

AUSTRALIAN VETERINARY EMERGENCY PLAN

AUSVETPLAN

1996

Disease Strategy

Bluetongue

AUSVETPLAN is a series of technical response plans that describe the proposed Australian approach to an exotic animal disease incursion. The documents provide guidance based on sound analysis, linking policy, strategies, implementation, coordination and emergency-management plans.

Agriculture and Resource Management Council of Australia and New Zealand

This Disease Strategy forms part of:

AUSVETPLAN Edition 2.0, 1996

[AUSVETPLAN Edition 1.0, was published in 1991]

This strategy will be reviewed regularly. Suggestions and recommendations for amendments should be forwarded to the AUSVETPLAN Coordinator (see Preface).

Record of amendments to this manual:

[Insert record of amendments as necessary]

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PREFACE

This **Disease Strategy** for the control; and eradication of **bluetongue**, is an integral part of the **Australian Veterinary Emergency Plan**, or AUSVETPLAN (Edition 2.0). AUSVETPLAN structures and functions are described in the **Summary Document**.

This strategy sets out the disease control principles that were approved in February 1991 by the then Australian Agricultural Council at meeting number 135, for use in a veterinary emergency caused by the introduction of exotic virulent bluetongue to Australia. The strategy has been updated and approved by the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) out-of-session in January 1996.

Bluetongue is designated as a List A disease by the Office International des Epizooties (OIE). List A diseases are, 'Communicable diseases which have the potential for serious and rapid spread, irrespective of national borders; which are of serious socioeconomic or public health importance and which are of major importance in the international trade of animals and animal products'. The principles contained in this document for the diagnosis and management of an outbreak of bluetongue conform with the **OIE International Animal Health Code 1992** (OIE Code; see Appendix 3).

Bluetongue (in its classical virulent form) is included in the list of diseases for which arrangements exist under the Commonwealth/States cost-sharing agreement for the eradication of certain exotic animal diseases. Information on the cost-sharing arrangements can be found in the AUSVETPLAN **Summary Document** and **Valuation and Compensation Manual**.

Detailed instructions for field implementation of the strategies are contained in the AUSVETPLAN **Operational Procedures Manuals** and **Management Manuals**. Cross-references to strategies, manuals and other AUSVETPLAN documents are expressed in the form:

Document Name, Section no.

For example, **Decontamination Manual, Section 3**.

In addition, *Exotic Diseases of Animals: A Field Guide for Australian Veterinarians* by W.A. Geering, A.J. Forman and M.J. Nunn, Australian Government Publishing Service, Canberra, 1995 (**Exotic Diseases Field Guide**) is a source for some of the information about the aetiology, diagnosis and epidemiology of the disease and should be read in conjunction with this strategy.

This strategy will be reviewed regularly. Suggestions and recommendations for amendments should be forwarded to:

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1 NATURE OF THE DISEASE

Bluetongue is an arboviral (insect-borne) virus disease of ruminants of variable clinical severity, characterised by inflammation of mucous membranes, widespread haemorrhages and oedema. Eight of the 24 international serotypes of bluetongue virus, and several related orbiviruses, have been recorded in northern Australia, but many of the highly pathogenic strains of bluetongue virus encountered in Africa, North America and parts of Asia are exotic to this country.

1.1 Aetiology

Bluetongue virus belongs to the *Orbivirus* genus of the Reoviridae family. The genome consists of ten segments of double-stranded RNA. Thus far 24 serotypes are recognised, of which eight have been isolated in Australia. At least four of these serotypes (BLU 3, 15, 16 and 23) are pathogenic under experimental conditions (Johnson et al, 1992).

The virulence of bluetongue virus strains varies considerably. However, other factors also influence the severity of the disease in sheep, including breed, age, exposure of animals to sunlight, walking on rough ground and stress.

To date all initial virus isolations of Australian bluetongue virus serotypes have been from insects, or from cattle with no evidence of clinical disease.

The serotypes are differentiated by serum neutralisation tests, but there are cross-reactions between some serotypes. All bluetongue viruses share group antigens, which can be demonstrated by agar gel diffusion tests, fluorescent antibody tests and group reactive ELISA. Complement fixation tests have been used in the past.

Several other orbiviruses have been loosely termed 'bluetongue-related' viruses because of serological and other relationships to bluetongue virus. The only such viruses known to be pathogenic for livestock are some members of the epizootic haemorrhagic disease of deer (EHD) serogroup and the Palyam serogroup of Reoviridae. Five members of each of these serogroups have been isolated in Australia.

1.2 Susceptible species

All ruminants, including sheep, goats, cattle, buffaloes, camels, antelopes and deer, are susceptible to bluetongue infection. Of the domestic species, sheep are the most severely affected. Sickness is sometimes reported in goats and severe disease and mortalities occur in white-tailed deer in the United States. Although the infection of cattle is of great epidemiological significance, it is generally subclinical. In the endemic region of Australia cattle and deer (farmed and feral) have bluetongue antibodies but no disease has been observed.

Antibodies have been detected in wild carnivores in Africa, and cross-contamination between bluetongue and canine vaccines during manufacture has resulted in the death of some vaccinated dogs in the United States.

Known insect vectors are discussed in Section 1.6.3

1.3 World distribution and occurrence in Australia

Bluetongue occurs as a clinical disease of small ruminants in most countries of Africa, the Middle East, the Indian subcontinent, China, the United States and Mexico. Bluetongue virus is present in Southeast Asia, northern Australia, Papua New Guinea and northern South America, normally without associated clinical disease.

The virus was thought to be confined to Africa but in the past 50 years bluetongue has increasingly been recognised wherever substantial populations of ruminants occur in the tropics and subtropics. The initial detection of virus in countries outside Africa has sometimes occurred because of spectacular outbreaks of disease.

Bluetongue virus and several related genera of orbiviruses are present in northern Australia. Bluetongue virus was first isolated in Australia from a pool of *Culicoides* insects trapped near Darwin in 1975. The virus serotype was identified as BLU 20. Since then, viruses belonging to a further seven serotypes — BLU 1, 3, 9, 15, 16, 21 and 23 — have been isolated from the blood of healthy sentinel cattle. Serological evidence of bluetongue infection has been found in sheep, cattle, buffalo, goats and deer. Apart from one clinical case in a sentinel sheep flock on a research station near Darwin in 1989, there has been no evidence of any clinical disease associated with bluetongue infection of any livestock species in the field in Australia. Experimental infections with these serotypes have produced variable pathogenicity in sheep, but infection has not been reported in the major sheep production areas (see Section 1.6.3).

Serotypes BLU 1 and 21 appear to be endemic in eastern Australia, although there is variable annual seroconversion in sentinel cattle. In favourable seasons cattle on the NSW south coast are infected and in other years activity is not detected in the State. BLU 3, 9, 15, 16, 20 and 23 have only been isolated in the top end of the Northern Territory and in northern Western Australia. Their ecology is not understood and it is not known whether they persist there or are irregularly reintroduced from Southeast Asia. Serotypes have been isolated in Southeast Asia that have not yet reached Australia, and it is likely that additional serotypes will be recovered in northern Australia.

To date, there has been no cases of clinical disease in Australia because the necessary mix of biological and epidemiological variables has not occurred. If this happens, however, disease will occur either insidiously or as a dramatic outbreak. Depending on epidemiological circumstances, an initial outbreak may end naturally, or may require human intervention to control. Once bluetongue disease has occurred, disease may become a regular feature, as is the case now with other endemic, insect-borne viral diseases.

1.4 Diagnostic criteria

[For terms not defined in the text see Glossary]

1.4.1 Clinical signs

Sheep

Bluetongue is primarily a disease of sheep but when sheep have positive BLU serology, care must be taken to avoid confusing clinical bluetongue and diseases with similar clinical signs (see Section 1.4.4).

The clinical signs in sheep can be very variable, ranging from acute to subclinical. The acute signs begin with fever, which may last about a week. The incubation period, generally 4–8 days, is possibly influenced by the dose of virus received. Within 24–36 hours of the onset of fever the lining of the mouth and nose become hyperaemic. This is accompanied by excess salivation and a clear nasal discharge. Over the next few days the discharge becomes thick with mucus and pus and may be blood stained. It eventually dries to form a crust around the nostrils.

In acute cases, the lips and tongue become very swollen and oedema may extend over the face to include the ears and intermandibular space. The hyperaemia becomes more intense and tiny, flat, red or purple (petechial) haemorrhages appear on the mouth, nose and conjunctival linings. The clinical feature that gives the disease its name, a deeply cyanotic (blue) tongue, occurs in only a small percentage of cases.

Necrotic lesions develop on the gums, cheeks and tongue 5–8 days after the onset of fever. These heal slowly under a membrane of pus and serum (diphtheritic membrane). Breathing becomes difficult. Profuse bloody diarrhoea occurs in some cases. Vomiting may also occur and lead to inhalation pneumonia.

Foot lesions, on one to four feet, may appear towards the end of the fever period. There is acute reddening and petechial haemorrhages on the coronary band at the top of the hoof. Affected sheep stand with arched backs and are reluctant to move.

There is rapid weight loss and weakness due to loss of appetite and specific muscular necrosis. Spasmodic twisting of the head and neck to one side (torticollis) is sometimes a late sign.

The mortality rate is variable: in highly susceptible sheep it can be up to 70%. Deaths may occur at any stage up to a month or more after the onset of signs. Convalescence in surviving sheep is prolonged. Breaks occur in wool, which add to the production losses.

Infection of pregnant ewes may lead to abortions, mummified foetuses, or the birth of stillborn or weak lambs, which may have congenital defects.

Experimental. In Australia, clinical signs in experimental sheep infected with bluetongue virus varied from inapparent through to a range of the signs discussed above. Depression, lameness, unwillingness or inability to stand, pneumonia and laboured breathing were observed. Lameness was caused by severe inflammation of the corona at the top of the hoof, which was sensitive to touch. Facial and submandibular oedema was present in more severe cases, and up to 40% of sheep died, although they were kept in isolation facilities where they were protected from sunlight and did not have to walk.

Goats

Goats are less commonly, and less severely, affected than sheep. The pathogenesis is similar and the clinical signs are milder.

Cattle

Infection in cattle, although of great epidemiological significance, is generally subclinical. Bovine bluetongue disease has not been recorded in Australia.

A report from the United States suggested only 0.01% of cattle infected with bluetongue virus show clinical signs. These include inflammation and mucosal erosions in the mouth and nose, mild laminitis and a stiff gait. Infection of early pregnant animals may lead to embryonic death and resorption.

Deer

Severe disease and mortalities occur in white-tailed deer in the United States where the pathogenesis and clinical signs are indistinguishable from the closely-related EHD virus.

Both farmed and feral deer in the endemic region of Australia have bluetongue antibodies, but no disease has been observed.

