FOOD SUPPLY MEDICINE AT MIZZOU

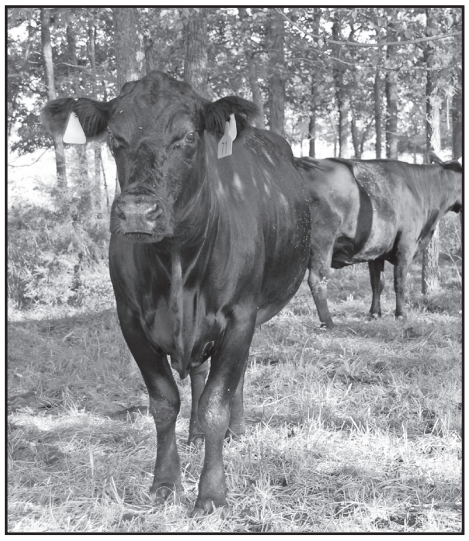
Spring 2011
Volume Three
Issue One

Spotlight on Food Animal Research at MU in 2010

The food animal faculty at the MU CVM is actively engaged in basic and applied research that has direct relevance to veterinary practice and food animal producers. The research team comprises faculty, staff, graduate students and undergraduate/professional students. While our primary focus is food animal diseases, we have active collaborations with faculty in small animal medicine and human medicine. Current areas of research include bovine mastitis, methicillin-resistant staphylococci, transition dairy cow metabolism, Johne's disease, and passive immunity. Research on these subjects is funded by the United States Department of Agriculture, Industry and the College of Veterinary Medicine.

Our research trainees' work has been highlighted locally, nationally and internationally. Dr. Jeanette Perry (MS degree candidate) studied the influence of coagulase negative staphylococcal species on milk somatic cell count and duration of intramammary infection in dairy cattle. In 2010, she was invited to present her work at the National Mastitis Council Annual Meeting in Albuquerque, N.M., the Fifth International Dairy Federation Mastitis Meeting in Christchurch, New Zealand, and the American Association of Bovine Practitioners Annual Meeting in Albuquerque, N.M.

Dr. Davin Ringen third-year food animal internal medicine resident and MS degree candidate) is studying prepartum parameters to predict intramammary infection in dairy heifers at calving. Ringen received a first-place award at the MU Phi Zeta Research Day in March 2010. In addition, he received the first-place resident award for presentation of his data at the American College of Veterinary Medicine Annual Meeting in Anaheim, Calif. Ringen also presented his work at MU Life Sciences Week and at the 2010 Mastitis Research Workers' Conference in Atlanta, Ga. He has been invited to present at the 2011 NMC meeting.



William Chamberlin (combined DVM/MS degree candidate) studied the influence of subclinical hypocalcemia at calving on post-partum liver health and disease incidence and defended his thesis in December 2010. Chamberlin presented his data at the MU Phi Zeta Research Day and MU Life Sciences week and was invited to present an abstract at the American Dairy Science Association meeting in Denver, Colo.

In addition to traditional graduate research training, we actively participate in the Veterinary Research Scholars Program (VRSP) for undergraduate and veterinary students. This past summer we had a VRSP student (Doug Suntrup) working on mastitis in dairy heifers and internal teat sealant compounds for dairy cattle at dry-off. Preliminary data from his work were presented in August 2010 at the National Veterinary Research Scholars Symposium.

Dr. Patrick Pithua has now been with our faculty for just longer than a year and has active research evaluating the efficacy of colostrum replacement products in ensuring calf health. This work is being conducted in collaboration with the University of California-Davis at the Tulare facility. Short-term goals include measurement of adequate passive transfer and measurement of calfhood morbidity and mortality. Long-term goals are focused on whether replacers are efficacious in preventing Johne's disease transmission. As Pithua builds on his first year, he hopes to study Johne's disease in meat and dairy goats, beef cattle, and wildlife hosts. If you have small ruminant, beef cattle, or captive cervids clients interested in participating in Johne's disease research, please contact Pithua.

CONTACTS:
Mastitis, infectious disease, and food animal internal medicine research: Dr. John Middleton – Phone 573-882-6857; middletonjr@missouri.edu
Johne's disease and calfhood health: Dr. Patrick Pithua – Phone 573-882-6857; pithuap@missouri.edu

Food Supply Faculty and Staff Updates

Since our last newsletter, Dr. Tessa (Marshall) Markovich has left the University of Missouri to return to her native New Zealand. We miss her expertise and her tireless work ethic, however we wish her the best as she begins her new life "down under."

