PROCEEDINGS

AAVP

AMERICAN ASSOCIATION OF VETERINARY PARASITOLOGISTS

42nd Annual Meeting
July 19-22, 1997
Reno, Nevada

AMERICAN ASSOCIATION OF VETERINARY PARASITOLOGISTS
AWARDS HISTORY

Distinguished Veterinary Parasitologists

1985	J. P. Dubey
1986	N. D. Levine
1987	E. J. L. Soulsby
1988	J. F. Williams
1989	K. D. Murrell
1990	W. C. Campbell
1991	J. H. Drudge & E. T. Lyons
1992	G. F. Otto
1993	T. R. Klei
1994	P. M. Schantz
1995	J. C. Williams
1996	T.B. Stewart

Hoechst-Roussel Agri-Vet Company Graduate Student Research Award

1987	L. G. Rickard
1988	D. A. Cross
1989	S. C. Barr
1990	J. C. Parsons
1991	C. E. Lanusse
1992	D. G. Baker
1993	R. A. Cole
1994	R. M. Kaplan
1995	S. T. Storandt
1996	A.L. Willingham III

Distinguished Service

1976	R. R. Bell
1987	N. F. Bake
1988	D. E. Cooperrider
1994	S. D. Folz

AMERICAN ASSOCIATION OF VETERINARY PARASITOLOGISTS
Founded 1956

Officers 1996-1997

President	Peter Schantz CDC, NCID Atlanta, GA
President-Elect	James Williams Louisiana State University Baton Rouge, LA
Vice-President	Lou Gasbarre ARS, USDA, LPSI Beltsville, MD
Secretary/Treasurer	Thomas Kennedy Mallinckrodt Veterinary, Inc. Mundelein, IL
Past-President	Byron Blagburn Auburn University Auburn, AL

Committee Chairs

Archives:
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Cornell University
Ithaca, NY

Awards:
Daniel Snyder
Eli Lilly and Co.
Greenfield, IN

Constitution/Bylaws:
Robert Corwin
University of Missouri
Columbia, MO

Education:
Bert Stromberg
University of Minnesota
St. Paul, MN

Finance:
Gil Myers
Magnolia, KY

Historian:
Raf Roncalli
Merck & Co.
Rahway, NJ

Newsletter:
Linda Mansfield
Michigan State University
East Lansing, MI

Nominations:
Tom Craig
Texas A&M University
College Station, TX

Outreach/Research:
Gerry Hackett
California State Polytechnic Univ.
Pomona, CA

Program:
James Williams
Louisiana State University
Baton Rouge, LA

Publications:
Lora Ballweber
Mississippi State University
Mississippi State, MS

AMERICAN ASSOCIATION OF VETERINARY PARASITOLOGISTS

AD HOC COMMITTEES

Representative to Fed. Soc. Parasitology	**R. Fayer**
Student Participation	**C. Seifker**
Presentation Quality	**C. Courtney**
Outreach for American Animal Hospital Association	**A. Marchiondo**

LIAISON TO . . . . . .

American Association of Bovine Practitioners	C. Speer
American Association of Equine Practitioners	J. DiPietro
American Association of Small Ruminant Practitioners	J. Miller
American Association of Veterinary Immunologists	L. Gasbarre
American Heartworm Society	J. McCall
American Society for Animal Science	J. Trischler
American Society of Parasitologists	R. Grieve
Australian Society for Parasitology	N. Sangster
American Association of Avian Pathologists	L. MacDougald
British Society of Parasitologists	G. Coles
Canadian Assoc. Advancement of Veterinary Parasitology	R. Pritchard
Central States Veterinary Conference	R. Arther
Council of Research Workers in Animal Disease	B. Stromberg
Council for Agricultural Science and Technology	T. Kennedy
Livestock Insect Workers Conference	P. Scholl
Livestock Conservation Institute	R. Fayer
National Beef Cattlemens' Association	G. Myers
National Pork Producers Council	J. Urban
New Zealand Animal Production Society	T. Watson
New Zealand Parasitology Society	T. Watson
Society for Neuroscience	D. Thompson
Southeastern Society of Parasitologists	D. Lindsay
U.S. Animal Health Association	J. P. Dubey
Western Veterinary Conference	M. Healey
Wildlife Diseases Association	D. Worley
World Assoc. for the Advancement of Vet. Parasitology	O. Slocombe