1.4.2 Pathology**Gross lesions**

In sheep the basic pathological process is endothelial damage. Haemorrhages, 2–15 mm in diameter, in the tunica media at the base of the pulmonary artery are regarded as being very characteristic of bluetongue. The most prominent gross lesions in the gastrointestinal tract are found in and around the mouth. There is oedema and hyperaemia in the mucosa which is occasionally cyanotic. Petechial or ecchymotic haemorrhages may also be present. Abrasions, which may be covered by grey necrotic material, are found on the lips, dental pad, tongue and cheeks. Hyperaemia of the ruminal pillars and reticular folds is common.

The lymph nodes and spleen are moderately enlarged and haemorrhagic. Pale areas of necrosis are scattered through the skeletal musculature. There is inflammation of the upper respiratory tract causing excess mucus secretion (catarrhal inflammation) and oedema of the lungs.

Microscopic lesions (histopathology)

Histologically, there is damage to the endothelium of small blood vessels. This results in vascular occlusion and clotting. In epithelial tissues this leads to lack of oxygen and sloughing of the epithelium.

Experimental Australian cases exhibited haemorrhages, inflammatory mononuclear cell infiltrations and necrosis of the heart muscle (myocardium).

1.4.3 Laboratory tests

Animal specimens should initially be sent to the State or Territory diagnostic laboratory from where they will be forwarded to the Australian Animal Health Laboratory (AAHL), Geelong for exotic disease testing after obtaining the necessary clearance from the chief veterinary officer (CVO) of the State or Territory of the disease outbreak and informing the CVO of Victoria (for transport of the specimens to Geelong).

Specimens required

It is essential for the diagnosis of bluetongue that the most appropriate specimens are carefully collected and properly transported. The following specimens are required for the diagnosis of bluetongue.

- Two 10 mL samples of blood from the jugular vein of each of up to six sheep with high (in excess of 40.5°C) temperatures. The virus is usually present in highest concentration in the blood of sheep during the early stage of the fever. Viraemia persists after the temperature subsides, but at a lower concentration. One 10 mL of blood is run into a sterile bottle and allowed to clot to provide a serum sample for the antibody test, and a second 10 mL is added to an anticoagulant, preferably EDTA, in vacutainers or commercially prepared disposable tubes. Separate needles should be used for blood collection from each animal to avoid cross-contamination of samples or the cross-infection of animals. The samples should be tightly capped and the one

with anticoagulant well rotated to ensure adequate mixing. As an extra precaution against leakage, adhesive tape should be wrapped round the cap and the top of the bottle.

- Sera from 10–15 convalescent sheep (if there are any). If no convalescent sheep are present, sera should be collected from in-contact sheep.
- Sera from in-contact cattle, ideally yearlings, and from other ruminants.
- Spleen and lymph nodes from all postmortem cases.
- Cardiac and skeletal muscle (especially if abnormal) in formol saline.

Transport of specimens

Specimens should be submitted on wet ice. If ice blocks are used, extreme care should be taken to ensure specimens do not contact the blocks. Direct contact with ice causes freezing, which inactivates the virus. Whole blood should be held at +4°C for transmission experiments with wild virus.

A full history and identification of samples is necessary. Duplicate samples, for differential diagnosis of endemic disease, should be collected and retained by the State/Territory diagnostic laboratory. For further information see the **Laboratory Preparedness Manual, Section 6 and Appendix 3**.

Laboratory diagnosis

Serological examination at the regional veterinary laboratory should be capable of providing results in 24–48 hours. Virus isolation by more traditional methods will provide confirmatory results in 1–3 weeks. AAHL testing will be directed towards demonstrating virus. Rapid diagnostic tests have been developed that give a provisional diagnosis within 24–48 hours, providing there is adequate virus in the sample. Diagnostic tests currently available at AAHL are shown in Table 1, below.

Table 1 Diagnostic tests currently available at AAHL for bluetongue

Test	Specimen required	Test detects	Time taken to obtain result
Antigen detection ELISA	whole EDTA blood or tissues	antigen	4 hours
Polymerase chain reaction	whole EDTA blood or tissues	virus topotype	2 days
Virus isolation and identification	whole EDTA blood	virus	1–3 weeks
Serotyping	virus isolate	serotype	5 days
Competition ELISA	serum	IgM and IgG antibody	4 hours
Indirect ELISA	serum	IgG antibody	4 hours
Serum neutralisation	serum	antibody	5 days
Pathogenicity testing in sheep	virus isolate	virulence	2 weeks

Source: Information provided by AAHL, 1995 [refer to AAHL for the most up-to-date information].

1.4.4 Differential diagnosis

The following sheep diseases must be considered in the differential diagnosis for bluetongue:

- scabby mouth (contagious pustular dermatitis)
- acute photosensitisation
- lameness due to footrot, foot abscess and other foot conditions
- acute haemonchosis (with depression and submandibular oedema)
- facial eczema
- *Oestrus ovis* infestation
- pneumonia
- plant poisoning
- Akabane disease (when deformed lambs are seen)
- infection with an EHD virus
- salmonellosis
- sheep pox
- foot-and-mouth disease
- peste des petits ruminants/rinderpest

1.5 Resistance and immunity

All species of ruminants appear to be susceptible to infection with bluetongue virus, although, in most, the infection does not result in disease. Disease is occasionally reported in goats, and in deer (United States) and cattle (United States and South Africa). The genetic basis of susceptibility/resistance is unknown.

After infection via the saliva of a biting midge, bluetongue virus multiplies in the regional lymph node and then spreads in the blood. This systemic multiplication and spread allows ample opportunity for humoral and cell-mediated immune responses to develop.

1.5.1 Innate and passive immunity

Sheep indigenous to tropical countries in Africa, the Middle East, Asia and the New World can be infected with bluetongue, but do not usually exhibit disease.

The lambs of susceptible breeds have been shown to be partially protected by colostral immunoglobulins (Jeggo et al 1984) when challenged several days after birth. This protection is temporal and serotype specific, and may be partial depending on the amount of colostral IgG transferred, and appears to offer little use as a disease control mechanism.

1.5.2 Active immunity

Systemic antibody is first detected around 1–2 weeks after infection and humoral immunity is considered to be lifelong and the most important protective mechanism against reinfection. After a single infection, group and type-specific antibodies can be detected. Neutralising antibodies are usually monotypic, although cross-reactions have been noted between serotypes BLU 3 and 16, 6 and 21, 4 and 20 and 5 and 9.

Normally consecutive infections with a second and especially a third serotype give rise to a comparatively short-lived, broad-reacting neutralising antibody response.

The persistence of virus in the body's circulation in the presence of homologous neutralising antibody can be explained by the intimate association of virus with the membranes of circulating erythrocytes and the consequent inaccessibility of the virus to immune mechanisms.

The immune response can sometimes be harmful. For example, the occasional disease in cattle is allergic, ie IgE-antibody-based (Osburn 1990); and although dual (concurrent) infections of sheep are uncommon, when they do occur the disease can be unusually severe, possibly via an antibody-dependent enhancement mechanism.

1.5.3 Cell-mediated immunity

The natural role of cell-mediated immunity is uncertain. Cellular immune responses have been demonstrated experimentally. They have been shown to be broadly reactive, but short lived.

1.5.4 Interferons

Bluetongue virus has been shown by some to be a potent stimulator of interferons. This may make sheep temporarily refractory to infection with a second virus type during early infection with an initial serotype, and may explain why dual infections are uncommon in individual animals when multiple serotypes are active in a livestock population.

1.5.5 Vaccination

Three types of vaccines can be considered: inactivated (killed), attenuated ('live') and recombinant virus vaccines, each of which is discussed below.

Inactivated vaccines

Inactivated vaccines are not used in endemic countries and effective ones have yet to be developed.

Attenuated ('live') vaccines

These are used widely and effectively in southern Africa and the United States. They are serospecific, but their disadvantages are:

- there is a risk of recombination of the vaccinal strain with field virus that could give rise to a new strain of virus of high virulence;
- there is the potential problem of reversion to virulence;
- attenuated bluetongue virus can cross the placenta and pregnant ruminants vaccinated with attenuated vaccines may suffer reproductive failure or produce offspring with congenital abnormalities (field virus does not cross the placenta);
- attenuated vaccine virus is likely to be excreted in the semen of vaccinated males during and soon after the viraemic period (field virus is rarely excreted in semen);
- the vaccine must be made from the serotype(s) responsible for the outbreak of clinical disease.

Recombinant vaccines

Second generation non-infectious subunit vaccines (recombinants and constructs) overcome some of the problems of attenuated vaccines. However, subunit proteins of one serotype will not give complete long-term protection against all serotypes. By careful choice of components, a broad-spectrum vaccine could be developed. Recombination

with field virus is not a problem. Non-infectious vaccines will not cause congenital abnormalities. Recombinant vaccines are under development and are not yet available.

Vaccination is discussed in more detail in Section 2.2.9

1.6 Epidemiology

Bluetongue is non-contagious. It is biologically transmitted by *Culicoides* insects (midges), but only a limited number of *Culicoides* species are efficient vectors (see Section 1.6.3). Cattle are the main amplifying hosts for bluetongue virus. They are also probably important maintenance hosts. The competent *Culicoides* vector species feed more abundantly on cattle.

The incidence and geographical distribution of bluetongue infections in Australia are determined largely by the distribution of insect vectors and this can vary from year to year. Infection in sheep is preceded by widespread infection of cattle and an increase in vector density. Very few sheep-to-sheep transmissions are believed to occur in Australia.

Major considerations for a bluetongue control strategy in Australia include:

- certain serotypes of bluetongue virus have been identified in parts of Australia;
- vectors competent to transmit the disease are present but are more likely to feed on cattle than sheep;
- the most effective vectors have limited distribution in Australia due to climatic factors;
- cattle have an important epidemiological role as primary and amplifying hosts, and as ongoing sources of infection for vectors; and
- the disease is most likely to occur in late summer or early autumn, due to the build-up of both virus in cattle and vector numbers.

1.6.1 Incubation period

The incubation period in susceptible animals is generally 4–8 days, and is possibly influenced by the dose of virus received. Because clinical disease in sheep usually follows amplification of virus in cattle and spread from cattle to sheep, disease may not be observed until one to two months after pathogenic virus has entered an area. The OIE Code specifies an incubation period of 40 days (see Appendix 3).

1.6.2 Persistence of virus

Bluetongue virus does not survive outside the vector species or susceptible hosts.

Live animals

In the older literature there are reports of long-term carrier states in cattle and sheep. However, most of the work was undertaken before researchers recognised the significance of multiple re-infection of animals with different virus serotypes. The duration of viraemia depends on several factors, including the strain of the virus, the longevity of the mammalian host's cells with which it is associated, and the sensitivity of the system used to detect the virus. Although virus may be detected in the blood of cattle in the experimental situation for several months (and in sheep for several weeks), infected animals can only transmit virus to a competent biting vector for several weeks after infection. It is now considered that the maximum duration of effective viraemia is

normally about 50 days in cattle and 20 days in sheep, although most animals are infectious to vectors for a much shorter period.

