbidity and mortality in poorly vaccinated chickens
- Drops in egg production in well-vaccinated layers
- Human infection: eye infections



# Aetiology

- **Family**
  - *Paramyxoviridae*
- **Subfamily**
  - *Avulavirinae*
- **Genus**
  - *Orthoavulavirus*
- **Species**
  - *Avian orthoavulavirus 1*
- **Virus**
  - *Newcastle Disease Virus / APMV-1*





# OIE Definition of ND

*'Newcastle disease is defined as an infection of birds caused by a virus of APMV-1 that meets **one of** the following criteria for virulence:*

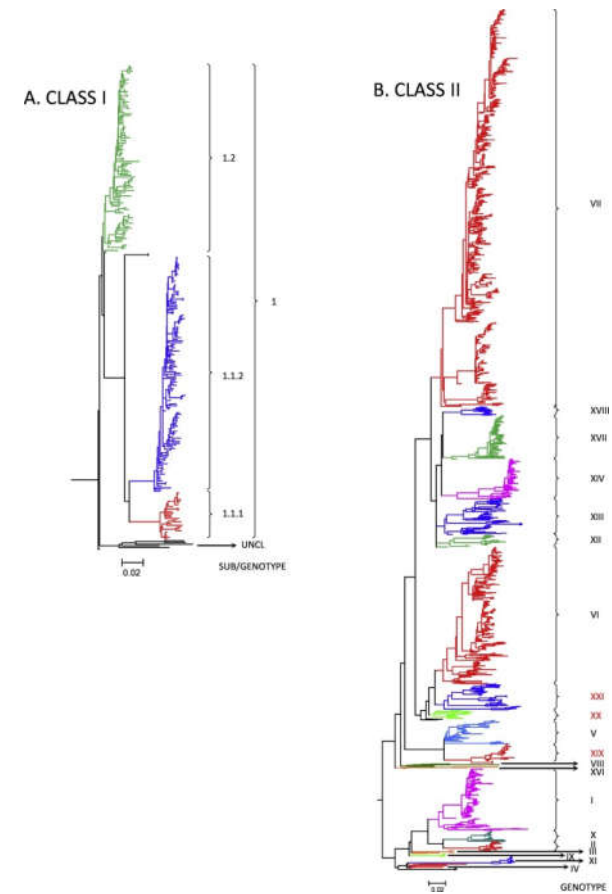
*a) The virus has an **ICPI** in day-old chicks of **0.7 or greater**. **OR***

*b) Multiple basic amino acids have been demonstrated at the C-terminus of the F2 protein and **phenylalanine at residue 117**, which is the N-terminus of the F1 protein.*

Strain	ICPI	Cleavage site of F protein
La Sota	0.4	<sup>112</sup> GRQGR↓L <sup>117</sup>
Mukteswar	<b>1.4</b>	<sup>112</sup> RRQRR↓F <sup>117</sup>

# Diversities of NDV

- Virulence diversities (DIVA)
  - Lentogenic: ICPI 0.0-0.7
  - Mesogenic: ICPI 0.7-1.3
  - Velogenic: ICPI 1.3-2.0
- Genetics diversities (Diagnosis)
  - Class I: 1 genotype
  - Class II: 21 genotypes
- Host diversities (Hard to eradicate)
  - Domestic birds
  - Wild birds



# Host Range

- At least **241** species from 27 of the 50 Orders of birds, including all the domestic avian species, can be infected
- Probable all bird species are susceptible, but the outcome of infection varies considerably among species