Registration - 42nd Annual Meeting
Ballroom Foyer
Saturday 19 July 2:00-7:00 PM
Sunday 20 July 8:00AM-5:00PM
SPEAKER READY ROOM
Gold, Silver Rooms, Peppermill 7AM-6PM Daily

SOCIAL PROGRAM

PFIZER RECEPTION
Saturday, 19 July 1997
Poolside, Peppermill Hotel
7:00-9:00 PM

FORT DODGE RECEPTION
Sunday, 20 July 1997
Manzanita A&B, Peppermill Hotel
7:00-9:00 PM

BAYER RECEPTION
Monday, 21 July 1997
Manzanita A&B, Peppermill Hotel
7:00-9:00 PM

PAST PRESIDENTS OF THE AMERICAN ASSOCIATION OF VETERINARY PARASITOLOGISTS

1956-1958	L.E. Swanson
1958-1960	F. R. Koutz
1960-1962	W. H. Krull
1962-1964	S. M. Gaafar
1964-1966	E. D. Besch
1966-1968	G. C. Shelton
1968-1970	J. H. Greve
1970-1972	H. J. Griffiths
1972-1973	D. E. Cooperrider
1973-1975	D. L. Lyles
1975-1977	H. J. Smith
1977-1979	N. F. Baker
1979-1981	E. L. Roberson
1981-1983	J. F. Williams
1983-1985	J. B. Malone
1985-1986	R. M. Corwin
1986-1987	K. D. Murrell
1987-1988	T. R. Klei
1988-1989	H. C. Gibbs
1989-1990	B. E. Stromberg
1990-1991	R. K. Pritchard
1991-1992	J. O. D. Slocombe
1992-1993	R. Fayer
1993-1994	G. Conder
1994-1995	C. Courtney
1995-1996	B. Blagburn
1996-1997	P. Schantz

AMERICAN ASSOCIATION OF VETERINARY PARASITOLOGISTS
SPONSORS-42nd ANNUAL MEETING

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* Provided honorarium for the Distinguished Veterinary Parasitologist
** Provided honorarium for Graduate Student Award

The American Association of Veterinary Parasitologists gratefully acknowledges the above corporations for their support and sponsorship of the 1997 Annual Meeting

American Association of Veterinary Parasitologists

42nd Annual Meeting

Peppermill Hotel & Casino, Reno, Nevada

SATURDAY, 19 JULY 1997	
Speaker Room	**GOLD** 2-6PM
MAPLE	**BALLROOM LOBBY**
Board Meeting 12:00-3:00PM	Registration 2:00-5:00PM
ASPEN	
Opening Remarks	
President Peter Schantz	
Vice-President Lou Gasbarre	
ASPEN	**GOLD**
Session 1: Swine Endo, Ectoparasites 3:30-5:00PM	**Session 2:** Comp Anim. Ectoparasites 3:30-5:00PM
Break 5:00-5:15PM	
ASPEN	**GOLD**
Session 1: Swine Endo & Ectoparasites 5:15-6:15PM	**Session 2:** Comp. Anim Ectoparasites 5:15-6:15PM
ASPEN	
PFIZER	**SYMPOSIUM**
Problems, Solutions Control in Grazing	for Nematode Cattle 6:15-7:00PM
POOLSIDE Pfizer Social 7-8:30PM	**LAKEVIEW** Grad Mixer 830-10PM

