Understanding the impact of *Mycoplasma ovipneumoniae* in domestic sheep

Mycoplasma ovipneumoniae is frequently present in domestic sheep operations and is associated with negative effects on productivity and profitability. Infection of a flock with this pathogen may increase frequency of pneumonia, reduce lambing rates, and impair feed efficiency, resulting in significant financial costs. In addition, presence of this pathogen is associated with increased risk for nearby wild bighorn sheep, which can trigger deadly pneumonia outbreaks. Research led by Professor Tom Besser at Washington State University aims to improve our understanding of the prevalence and severity of this infection.

People rear domestic sheep for a wide variety of reasons including as a primary occupation producing meat and fibre commodities, producing specialty fibre for art or crafts, producing breeding stock for other sheep producers, providing weed control or pasture maintenance services, producing milk for custom cheeses, or simply as a hobby or a means to introduce children to animal husbandry. The health of the animals in these flocks is important for the animals' own welfare and to maximise their productivity to the operator.

A known pathogen with the potential to damage health and productivity of sheep is *Mycoplasma ovipneumoniae*. This mycoplasma affects respiratory systems and is transmissible between flock members and between flocks, given animal contacts. Until recently, most studies were conducted in Europe, Asia or New Zealand under management systems with limited relevance to United States operations. Further, most of the studies had been conducted using poorly sensitive culture methods, whereas more sensitive and reliable DNA based methods are now available.

Professor Tom Besser works as a research scientist at the Washington Animal Disease Diagnostic Laboratory (WADDL) at Washington State University. His extensive experience in infectious disease research perfectly places him to coordinate the multidisciplinary team who contributed to this work on *M.ovipneumoniae* in domestic sheep operations. The team includes, Kezia Manlove of Utah State University, Frances Cassirer of Idaho Department of Fish and Game, and Margaret Benson of the Washington State University Department of Animal Science. Their work on the effects of *M.ovipneumoniae* infection in domestic sheep follows logically from previous work led by Prof Besser characterising *M.ovipneumoniae* as the primary pathogen contributing to the devastating pneumonia outbreaks that have limited the recovery of North American bighorn sheep populations.

An image of the process of obtaining a nasal swab from a sheep. Photo credit: Darryn Epps.

THE SHEEP 2011 PROJECT

This work follows a comprehensive evaluation of domestic sheep operations across the country conducted by the U.S. Department of Agriculture entitled 'Sheep 2011'. In that project, over 450 sheep operators completed a general survey questionnaire covering a range of issues pertinent to domestic sheep production and hosted a site visit at which veterinary officers took nasal swab and blood samples from 16 randomly selected ewes for *M. ovipneumoniae* testing at WADDL. Operations at which *M.ovipneumoniae* was detected by a DNA based test from the nasal swabs, or specific antibodies recognising *M.ovipneumoniae* were detected in one or more blood samples, were classified as infected. Subsequently, infected and negative operations were compared against five ewe welfare and productivity factors: number of lambs born per ewes bred; number of pregnant ewes lambing at full term; number of birthed lambs surviving to weaning; lamb weight at weaning and number of sheep dying of respiratory disease.

The Sheep 2011 project team also explored biosecurity-related factors for possible association with presence of *M.ovipneumoniae* infection in the domestic sheep operations. These factors included: operation size; type of operation management; operation biosecurity (rated -1 to 10); overall disease burden (rated 0 to 11) and antibiotic use (rated 0 to 5).