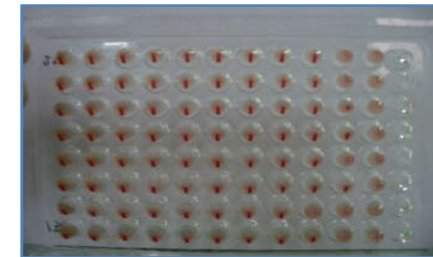
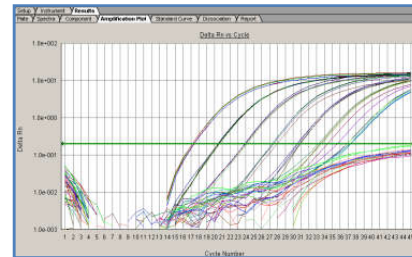
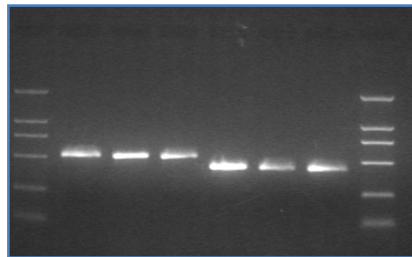
# Morbidity and Mortality

- Morbidity: up to 100%
- Mortality: 90%
- Varies greatly depending on
  - Virulence and strain
  - Avian species and susceptibility of host
  - Environmental conditions
  - Vaccination history
- Some species show few or no signs
  - Carrier state may exist



# Laboratory Diagnosis

- Virological Test
  - Virus isolation: BSL-3 facilities
  - RT-PCR and Real-time RT-PCR: Multiple genotypes
- Serological Test
  - HI and ELISA
  - Cannot differentiate infected from vaccinated flocks



# Real-time RT-PCR for virulent NDVs

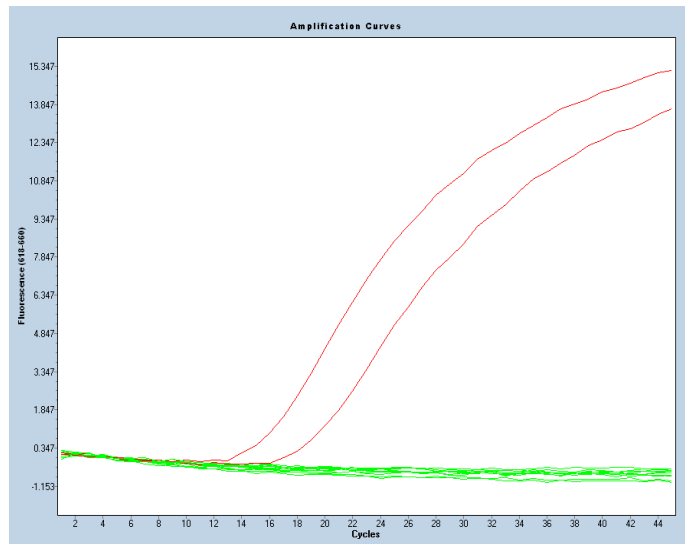


Fig. 1 The specificity of real-time RT-PCR

No cross-reactions were observed with other avian pathogens, like AIV, IBV, EDSV, APMV-4.