Animal products and by-products

Animal carcasses and products such as meat and wool are not a method of spread.

Environment/fomites

Bluetongue virus does not persist in the environment and fomites do not play any role in the spread of the disease. Insect vectors can be carried over long distances by wind (see Sections 1.6.4 and 1.7).

Vectors

Vectors are infected for life. When susceptible midges bite viraemic hosts (normally cattle), sufficient virus may be imbibed to infect the insect. The virus may cross the gut of the insect and after an intrinsic incubation period of 1–2 weeks is excreted in the saliva of competent midges when they feed (1–2 times a week). See further discussion of insect vector species in Section 1.6.3.

1.6.3 Modes of transmission

Bluetongue is not a contagious disease. The virus is not normally transmitted by direct contact, or by indirect means, between animals in the absence of insect vectors. Virus has only rarely been detected in bull semen (see below).

For a midge to be a vector of bluetongue it must be exposed to infection by feeding on (viraemic) hosts. The virus must then infect the midge and be excreted by it when it subsequently feeds. Of the 180-odd midge species in Australia, only 6 species of *Culicoides* in northern Australia have been shown to be capable of being infected by bluetongue virus and of playing a role in the ecology of the disease. These are *C. actoni*, *brevitarsis*, *fulvus*, *oxystoma*, *peregrinus* and *wadai* (Standfast et al 1992). *C. brevitarsis* is the most common. Figure 1 shows the maximum known geographical range of these species based on insect collections over the years to 1993.

Light trap collections have indicated that *C. actoni*, *fulvus*, *oxystoma* and *peregrinus* are not likely to be involved in any transmission of virus from cattle to sheep. Therefore *C. brevitarsis* and *C. wadai* are the vectors of concern for disease in sheep. *C. brevitarsis*, is closely associated with cattle and not only has a strong host preference for cattle (and horses), but also lays its eggs, after feeding, in cattle dung. The life cycle of *C. brevitarsis* is described in Figure 2. *C. wadai* has a similar life cycle.

C. wadai is abundant in northern and eastern Australia. It was first recorded in 1971 near Darwin, and it is presumed that it has not yet achieved its maximum geographic distribution. It has the potential to expand into commercial sheep-producing areas (Figure 3).

BLU 1 and 21 are endemic in Queensland and northeast New South Wales and have extended as far as southern coastal New South Wales in favourable seasons. To date serotypes BLU 3, 9, 15, 16, 20 and 23 have been detected only in the Northern Territory and northern Western Australia.

C. marksi and *C. victoriae* are present in large numbers in the sheep-raising areas of southern Australia and feed on sheep. If they were capable of transmitting bluetongue virus, this would be of great significance. However, there is strong epidemiological evidence that neither transmits bluetongue virus and experimental evidence that the latter

is refractory to infection. Cattle have been found to be seropositive for bluetongue virus only within the range of *C. actoni*, *brevitarsis*, *fulvus*, *oxystoma*, *peregrinus* and *wadai*.

Virus transmission may occur at any time of the year in the tropics, but is most active after seasonal rainy periods. In Australia the favoured transmission season is the latter half of summer and autumn. In the more temperate areas of its range, such as parts of South Africa and the United States, bluetongue occurs seasonally. Outbreaks occur in late summer and early autumn, but stop suddenly with the onset of frosts.

Figure 4 shows the areas of Australia where bluetongue virus is considered to be endemic.

Artificial breeding

Virus rarely may be excreted in the semen when males are viraemic. Excretion is more likely if there is inflammation of the genital tract, if the animal is aged or if the virus has been laboratory adapted (as in live vaccines or experimental infection; see Section 1.5.3). Contaminated semen may infect recipient cows, but these will not initiate a cycle of transmission unless competent insect vectors are abundant. Infection of other ruminant species presumably occurs under similar circumstances.

There is much evidence from in vitro and in vivo work that embryos from infected donors washed to International Embryo Transfer Society (IETS) protocols do not transmit the virus. (See the **Artificial Breeding Centres Enterprise Manual**.)

1.6.4 Factors influencing transmission

Bluetongue virus may be introduced to new regions by the movement of infected animals, but will survive in a new region only if competent vectors and sufficient susceptible hosts are present. Natural spread of infected insect vectors from endemic areas during favourable seasons, or possibly by the long distance carriage of infected vectors in wind currents, is possible (see Section 1.7).

Temperature, wind direction and distance from source of infection are all relevant factors in the dispersal of *Culicoides* as follows.

Temperature:

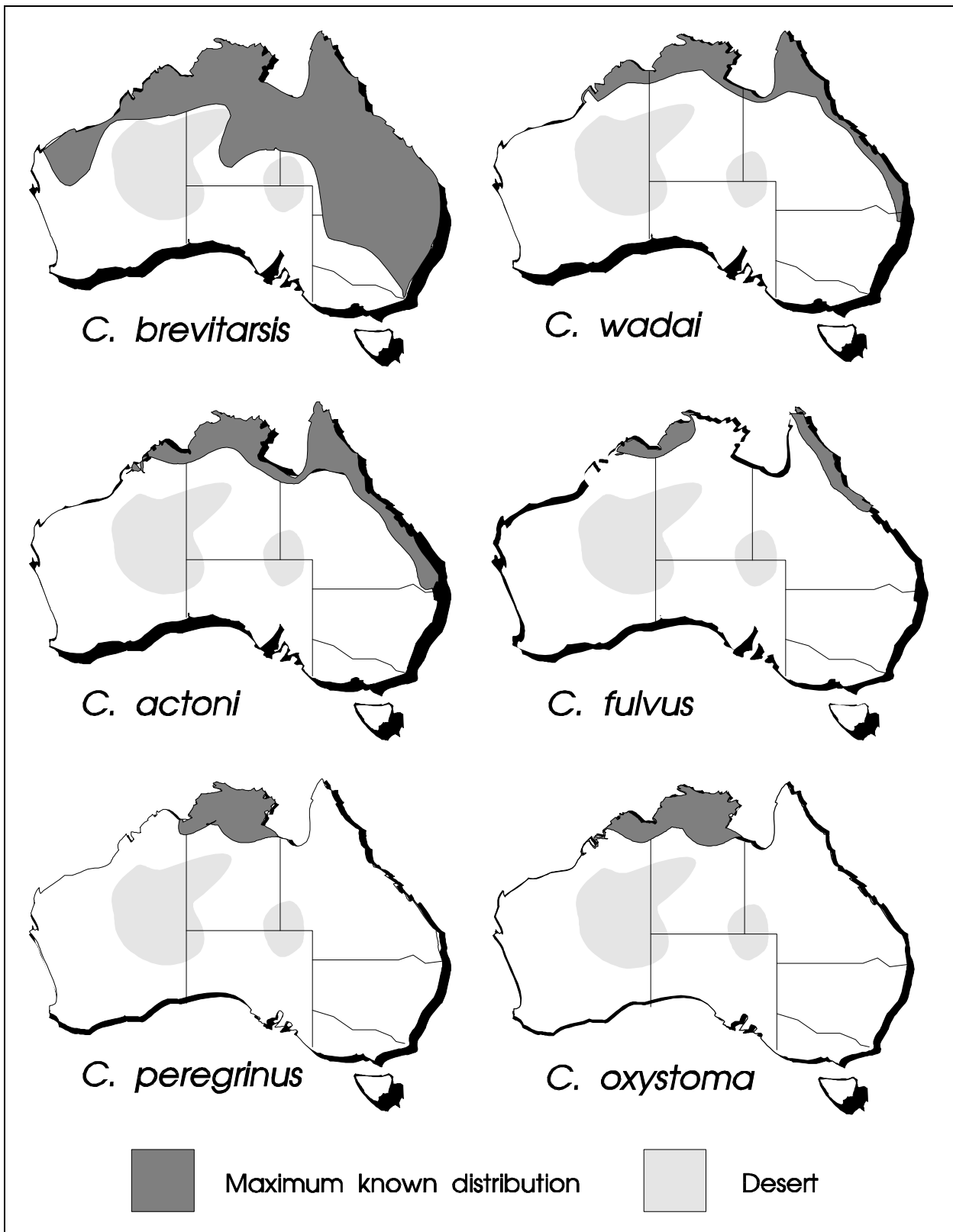
- the insects breed and are more active in warmer temperatures; adults are killed by frosts, but larvae can survive in dung for up to 2 months at low temperatures.

Wind direction:

- the effect of wind speed is uncertain; lower wind speeds encourage local spread, as the insects will not fly in higher winds (>8 km/hr), although strong winds could cause rapid movement over greater distances.

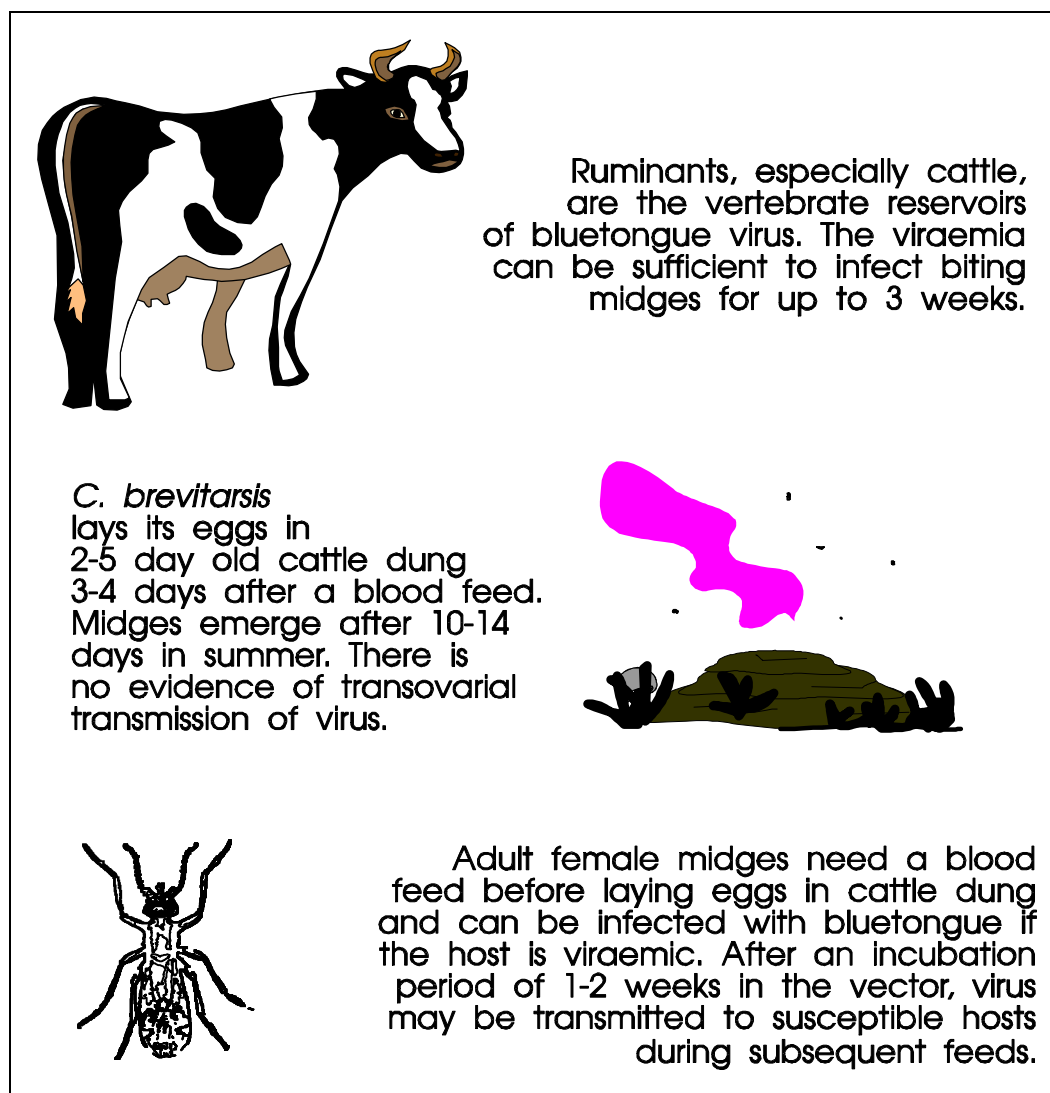
Distance from source of infection:

- models can predict the probability of vector survival over winter. Using recent historical temperature data, the overwinter survival rate of *C. brevitarsis* in NSW is 50% at Port Macquarie and 0% at Goulburn, Tamworth and Mudgee. If temperatures were to rise 2°C (due, for example, to the greenhouse effect), the respective figures would be 100%, 0.1%, 0.1% and 0%.



(prepared by CSIRO Division of Tropical Animal Production, Qld)

Figure 1 Maximum known range of bluetongue vectors



(prepared by CSIRO Division of Tropical Animal Production, Qld)

Figure 2 The life cycle of bluetongue virus and *C. brevitarsis*

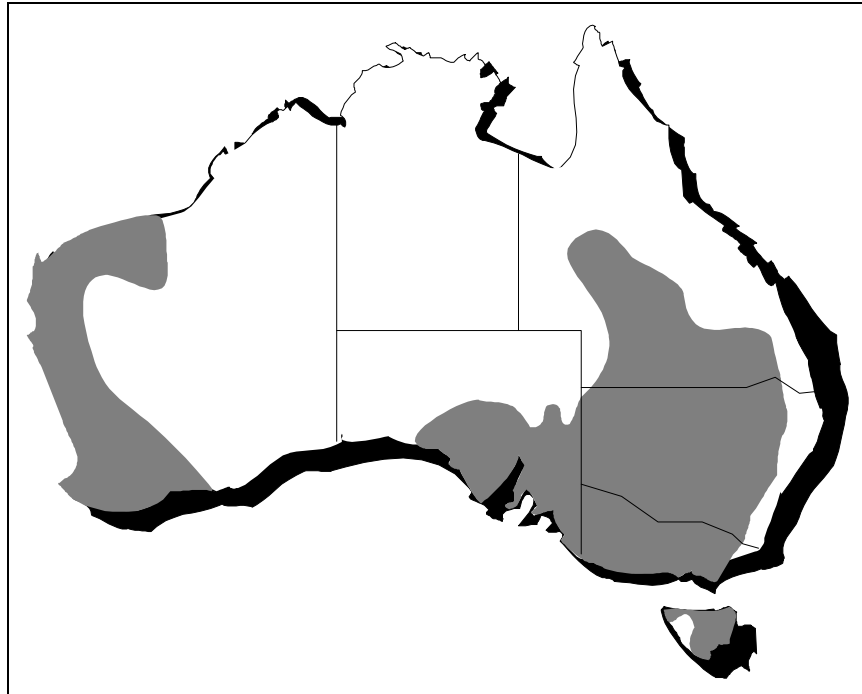
1.7 Manner and risk of introduction

Bluetongue virus may spread by the movement of viraemic ruminants, the inoculation of infected imported biological products into ruminants, or by the wind dispersal of infected vectors. Australian quarantine should prevent the legal introduction by the first two means, but is defenceless against the last.

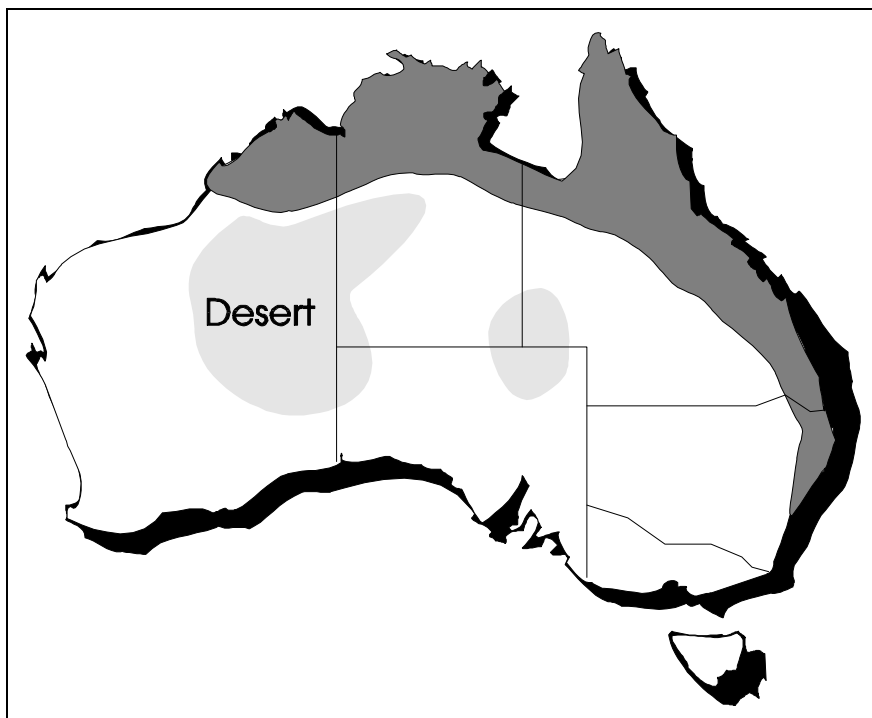
It is generally accepted that windborne spread of bluetongue-infected vectors occurred across the Mediterranean. The most plausible portal of entry to Australia is via infected midges blown on the annual north-west monsoons from Indonesia to the top end of the Northern Territory.

The irregular detection of a total of 8 BLU serotypes in the top end of the Northern Territory suggests that there have been multiple entries of virus. Research undertaken in Southeast Asia has uncovered additional serotypes (BLU 2, 7 and 12) exotic to Australia, so the risk of further serotypes entering northern Australia is substantial.

The natural history of bluetongue in Australia will probably continue to evolve. Serotypes that have been confined to northern Western Australia and the Northern Territory may spread, *C. wadai* will eventually reach its distribution potential when climate allows and potential vectors in Indonesia, such as *C. nudipalpis* and *C. orientalis*, are likely to enter Australia.



(prepared by CSIRO Division of Tropical Animal Production, Qld)
Figure 3 Commercial sheep-raising areas



(prepared by CSIRO Division of Tropical Animal Production, Qld)
Figure 4 Bluetongue virus endemic area

2 PRINCIPLES OF CONTROL AND ERADICATION

2.1 Introduction

The most likely scenario for an outbreak of classical bluetongue in Australia is for the disease to occur in sheep near a known endemic area after an unusually wet season late in the virus transmission season (April–June) (see Section 1.6.3). The transmission cycle ends with the first onset of frosts, which kill infected vectors. Virus activity the following summer–autumn depends on the intervening rainfall, with vector activity contracting northward if a dry spring–summer is experienced.

Serotypes (BLU 1 and 21) that have occasionally infected sheep in Queensland and New South Wales do not appear to be very pathogenic. For an outbreak of disease to occur these serotypes would need to acquire virulence. A more likely scenario is the movement of more pathogenic serotypes (BLU 3, 15, 16 or 23) from the Northern Territory to sheep production areas.

The National Arbovirus Monitoring Program (NAMP) would be expected to detect this movement out of the Northern Territory. A raised level of surveillance would likely be put in place to carefully track any movement of these more pathogenic serotypes into sheep areas.

Before embarking on any control strategy for bluetongue, the initial outbreak must be investigated thoroughly. All environmental factors, including the presence of ruminants, stocking densities, movements of ruminants onto and off the property, and recent rain and wind patterns, should be recorded.

When bluetongue is suspected a specialist diagnostic team should investigate the disease outbreak as follows:

- collect samples for diagnosis as outlined in Section 1.4.3;
- obtain a detailed history of the affected animals and their environment, paying particular regard to the onset of clinical signs or deaths, movements of other animals onto and off the affected and neighbouring properties, insect activity in the area, and the possibility of needle (or other) transmission;
- collect sera and whole blood for serology, virus isolation and transmission studies from other livestock on the affected property and neighbouring properties; and
- arrange for the collection of insects for identification and virus isolation.

For further discussion of the investigation phase, see the **Control Centres Management Manual**).

Overall disease control strategy

It is unlikely that sufficient vaccines will be available in the first disease outbreak season to protect susceptible sheep (see Section 2.2.9). Hence, in the year of occurrence, the control strategy should involve containing spread and reducing transmission by all practical means other than vaccination, even though all of these methods have limitations. Sufficient vaccine (preferably inactivated or subunit) could be available in subsequent year(s) to immunise at-risk populations of sheep if epidemiological investigations indicated that recurrent outbreaks are likely.

The elements of this strategy are described below.

2.2 Methods to prevent spread and eliminate pathogens

2.2.1 Quarantine and movement controls

Although bluetongue is not a contagious disease, prohibiting the movement of affected and in-contact ruminants on the affected and neighbouring properties will slow dispersion of diseased animals and will permit a more detailed epidemiological assessment of the outbreak to be undertaken. Animal welfare considerations may also dictate that clinically-affected sheep should not be moved. The extent of application of quarantine will depend on epidemiological predictions (see Appendix 1).

Zoning

Infection may not occur in particular regions because of the lack of vectors. After any clinical outbreak in Australia, it will be particularly important for trade purposes to demonstrate that vector-free parts of Australia are still vector and virus free. This will be achieved by active surveillance undertaken by NAMP. Zones may be established in accordance with the OIE Code (Appendix 3).

2.2.2 Tracing

Disease will most likely result from the movement of pathogenic virus in infected vectors into sheep-raising areas. This movement should be detected by NAMP. Disease may also occur as a result of moving susceptible sheep into a northern endemic region, or the movement of viraemic cattle from an endemic region to a location where there is an abundance of competent vectors that can carry the virus to sheep. Trace-back may help to establish how disease has entered an area.