ANALYSING THE SHEEP 2011 DATA

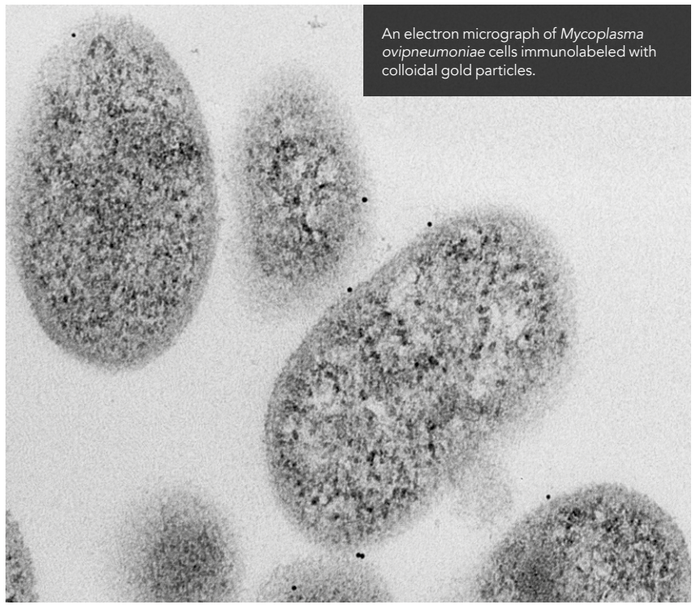
Analysis of the data, including the welfare indicators and the risk factors, led to a series of important findings which may be of interest to domestic sheep operators (https://tinyurl.com/NAHMS-Sheep-2011-Mo; https://tinyurl.com/risk-and-welfare).

Of the 453 farms that participated in the study, 88.5% tested positive for *M. ovipneumoniae* including all herded operations and more than 85% of pastured or fenced operations. The operations which tested positive were significantly larger than those which tested negative, a median size of 171 ewes for positive operations compared to 70 ewes for negative. The trends in type and size of operation across the United States were previously reported by the United States Department of Agriculture. *M.ovipneumoniae*-positive operations had higher biosecurity risk scores, indicating that careful attention to biosecurity may reduce exposure to Mo. Finally, *M.ovipneumoniae*-positive operations had higher overall disease burdens, indicating its possible contribution to respiratory disease in U.S. sheep operations, as has been noted in other countries. However, no association between antibiotic use and prevalence of *M.ovipneumoniae* was observed.

Most specific welfare indicators evaluated in the study were negatively affected by the presence of *M.ovipneumoniae*. For example, the team found that birth rates were lower, and the proportion of still-born lambs was higher in positive operations. Other factors were less significantly affected. These findings were illustrated by applying the measured factors affected by *M.ovipneumoniae* to two hypothetical flocks of 155 ewes, one testing positive, the other negative. According to the results of this study, the *M.ovipneumoniae*-positive herd would produce 8.5 fewer lambs each year, with an estimated annual cost between $637 and $1,275.

Factors which may lead to a domestic sheep operation becoming infected with M.ovipneumoniae include flock size and biosecurity practices.

www.researchoutreach.org



An electron micrograph of *Mycoplasma ovipneumoniae* cells immunolabeled with colloidal gold particles.

THE LAMB FEEDING PILOT PROJECT

Prof Besser and his team also conducted a pilot study to evaluate the possibility of rearing *M.ovipneumoniae* negative lambs within a positive flock, and to compare the growth of the resulting negative lambs with those of their *M.ovipneumoniae* exposed flock mates. After three successive nasal swab tests conducted over six months, ewes with uniformly *M.ovipneumoniae*-negative results and their lambs were penned separately from the rest of the flock until the lambs were weaned at 60 days of age. At weaning, cohorts of 20 lambs each were randomly selected from the negative and exposed groups and reared separately under otherwise identical husbandry conditions. Lambs were weighed and tested for *M.ovipneumoniae* infection at 14-day intervals until harvested as they reached a body weight of 135 pounds (62 kg). Average daily weight gains and carcass quality characteristics were compared between the negative and exposed groups.

ANALYSING THE LAMB FEEDING PROJECT DATA

M.ovipneumoniae was not detected in any of the samples obtained from the negative group lambs during feeding or from their lungs at harvest. In contrast, *M.ovipneumoniae* was detected in all exposed lambs by 30 days after weaning and continuing until the end of the trial. Negative group lambs exhibited significantly fewer signs of respiratory disease, and at harvest lungs of negative group lambs showed significantly less microscopic evidence of infection and inflammation. Negative group lambs gained weight significantly faster, with improved yield grade and quality compared to exposed group lambs.

These findings indicate current DNA-based testing is capable of successfully segregating a negative subgroup from within an infected flock, a practical illustration of the sensitivity of this diagnostic test. In addition, the *M.ovipneumoniae*-negative lambs produced in this manner showed significantly improved health and productivity, indicating that *M.ovipneumoniae* infections as found in many domestic sheep operations impose largely silent costs in productivity, and likely also in animal welfare.

