# CONSIDERATIONS FOR DEVELOPING REGULATORY POLICY TO PREVENT IMPORTATION OF ARTHROPOD-BORNE ANIMAL DISEASES: THE LESSONS LEARNED FROM BLUETONGUE VIRUSES

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## Introduction

The presence of bluetongue (BLU) viruses in exporting countries has been a major barrier to the international movement of livestock. The resulting trade restrictions have been based on the classification of BLU as an emerging disease of livestock. This perception resulted in its placement on the Office International des Epizooties (OIE) List A as one of 15 diseases "which are highly contagious and pose particularly serious threats to national and regional economies".[1] Subsequent research has established that although BLU viruses are present in a large portion of the world, these viruses are neither contagious, nor has there been a serious or rapid spread of disease.[2,3] These scientific studies have produced fundamental knowledge on the genetics and evolution of the vector[3,4,5,6,7] and the epidemiology of the viruses,[2,8,9] but this knowledge has yet to cause any "regulatory evolution" of BLU trade restrictions.

A major factor that makes arthropod-borne diseases different from other diseases is the arthropod vector. The presence of a vector is a major consideration when formulating disease control and/or regulatory policy. The spread of an arthropod-borne disease cannot be a threat to a region if competent vectors do not exist. On the other hand, if a country or region has competent vectors, strategies must be devised to minimize the risk of disease. The initially stringent BLU trade regulations were conservative, and rightly so, based on the then available knowledge and perceptions of BLU viruses and vectors. The regulations devised at that time to protect the animal industries have had and continue to have a negative economic impact by prohibiting the introduction of germplasm and genetic lines from countries labeled as BLU virus countries. The introduction of new germplasm could increase animal productivity and other desirable traits resulting in economic gain to all.

Entomologic and epidemiologic studies of BLU disease should be viewed as a model for considerations given to other arthropod-borne diseases of animals in devising both international trade regulations and disease control measures. Conclusions from research of this nature demonstrates that the perceived threats of spreading disease may be overly restrictive and the economic losses due to such restrictions can be safely reduced.

## Entomologic Studies in the USA

*Culicoides variipennis* is the principal vector of BLU viruses in the USA.[8,10] Although this insect species occurs throughout the USA, clinical BLU disease and seropositive animals occur only in specific regions. In an attempt to understand the role of *C. variipennis* in the regional distribution of BLU, geographic variation of this species has been analyzed. Morphologic studies have identified 5 subspecies: *C.v. variipennis* (northeast-north central-midwest USA), *C.v. sonorensis* (southwest-western USA), *C.v. occidentalis* (far western USA), *C.v. australis* (south-central USA), and *C.v. albertensis* (central-north

central USA).[11,12] Genetic analysis of 26 *C. variipennis* populations from throughout the USA[4,5] supported the existence of at least 3 of the 5 subspecies, *C.v. occidentalis, C.v. sonorensis,* and *C.v. variipennis*[5,6].

The occurrence of BLU disease in the USA correlates with the regional distribution of the *C.variipennis* subspecies. *C.v. sonorensis* is the subspecies present in regions of the USA where BLU disease, BLU virus activity, and seropositive animals from active infections are prevalent.[2,9] There is little or no epidemiologic or serologic evidence to support the presence of active BLU virus transmission in the regions inhabited by *C.v. variipennis*[9] and no evidence demonstrating that *C.v. occidentalis* is a vector of BLU viruses[8]. In addition to these epidemiologic data, laboratory vector infectivity studies have shown that populations of *C.v. variipennis* and *C.v. occidentalis* are less susceptible to infection with BLU viruses than the majority of populations of *C.v. sonorensis,* the subspecies present in regions where BLU disease is prevalent.[3,7,13,14]

**Proposed Regulatory Changes**

Walton, et al.[2] have proposed the following regulatory changes. In the northeastern and midwestern USA and most parts of Canada (Zone 1, Figure 1), ruminant livestock native to or resident in this area for at least three months or one winter before export should be permitted unrestricted international movement. This recommendation is based on the presence of the incompetent BLU virus vector, *C.v. variipennis;* low temperatures and short seasons of insect activity that decrease vector efficiency; the lack of serologic or clinical evidence for BLU in this zone; and the duration of viremia now believed by the scientific community to occur in cattle. In a zone of 9 states that stretches from North and South Carolina in the southeastern USA, through Tennessee, Kentucky, Missouri, Iowa, and South Dakota to Wyoming and Montana in the western USA (Zone 2, Figure 1), a single serologic test of ruminants should continue. Serologic tests of herds or flocks for BLU antibodies provide valuable epidemiologic information, but their usefulness for individual animals is equivocal. This recommendation is based on the infrequent occurrence of BLU disease, the low serologic prevalence of BLU and the transition in this zone from the incompetent vector, *C.v. variipennis* to the competent vector, *C.v. sonorensis*[5]. The southeastern and western USA (Zone 3, Figure 1) is the area of the USA in which classical endemic BLU disease has been described; consequently, no regulatory changes are recommended for this area. Walton, et al.[2] based this recommendation on the endemic nature of BLU viruses in this region and the presence of the competent vector, *C.v. sonorensis*. Although no regulatory changes were recommended, consideration was given to re-defining the BLU serologic requirements. These modifications may include using an enzyme labeled immunosorbent assay (ELISA) rather than the agar gel immunodiffusion (AGID) test currently in use, allowing the importation of a seropositive ruminant due to the lower risk of introducing a BLU virus into an importing country, and allowing the "winter" movement of BLU tested animals.[15,16]