SUNDAY, 20 JULY 1997	
Speaker Room	**SILVER** All day
PINION-RW-SEQUOIA	**ASPEN**
Session 3: Cattle Ectoparasites 8:00-9:30AM	**Session 4:** Wildlife Parasites 8:0-9:30AM
Break -	9:30-1000AM
PINION-	**RDWD-SEQUOIA**
Session 5: Modern Concepts in Biology ,Control	Nematode 10:00-12:00
Lunch	Noon-1:00PM
PINION-	**RDWD-SEQUOIA**
Presidential Address: Peter Schantz 1:00-1:20PM	**Awards:** Dan Snyder 1:20-2:00PM
PINION-SEQUOIA	**ASPEN**
Session 6: Cattle and Avian Endoparasites 2:00-4:00PM	**Session 7:** Swine Endoparasites 2:00-4:00PM
Break	4:00-4:30PM
Session 8: Cattle Endoparasites 4:30-6:15PM	**Session 9:** Companion Animal Endoparasites 4:30-6:15PM
MANZANITA	**A&B**
FORT DODGE "The Quest for a of Worm Control" Fort Dodge	**SYMPOSIUM** New Generation 6:15-6:45PM Social 6:45-8:30PM

MONDAY, 21 JULY 1997	
Speaker Room	**SILVER** All day
REDWOOD-SEQUOIA	**PINION**
Session 10: Cattle Endoparasites 8:00-9:45AM	**Session 11:** Ruminant Endoparasites 8:00-9:45AM
Break -	9:45-10:00AM
RWD-SEQUOIA	**PINION**
Session 12: Cattle Endoparasites 10:00-12:00PM	**Session 13:** Comp. Anim. Ectoparasites 11:00-12:00PM
Lunch	Noon-1:00PM
PINION-	**RDWD-SEQUOIA**
Business 1:00-	Meeting 2:00PM
PINION-SEQUOIA	**OAK**
Session 14: Cattle Endoparasites 2:00-3:45PM	**Session 15:** Comp. Anim.Endoparasites 2:00-3:45PM
Break	3:45-4:0PM
Session 16: Sheep Endoparasites 4:00-6:00PM	**Session 17:** Equine Endoparasites 4:00-6:00PM
MANZANITA	**A&B**
BAYER "Technical Update 6:00 Bayer	**SYMPOSIUM** on Advantage® " -6:45PM Social 6:45-8:30PM

TUESDAY, 22 JULY 1997
Speaker Room **SILVER** All day
PINION-REDWOOD-SEQUOIA
Special Symposium: Advances in Cestode Research 8:00-10:00AM
Break 10:00-10:15AM
PINION-REDWOOD-SEQUOIA
AAVP/AAVI Symposium: Immune Response Against Parasites at Mucosal Surfaces 10:15-12:15PM
Lunch-12:15-1:30PM
B-10 CONVENTION CENTER
AAVP/AVMA Symposium: Advances and Controversies in Vet. Parasit. 1:30-3:00PM
Break 3:00-3:30PM
AAVP/AVMA Symposium: Continued 3:30-5:00PM

PROGRAM

Saturday, July 19, 1997

12:00-3:00 Platinum Room
AAVP Board Meeting

1:00-8:00 Gold Room
Speaker Preparation

2:00 **Registration - Ballroom Lobby**

3:00 **Room: Aspen**
Opening Remarks
President Peter Schantz
Vice President & Program Chairman
Louis Gasbarre

Session I Room: Aspen
Topic: Swine Endo & Ectoparasites
Moderators: D.P. Jasmer,
T.L. Skogerboe

3:30 (1) Vertical Transmission of *Toxoplasma gondii* in rats. J.P. Dubey

3:45 (2) Swine Immune Responses to *Toxoplasma gondii* Infections and to Vaccination with Irradiated Oocysts. J.K. Lunney, S. Hyatt, J.P. Dubey

4:00 (3) Reversal of *Trichinella spiralis* Infected Cell Characteristics is Associated with Nuclear Antigen Depletion. C. Yao, S. Bohnet, D.P. Jasmer

4:15 (4) Production and Use of Proficiency Samples as part of a Quality Control System for Trichinella Digestion Diagnostic Program. L.B. Forbes, R.A. Rajic, A.A. Gajadhar

