An overview of arboviruses and vectors in Australia

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Arbovirus infections of animals in Australia

A relatively long history of arbovirus and vector research:

Culicoides borne:

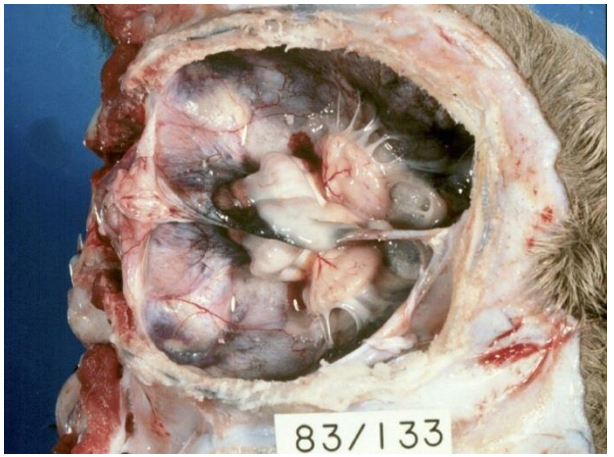
- Akabane and related orthobunyaviruses (Simbu group);
- Orbiviruses – Bluetongue and EHD groups; Wallal, Warrego, Eubenangee, Elsey)

Mosquito transmitted:

- Bovine ephemeral fever;
- Alphaviruses – Ross River;
- Flaviviruses – Murray Valley Encephalitis, West Nile.

Orthobunyaviruses

- Outbreaks of congenital abnormalities in cattle – 1938, 1956, 1974, 1983, 2004;
- Thought to be due to vector-borne virus;
- Shown in 1974 to be due to Akabane virus in Japan and Australia (first isolated in 1959 in Japan, 1968 in Australia);
- AG/HE outbreak in cattle in 1978 due to Aino virus;
- No evidence of disease with other Simbu viruses in Australia;
- Annual transmission of Simbu viruses in livestock (mainly cattle).



Bluetongue viruses

- During the search for the vector of BEF, mosquitoes and biting midges (Culicoides spp) were caught and virus isolation attempted;
- In 1975, an unidentified virus found in the north.
- In 1977, unknown virus shown to be bluetongue.
- No evidence of disease;
- 12 serotypes detected, not all endemic;
- Some serotypes have caused severe disease under experimental conditions;
- Significant impact on livestock trade.

Distribution of Bluetongue viruses in Australia

- Natural distribution of viruses determined solely by distribution of insect vector;
- BTVs transmitted exclusively by biting midges – *Culicoides* species;
- In eastern Australia (NSW & southern Qld), *Culicoides brevitarsis*
- In northern Australia, especially the ‘Top End’ of NT, *C. brevitarsis* and additional tropical vectors (*C. actoni, fulvus, dumdumi, wadai*).

Other orbivirus infections

- During arbovirus epidemiology studies many other viruses were isolated from animals and insects;
- Many are related to BTV and have similar genetic and antigenic characteristics;
- Epizootic haemorrhagic disease viruses (EHDV) – found in cattle but no association with disease.
- Wallal and Warrego viruses caused outbreak of blindness in kangaroos in Southern Australia in 1995-96.
- Eubenangee virus causes sudden death in Tammar wallabies – severe haemorrhagic disease (1998, 2000s)
- Elsey and related viruses caused sporadic cases of encephalitis in horses in the Northern Territory and Queensland