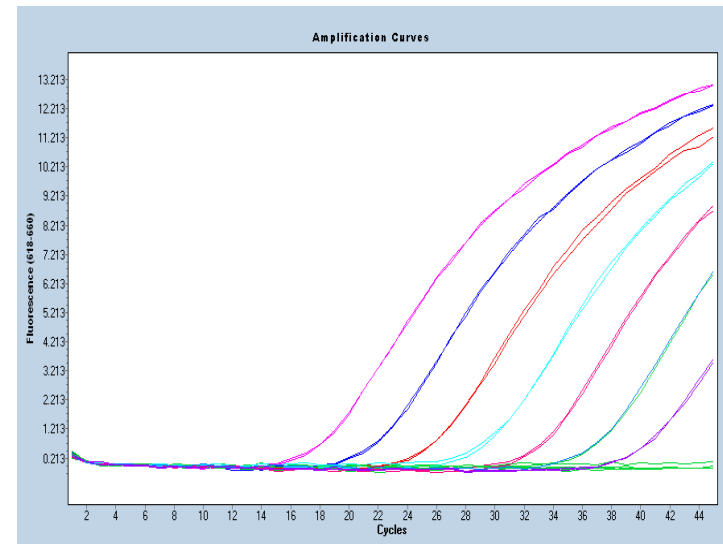
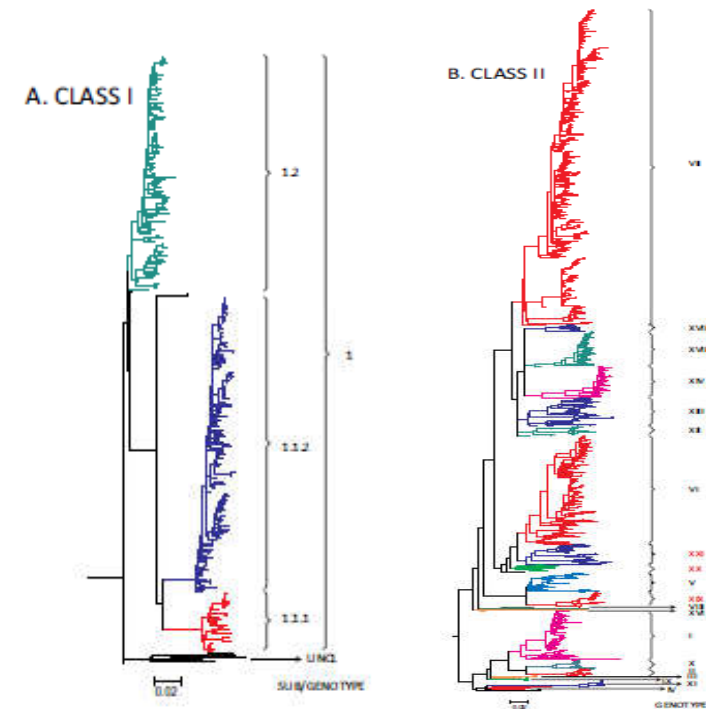


Fig. 2 The sensitivity of real-time RT-PCR

The concentration of samples was  $10^6 \sim 10^0$  copies/ $\mu\text{L}$ , and the minimal detection threshold was 10 copies.

# Challenges in detection

- ▶ High genetic diversity of NDV
  - Class I: 1 genotypes
  - Class II: 21 genotypes
- ▶ Difficult to establish a diagnostic method with high specificity and sensitivity.
- ▶ Constant evolution of virulent viruses, leading to generation of new genotype or sub-genotype.
- ▶ Need to improve the existing tests for detection of variants.



# Outline

- Overview of Newcastle disease
- **Global situation of Newcastle disease**
- Control strategies and challenges for ND
- Current situation and control experiences in China