4:30 (5) Field Evaluation of ELISA and Risk Factor Analysis for Trichinellosis on New England Swine Farms. H.R. Gamble, W.G. Smith, R.C. Brady, L.E. Miller

(Session I continued)

4:45 (6) Development of a Swine Animal Model Where Opportunistic Invasion of the Colon by *Campylobacter jejuni* Occurs Spontaneously. L.S. Mansfield, D.T. Gauthier, S.R. Abner, K.M. Jones, J.F. Urban

5:00 **Refreshments**

5:15 (7) Anthelmintic Use on Saskatchewan Pig Farms: Results from a Postal Survey. B. Wagner, L. Polley

5:30 (8) A Survey of Sarcoptic Mange in Slaughter Pigs at Seven Midwest Packing Plants. J.J. Melancon

5:45 (9) Study One: Duration of Efficacy of Doramectin and Ivermectin Against *Sarcoptes scabiei* var. *suis*. J.J. Arends, T.L. Skogerboe, L.K. Ritzhaupt

6:00 (10) Study Two: Duration of Efficacy of Doramectin and Ivermectin Against *Sarcoptes scabiei* var. *suis*. J.J. Arends, T.L. Skogerboe, L.K. Ritzhaupt

Saturday, July 19, 1997

Session 2 Room: Platinum
Topic: Companion Animal Ectoparasites
Moderators: B.L. Blagburn, M.W. Dryden

3:30 (11) Comparative Evaluation of Flea Counting Techniques on Dogs and Cats. V.M. Goffaux, P.J. Boyd

3:45 (12) A Retrospective Evaluation of the Effects of Lufenuron (Program®) on Flea Allergy Dermatitis (FAD) in Dogs and Cats. M. Groh, R. Sifferman

4:00 (13) Efficacy of Combined Formulation of Milbemycin Oxime and Lufenuron in Controlling Flea Infestations. G. Pengo, P. Sica, R.Steiger, D. Stansfield

4:15 (14) Control of Flea Populations on Naturally Infested Pets and in Private Residences with Either Topical Imidacloprid Spot Application or the Combination of Oral Lufenuron and Pyrethrin Spray. M.W. Dryden, H.R. Perez, D.M. Ulitchny

4:30 (15) Titration of Pyriproxyfen in Virbac KnockOut® IGR Shampoos. T.A. Miller, L.R. Cruthers

4:45 (16) Persistent Ovisterilant Efficacy of Virbac KnockOut® IGR Collars. T.A. Miller, B.L. Blagburn

5:00 **REFRESHMENTS**

(Session 2 continued)

5:15 (17) An Investigative Study to Evaluate the Effect of Water Immersion or Shampooing on the Efficacy of Frontline® Top Spot™. P.A. Tanner, M.N. Romano

5:30 (18) Residual Efficacy of Frontline® Top Spot™ for the Control of Fleas in the Cat. P. Tanner, J.S. Hunter III, N. Meo, D.M. Keister

5:45 (19) Comparative Studies to Evaluate the Flea Control Efficacy of Frontline® Top Spot™ Against Advantage Flea Adulticide in the Dog and Cat. P.A. Tanner, M.N. Romano

6:00 (20) Peritoneal Cestodiasis in Dogs. W. Boyce, C. Kerner, G. Lee, S. Nadler, E. Platzer

Saturday, July 19, 1997

Pfizer Symposium: Aspen Room

6:15 **Topic: Problems and Solutions for Nematode Control in Grazing Cattle**
Moderator: G. Conder

(21) Factors Influencing the Control of *Ostertagia ostertagi* Infections of Cattle L.C. Gasbarre

(22) The Impact of the Environment on Strategic Parasite Control Programs in Cattle. B.E. Stromberg

(23) Strategic Control of Nematode Parasites of Grazing Cattle. R.S. Rew

7:00-8:30 Social - sponsored by Pfizer Animal Health
Poolside

8:30-10 Graduate Student Mixer, **Lakeview**

Sunday Morning, July 20, 1997

Speaker Preparation: Silver Room

Session 3 Room: Pinion, Redwood, Sequoia
Topic: Cattle Ectoparasites
Moderators: S.E.Marley, W.G. Ryan