2.2.3 Surveillance

After an occurrence of clinical disease surveillance on neighbouring properties will be required. The extent of this will depend on the probability of transmission based on climatic conditions, concentrations of cattle and sheep populations and presumed method of entry of the virus to the area.

Comprehensive vector and serological surveys should be initiated concurrently to establish the past, present and possible future distribution of bluetongue virus in sheep and cattle in the area. The size of the area may be very large (100 km radius), depending on meteorological and other factors provided by epidemiologists. Priority should be given to the area surrounding the affected property(ies).

The initial disease outbreak may be localised, but virus activity will probably be more widespread. NAMP monitors the absence/presence of bluetongue virus, which is required to:

- monitor the absence of the virus for the satisfaction of our livestock trading partners in accordance with OIE requirements;
- track the movement of the various serotypes of bluetongue virus to provide early warning of impending disease; and
- understand the basic ecology of bluetongue virus and other arboviruses.

Vector monitoring is undertaken in conjunction with virus monitoring (see Appendixes 4 and 5).

NAMP is a nationally planned, coordinated and evaluated program. Additional surveillance designed on a sound epidemiological basis may be required for export purposes, in accordance with the OIE Code (Appendix 3) or the requirements of individual countries. Sampling under NAMP is likely to be intensified in the face of an outbreak.

2.2.4 Treatment of infected animals

There is no effective treatment available. Affected animals should be handled humanely, moved as little as possible and provided with soft food, shade and water. Treatment of valuable sheep with non-corticosteroid anti-inflammatory drugs should be considered, as reducing inflammation and pain can help recovery.

2.2.5 Destruction of animals

There is no justification, on disease control grounds, for destruction of affected animals. Although there is no risk of spread of disease, there might be justification for trade, commercial reasons or on animal welfare grounds to destroy affected animals. This can be carried out on the affected property or at an abattoir (see **Destruction of Animals Manual**).

2.2.6 Treatment of animal products and by-products

Meat and wool do not transmit virus so treatments are not necessary. Semen is very rarely contaminated but should not be collected from animals that may be viraemic (see Section 1.6.3).

2.2.7 Disposal

Method of disposal of animals that have died from, or been destroyed because of, bluetongue is not critical, as bluetongue virus does not survive outside living vectors or hosts (see **Disposal Procedures Manual**).

2.2.8 Decontamination of fomites

As infectious virus does not occur free in the environment, decontamination is not necessary.

Disinfection of personnel, equipment and the immediate surroundings is of no benefit in preventing the spread of bluetongue. However, hygienic precautions should be taken to prevent the spread of other diseases, especially before bluetongue has been formally diagnosed. Refer to the **Decontamination Manual, Tables 2.5, 3.5 and 4** for advice on the best disinfectants to use.

2.2.9 Vaccination

Vaccines are not presently available and the most suitable type of vaccine for use in Australia is being investigated. Attenuated ('live') vaccines are used overseas but would not be imported to Australia because of the shortcomings of this type of vaccine (see Section 1.5.5) and there would be the risk of introducing foreign genes into Australia's bluetongue gene pool.

The problems of attenuated vaccine used overseas also need to be taken into account before Australian stocks of attenuated virus, which were prepared as seed for live vaccines, are used. Apart from the fact that attenuated virus (unlike wild virus) can cross the placenta, and also contaminate semen (see Section 1.5.3), it could revert to a virulent virus and become a permanent feature of bluetongue in Australia if vectors biting vaccinated sheep are naturally infected. Experimentally, *C. wadai* has been infected when biting vaccinated sheep. There are current Australian research projects looking into the use of inactivated and subunit vaccine.

Attenuated vaccine seeds have been prepared for all Australian serotypes. Vaccines can be used to raise the immunity of susceptible sheep or theoretically to produce a barrier of resistant animals. The possible vaccination measures are: cattle only; sheep and cattle; and sheep only. Vaccination will reduce the number of susceptible animals, and therefore fewer animals will become viraemic following infection. Vaccination of cattle may be a more effective control measure than vaccination of sheep, as viraemic cattle are more common than viraemic sheep and are more frequently the source of bluetongue virus.

Vaccination of sheep can be effective for reducing the number of cases of bluetongue. The large-scale use of attenuated vaccines in South Africa and Israel has made sheep farming possible in regions where it was previously uneconomical.

There are substantial logistical problems associated with maintaining stocks of vaccine, if the use of attenuated vaccines is to be included in a control strategy. Holding stocks of different serotypes of vaccine 'on the shelf' would be a substantial recurring cost. Where stocks of ready-to-use vaccines of different serotypes are not available for immediate use, delays will occur until they are manufactured. It has been estimated that, if tested bluetongue vaccine seed stocks were held, sufficient attenuated vaccine would not be available for at least twelve months, even if given top priority. This vaccine would only be used for the season following the outbreak.

2.2.10 Wild animal control

Wild animal control is not relevant to the control of bluetongue. Deer and goats are generally unimportant in the spread of disease because vectors have a host preference for cattle and the height and duration of viraemia in cattle is large compared with the other species.

2.2.11 Vector control

When bluetongue is diagnosed in an area, such as southern Australia, where vectors of the virus are not known to occur, steps should be taken to verify that it is indeed a vector-free area by immediately deploying light traps and regular serological monitoring of cattle on neighbouring properties. If vectors are not caught and cattle do not have locally-acquired antibody, the clinically-affected sheep must have been introduced, infected, and cannot act as a (vector-transmitted) source of virus for other animals (see Appendix 4).

Eradication of vectors is not an option. In known vector zones local vectors will be carrying the virus, cattle and other ruminants are likely to provide a reservoir and the virus will have dispersed widely during the incubation period.

Ivermectin treatment of cattle and other ruminants

In a laboratory trial *C. brevitarsis* feeding on cattle treated with the normal subcutaneous anthelmintic dose of the pesticide ivermectin were shown to have a mean mortality rate of

99% for up to 10 days post-treatment, and 40% 18 days post-treatment (Muller and Harris 1994). In a field trial using subcutaneous ivermectin on cattle, a population of *C. brevitarsis* was reduced to a level that provided up to six weeks of low risk of virus transmission.

Further, the dung of cattle treated with ivermectin is larvicidal to *Culicoides* species for up to 28 days. The local transmission of bluetongue can be suppressed effectively for 6 weeks because the effects on adults and larvae are cumulative. The effect on surrounding untreated herds would be minimal. All withholding periods must be observed. On the basis of research to date, treatment of quarantined stock could allow movement of stock in 28 days, by which time they would not be infectious for vectors.

Application of insecticide to the environment

Aerial application of insecticides is an untested method of outbreak control for *C. wadai* and *C. brevitarsis*. Except for very small outbreaks there is insufficient capacity in Australia to deliver insecticide, and widespread application of chemicals is inappropriate because of the indiscriminate effect on the environment. Spraying may be effective against adult insects present in the area sprayed, but as *C. wadai* and *C. brevitarsis* are obligate cattle dung-breeders, the next generation would soon emerge and be unaffected. This option is not considered to be appropriate (see Appendix 5).

Insect repellents

Although trials with livestock have not been undertaken, external treatment with an insect repellent may be used to protect individual valuable animals, in conjunction with other disease control methods. Withholding periods must be observed.

Housing and segregation

In the face of an outbreak, individual stock owners may wish to protect valuable sheep by housing or moving from vector-prone areas.

Housing horses between dusk and dawn is a very effective control measure against 'Queensland itch', which is also caused by *Culicoides* species. This is a useful ancillary control measure for sheep, especially stud rams.

Proximity between sheep and cattle may affect the rate of infection of sheep. In South Africa it has been reported that, because midges have a much greater preference for cattle than sheep, introducing cattle to a sheep flock can draw vectors away from the sheep and reduce the level of virus transmission to sheep (Bath 1989). On the other hand, the presence of cattle may encourage virus amplification and an increase of vector numbers in the local area. It is not known under Australian conditions whether segregation or aggregation of cattle and sheep will influence virus transmission.

2.2.12 Sentinel and restocking measures

As compulsory destocking will not be enforced, the restocking and use of sentinel animals would not occur for bluetongue.

2.2.13 Public awareness

An outbreak of bluetongue could be expected to attract considerable media attention. As a high priority and before there is any media coverage, people with affected stock and others in the immediate vicinity must be contacted and briefed about the situation and its implications. Trading partners and OIE must also be notified within 24 hours of confirmation of diagnosis and before there is any media coverage. Publicity should

instruct producers and the public of the salient features of the ecology of bluetongue, reporting procedures, methods of control (particularly that stamping out will not occur and movement controls will be minimised), treatment and the safety of animal products.

Media releases should be low-key and matter-of-fact, emphasising what to look for and how to report, that animals will not be slaughtered, and that the product is safe for people. Media releases should keep things in perspective, assuming until proven otherwise that this is a predicted and isolated occurrence rather than the start of a major epidemic. For further information see the **Public Relations Manual**.

2.3 Feasibility of control in Australia

A decision on the control measures to be adopted will depend on all the factors considered in the previous sections. None of the control measures discussed may be appropriate or feasible, in which case it could be technically valid and most cost effective to adopt a 'wait and see' attitude and allow the outbreak to run its natural course. Owners may voluntarily vaccinate, at their own expense, if vaccine is available. In an endemic area, it may be appropriate to simply monitor the disease and mount extension activities. This would be especially the case if there was an outbreak towards the end of the arbovirus season in a temperate area. The temptation to overreact must be strenuously avoided.

3 POLICY AND RATIONALE

3.1 Overall policy bluetongue

Bluetongue is an OIE List A disease that has the potential for rapid spread with significant production loss and is of major importance to the international trade in livestock (including sheep, goats, cattle and deer).

The policy is to minimise the economic impact and to eliminate the clinical disease if circumstances permit. This would be feasible if there is early detection of the disease in isolated animals and there is an absence of infected vectors, or if the disease occurs in a vector-free area (or if frosts were imminent in vector areas). If the disease occurs in areas with competent vectors early in the vector season then control will be difficult.

A combination of strategies will be used in limiting and controlling the disease including:

- ☞ *movement controls and quarantine* on livestock in declared areas;
- ☞ *treatment and husbandry procedures* to control vector attack on ruminants, minimise health and production effects and provide animal welfare relief in declared areas;
- ☞ *tracing and surveillance* to determine the source and extent of infection and to provide proof of freedom from the disease;
- ☞ *zoning* to define infected and disease free areas;
- ☞ *vector control* may be considered;
- ☞ *vaccination* as the main disease control strategy if bluetongue becomes established in a recognised sheep district;
- ☞ *an awareness campaign* to facilitate cooperation from industry and the community.

There is no justification for a stamping-out policy but some animals may need to be destroyed for welfare reasons.

The presence of clinical disease will probably result in short-term disruption to the live ruminant export trade until free areas are defined and trading partners are confident in the information. It should not, but may, affect the trade in animal products. There is no scientific justification for any bans on products.