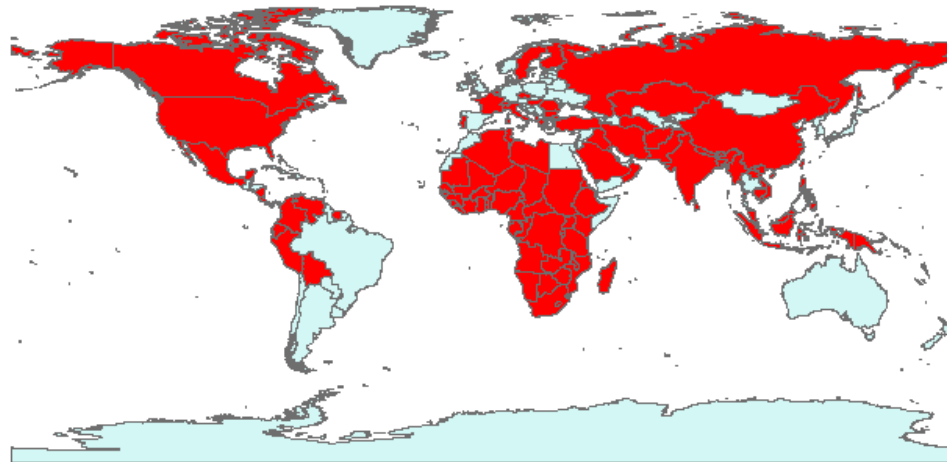
# The History of ND

- The first documented outbreaks of ND occurred in Java, Indonesia, and Newcastle-upon-Tyne, England *in 1926*
- There is evidence that the virulent virus may existed *before 1926*
- ND has been presented throughout the world
- Five panzootics of ND has been identified since 1926
  - 1<sup>st</sup> : From Southeast Asia and England since 1926 / II-III-IV
  - 2<sup>nd</sup>: From Middle East since 1960s / V / captive cage birds
  - 3<sup>rd</sup>: From Middle East since mid-1970s / VI (racing pigeons)
  - 4<sup>th</sup>: From Southeast Asia since late 1980s / VII.1
  - 5<sup>th</sup>: From Asia since late 2000s / VII.2



# Global Situation of ND (2014-2019)

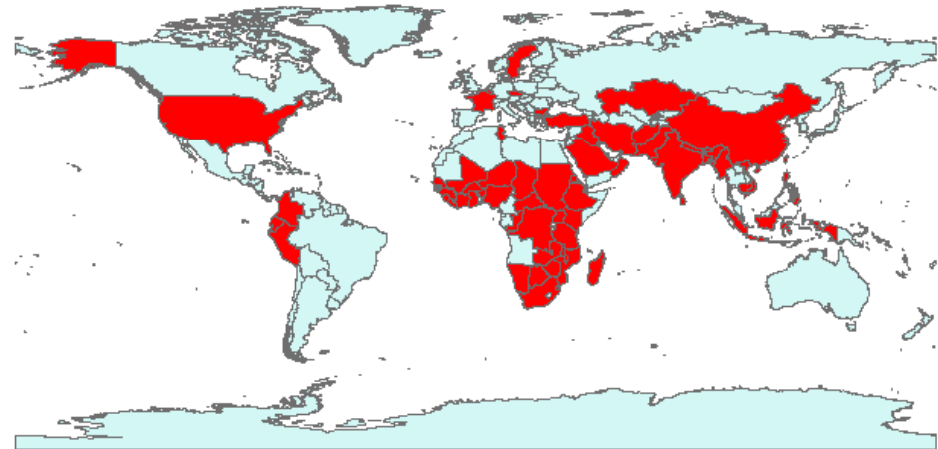
- There are few areas of the world that have not been affected by ND
- 109 OIE members reported the disease in the past 6 years



*Data source: OIE (<https://www.oie.int>)*

# Global Situation of ND in 2019

- 46 OIE members reported the disease in 2019
  - Asia: 21 (*China*)
  - Africa: 17
  - Europe: 2  
*Bulgaria /Switzerland*
  - North America:3  
*United States/Haiti/ Mexico*
  - South America: 3  
*Colombia/Ecuador/Peru*



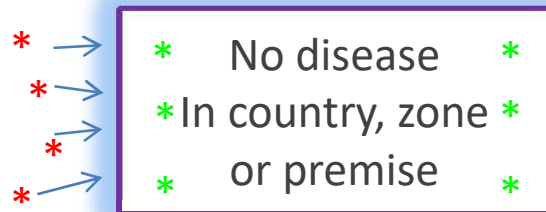
Data source: OIE (<https://www.oie.int>)

# Outline

- Overview of Newcastle disease
- Global situation of Newcastle disease
- **Control strategies and challenges for ND**
- Current situation and control experiences in China

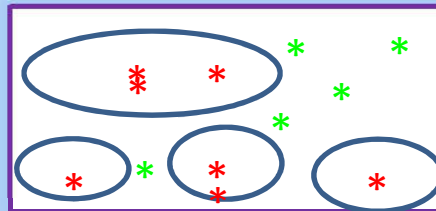
# Strategies for Disease Prevention and Control