Bovine ephemeral fever virus

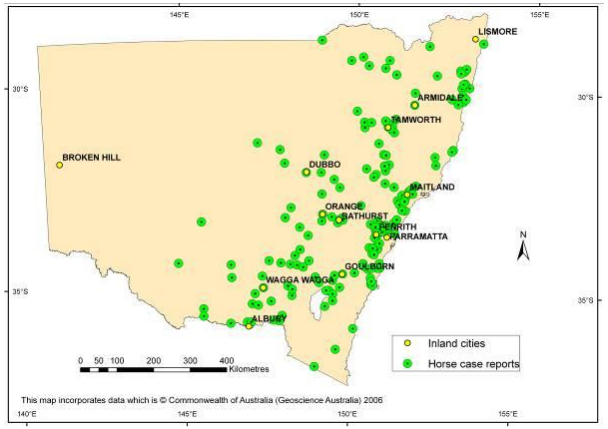
- Prior to 1975, bovine ephemeral fever virus caused intermittent major epizootics of disease sweeping from the tropical north to the far south of Australia;
- Virus spread over several thousand kilometres in 1-2 months.
- Mosquito vector was suspected;
- Now endemic in both Northern and parts of Eastern Australia;
- Vaccination of dairy cattle and bulls in some regions

Alphavirus infections of animals

- Many different alphaviruses isolated from insects;
- Little evidence of disease in animals;
- Mosquito vectors;
- High transmission rates in high rainfall coastal regions and inland regions with large wetlands;
- Ross River virus sometimes associated with fever, myopathy and arthropathy in horses.
- Laboratory confirmation generally poor; High VN Ab titres common in horses.

Flavivirus infections of animals

- Many different flaviviruses isolated from mosquitoes;
- Viruses from the Japanese encephalitis group infect domestic animals (especially chickens, dogs, horses)
- JE incursion into far northern Queensland (1998-2000), 1 human death, pigs infected;
- Murray Valley Encephalitis and West Nile viruses both associated with cases of encephalitis in horses
- In 2011 outbreak of neurological disease in horses in SE Australia – more than 1000 cases, 10% mortality, predominantly WNV. No disease in wild birds.
- Rare cases of MVE encephalitis in northern Australia



Alphavirus infections of humans

- Infections and disease associated with alphaviruses are common – particularly Barmah Forest virus and Ross River Virus.
- Account for most locally acquired arbovirus infections
- Causes of fever, rash, muscle & joint pain. Seasonal occurrence associated with large mosquito populations;
- Cases of disease are notifiable through the National Notifiable Diseases Surveillance System (NNDSS).
- Chikungunya virus is exotic but some imported cases are confirmed

Flavivirus infections of humans

- Viruses from the *Flaviviridae* family are less common than alphavirus infections;
- Murray Valley Encephalitis and West Nile viruses are both associated with sporadic/rare cases of encephalitis. A single outbreak in 1950s;
- Small numbers of Dengue cases occur in tropical regions but larger numbers of imported cases are confirmed;
- After the JE incursion into far northern Queensland, there was a single human case;
- Zika virus remains exotic but imported cases are detected;
- Sentinel chicken and mosquito surveillance programs operate in several states

Arbovirus surveillance in animals

- Major vector-borne viruses systematically monitored for >30 years through the National Arbovirus Monitoring Program (NAMP)
- Virus surveillance in animals using sentinel cattle herds – BEF, BTV & Simbu viruses;
- Vector distribution monitored mainly by use of light traps targeting *Culicoides* spp;
- Virus transmission patterns established to define free areas;

Objectives of the NAMP

- Market access – to facilitate the export of live cattle, sheep and goats, and ruminant genetic material to countries where arbovirus certification is required;
- Bluetongue early warning – to detect incursions of exotic strains of bluetongue virus (BTV) and vectors (*Culicoides* species biting midges) into Australia
- Risk management – to detect changes in the seasonal distribution in Australia of endemic bluetongue, Akabane and BEF viruses and their vectors, to support livestock exporters and farmers