The management of an outbreak will require careful assessment by specialist officers to facilitate plans to lessen the impact of an outbreak.

Bluetongue is included in the Commonwealth/States cost-sharing agreement.

The CVO(s) in the State(s)/Territory(s) in which the outbreak(s) occurs will be responsible for implementing disease control measures (in accordance with relevant legislation), and will make ongoing decisions on follow-up disease control measures in consultation with the Consultative Committee on Exotic Animal Diseases (CCEAD), the State/Territory and Commonwealth governments, and representatives of the affected industries. The detailed control measures adopted will be determined using the principles of control and eradication (Section 2) and epidemiological information about the outbreak. For further information on the responsibilities of the State/Territory disease control headquarters and local disease control centre(s), see the **Control Centres Management Manual, Part 1, Sections 3 and 4**.

3.2 Strategy for control and eradication

When a clinical outbreak of bluetongue disease occurs in sheep, the initial strategy should be as follows:

- quarantine animals on affected properties until an adequate investigation is undertaken; and
- undertake an epidemiological assessment.

The aim of investigations would be to gain an immediate understanding of the extent of infection, vectors and disease, the virulence of the virus, whether it is a new or endemic serotype and whether the outbreak is the start of an epidemic or the tail end of what has largely been a subclinical event. Virus and/or vector-free areas need to be identified as soon as possible. The use of vaccine may depend on the type of vaccine available and the analysis of the epidemiological findings.

There is a need to liaise immediately with industry and then the media to inform them about the presence of the disease and the control measures that are proposed or recommended.

3.2.1 Stamping out

A stamping-out policy would not be justifiable for bluetongue because of the impossibility of eliminating the insect vector. It may be necessary to slaughter infected animals in some cases for animal welfare reasons or perhaps for trade purposes but the latter should be strongly opposed.

3.2.2 Quarantine and movement controls

The premises on which the affected animals are detected will be subjected to quarantine and movement controls and will be officially declared an infected premises (IP) as will all immediately neighbouring premises. This is to attempt to contain the infection until a full investigation is undertaken to determine the correct control strategy for the outbreak.

The IPs will constitute the restricted area (RA) in the first instance while investigations into the extent of the infection are continuing. A control area (CA), if considered necessary, will be declared after epidemiological investigations are complete. If it is considered that the virus has infected the vector population then a control area should be declared immediately to restrict uncontrolled movements of potentially-infected stock into the free areas.

Dangerous contact premises (DCPs) are those that have received animals from the IP during the period of 40 days before the appearance of first clinical signs and until quarantine was imposed on the IP. The need for an RA to surround DCPs will be determined at the time taking into consideration the wide range of factors at that time.

While the infected animals are not contagious, the restriction of a known or potential source of virus will help to reduce spread to free areas and help maintain confidence that infection is not being distributed by known infected animals.

The results of the epidemiological investigations will determine whether continuing quarantine and movement controls are warranted. It is important to be aware of possible trade concerns regarding the movement of animals from the vicinity of the outbreak area to free areas even if they represent negligible risk.

For further details see Appendixes 1, 2 and 3.

Zoning

Zoning is an important strategy that must be implemented to establish trading partner confidence and enable the export trade in live animals to continue. The zones will be determined as a result of the epidemiological investigations and from the information that is available from the past and continuing National Arbovirus Monitoring Program (NAMP). Zoning according to the OIE Code may impose some concerns as it does not relate to vector-free zones (see Appendix 3).

Both the virus and vector-free areas will have to be identified so that the bluetongue-free areas are well defined, recognisable and understood.

3.2.3 Treatment of infected animals

There is no effective treatment of infected animals. It may be necessary, in many cases, to alleviate the effects of the disease for welfare purposes. Anti-inflammatory medications and treatment against secondary infections may be required. Animals should not be moved unless necessary, and should be provided with shade, soft food and water.

If only a few infected animals are involved and vectors are present, it would be advisable to treat these animals with insecticide and insect repellent to reduce further spread of the virus by vectors.

3.2.4 Treatment of animal products and by-products

The virus does not survive in the environment or in animal products and by-products such as meat, milk and wool and does not persist on fomites. It can, however, be found in semen from viraemic bulls. Semen should therefore not be collected from bulls during this infective phase.

3.2.5 Vaccination

It is unlikely that vaccination would be used to help control Australia's first outbreak of bluetongue. Such an outbreak would probably be in the autumn, after one or more favourable seasons have been conducive to the build-up of vectors. The advice is likely to be to 'sit tight' until the first frosts abort the spread of virus. However, if the first outbreak is earlier than expected, and if epidemiological factors suggest that a prolonged period of infection of sheep is likely, vaccine may be used if available (unlikely within twelve months of the initial outbreak). It would cost up to \$0.5 million to develop a tested

attenuated vaccine, with most of the cost involving infrastructure and the establishment of vaccine banks. Individual owners may voluntarily elect to vaccinate with an approved vaccine if one is available. It may be more effective to vaccinate cattle than sheep (see Section 2.2.9) but as cattle are not affected by the disease this may only be considered as an option on farms with both sheep and cattle.

While attenuated vaccines do not have the support of Australian industry and some scientists, they are widely and successfully used in other countries and are reported to be safe and effective. Further investigations may indicate their usefulness in the face of a prolonged outbreak or continuing seasonal clinical disease and in the absence of suitable effective alternatives. At present the only vaccines that have support for use in Australia are inactivated and non-infectious subunit vaccines and effective ones are yet to be developed.

It will be necessary to initiate action that will lead to the availability of an effective vaccine if a decision to vaccinate is made.

3.2.6 Tracing and surveillance

Tracing will be used to determine the movements of ruminants onto and off the IP during the period of 40 days before the first signs of clinical disease and up to the introduction of quarantine and movement controls. The tracing of products, people and things would be of no benefit.

A surveillance and monitoring program for virus and competent vectors in affected or threatened areas will be initiated immediately the infection is detected. The survey will attempt to determine the extent of the virus and vectors and the serotype will need to be identified and its virulence assessed. The survey will also help to define the limits of the bluetongue-free area. The ability to distinguish between natural infections and vaccination responses is necessary when vaccination is used.

The epidemiological assessment should include :

- examination of the time and location of the outbreak and the susceptible population;
- recording of recent movements of ruminants on and off the property;
- identification of the species of vectors and virus serotypes present;
- collection of meteorological data; and
- a serum survey of affected animals and contacts.

The NAMF will be used to continually monitor the limits of the virus and vector-infected and free areas.

For further information see Appendix 4.

3.2.7 Vector control

Some control measures, such as ivermectin treatment of cattle (see Section 2.2.11), will be difficult to implement. There needs to be a high adoption rate for such a measure to be effective. The cost involved may exceed the economic return for producers who have not incurred direct financial loss as a result of the disease.

Other measures may be adopted to protect valuable animals such as housing and insect repellents but the latter have not been adequately trialed in Australia. The use of ivermectin and repellents will require that withholding periods be met. The removal of

cattle from sheep populations or the introduction of cattle to sheep populations may be used to attempt to draw vectors away from sheep and reduce clinical disease.

The use of aerial spraying is unlikely to be considered because of environmental concerns and the enormous cost and resources required to implement such a program.

For further details see Appendix 5.

3.2.8 Decontamination

As the bluetongue virus does not survive outside of the vector or living host or on fomites decontamination procedures are not warranted. Hygienic procedures, however, should be adopted in the handling and treatment of animals.

3.2.9 Media and public relations

It will be necessary to maintain close liaison with industry, the media and the public to ensure that all are fully informed of the effects of the disease and the disease control measures that are proposed. Public confidence in the products must be maintained so that demand is not affected.

The industry and the media must be informed that prevailing circumstances will determine very strongly the most appropriate control measures. The rationale for control policies of an arboviral disease like bluetongue will be more difficult to promote to the livestock industries because disease control has previously been based on diseases such as tuberculosis, brucellosis and foot-and-mouth disease where stamping out can play a major role. The pivotal role of vectors in disease distribution will be the most difficult aspect to convey to the livestock industry.

3.3 Social and economic effects

The economic costs of the disease on affected rural communities would depend on many factors, including the virulence of virus involved in the outbreak. The areas of loss would be associated with production losses due to the effects of the disease, effects on markets and costs of the control measures.

Production losses are those due to deaths and reduced quantity and quality of wool and decreased efficiency of fat lamb production. Sheep losses are expected to be sporadic in areas occasionally populated by vectors.

There is likely to be a reduction in exports of both ruminant products and live animals, particularly sheep and sheep products, at least in the short term, until the outbreak situation is well-defined and detailed information can be provided to trading partners. The sheep industry will suffer the most as sheep are more likely to be affected by an outbreak. The regaining of export markets will require the targeting of advice to the particular country depending on its bluetongue status and the presence or absence of competent bluetongue vectors.

It is possible that domestic consumption of sheep meat could be affected if the effects of the disease are not properly explained to the public. A combination of resistance in both the export and domestic markets could result in reduced value of livestock.

The effects of quarantine and movement controls will reduce market access options and the costs of exports will be increased due to possible increased cost of testing. If the

investigations lead to the prediction that the disease is likely to be ongoing or seasonal, then additional costs will be incurred by producers through altered husbandry methods and the cost of insecticide usage and vaccination.

The potential loss of markets will have an important effect on the Australian economy.

3.4 Criteria for proof of freedom

As indicated previously, proof of national freedom is unlikely to be attainable. Australia should continue to promote the concept of regional freedom from infection. Regional freedom from infection should only be claimed after a comprehensive survey has been undertaken based on sound epidemiological principles, as outlined in the OIE Code. Monitoring undertaken by NAMP will help to fulfil this objective (see Appendix 5).

3.5 Funding and compensation

Bluetongue (in its classical virulent form) is included in the list of diseases for which arrangements exist under the Commonwealth/States cost-sharing agreement for the eradication of certain exotic animal diseases. Information on the cost-sharing arrangements can be found in the AUSVETPLAN **Summary Document, Appendix 3** and in the **Valuation and Compensation Manual**.

It is possible that funding may be limited because the disease may not be considered eradicable as defined by the agreement. Under the cost-sharing agreement funding could be expected for:

- investigating reports of new cases;
- limited compensation for diagnosis and investigations;
- additional surveillance and monitoring to determine spread and distribution of vectors and virus-infected stock; and
- compulsory vaccination (in the unlikely event that it is required).

Compensation may not be available for sheep deaths. Costs for treatment and management of clinical cases and voluntary vaccination of infected/at-risk flocks would be borne by individual producers.

3.6 Strategy if the disease becomes established

If bluetongue infection causes recurring serious disease in sheep areas, preventative vaccination may need to be introduced. Effective vaccines, supported for use in Australia, are still to be developed. The costs associated with insecticide treatment would be high and the treatment is likely to be ineffective unless it is adopted over large areas by a majority of producers.