8:00 (24) Initial and Residual Efficacy of a Pour-on Formulation of Fipronil Applied to Cattle infested with *Boophilus microplus* (Canestrini) J.S.Hunter, D.M. Keister, P. Jeannin, R.B. Davey, J.E. George

8:15 (25) Efficacy of Doramectin Pour-on Against *Damalinia bovis* on Cattle. L. Smith, W. Lodi, K. Rooney, S. Marley, G. Conder

8:30 (26) Efficacy of Doramectin Pour-on Against Lice, Mites, and Grubs of Cattle. K. Rooney, E. Illyes, D. Keller, T. Meinert, N. Logan, G. Conder. S. Sunderland, P. Sarasola

8:45 (27) Eprinomectin: A Novel Avermectin for Control of Lice in Cattle. J.E. Holste, L.L. Smith, J.A. Hair, J.L. Lancaster, J.E. Lloyd, W.K. Langholff, R.A. Barrick, J.S. Eagleson

9:00 (28) Efficacy of Topically Applied Eprinomectin Against *Chorioptes bovis* Mites. L.L. Smith, K.E. Sterner, D. Bowman, J.A. Hair, D. Barth, B.N. Kunkle, J.E. Holste

9:15 (29) The History of Myiasis in the Americas. R.A. Roncalli

10:00 **REFRESHMENTS**

Session 4 Room: Aspen Rooms
Topic: Wildlife Parasites
Moderators: A.Gajadar, K.R. Kazacos

8:00 (30) Molecular Phylogenetic Relationships Among *Sarcocystis* Species of Wild and Domestic Animals. C.K. Fenger, D.E. Granstrom, J.L. Langemeier, A. Gajadhar, J.P. Dubey

8:15 (31) Isolation, Culture, Western Blot Analysis and SSURNA Sequence Analysis of a *Sarcocystis neurona*-like Protozoan from a Wildcaught Opossum from Michigan. A.J. Murphy, P.M. Gearhart, L.S. Manfield

8:30 (32) Recovery from Blindness Caused by Toxoplasmosis in Bennett's Wallabies (*Macropus rufogriseus*). C.A. Crutchley, J.P. Dubey, D.S. Adams

8:45 (33) Studies on the Large Ribosomal Subunit to Develop a Diagnostic Test for the Identification of *Elaphostrongylus cervi.* G.M. Falk, A.A. Gajadhar

9:00 (34) Population Dynamics of Gastrointestinal Nematodes in the White-tailed Deer (*Odocoileus virginianus*). A. Derosa

9:15 (35) Natural Co-Infection of a White-tailed Deer Population with *Ehrlichia chaffeensis*, the Human Granulocytic Ehrlichiosis Agent, and an *Ehrlichia*-like Organism. S.E. Little, D.E. Stallknecht, J.M. Lockhart, J.E. Dawson, W.R. Davidson

Sunday, July 20, 1997

Morning

Session 5 Rooms: Pinion, Redwood, Sequoia
Topic: Modern Concepts in Nematode Biology and Control
Moderators: R.H. Fetterer, T.G. Geary

10:00 (36) Nematode Amphidial Neurons: Comparative Ultrastructure, Putative Function and Evidence from Ablation. F.T. Ashton, G.A. Schad

10:40 (37) A Conserved Signalling Pathway Controls *Caenorhabditis elegans* Dauer Larva Development. D.L. Riddle

11:20 (38) Pharmacology of Anthelmintic Resistance: From Molecules to the Field. N. Sangster

12:00 **LUNCH**

1:00 **Rooms: Pinion, Redwood, Sequoia**
PRESIDENTIAL ADDRESS
Peter Schantz

1:20 **AWARDS**
Dan Snyder

Afternoon

Session 6 Rooms: Pinion, Redwood, Sequoia
Topic: Cattle & Avian Endoparasites
Moderators: H.D. Chapman, J.P. Dubey