## Prevention



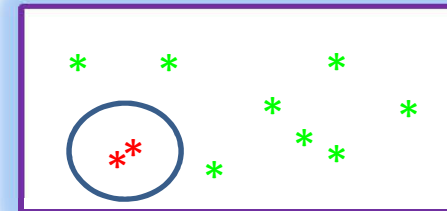
**Measures to avoid disease outbreak**

## Control



**Measures to contain disease outbreak**

## Eradication



**Measures to achieve freedom from the disease**

# Prevention Strategies

- Quarantine
  - Prevent disease introduction, transmission and spread
- Bio-security practice
  - Humans, Flocks, Facilities, Premises, Environment, Disinfection, .....
- Vaccination campaign
  - Vaccination can reduce the losses in poultry flocks but can not ensure the prevention of virus circulation (replication and shedding)
- Active surveillance
  - Early detection and rapid response



# Control Strategies

- Zoning
- Movement control
- Surveillance and outbreak investigation
- Stamping out with compensation
- Disposal and disinfection
- Vaccination

*Bio-security and vaccination alone have not been sufficient to eliminate the circulation of virulent strains!*



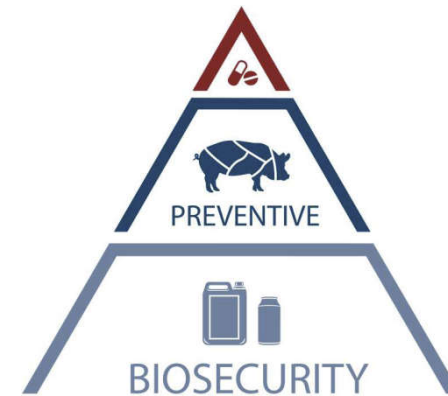
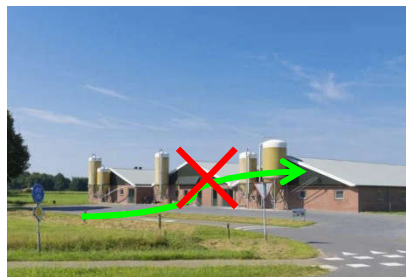
# Biosecurity

- Definition

- The combination of all measures taken to reduce the risk of introduction and spread of diseases

- Methodology

- External Biosecurity: Reduce introduction
- Internal Biosecurity: Reduce spread



**BIOSECURITY is the basis of all disease control program**



# Challenges on Prevention and control

- Global distribution of the disease
  - More than 50% OIE members reported the disease in the past 5 years
  - Underreported outbreak: developing countries / backyard poultry
- Diversity of circulating virulent NDVs
  - New genotypes emerging
  - Recent viruses from Asia, America and Africa are different
- Wide host range
  - Waterfowl / Wild birds