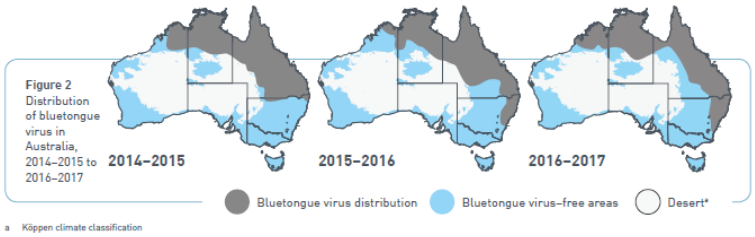


Figure 2 Distribution of bluetongue virus in Australia, 2014–2015 to 2016–2017

Distribution of Bluetongue viruses in Australia

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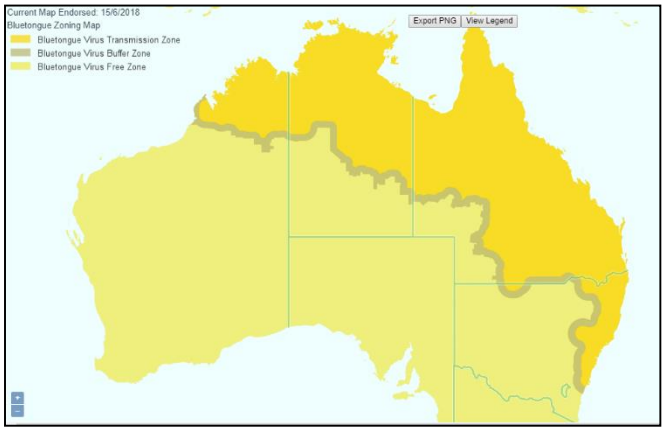
Bluetongue zones in Australia

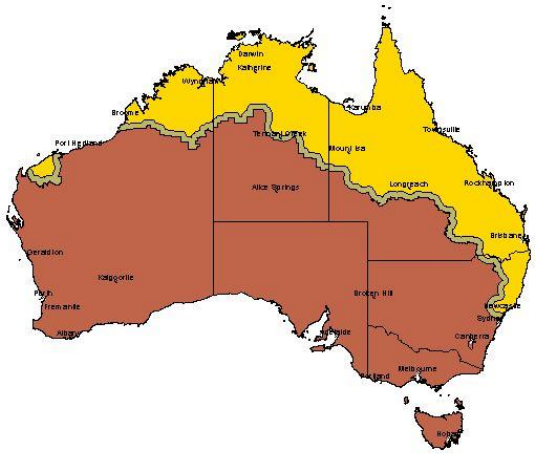
- BTV zone defined by composite distribution of viruses in previous 2 years
- A location must be BTV free continuously for 2 years to effect a change of status
- Detection of BTV in a sentinel herd in free zone activates immediate investigation, notification and change of status if BTV confirmed;
- Zone map changed and notification by email to exporters or anyone registered to receive notification of changes;

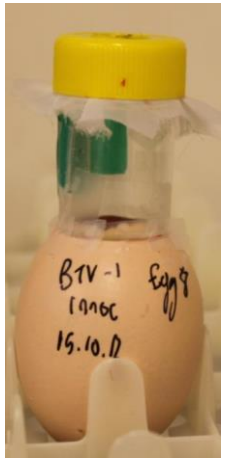


Bluetongue virus research

Research undertaken to:

- Investigate epidemiology of BTVs in Australia;
- Study pathogenicity of viruses - why no disease in the field?
- Investigate vector competence;
- Molecular characterization of new strains of BTV each year to identify serotype and topotype (origin).
- Develop improved diagnostic tests eg serotype-specific qRT-PCR assays;





Challenges for the diagnosis of arbovirus disease

Some of the limitations:

- Early reporting and appropriate samples early in the course of the disease;
- Orbiviruses have prolonged viraemias/detection of RNA
- Orthobunyaviruses have very short viraemias;
- Disease outbreaks with congenital defects are the outcome of infection many months ago.
- Background infection with non-pathogenic strains/serotypes (eg orbiviruses, orthobunyaviruses)
- Multiple infections resulting in extensive cross reactivity in serological assays (eg flaviviruses)
- Animals may be strongly seropositive by the onset of disease (eg WNV in horses – role of IgM based assays)