We are happy to announce that Dr. Meera Heller will be joining the food-supply faculty in October of 2011. Heller is a 2001 DVM graduate of the University of California-Davis. After an internship at the Atlantic Veterinary College in Prince Edward Island, Canada, she returned to UC-Davis for a large animal internal medicine residency and graduate studies. She earned a PhD in 2009. She is board certified by the American College of Veterinary Internal Medicine. She will bring to Missouri her clinical interests and expertise in food animal medicine and surgery as well as a research interest in immune responses to intracellular pathogens. We look forward to welcoming her next fall.

Even after Heller joins our faculty, we will still have one vacant position that we hope to fill. Our next goal will be to recruit a production medicine/field service clinician. We envision that this person will focus on student instruction and clinical services to beef, dairy, and small ruminant herds.

In 2010, we both welcomed and said goodbye to some of our house officers. Joining us as interns were Drs. Noe Galvan and Josh Schaeffer. Galvan is a 2010 graduate of the University of Wisconsin. You will see some of his work related to anthelmintic resistance in alpacas elsewhere in this newsletter. Schaeffer is one of our own, a 2010 graduate of the University of Missouri. He plans to continue his training at Mizzou as Production Medicine resident when he completes his internship in 2011.

Completing their residencies in 2010 were Drs. Craig Lewis and Jeannette Perry. Lewis completed a Production Medicine residency and Perry completed an Internal Medicine residency. We are proud of their accomplishments and thankful for their service to food-supply medicine at MU. We wish them all the best in their future endeavors.

Dr. Davin Ringen is currently a third-year internal medicine resident. He shares some of his insights on intramammary infections in dairy heifers elsewhere in this newsletter. He will complete his residency and master's of science degree in 2011.

We will be recruiting at least one house officer in 2011. If you or someone you know is interested in advancing their training in food-supply medicine, please let us know. Dr. John Middleton (573-882-6857; middletonjr@missouri.edu) will be happy to provide more information.

As you may know, the office and technical staff of a veterinary hospital is essential to its successful operation. This is also true of the Food Animal Clinic at the University of Missouri, College of Veterinary Medicine. We would like to take this opportunity to introduce members of our staff.

Julie Holle is the senior veterinary technician in the Food Animal Clinic. She joined our staff in 1983, so she has a wealth of experience and institutional knowledge of our operation. Besides assisting with patient care, she also helps with inventory, ordering, and student instruction. Whenever a student or clinician is unsure of the best way to proceed with a technical procedure or needs to find a piece of equipment, the most common response is "Let's ask Julie."

Dr. Noe Galvan

Dr. Josh Schaeffer

Flo Nelson joined the staff of the Veterinary Medical Teaching Hospital in 1979 as a medical records clerk. Nelson now holds the title of office supervisor. In this role, she is still involved with medical records, especially our efforts to transition to a paperless system. She supervises a number of other staff members and pays special attention that our

continued on page 3

People *continued*

Julie Holle

billings and other fiscal matters are handled accurately and efficiently. Her vast experience, her attention to detail, and her commitment to providing excellent customer service are all valued assets for the University of Missouri Veterinary Medical Teaching Hospital.

Flo Nelson

Karen Siegler is the primary receptionist for the Food Animal Clinic. She joined our staff in 2007. Siegler is a very important part of our team as she is often the first person whom our clients hear or see when they interact with the Food Animal Clinic.

Karen Siegler

Siegler, Nelson and Holle are all integral parts of our food-supply medicine team. They are dedicated to high standards of patient care and customer service and are happy to help you and your clients in any way they can. They can be reached at 573-882-6857.

Food Animal Medicine and Surgery House Officer Sought

The University of Missouri College of Veterinary Medicine, Department of Veterinary Medicine and Surgery, is soliciting applications for either a one-year rotating internship or a three-year residency in Food Animal Medicine and Surgery.

The 12-month internship will include approximately six months in-house medicine and surgery, two months production medicine, two months ambulatory practice, and one month elective clinical service. The remaining one month will be devoted to scholarly activities and vacation (10 days). The intern will be expected to complete a scholarly project during the course of their internship. The intern will be assigned to after-hours emergency duty in rotation with other house officers and faculty.