## Challenges on Prevention and control (cont.)

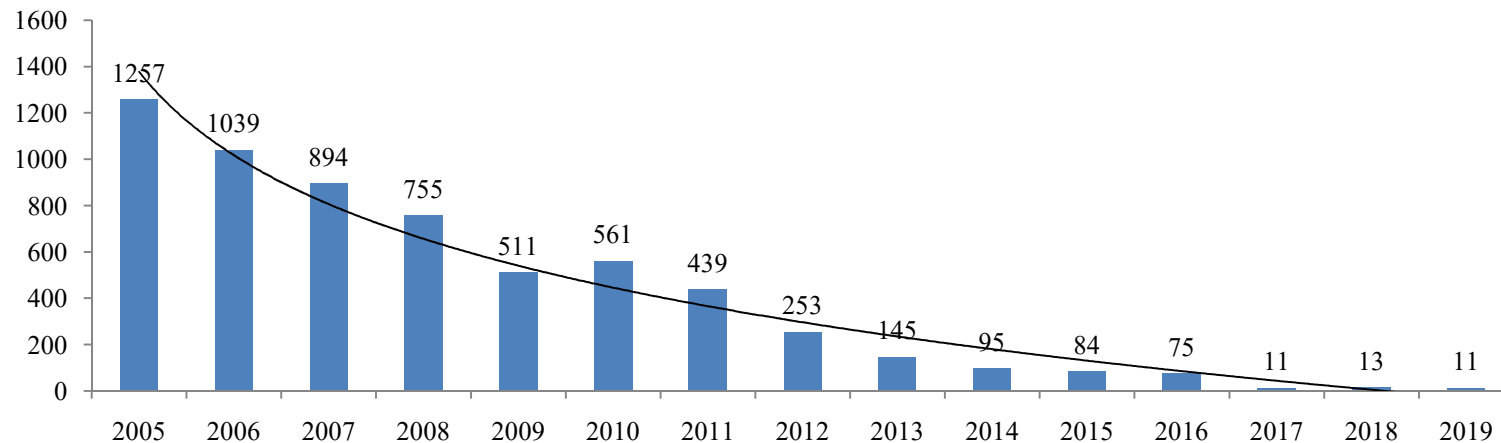
- Backyard flocks still have a large proportion
  - Low bio-security, high risk to get infected
- Vaccination does not prevent virus replication
  - Virus shedding: viruses continue to replicate and evolve
  - Virus evolution: challenge on vaccination and virus detection
- There is only one effective strategy to eliminate NDV
  - Eradication through culling is used, but not affordable in developing countries

# Outline

- Overview of Newcastle disease
- Global situation of Newcastle disease
- Control strategies and challenges for ND
- **Current situation and control experiences in China**

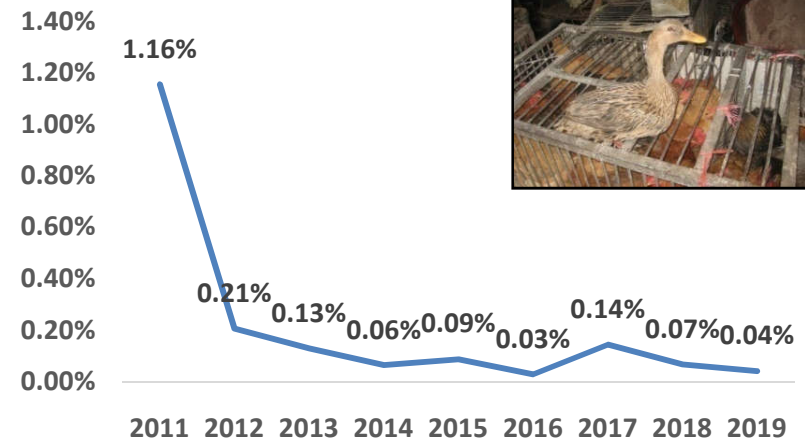
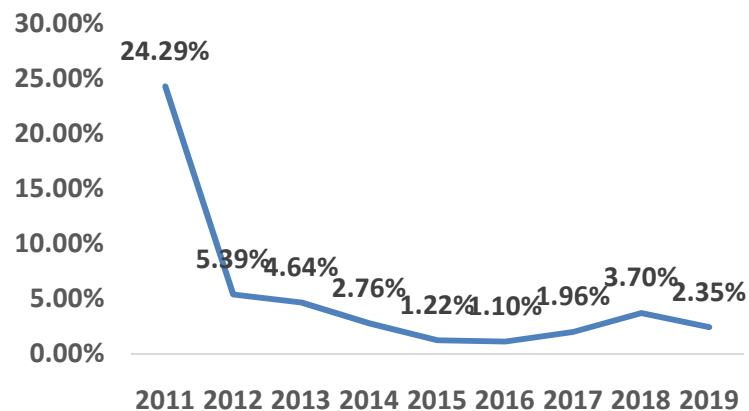
# ND in China