APPENDIX 1 Guidelines for classifying declared areas

Infected premises (IP)

A premises classified as an IP will be a defined area (which may be all or part of a property) in which bluetongue disease exists or in which the virulent virus exists or is believed to exist.

Dangerous contact premises (DCP)

Premises classified as DCPs are those that have received ruminant livestock from an IP during the 40 days before the first signs of clinical disease and up to the time quarantine was imposed.

Suspect premises (SP)

This term should be used sparingly. Every effort should be made to clarify the status of a property to either free, DCP or IP as soon as possible.

Restricted area (RA)

This should include the infected premises and neighbouring premises to include an area within a radius of approximately 10 km around the IP in the first instance.

Control area (CA)

The control area will be determined by the tracing and surveillance being undertaken immediately following the detection of disease. If it is suspected that the virus is present in vectors, a control area may be declared immediately to prevent the free movement of possibly infected animals into free areas. To be effective this area should be approximately 100 km around the RA.

NB An RA and CA are not applicable for disease management, but virus-free zones will need to be defined for trade purposes. The following factors must be taken into account for assessment of a disease-free zone:

- number, distribution and density of cattle, sheep and other ruminants;
- vectors;
- climate;
- geographical features; and
- virus activity as demonstrated by seroconversions.

The continued classification of IPs, DCPs, RA and CA will depend on the assessment of the epidemiological findings.

APPENDIX 2 Recommended quarantine and movement controls

Infected premises

All ruminants should be placed under quarantine to permit an adequate investigation. Movement to slaughter would not be restricted.

Dangerous contact premises

The imposition of quarantine and movement controls will be determined at the time based on the prevailing range of epidemiological factors.

Suspect premises

See Appendix 1.

Restricted area

Restrictions would probably apply on a regional or district basis rather than on an individual property basis. Susceptible ruminants should not be moved into an outbreak area. After an initial evaluation period, cattle should not be moved, except for slaughter or to a non-vector area and provided their presence in such an area is not an impediment to trade (the presence of infected animals in vector-free areas does not present a disease risk, but could compromise the ability to certify that area free of bluetongue for trade purposes).

Control area

Animals should be permitted to move to slaughter after taking into consideration any likely impact this may have on overseas trade if moved into a free area. If breeding animals are to be moved to a free area in the early stages of an outbreak, they should first be tested and negative results ensured. This testing should continue until, based on the results of investigations, vector-free areas have been clearly identified.

APPENDIX 3 OIE International Animal Health Code for bluetongue

[NB The following text is taken directly from the OIE International Animal Health Code (1992); Chapter 2.1.9. For definitions, Appendixes, etc see the original text. The OIE Codes are amended every year in May. There have been no amendments to the code for bluetongue in 1993, 1994 or 1995.]

Preamble: For diagnostic test, reference should be made to the *Manual* (A9) [see OIE publications under References].

Article 2.1.9.1.

For the purposes of this *Code*, the *incubation period* for bluetongue (BT) shall be 40 days.

Article 2.1.9.2.

For the purpose of this *Code*:

BT: free country/part of the territory of a country

A country or part of the territory of a country may be considered free from BT when the disease is compulsorily notifiable in the country and when no clinical, serological and epidemiological evidence of BT has been found during the past two years. If a country or part of the territory of a country is considered free from BT and imports animals, *semen* and ova from an infected country the *importing country* will not lose its free status provided the importations are carried out in conformity with the provisions of Articles 2.1.9.6., 2.1.9.8. and 2.1.9.9.

Article 2.1.9.3.

Veterinary Administrations of BT *free countries* may prohibit importation or transit through their territory, directly or indirectly, from countries not considered free from BT of:

- 1) domestic and wild ruminants;
- 2) *semen* of domestic and wild ruminants;
- 3) *embryos/ova* of domestic ruminants;
- 4) *pathological material* and *biological products* (from ruminants) which have not been processed to ensure the destruction of BT virus.

Article 2.1.9.4.

When importing from a BT *free country* or a BT *free part of the territory of a country*, *Veterinary Administrations* should require:

for domestic ruminants

the presentation of an *international animal health certificate* attesting that the animals:

- 1) showed no clinical sign of BT on the day of shipment;
- 2) were kept in a BT free country or a BT free part of the territory of a country, since birth or for at least the past 40 days.

Article 2.1.9.5.

When importing from a BT *free country* or a BT *free part of the territory of a country*, *Veterinary Administrations* should require:

for wild ruminants

the presentation of an *international animal health certificate* attesting that the animals:

- 1) come from a BT free country or a BT free part of the territory of a country; if the country of origin has a common border with a country not considered free from BT;
- 2) were kept in a *quarantine station* for the 40 days prior to shipment and were subjected to a diagnostic test for BT with negative results;
- 3) were protected from insect vectors during quarantine and transportation to the *place of shipment*.

Article 2.1.9.6.

When importing from a country or a part of the territory of a country not considered free from BT, *Veterinary Administrations* should require:

for domestic ruminants

the presentation of an *international animal health certificate* attesting that the animals:

- 1) showed no clinical sign of BT on the day of shipment;
- 2) were subjected to the sero-neutralisation test for BT with negative results, during the 30 days prior to isolation or entry into quarantine;
- 3) were kept in the *exporting country* for 40 days prior to shipment, in an *establishment* where no *case* of BT was officially reported during that period and were subjected to diagnostic tests for BT with negative results within seven days prior to shipment; or
- 4) were kept in a *quarantine station* for the 40 days prior to shipment and were subjected to diagnostic tests for BT with negative results;
- 5) were protected from insect vectors during quarantine and transportation to the *place of shipment*.

Article 2.1.9.7.

When importing from a country or a part of the territory of a country not considered free from BT, *Veterinary Administrations* should require:

for wild ruminants

the presentation of an *international animal health certificate* attesting that the animals:

- 1) were subjected to diagnostic tests for BT with negative results, during the 30 days prior to shipment; or
- 2) were kept in a *quarantine station* for the 40 days prior to shipment and were subjected to a diagnostic test for BT with negative results;
- 3) were protected from insect vectors during quarantine and transportation to the *place of shipment*.

Article 2.1.9.8.

When importing from a BT *free country* or a BT *free part of the territory of a country*, *Veterinary Administrations* should require:

for semen of domestic ruminants

the presentation of an *international animal health certificate* attesting that:

- 1) the donor animals showed no clinical sign of BT on the day of collection and for the following 40 days;
- 2) the animals were kept in a BT free country or BT free part of the territory of a country;
- 3) the semen was collected, processed and stored strictly in accordance with Appendices 4.2.1.1. and 4.2.1.2.

Article 2.1.9.9.(under study)

When importing from a BT *free country* or a BT *free part of the territory of a country*, *Veterinary Administrations* should require:

for embryos/ova of domestic ruminants

the presentation of an *international animal health certificate* attesting that the:

- 1) donor females were kept in a BT free country or a BT free part of the territory of a country since birth and were kept in the same herd for at least the 40 days prior to departure to the *collection unit*;
- 2) donor females and all other animals in the herd of origin showed no clinical sign of BT during the 24 hours prior to departure to the collection unit;
- 3) donor females were fertilised with *semen* meeting the requirements provided in Article 2.1.9.8.;
- 4) collection unit remained free from BT during the 40 days following collection;
- 5) the embryos/ova were collected, processed and stored strictly in accordance with Appendices 4.2.3.1., 4.2.3.3., 4.2.3.4. or 4.2.3.5. as relevant.

Article 2.1.9.10.

When importing from a country or a part of the territory of a country not considered free from BT, *Veterinary Administrations* should require:

for semen of domestic ruminants

the presentation of an *international animal health certificate* attesting that:

- 1) the donor animals showed no clinical sign of BT on the day of collection and for the following 40 days;
- 2) the donor animals were subjected to diagnostic tests for BT with negative results on the day of collection and again 40 days following the date of collection;

- 3) the donor animals were protected from insect vectors for the 40 days prior to collection, in an *establishment* or *AI centre* where no *case* of BT was officially reported during that period;
- 4) the semen was collected, processed and stored strictly in accordance with Appendices 4.2.1.1. and 4.2.1.2.

Article 2.1.9.11.(under study)

When importing from a country or a part of the territory of a country not considered free from BT, *Veterinary Administrations* should require:

for embryos/ova of domestic ruminants

the presentation of an *international animal health certificate* attesting that:

- 1) the donor animals and all other animals in the herd of origin showed no clinical sign of BT during the 24 hours prior to departure to the *collection unit*, and that no *case* of BT was officially reported in the herd of origin during the 40 days following their departure;
- 2) the donor animals were subjected to diagnostic tests for BT with negative results on the date of collection and again 40 days following the date of collection;
- 3) the ova were fertilised with semen from donors subjected to diagnostic tests for BT with negative results;
- 4) were transported to the collection unit without passing through a BT infected zone, and that the collection unit remained free from BT during the 40 days following collection;
- 5) the embryos/ova were collected, processed and stored strictly in accordance with Appendices 4.2.3.1., 4.2.3.3., 4.2.3.4. or 4.2.3.5. as relevant.

APPENDIX 4 Procedures for surveillance and proof of freedom

A surveillance and monitoring program for virus and vectors should be undertaken in affected and threatened areas. The ability to distinguish between natural infections and vaccination responses is necessary when vaccination is utilised.

A stamping-out policy is not applicable for bluetongue disease or vectors. Proof of national freedom from the disease would be an impossibility but regional freedom may be demonstrable.

Bluetongue virus is active in the northern part of Australia. However, there have not been any cases of clinical disease to date because the mix of biological and epidemiological variables required to cause the disease has not occurred. If this happens disease will occur either insidiously or as a dramatic outbreak. Depending on epidemiological circumstances, an initial outbreak may terminate naturally or may require human intervention. Once bluetongue disease has occurred, disease may become a regular feature, as is the case with other endemic arthropod-borne viral diseases.

Some States, regions or districts may not have clinical cases. It is appropriate to have an established surveillance system to monitor for the absence/presence of bluetongue virus. Such a surveillance system has several uses:

- to monitor the absence of the virus for the satisfaction of our livestock trading partners;
- to track the movement of the various serotypes of bluetongue virus for early warning of impending disease; and
- to understand the basic ecology of bluetongue virus and other arboviruses.

The National Arbovirus Monitoring Program (NAMP) has been implemented to fulfil this role.

Normally vector monitoring should be undertaken in conjunction with virus monitoring.

Surveillance systems should be nationally planned, coordinated and evaluated. When required, such as for export purposes, the surveillance system should be designed on a sound epidemiological basis.

Sentinel herds should normally consist of 10 individually identified young yearling cattle bled at least monthly. Sera should be examined for BLU group antibodies by ELISA or AGID serology. Reactors should be examined for the infecting BLU serotype by specific ELISA or neutralisation serology.