The three-year residency will consist of a minimum of 104 weeks of clinical training designed to achieve specialty certification by the American College of Veterinary Internal Medicine, Large Animal Internal Medicine Specialty or other applicable specialty approved by the American Board of Veterinary Specialization. Approximately 78 weeks will be assigned to in-house medicine and surgery case management with the remaining 26 weeks of clinical training being derived from electives chosen by the candidate. The remaining time will be spent on scholarly activities such as research, coursework, and vacation (10 days/year).

Clinical areas that can be selected for electives include ambulatory practice, production medicine, theriogenology, equine medicine and surgery, and approved externships. The residency is currently approved by the American College of Veterinary Internal Medicine (ACVIM). The residency emphasizes broad-based food animal practice skills, advanced training and expertise in food animal internal medicine, competence in quantitative concepts related to population medicine, and scholarly productivity.

Residents will be assigned to after-hours emergency duty in rotation with other house officers and faculty. The residency requires enrollment in a graduate degree program leading to either a MS or PhD degree. An MS degree likely will be completed during the course of the three-year residency, but completion of a PhD degree likely will require an additional one to two years of coursework and research.

continued on page 8

Mastitis in Peripartum Dairy Heifers:

Can We Predict Who Will be Infected at Calving?

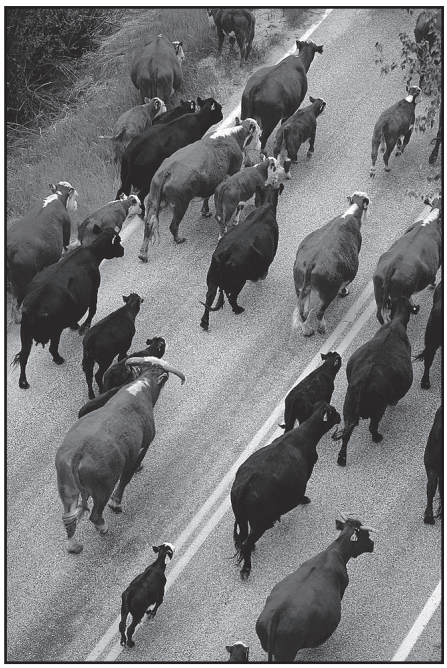
Davin Ringen and John Middleton

Mastitis is the most prevalent infectious disease on dairy farms in the United States. While mastitis is usually considered a disease of lactating cattle, dairy heifers commonly have intramammary infections (IMI) during late gestation and at the time of calving. The prevalence of IMIs in dairy heifers ranges from 30 to 75percent of mammary quarters during late gestation and 12-45 percent of mammary quarters at the time of calving (Fox, 2009).

Coagulase-negative staphylococci (CNS) are the predominant mastitis pathogens isolated from heifers during late gestation and early lactation. Depending on geographic location within the United States, Staphylococcus aureus or Streptococcus spp. are the next most commonly isolated pathogens. These infections not only impact future milk production and milk quality of the heifer but account for economic losses for the producer (Oliver, 1987; Nickerson et al., 1995; Fox et al., 1995).

According to the USDA National Animal Health Monitoring System dairy survey (NAHMS, 2008), the average annual dairy herd attrition rate is 36 percent. Hence, the dairy heifer is an important source of replacement animals. However, heifers may serve as reservoir for the introduction of new mastitis pathogen strains into a herd.

Middleton and co-workers evaluated dairy herd cattle importation practices and found that herds that purchased replacement heifers had a higher prevalence of S. aureus mastitis than herds that purchased lactating cattle for expansion. Additionally, herds that purchased replacement heifers had more total strains of S. aureus and more new strains enter the herd than closed herds that reared their own replacements (Middleton et al., 2002).



Contagious mastitis pathogens are most commonly spread from cow to cow during milking. The obvious question then becomes, how do dairy heifers become infected with contagious mastitis pathogens if they have not gone through the rigors of the milking process?

Roberson and co-workers investigated heifer body site colonization with S. aureus in association with IMI and found that heifers with S. aureus cultured from a body site, particularly teat or udder skin, were 3.34 times more likely to have a S. aureus infection at the time of calving (Roberson et al., 1998). Furthermore, strains of S. aureus isolated from dairy heifers tend to be the same as those isolated from the milk of lactating cattle in the same herd suggesting that there is a circulation of mastitis pathogens between heifers and lactating herd (Middleton et al. 2002; Roberson et al., 1998). The exact mechanism by which heifers become infected with these strains is still largely unknown. However, some data suggests that flies, teat end scabs and lesions, and trauma to the teat may be significant risk factors for the acquisition of S. aureus IMI in heifers (Nickerson et al., 1995; Owens et al., 1998).