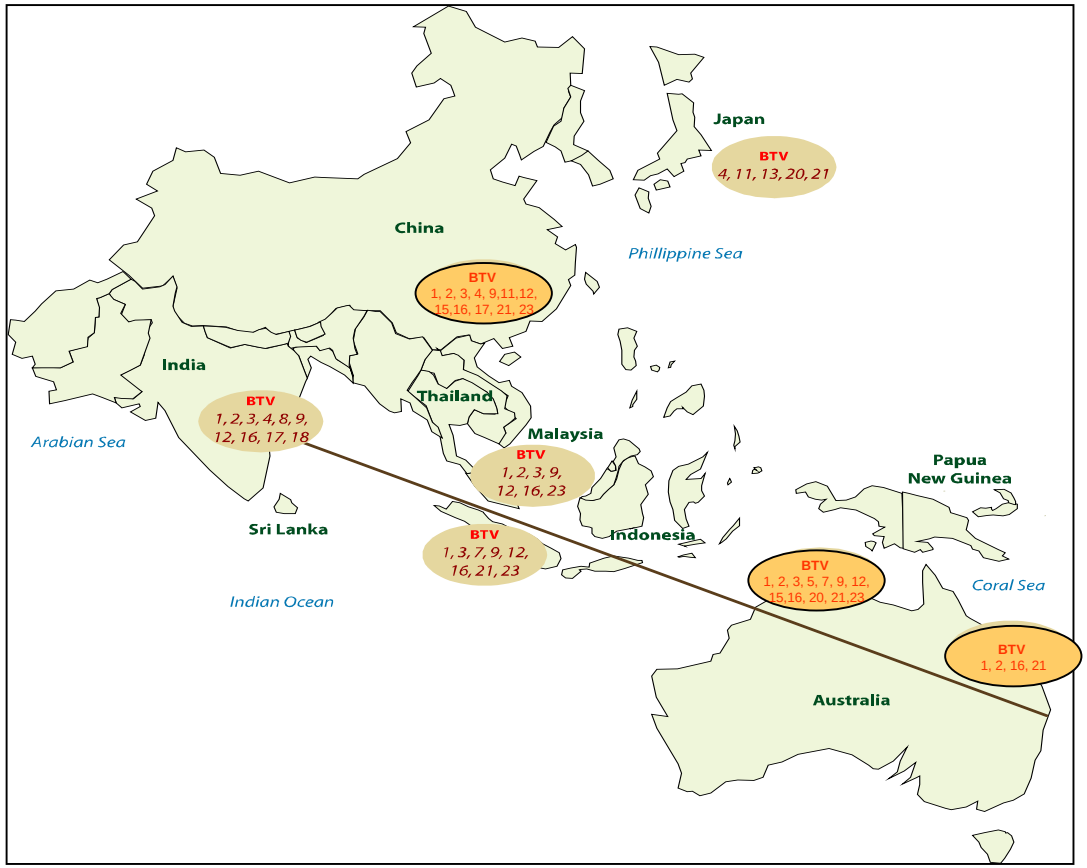

Thank you for your attention

Trends in the Australasian region

- Considered to be an evolving episystem;
- Viruses moving from equatorial regions to the north and south

Trends in the Australasian region

- Recent incursions of BTV 2, 5, 7 &12 into Australia;
- Evidence of exchange of genotypes (within a serotype) between Australia and southern Asia;
- Will other serotypes move to Australia or the Asian region??



Example of sentinel herd results

PATERSON - BTV1 PCR (2016/17)

ANIMAL	EARTAG	MAR	APR	MAY	JUN	JUL	END
1	1619	NT	35.8	38.1	-	NT	NT
2	1620	NT	32.9	38.1	-	NT	NT
3	1621	NT	32.8	37.7	-	-	NT
4	1622	NT	32.2	36.0	34.3	32.3	NT
5	1624	NT	-	39.0	-	-	NT
6	1625	NT	-	-	36.9	NT	NT
7	1626	NT	33.9	-	-	-	NT
8	1627	NT	-	34.4	33.8	34.8	NT
9	1629	NT	-	-	-	-	NT
10	1630	NT	33.0	35.8	-	-	NT
At Risk (A)		9	9	1	0	0	0
No S/C (S)		0	8	1	0	0	0
TOTAL (T)		10	10	10	10	10	10