In this first comprehensive study of the extent of M.ovipneumoniae infection in the United States this research has found that more than 85% of operations are infected.

A FIRST FOR U.S. SHEEP PRODUCTION

The Sheep 2011 data provided the first comprehensive study of the extent of *M.ovipneumoniae* infection in the United States this research has found that more than 85% of operations are infected. They have identified that this infection prevalence translates to welfare implications for domestic sheep and financial loss for operation owners. The highly sensitive DNA based testing used in these studies documented a greater prevalence of infection than most previous studies conducted in other countries using conventional culture methods. It is important that future research using similar methodology seek to replicate these results under other management systems and environmental conditions.

While the authors of these studies found no significant regional differences within the United States, operation size was an important predictor of *M.ovipneumoniae* infection rate and it would be extremely valuable if future research could determine the specific management factors that contribute to the lower infection rate affecting smaller size operations so that these could be applied more broadly to reduce infection prevalence within domestic sheep. The apparent effects of *M. ovipneumoniae* on disease burdens of domestic sheep as well as welfare and productivity metrics support the need for additional research to confirm these adverse associations, and to develop effective management tools to control this previously understudied pathogen. The Lamb Feeding Project demonstrates progress in identifying steps for control of this organism.

Behind the Research

Professor Tom Besser

E: tbesser@wsu.edu **T:** (1) 509-335-6075
W: https://vmp.vetmed.wsu.edu/people/faculty/profile/thomas-e-besser

Research Objectives

The research of Professor Tom Besser centres on the epidemiology and management of respiratory disease in domestic and wild sheep.

Detail

Bio

Professor Tom Besser obtained his Veterinarian qualification from the University of Minnesota and his PhD from Washington State University. Tom has almost 40 years' research experience into infectious diseases of animals. He has worked for Washington Animal Disease Diagnostic Laboratory since 1990.

Funding

- United States Department of Agriculture, including the Agricultural Research Service, the Center for Epidemiology and Animal Health, and the Forest Service
- The Idaho Department of Fish and Game
- The University of Idaho
- The Wild Sheep Foundation and its state chapters and affiliates

Collaborators

- Kezia Manlove (Utah State University)
- E. Frances Cassirer (Idaho Department of Fish and Game)
- Margaret Benson (Washington State University Dept. of Animal Science)

References

Besser TE, Levy J, Ackerman M, Nelson D, Manlove K, Potter KA, *et al.* (2019). A pilot study of the effects of Mycoplasma ovipneumoniae exposure on domestic lamb growth and performance. *PLoS ONE* 14(2): e0207420. https://doi.org/10.1371/journal.pone.0207420

Cassirer, E.F., Manlove, K.R., Almberg, E.S., Kamath, P.L., Cox, M., Wolff, P., Roug, A., Shannon, J., Robinson, R., Harris, R.B. and Gonzales, B.J. (2018). Pneumonia in bighorn sheep: Risk and resilience. *The Journal of Wildlife Management*, [online] 82(1), pp.32-45. https://wildlife.onlinelibrary.wiley.com/doi/pdf/10.1002/jwmg.21309

Manlove, K., Branan, M., Baker, K., Bradway, D., Cassirer, E.F., Marshall, K.L., Miller, R.S., Sweeney, S., Cross, P.C. and Besser, T.E. (2019). Risk factors and productivity losses associated with Mycoplasma ovipneumoniae infection in United States domestic sheep operations. *Preventive Veterinary Medicine*, [online] 168, pp.30-38. https://www.sciencedirect.com/science/article/pii/S0167587718304446

Personal Response

Are there opportunities for studies into other domestic animal production operations to use the techniques developed through your research? What do you envisage the long-term impact of this methodology to be?

" The data from these projects offer intriguing clues that *M. ovipneumoniae* may present domestic sheep with adverse productivity and health effects, even when significant respiratory disease is not observed. These findings merit follow up studies: How much do the adverse effects scale with prevalence of the pathogen? Are these effects general across genetic strains of the pathogen, or are some genotypes more virulent than others? What is the most efficient method to eliminate the pathogen from domestic sheep operations of different sizes and management systems? If the pathogen is eliminated, what level of biosecurity is required to keep it out? "

College of Veterinary Medicine