Coagulase-negative staphylococci are by far the most commonly isolated bacteria from the mammary glands of heifers during both late gestation and early lactation. These staphylococci are generally regarded as minor mastitis pathogens. Coagulase negative staphylococci result in moderate elevations in somatic cell count (SCC) and decreases in milk production. However, there is still debate as to the importance of individual CNS species in mammary infection and inflammation. Recent work from Belgium found that heifers with a CNS IMI during early lactation had increased SCC compared to heifers that were not infected, however infected heifers produced more milk and had fewer cases of clinical mastitis compared to heifers that did not have a CNS IMI during early lactation (Piepers et al., 2009). The researchers concluded that although CNS are frequently isolated, and a common cause of subclinical IMI and increased SCC, their overall impact may be minimal (Piepers et al., 2009). Other recent work has shown that there are differences in milk SCC and duration of infection between CNS species infecting the mammary gland (Perry et al., 2010).

Detecting IMI in heifers and preventing the possible entry of contagious

continued on page 5

Mastitis *continued*

pathogens into the lactating herd via heifers is dependent on the goals of the individual dairy operation. Traditionally, detection of IMI in heifers occurs once the heifer starts lactating. If the goal is to minimize potential entry of contagious pathogens, mastitis detection after comingling new arrivals, i.e. heifers, with the lactating herd may be too late. Occasionally buyers visually inspect pre-partum secretions or milk from purchased heifers at the time of purchase simply to assess teat patency and detect clinical mastitis. However, because the majority of pre-partum IMIs in heifers are subclinical, i.e., not overtly obvious, the crude assessment of teat patency and appearance of milk will likely not detect heifers with subclinical, potentially, contagious pathogen IMIs. In addition, pre-partum secretions are highly variable in appearance and visual inspection does not generally provide any diagnostic value.

Numerous studies have investigated blanket treatment of heifers with intramammary antibiotics during late gestation as a method to decrease IMI at the time of calving. In these scenarios, all heifers entering the lactating population are treated prior to calving regardless of pre-partum IMI status. Blanket intramammary antibiotic treatment during late gestation does decrease SCC and decrease the number of IMIs in early lactation (Borm et al., 2006). However, there does not appear to be any increase in first lactation milk production when heifers are treated with pre-partum intramammary antibiotics (Borm et al., 2006). Pre-partum treatment of heifers with intramammary antibiotics also constitutes extra-label drug use and because many of the quarters may be uninfected at the time of treatment such use is a violation of AMDUCA.

The University of Missouri has been investigating the utility of pre-partum parameters to predict whether a heifer will have an IMI at the time of calving. The objectives of the study were as follows:

- Define the prevalence of mastitis pathogens in pre-partum heifers during the pre-partum period and early lactation,;
- Determine the relative risk of having an IMI during early lactation based IMI status during the pre-partum period:
- Determine the proportion of IMIs diagnosed during early lactation that can be attributed to a pre-partum infection;
- Determine if sampling heifers during the pre-partum period increases the likelihood of an individual quarter having an IMI during early lactation.

A total of 294 heifers were systematically assigned to one of three groups:

- G1) pre-partum secretions from all mammary quarters (n=98),
- 2) no pre-partum secretions collected (n=98)
- G3) pre-partum secretions from two diagonal quarters (n=98).

Group assignments were designed to assess whether pre-partum sampling increased the likelihood of IMI at calving. Mammary quarter secretions were collected for bacterial culture approximately two weeks prior to expected calving date. Quarter milk samples were collected for bacterial culture once weekly during the first three weeks of lactation. Bacterial isolates were classified as staphylococci, non-agalactiae streptococci and Gram-negatives. Mammary quarter samples yielding two different bacteria were classified as mixed infections and those yielding ≥ 3 bacterial types were classified as contaminated. Bacterial isolates were speciated using gene sequencing methods and strain-typed using pulse-field-gel-electrophoresis to evaluate the relatedness of bacteria isolated from pre-and post-partum samples from the same mammary quarter. Relative risk (RR) and attributable fraction of the population (AFP) were calculated using 2x2 tables.