APPENDIX 5 Procedures for vector monitoring and control

Monitoring

The most commonly used traps for collecting biting midges are light traps. CSIRO and the Queensland and NSW departments of agriculture should have available adequate supplies of these traps. Many local government authorities also use carbon dioxide baited light traps to collect mosquitoes. These could be adapted for biting midges if necessary. Some preliminary CSIRO trials have indicated that carbon dioxide and octenol are useful attractants for biting midges when used with light traps. An essential supplementary collection method for biting midges is a vehicle-mounted trap, sometimes called a truck trap. This is particularly useful where evening and night temperatures are low enough to reduce insect activity before it is dark enough for light traps to become attractive.

Larval sampling is considerably more time-consuming than adult sampling, and may not be as reliable an indicator of presence or prevalence as adult trapping. Maps with appropriate detail will be required to plot the distribution of traps and stock.

The limiting factor in any monitoring program will be the availability of staff with taxonomic expertise to identify the collections.

If collections are to be processed for virus isolation, insects will need to be collected live for immediate processing, or holding in suitable storage such as liquid nitrogen. Collections for population analysis should be stored in 70% ethanol. The technology which would allow isolation of virus from insects preserved in alcohol (polymerase chain reaction) is currently being refined.

Collections should aim to give:

- a list of all the potential vectors present;
- the relative abundance of those species; and
- the age structure of those populations.

Control

The main aim of any vector control program must be breaking the transmission cycle by rapid reduction of numbers of all insects which are capable of taking up virus from vertebrate hosts. In Australia south of the Tropic of Capricorn, the main potential vector of bluetongue, *C. brevitarsis*, breeds in cow dung and feeds on cattle, often in large numbers.

If *C. brevitarsis* is a major target of a control program, the use of a systemic insecticide in cattle in the area offers a specific procedure. For example, a laboratory trial has shown that a subcutaneous injection of a formulation of ivermectin will produce 99% mortality in *C. brevitarsis* feeding on treated cattle for up to 10 days after treatment. The larval stages in dung of treated animals will also be controlled for up to 4 weeks. A field trial of subcutaneous ivermectin has shown that a field population of *C. brevitarsis* was reduced to a point where there is a period of up to 6 weeks of low risk of virus transmission.

The effect on *C. brevitarsis* of subcutaneous and oral formulations of ivermectin in sheep has also been tested. The effect of the subcutaneous treatment was gone by 16 days and of the oral treatment by 4 days. It is more effective to treat cattle, even when disease is in

sheep. The subcutaneous formulation of ivermectin is not repellent and, therefore will not prevent infection.

A pour-on formulation of ivermectin is also available, but as yet this has not been tested. Other systemic insecticides are also coming on the market.

The ability of broad scale insecticide treatments to control adult biting midges in a rural area has never been tested and is unlikely to be used. However, should it be considered necessary to mount such an operation, the main types of insecticide application are:

- ultra-low volume (ULV) application from the ground;
- ULV from the air;
- thermal fogs or mists from the ground.

In the event of a decision to treat a broad-scale area, ground-based ULV application would be the most likely method. The insecticide used will be determined by consultation with appropriate environmental authorities, and also by bearing in mind what products are rapidly available in sufficient quantity. Treatment will depend on prevailing weather, the terrain and its influence on machinery access.

Appropriate protective clothing and equipment must be provided and its use made compulsory for staff involved in any insecticide applications. These staff must follow recommended safety guidelines, and adequate first aid measures must be on hand. When systemic or topical insecticides are used on livestock, the relevant withholding periods must be observed.

GLOSSARY

Agar gel immuno-diffusion test	Test for the presence of antibodies.
Animal by-products	Products of animal origin destined for industrial use, eg raw hides and skins, fur, wool, hair, feathers, hooves, bones, fertiliser.
Animal products	Meat products and products of animal origin (eg eggs, milk) for human consumption or for use in animal feeding.
Arboviral	<i>Arthropod-borne virus</i> .
AUSVETPLAN	A series of documents that describe the Australian response to exotic animal diseases, linking policy, strategies, implementation, coordination and emergency-management plans.
Consultative Committee on Exotic Animal Diseases	A committee of State/Territory CVOs, AAHL and CSIRO, chaired by the CVO of Australia (Cwlth DPIE), to consult in emergencies due to the introduction of an exotic disease of livestock, or serious epizootics of Australian origin.
Complement fixation test	A measure of the ability of antigen–antibody complexes in a sample to bind complement thus reducing its ability to lyse red blood cells.
Control area	A bigger area than a restricted area (possibly as big as a State) where restrictions will reduce the chance of the disease spreading further afield (<i>see</i> Appendix 1).
Corona	Band at the top of the hoof
Cyanosis (adj: cyanotic)	Blueness of the skin and/or mucous membranes due to insufficient oxygenation of the blood.
Dangerous contact animal	An animal showing no clinical signs of disease but which, by reason of its probable exposure to disease, will be subjected to disease control measures.
Dangerous contact premises	Premises containing dangerous contact animals (<i>see</i> Appendix 1).
Ecchymotic haemorrhages	Small round spots or purplish discolouration caused by bleeding or bruising in the skin or mucous membrane
ELISA	Enzyme-linked immunosorbent assay — a serological test designed to detect and measure the presence of antibody or antigen in a sample. The test uses an enzyme reaction with a substrate to produce a colour change when antigen–antibody binding occurs.
Fluorescent antibody test	Use of a fluorescently tagged antibody to detect a specific antigen
Fomites	Inanimate objects (eg boots, clothing, equipment, vehicles, crates, packagings) that can carry an infectious agent and spread disease through mechanical transmission. Fomites do not play any role in the spread of bluetongue.
Hyperaemia	An increase in the amount of blood in a tissue or organ due to a widening of the supplying arteries.

Immunoglobulin	Antibody proteins
– IgE	Immunoglobulin usually present at very low levels but increases in hypersensitivity (allergic) reactions.
– IgG	The main form of immunoglobulin produced in response to an antigen. It is mainly found in body fluids.
– IgM	High molecular weight immunoglobulin; IgM antibodies are the first to be synthesised and released in response to a primary antigenic stimulation.
Incubation period	The period which elapses between the introduction of the pathogen into the animal and the occurrence of the first clinical signs of the disease.
Infected premises	<i>see</i> Appendix 1.
Laminitis	Inflammation of the sensitive laminae of the hoof.
Local disease control centre	An emergency operations centre responsible for the command and control of field operations in a defined area.
Movement controls	Restrictions placed on movement of animals, people and things to prevent dissemination of disease.
Mummified foetus	Dry/shriveled foetus due to the resorption of fluids from the placenta following death in the uterus.
Petechial haemorrhages	Tiny flat red or purple spots in the skin or mucous membrane caused by bleeding from small blood vessels.
Premises	A defined area or structure, which may include part or all of a farm, enterprise or other private or public land, building or property.
Quarantine	Legal restrictions imposed on a place, animal, vehicle or other things limiting movement.
Restricted area	A relatively small declared area (compared to a control area) around an infected premises that is subject to intense surveillance and movement controls (<i>see</i> Appendix 1).
Seroconversion	Appearance in the blood serum of antibodies following vaccination or natural exposure to an infected agent.
Serosurveillance	Surveillance of an animal population by testing serum samples for the presence of antibodies to disease agents.
Serotype	A subgroup of microorganisms identified by the antigens carried.
Sentinel animals	Animals of known health status monitored for the purpose of detecting the presence of a specific exotic disease agent.
Serum neutralisation	A serological test designed to detect and measure the presence of antibody in a sample. The test is based on, the ability of an antibody to neutralise the biological activity of an antigen. Antibody in serum is serially diluted to detect the highest dilution that neutralises a standard amount of antigen. The neutralising antibody titre is given as the reciprocal of this dilution.
Stamping out	Eradication procedures based on quarantine and slaughter of all infected animals and animals exposed to infection. A stamping-out strategy is not appropriate for bluetongue.

State/Territory disease control headquarters	The emergency operations centre that directs the disease control operations to be undertaken in the State/Territory.
Surveillance	A systematic program of inspection and examination of animals, areas or things to determine the presence or absence of bluetongue or its insect vectors.
Susceptible species	Animals that can be infected with the disease (for bluetongue — ruminants).
Suspect animal	An animal that may have been exposed to an exotic disease such that its quarantine and intensive surveillance is warranted; OR an animal not known to have been exposed to a disease agent but showing clinical signs requiring differential diagnosis.
Suspect premises	<i>see</i> Appendix 1
Tracing	The process of locating animals, persons or things that may be implicated in the spread of disease, so that appropriate action can be taken.
Transovarial transmission	Transmission of virus vertically between generations of vectors without a stage in a vertebrate host (particularly transmission into eggs).
Vaccine	
– attenuated	A vaccine prepared from infective or ‘live’ microbes that have lost their virulence but have retained their ability to induce protective immunity.
– inactivated	A vaccine prepared from a virus that has been inactivated (‘killed’) by chemical or physical treatment.
– recombinant	A vaccine produced from virus that has been genetically engineered to contain only selected genes, including those causing the immunogenic effect (subunit and construct vaccines).
Vector	A living organism (frequently an arthropod) that transmits an infectious agent from one host to another. A <i>biological</i> vector is one in which the infectious agent must develop or multiply before becoming infective to a recipient host. A <i>mechanical</i> vector is one that transmits an infectious agent from one host to another but is not essential to the life cycle of the agent. Bluetongue is transmitted biologically by biting midges (<i>Culicoides</i>).
Viraemia	The presence of viruses in the blood.
Zoning	The process of defining disease-free and infected zones in accord with OIE guidelines, in order to facilitate trade.

Abbreviations

AAHL	CSIRO Australian Animal Health Laboratory, Geelong
AI	Artificial insemination
AGID	Agar gel immunodiffusion test
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
BLU	Bluetongue (used to refer to virus serotypes)
BT	Bluetongue (OIE Code)
CA	Control area
CCEAD	Consultative Committee on Exotic Animal Disease
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CVO	Chief veterinary officer
DCP	Dangerous contact premises
DPIE	Department of Primary Industry and Energy
EDTA	Ethylene diamine tetra-acetic acid (anticoagulant for whole blood)
EHD	Epizootic haemorrhagic disease
ELISA	Enzyme-linked immunosorbent assay
Ig	Immunoglobulin
IP	Infected premises
NAMP	National Arbovirus Monitoring Program
OIE	World Organisation for Animal Health [Office International des Epizooties]
RA	Restricted area
RNA	Ribonucleic acid
ULV	Ultra-low volume

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Video/training resources

- On alert for bluetongue* (video), AAHL 1991 (available from the Animal Diseases/Incidents Section, DPIE, Canberra; or AAHL)
- On alert for bluetongue* (48 slides), available from the Animal Diseases/Incidents Section, DPIE, Canberra.

[See the **Summary Document** for a full list of training resources.]

OIE publications

- OIE Code (1992). *International Animal Health Code* (6th edition), OIE, Paris, France.
- OIE Manual (1992). *Manual of Standards for Diagnostic Tests and Vaccines* (2nd edition), OIE, Paris, France.

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