- The first confirmed outbreak was in 1946
- Since 1980s an intensive vaccination program was implemented
- In recent years the outbreaks of ND gradual declined



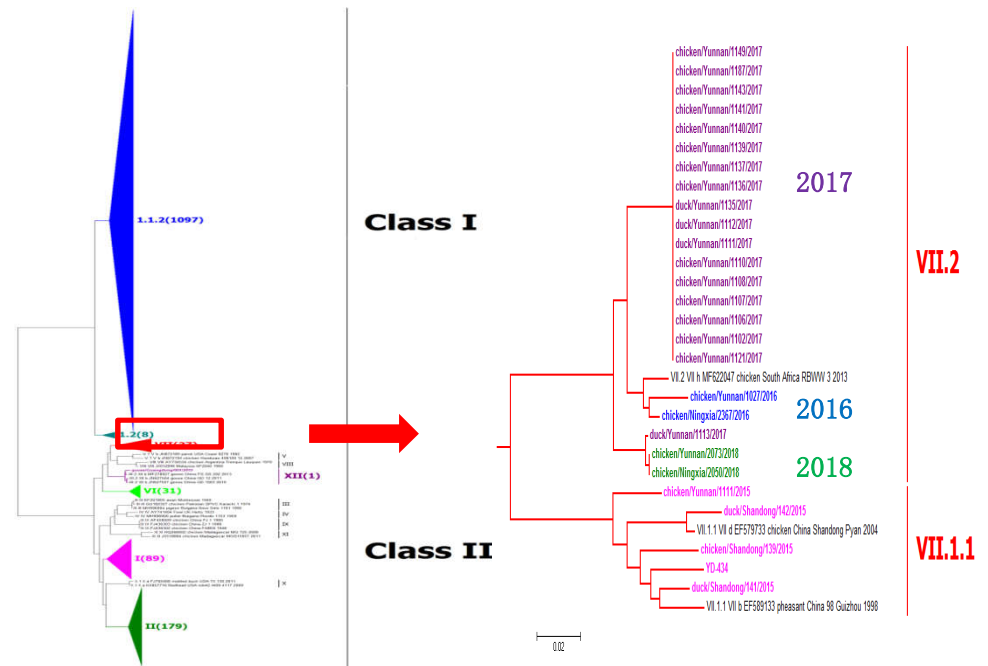
# Risk-based Surveillance

- Early warning
- Identify prevalent virus
- Evaluation of vaccination and diagnosis



# Molecular Epidemiology

- 1432 NDV obtained from 2014-2019
- Diversity on virulence
  - Virulent: 59 (4%)
  - Low virulent: 1373 (96%)
- Diversity on genetic
  - Class I: 1097
  - Class II: 335
- Virulent virus
  - Genotype VI: 31
  - Genotype VII: 27
  - Genotype XII: 1



# Control Experiences from China

- Effective surveillance system
  - Response for evaluation on diagnosis and vaccination
- Successful vaccination campaign
  - Genotype-matched vaccine: reduction of virus shedding (A-VII)
  - Quality control
- Reduction of backyard poultry
  - Requirement of environmental protection
- Enhanced bio-security practice
  - Waterfowl
  - Movement control: Quarantine



# Acknowledgements

- **Dr. Wang Zhiliang (OIE expert)**
- Dr. Wang Jingjing
- Dr. Yu Xiaohui
- Dr. Jiang Wenming
- Dr. Wang Kaicheng
- Dr. Liu Shuo
- Dr. Li Yang
- .....





# Contact Information



**Hualei Liu**

*PhD, Professor*

*Director of Avian Diseases Surveillance Laboratory*

*China Animal Health and Epidemiology Center*

*Ministry of Agriculture and Rural Affairs*

*P.R. China*

*Office address: No. 369 Nanjing Road, Qingdao*

*Email: hualeiliuwy@163.com*