Forty-five percent of mammary quarters had a pre-partum IMI. During the first three weeks of lactation the mean prevalence of IMI was 23.3 percent of quarters. Staphylococci were most frequently isolated bacteria from pre-partum secretions and milk with S. chromogenes and S. aureus being the most common species. Using data from 228 mammary quarters, the RR and AFP for the association between a post-partum and pre-partum IMI were 11 and 77percent, 43 and 86 percent, and 12 and 68 percent for all staphylococci, S. aureus only and CNS only IMIs, respectively. Mammary quarters sampled pre-partum were no more likely to have a post-partum IMI than those not sampled (Chi-square, $P \geq 0.27$).

These data demonstrate that pre-partum IMIs persist into early lactation and that pre-partum secretion cultures may be a useful, not only in predicting IMI at calving, but also in assessing risk of introducing new contagious mastitis pathogens, e.g., S. aureus, into the lactating herd. If heifers infected with S. aureus could be identified before entry into the lactating population, management decisions could be made whether to treat, segregate or not allow the heifer onto the farm.

References:

Borm AA, Fox LK, Leslie KE, Hogan JS, et al. Effects of pre-partum intramammary antibiotics therapy on udder health, milk production and reproductive performance in dairy heifers. J Dairy Sci 2006:89;2090-2098.

Fox LK, Chester ST, Hallberg JW, et al. Survey of intramammary infections in dairy heifers at breeding age and first parturition. J Dairy Sci 1995;78:1619-1628.

Fox LK. Prevalence, incidence and risk factors of heifer mastitis. Veterinary Microbiol-

continued on page8

Anthelmintic Resistance in Alpacas

Noe Galvan and John Middleton

South American Camelids (SACs) are susceptible to the ill effects of endoparasitism, much like sheep and goats. There are a variety of endoparasites found in SACs, all of which may contribute to production losses. However, certain gastrointestinal (GI) nematodes are more concerning than others based on the clinical outcomes in the host. In sheep and goats, Haemonchus contortus is a major concern because it can cause severe anemia and hypoproteinemia leading to weakness, peripheral edema, ascites, pleural effusion and ultimately death. Anthelmintic resistance has been broadly recognized in sheep and goats. Haemonchus spp. is the most common GI nematode that we see anthelmintic resistance to in sheep and goats and recent observations suggest that this may now be the case in SACs.

The University of Missouri conducted a herd investigation in the summer of 2010 on a local alpaca farm prompted by a series of cases presented to the veterinary medical teaching hospital with life-threatening anemia and weight loss. All cases were profoundly anemic and hypoproteinemic despite recent anthelmintic treatment and all required whole blood transfusions. The deworming protocol on the farm included monthly treatments with doramectin (Dectomax, Pfizer) and albendazole (Valbazen, Pfizer). While both drugs are not labeled for use in SACs, the owner reported using the label doses for cattle. It was hypothesized based on the historical frequency of deworming and apparent lack of response of treated individuals to existing on-farm deworming protocols that the gastrointestinal (GI) nematode populations on the farm were at least partially drug resistant. Hence, the aim was to conduct an anthelmintic treatment trial to determine product efficacy.

Routine fecal flotation techniques can be used to enumerate the number of eggs per gram of feces. However, a single fecal egg count will only predict parasite burden and cannot be used to quantify resistance. To determine if the nematode population is resistant to the dewormers used in a given herd, a fecal egg count reduction test must be performed in which a quantitative fecal egg count is conducted immediately before and approximately 10-14 days after anthelmintic dosing.

In the herd described here, 30 alpacas of various ages and sexes were systematically assigned to one of three groups of 10 animals each as follows:

1) doramectin (Dectomax, 0.2 mg/kg, Pfizer),

2) fenbendazole (Panacur, 10 mg/kg, Intervet/Schering Plough),

and 3) albendazole (Valbazen, 10 mg/kg, Pfizer).

Fecal samples were collected from the rectum of each animal immediately before and 10 days post-treatment and quantitative fecal egg counts were performed using the Modified Stoll's technique. Fecal egg counts were expressed as eggs/gram of feces. None of the animals experienced an adverse reaction following treatment. Animals were also evaluated for anemia based on assessment of conjunctival mucous membrane color using a modification of the FAMACHA scoring method (1/5 being white and 5/5 being pink). Mean fecal egg count reduction was calculated within group as ((Mean baseline fecal egg count – Mean follow-up fecal egg count)/Mean baseline fecal egg count) x 100 and expressed as a percentage. Two animals died (one in the doramectin group and one in the fenbendazole group) prior to the 10 day follow-up fecal egg count and were therefore removed from data analysis. Pre- and post-treatment fecal egg counts and mucous membrane scores were compared between groups using a repeated measures analysis of variance ($P < 0.05$). The correlation between mucous membrane score and fecal egg count was studied using Pearson Product Moment Analysis. Fecal egg count reduction (FECR) testing was considered successful if the mean fecal egg count for Trichostongyle-type eggs was reduced by >90 percent within study group. Mean fecal egg count and mucous membrane scores are depicted in Table 1.