PATERSON - BTV21 PCR (2016/17)

ANIMAL	EARTAG	MAR	APR	MAY	JUN	JUL	END
1	1619	NT	-	-	-	NT	NT
2	1620	NT	-	38.0	-	NT	NT
3	1621	NT	-	-	-	-	NT
4	1622	NT	36.7	-	36.1	-	NT
5	1624	NT	-	-	-	-	NT
6	1625	NT	-	-	34.6	NT	NT
7	1626	NT	-	33.1	30.7	-	NT
8	1627	NT	31.3	30.3	30.3	37.6	NT
9	1629	NT	35.6	31.6	32.5	31.9	NT
10	1630	NT	-	31.4	-	36.2	NT
At Risk (A)		9	9	1	0	0	0
No S/C (S)		0	8	1	0	0	0
TOTAL (T)		10	10	10	10	10	10

PATERSON - BTV16 PCR (2016/17)

ANIMAL	EARTAG	MAR	APR	MAY	JUN	JUL	END
1	1619	NT	-	-	-	NT	NT
2	1620	NT	-	-	-	NT	NT
3	1621	NT	-	-	-	-	NT
4	1622	NT	-	-	-	-	NT
5	1624	NT	29.0	30.3	31.9	31.9	NT
6	1625	NT	35.7	36.6	40	NT	NT
7	1626	NT	-	-	-	-	NT
8	1627	NT	-	-	-	-	NT
9	1629	NT	-	-	-	-	NT
10	1630	NT	-	-	-	-	NT
At Risk (A)		9	9	1	0	0	0
No S/C (S)		0	8	1	0	0	0
TOTAL (T)		10	10	10	10	10	10

Example of sentinel herd results

PATERSON - BLUETONGUE VIRUS - ELISA (2016/17)

ANIMAL	EARTAG	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	END
1	1619	-		-	-	-	-	85+	90+	93+	93+	95+
2	1620	-		-	-	-	-	95+	94+	88+	92+	90+
3	1621	-			-	-	-	-	91+	92+	93+	97+
4	1622	96+		94+	95+	96+	92+	94+	93+	88+	95+	91+
5	1624	-		-		-	-	86+	88+	77+	91+	96+
6	1625	-			-	-	-	92+	92+	93+	83+	94+
7	1626	-		-	-	-	-	91+	93+	93+	91+	95+
8	1627	-		-	-	-	-	65?	92+	92+	90+	95+
9	1629	-		-	-	-	-	91+	93+	84+	90+	95+
10	1630	60?		-	-	-	-	92+	93+	91+	71+	96+
At Risk (A)		8		6	8	9	9	9	1	0	0	0
No S/C (S)		0		0	0	0	0	8	1	0	0	0
TOTAL (T)		10		8	9	10	10	10	10	10	10	10

PATERSON - BLUETONGUE VIRUS - PAN PCR (2016/17)

ANIMAL	EARTAG	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	END
1	1619	NT		NT	NT	NT	-	33.4	31.4	33.7	-	NT
2	1620	NT		NT	NT	NT	-	32.6	31.7	33.9	-	NT
3	1621	NT			NT	NT	-	32.2	30.3	32.2	32.8	NT
4	1622	NT		NT	NT	NT	-	31.1	29.9	28.8	30.4	NT
5	1624	NT		NT		NT	-	26.9	27.6	28.9	30.9	NT
6	1625	NT			NT	NT	-	33.4	33.8	34.3	-	NT
7	1626	NT		NT	NT	NT	-	32.6	31.5	31.9	33.4	NT
8	1627	NT		NT	NT	NT	-	28.6	28.4	29.4	32.6	NT
9	1629	NT		NT	NT	NT	-	34.9	30.7	29.9	32.0	NT
10	1630	NT		NT	NT	NT	-	31.5	29.4	32.1	33.0	NT
At Risk (A)		8		6	8	9	9	9	1	0	0	0
No S/C (S)		0		0	0	0	0	8	1	0	0	0
TOTAL (T)		10		8	9	10	10	10	10	10	10	10