2:00 (39) Neosporosis: New Isolate Characterizations and Insights on Pathogenesis in Cattle . P.A. Conrad, M.L. Anderson, J. Rowe, A.E. Marsh, M. Ho, K. Louie, K.W. Sverlow, A. Packham, B.C. Barr

2:15 (40) Determination of the Role of BVD Virus in *Neospora caninum*-Infected Cattle. R.D. Pinckney, W.W. Zhang, R.D. Schultz, H.W. Momont, D. Sockett, P.S. Schmidt

2:30 (41) Oral Inoculation of Cats with *Neospora caninum*. M.M. McAllister, D.S. Lindsay, R.A. Wills, A.M. McGuire, J.D. Tranas

2:45 (42) Vaccination with *Neospora caninum* Causes Decreased Mortality But Not Tissue Cyst Production in Mice Orally Challenged with *Toxoplasma gondii* Oocysts. D.S. Lindsay, S.D. Lenz, C.C. Dykstra, B.L. Blagburn, J.P. Dubey

3:00 (43) Diagnostic Strategies for *Tritrichomonas foetus* in Bulls. S. Parker, J. Campbell, H. Cook, A. Gajadhar

3:15 (44) Transport and Culture Conditions Potentially Affecting the Sensitivity of the Diagnostic Test for *Tritrichomonas foetus*. L. Bryan, J. Allen, J. Campbell, A. Gajadhar

3:30 (45) Development of Immunity to *Eimeria* Species in Broilers Reared on New or Used Litter and Given Anticoccidial Drugs in the Feed. H.D. Chapman

3:45 (46) Role of Interferon-Gamma and Nitric Oxide in Avian Coccidiosis. H.S. Lillehoj, P. Allen

4:00 **REFRESHMENTS**

Sunday Afternoon July 20, 1997

Session 7 Rooms: Aspen
Topic: Swine Endoparasites
Moderators: C.M. Christensen, D.E. Hill

2:00 (47) Pharmacokinetics of Doramectin and Ivermectin in Swine. C. Friis, H. Bjoern

2:15 (48) Duration of Activity of Doramectin and Ivermectin Against *Ascaris suum* in Experimentally Infected. Pigs. C.A. Lichtensteiger, J. A. DiPietro, A.J. Paul, E. Neumann, L. Thompson

2:30 (49) Effect of *Metastrongylus* spp. Infection on Performance of Growing Pigs. M.A. Baudena, E. Kabagambe, Y. Li, T. Pena, R. Rutledge, G. Baptista

2:45 (50) Transmission Dynamics of *Oesophagostomum dentatum* and *Hyostrongylus rubidus* in Outdoor Pigs. A. Roepstorff, K.D. Murrell

3:00 (51) Transmission Dynamics of *Ascaris suum* and *Trichuris suis* in Outdoor Pigs. A. Roepstorff, K.D. Murrell

3:15 (52) Effect of Protease Inhibitors on *in vitro* Development of the Third- to Fourth-Stage of *Ascaris suum*. M.L. Rhoads, R.H. Fetterer

3:30 (53) Effect of Disulfiram on Eggshell Morphology of *Trichuris muris*. D.E. Hill, R.H. Fetterer

3:45 (54) Studies of Reproduction Biology of *Oesophagostomum* Species in Pigs Using a Novel Transplantation Technique. C.M. Christensen

4:00 **REFRESHMENTS**

Session 8 Rooms: Pinion, Redwood, Sequoia
Topic: Cattle Endoparasites
Moderators: S. Almeria, J.A. Stuedemann

4:30 (55) Paraban, a Window-based Model for Parasite-Control in Cow-calf and Stocker Operations. G. Smith, J. Jacobsen, M. Soll, J. Guerrero

4:45 (56) Control of Gastrointestinal Nematodes in the Pyrenees (Spain) Based on Epidemiological Data, Confirmation with a Mathematical Model. S. Almeria, J. Guerrero, J. Uriarte