Fecal egg count was significantly negatively associated with mucous membrane color ($P = 0.03$) indicating that as fecal egg count increased mucous membrane score decreased. Hence, animals became increasingly more anemic as fecal egg count increased. While the fecal egg count does not adequately differentiate between species of Trichostrongyloidae, the presence of high fecal egg counts in conjunction with anemia and hypoproteinemia suggested the prevalent problem was Haemonchus spp.

While anthelmintic resistance in sheep and goats has been well-documented in the literature, there are few previous reports documenting anthelmintic resistance in SACs. Data from this herd demonstrate the presence of anthelmintic resistance to two classes of dewormer, an avermectin and two benzimadazoles, in a herd of alpacas. None of the treatment groups achieved a >90 percent mean fecal egg count reduction and several animals had increases in fecal egg count after treatment including one animal in group 2 that had a five-fold increase in fecal egg count following treatment with fenbendazole.

Generally, when GI nematodes develop resistance to one drug in a class of anthelmintics they develop resistance to all drugs in that class as is the case here

continued on page 7

Resistance *continued*

Table1 — Results of fecal egg count and mucous membrane scoring by group study

Group	Mean nematode FEC before eggs/ gram	Mean nematode FEC after eggs/gram*	Mean FECR %	Mean mucous membrane score before	Mean mucous membrane score after**
Doramectin (0.2 mg/kg)	961	629	35	3.0	2.9
Fenbendazole (10 mg/kg)	1124	2393	-113+	3.4	2.8
Albendazole (10 mg/kg)	1295	525	59	3.9	3.5

*No significant difference between groups or sample periods (P > 0.26)
**No significant difference between groups or sample periods (P > 0.10)
+One animal in this group had a 5 fold increase in fecal egg after treatment impacting the overall mean FECR.

where there is resistance to both fenbendazole and albendazole. When resistance occurs, an alternate class of anthelmintic to which the parasites are susceptible must be employed. In this herd treatment of parasite susceptible animals, i.e., animals with high fecal egg counts and/or mucous membrane pallor, was switched to pyrantel at 18 mg/kg, a drug not previously used to treat alpacas in the herd.

Despite treatment with a new class of drug, the herd suffered ongoing losses into the early fall. Animals in this herd were intensively managed with many animals on a very small acreage. Hence, in addition to anthelmintic resistance, frequent reinfection due to high numbers of parasite larvae on pasture and overgrazing of available pasture compounded the problem. It was recommended that the numbers of animals be decreased, the available acreage per animal increased, or the animals be dry-lotted and fed stored forage to decrease ingestion of infective larvae on pasture grasses.

Perpetuating generations of parasites with resistant alleles against previously effective deworming medication is a serious concern because parasites that are resistant to a particular medication will continue to exist in the environment exposing the herd to a constant source of resistant parasite larvae. Additionally, resistance is a major concern because there are currently no new deworming products being developed and thus we may soon run out of effective anthelmintic medications. Hence, animal husbandry, pasture management, and judicious and strategic use of anthelmintics are imperative to maintaining animal health and productivity. Further information on preventing anthelmintic resistance in SACs and small ruminants can be found in the references listed below.

References:

Byers, S. Colorado State University Extension. Parasite Management in Camelids. Available at: http://veterinaryextension.colostate.edu/menu2/camelids/Parasite%20Control%20in%20Camelids.pdf.

Fleming, S.A., Craig, T., Kaplan, R.M., et al. Anthelmintic Resistance of Gastrointestinal Parasites in Small Ruminants. Journal of Veterinary Internal Medicine. 2006;20:435-444.