These regulatory recommendations are contingent on continued surveillance and research programs which will strengthen these recommendations and aid in the development of new BLU regulatory recommendations. BLU serologic surveillance by random flock and herd testing and virologic investigation of suspected BLU cases must be continued. Walton, et al.[2] have made a number of recommendations for future vector research including further vector competence studies of

*C.v. variipennis*, *C.v. occidentalis*, and *C.v. sonorensis* and other potential USA *Culicoides* vectors, definition of the transition zone between *C.v. variipennis* and *C.v. sonorensis* in the USA, and validation and vector characterization of the two other suspected USA subspecies, *C.v. australis* and *C.v. albertensis*.[11]

**Implications for other arthropod-borne diseases**

It is apparent that BLU virus vector-epidemiology research can serve as a model for developing studies for understanding the epidemiology of other arthropod-borne ruminant diseases and for developing reasonable,

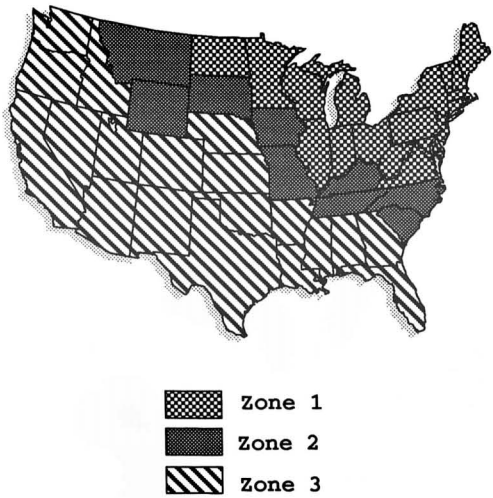


Figure 1. An epidemiologic- and entomologic-based recommendation for regional movement of livestock from the USA to minimize the risk of transmission of BLU viruses. (Walton, et al.,[2] CRC Press, Baton Raton, FL)

yet safe trade regulations. Vector studies such as these could be applied to other *Culicoides*-vectored pathogens such as bovine ephemeral fever virus[17], Akabane virus[17] and epizootic hemorrhagic disease viruses such as Ibaraki virus; mosquito borne pathogens such as Rift Valley fever virus[17], Akabane virus[17], bovine ephemeral fever virus[17]; tick borne pathogens such as *Anaplasma* spp. (the causative agents of anaplasmosis)[18], *Babesia* spp. (the causative agents of babesiosis)[18], *Theileria parva* (the causative agent of East Coast Fever)[18] and *Cowdria ruminantium* (the causative agent of heartwater)[18]; and the tsetse fly-vectored pathogen, *Trypanosoma brucei* (the causative agent of nagana)[18]. The use of genetic approaches and molecular biologic techniques can afford a quick genetic analysis of a given vector.[19] Regional and geographic distribution of the vectors can be determined and correlated with serologic and epidemiologic evidence in these specific regions. From this information informed decisions can then be made to implement regional disease control efforts and in formulating trade regulations. The major hindrance to the implementation of such vector studies is the lack of

resources in the developing countries where many of these pathogenic agents currently cause disease problems.

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**Summary**

Epidemiologic and entomologic investigations on bluetongue viruses have provided important information upon which to develop meaningful, less restrictive but safe regulatory policies for the international movement of ruminants and germplasm. The result of changes would be economic gain for all countries concerned with continued protection against the importation of foreign diseases. The goal of regulations should be to safely protect indigenous animals, but to do so without needlessly interfering with trade.

It is apparent that research on bluetongue disease has been beneficial and new information on other arthropod-borne pathogens, their vectors, and their hosts will continue to be useful to protect ruminant livestock. Continued research along the lines reviewed here on *Culicoides* spp.[19] and other vectors of arthropod-borne diseases and these pathogens must be supported.

**Summary** (Français)

Les investigations épidemiologiques et entomologiques sur les virus de la fievre catarrhale du mouton ont procuré une information grâce à laquelle on a pu développer des mesures régiementaires, significatives, moins restrictives mais sûres pour le mouvement international des ruminants et du germeplasma. Le résultat des changements serait un gain économique pour les pays concernés avec une protection constante contre l'importation des maladies de l'étranger. Le but des régulations devraient être de protéger sans risque les animaux du pays mais de le faire de façon qu'on n'intervienne pas dans le commerce inutilement.

De facon évidente, les recherches sur la maladie de la fievre catarrhale du mouton ont été bénéfiques et de nouvelles informations sur d'autres pathogènes transmis par arthropodes, leurs vecteurs et leus hôtes, continuera à être utile pour protéger le bétail. La recherche permanente parmi les thèmes examinés ici, sur d'autres vecteurs de maladies transmises par arthropodes et ces pathogènes doit être soutenue.

**Summary** (Español)

Investigaciones epidemiológicas y entomológicas sobre los víruses de la enfermedad lengua azul han aportado información importante sobre la cual se pueden desorrollar medidas regulatorias con menos restricciones y con mas sentido para el movimiento de rumiantes y germoplasma a nivel internacional. El resultado de estas cambios será la ganancia de tipo económico para todos los paises envueltos en la protección constante contra la importación de enfermedades exóticas. El objetivo de las regulaciones debe ser el asegurar la protección de animales nativos, y hacerlo de tal manera que no interfieran innecesariamente con el comercio de estos.

Aparentemente, la investigación sobre la enfermedad lengua azul ha sido benéfica; además, información nueva sobre otros patógenos tranmitidos por artrópodos, al igual que sus vectores y hospedadores, seguirá siendo útil para proteger al ganado. La continua investigación sobre los temas examinados aquí, y que están relacionados con *Culicoides* spp. y otros vectores de enfermedades transmitidas por artrópodes y sus agentes etiológicos, debe ser apoyada.