Contacts:
Dr. John Middleton: 573-882-6857; middletonjr@missouri.edu
Dr. Noe Galvan: 573-882-6857; galvann@missouri.edu

Trichomoniasis Update

Craig A. Payne, DVM, MS
Department of Veterinary Extension and Continuing Education

Since March of 2010, Dr. Linda Hickam at the state veterinary office has been monitoring the number and origin of positive Tritrichomonas foetus samples coming through the CVM Veterinary Medical Diagnostic Laboratory and the state veterinary diagnostic lab in Springfield. With this information, she has created several maps over the past year that show the counties where the positive samples have come from as well as the number of positive samples within each county. From March 1 through Dec. 15, 2010, there were 61 positive samples originating from 22 different counties. This does not include results from samples that were sent to diagnostic laboratories in other states and therefore it likely under estimates the number of positive animals and the number of counties that have experienced Trichomoniasis.

Counties Experiencing Trichomoniasis and the Number of Cases Found

Barry	10	Lawrence	5
Barton	2	McDonald	1
Benton	1	Miller	4
Christian	1	Morgan	1
Clark	2	Newton	6
Cole	1	Polk	6
Gasconade	1	St. Francois	1
Greene	1	St. Louis	2
Harrison	1	Stone	1
Henry	1	Vernon	10
Johnson	2	Wayne	1

College of Veterinary Medicine
University of Missouri
900 East Campus Drive
Columbia, MO 65211

House Officer *continued*

The graduate degree requirement may be waived for a candidate who has completed an MS or PhD in a related field. Active faculty research supporting graduate studies includes bovine mastitis, multi-drug resistant organisms, Johne's disease, neonatal passive immunity, and epidemiology. Candidates with internship or equivalent private practice experience are encouraged to apply. The resident is reviewed semi-annually and the residency is renewed based on satisfactory performance.

The in-house caseload consists of approximately 65 percent cattle, including beef and dairy, 20 percent camelids, 10 percent goats and sheep, and 5 percent swine. Eight clinical faculty and three extension faculty, including three ACVIM large animal internal medicine diplomates (two food animal; one equine), two ABVP diplomates, one ACVPM diplomate, and three ACT diplomates support the training program.

Eligibility for veterinary licensure in Missouri is required (graduates of AVMA accredited veterinary colleges who have passed the NAVLE, veterinarians who have successfully completed the foreign equivalency process or veterinarians who have completed a one-year internship at an AVMA-accredited institution).

The University of Missouri is located in Columbia, Mo., a city of approximately 100,000 people that is consistently rated among America's most livable small cities. Columbia is noteworthy due its relatively low cost of living and numerous recreational opportunities.

For more information, contact Dr. John R. Middleton, Department of Veterinary Medicine and Surgery, College of Veterinary Medicine, University of Missouri, 900 East Campus Drive, Columbia, MO 65211; 573-882-6857, or middletonjr@missouri.edu.

The University of Missouri is an AA/EOE and members of underrepresented groups are encouraged to apply.

Mastitis *continued*

ogy 2009: 134; 82-88.
Middleton JR, Fox LK, Gay JM, et al. Use of pulsed-field gel electrophoresis for detecting differences in Staphylococcus aureus strain populations between dairy herds with different cattle importation practices. Epidemiol Infect 2002;129:387-395.

Nickerson SC, Owens WE, Boddie RL. Mastitis in dairy heifers: Initial studies on prevalence and control. J Dairy Sci 1995;78:1607-1618.

Oliver SP. Intramammary infections in heifers at parturition and during early lactation in a herd with a high prevalence of environmental mastitis. Tennessee Farm Home Sci 1987;143:18-22.
Owens WE, Oliver SP, Gillespie BE, et al. Role of horn flies (Haematobia irritans) in Staphylococcus aureus-induced mastitis in dairy heifers. Am J Vet Res 1998;59:1122-1124.

Perry J, Middleton JR, Zadoks RN. Relationship between coagulase negative staphylococcal species, milk somatic cell count, and duration of intramammary infection on a United States dairy. Proc Intl Dairy Fed. 2010:392-396.

Piepers S, Opsomer G, Barkema HW, de Kruif A, De Vliegher S. Heifers infected with coagulase-negative staphylococci in early lactation have fewer cases of clinical mastitis and higher milk production in their first lactation than non-infected heifers. J Dairy Sci 2009:93;2014-2024.

Roberson JR, Fox LK, Hancock DD, et al. Sources of intramammary infections from Staphylococcus aureus in dairy heifers at first parturition. J Dairy Sci 1998;81:687-693.

Contacts:
Dr. Davin Ringen: 573-882-6857; ringend@missouri.edu.
Dr. John Middleton: 573-882-6857; middletonjr@missouri.edu.