5:00 (57) Gastrointestinal Nematode Infections in Dairy Calves Following One, Two or Three Moves to Clean Pasture. M. Eysker, J.H. Boersema, J.B. Githiori, F.N.J. Kooyman

5:15 (58) Cattle Management to Reduce Nematode Contamination Potential of Parasite-Free Bermudagrass Pastures. J.A. Stuedemann, H. Ciordia, T.B. Stewart, D.H. Seman, S.R. Wilkinson, A.J. Franzluebbers, A.L. Dillard, A.D. Lovell

5:30 (59) Lungworm Outbreak in Lactating Dairy Cows. D.H. Bliss, G.H. Myers

5:45 (60) Evaluation of Anthelmintic Treatments in Cattle Grazing Great Basin Rangeland in Nevada and California. W.G. Kvasnicka, D.H. Bliss, R. Torell

6:00 (61) Productivity of Stocker Cattle Treated with the Ivomec SR Bolus vs. Benzimidazole Anthelmintics and Topical Fenthion from Grazing to Slaughter. L. Ballweber, D. Bechtol, J.R. Brown, J.A. Hawkins, R. Alva, R. Plue

Sunday July 20, 1997

Session 9 Rooms: Aspen
Topic: Companion Animal Endoparasites
Moderators: C.H. Courtney, J.W. McCall

4:30 (62) Canine Heartworm Prophylaxis by High Oral Dosages or Transdermal Administration of Diethylcarbamazine. J.W. McCall, S.L. Stroh, A.A. Marchiondo, T.L. McTier

4:45 (63) Correlation of Mosquito Species Population Distribution and the Seasonal Transmission of *Dirofilaria immitis.* R.A. Holmes, G. Faget, M. Yates

5:00 (64) Development of a Molecular Probe Based on the Small Subunit Ribosomal RNA for the Detection of *Dirofilaria immitis.* K.J. Watts, C. Sulsona, E.C. Griener, R.R. Ganta, C.H. Courtney

5:15 (65) Canine Filariasis in California: *Dipetalonema reconditum*, Distribution and Prevalence as an Indication of Vector Abundance and Survival. J.H. Theis, F. Stevens

5:30 (66) Canine Filariasis Due to *Dipetalonema reconditum* in California: The Effects of Management, Geographical Location of the Dog's Domicile, Age, Gender and Plant Climate Zones on the Risk of Infection. J.H. Theis, F. Stevens

6:00 (68) Canine Filariasis Due to Dirofilariasis in California: The Effects of Rain and Snowfall on the Western Facing Slopes of the Sierra Nevada Mountains on Prevalence and Distribution Within the Plant Climate Zones of Northern California. J.H. Theis, F. Stevens, P.H. Kass

Rooms: Manzanita A&B
6:15 **Fort Dodge Animal Health Symposium**
Topic: The Quest for a New Generation of Worm Control
Manzanita A&B
7-9 **(Social by Fort Dodge Animal Health)**

Monday Morning, July 21, 1997

Session 10 Rooms: Redwood, Sequoia
Topic: Cattle Endoparasites
Moderators: T.A. Yazwinski, G.L. Zimmerman

8:00 (69) Evaluation of Coat Length, Rainfall, and Exposure to Prevailing Weather Conditions on the Efficacy of Topically Applied Eprinomectin. J.S. Eagleson, R.P. Gogolewski, S.R. Pitt, D.R. Thompson, J.A. Hair

8:15 (70) The Efficacy of an Eprinomectin Pour on Product Against *Cooperia* spp. and *Nematodirus helvetianus.* J.S. Eagleson, D. Farrington, L.G. Cramer

8:30 (71) Efficacy of Eprinomectin Pour-on Against Nematode Parasites of Cattle with Emphasis on Inhibited Early Fourth-Stage Larvae (IEL_4) of *Ostertagia* spp. J.C. Williams, J.A. Stuedemann, K. Bairden, D. Kerboeuf, H. Ciordia, J. Hubert, S.D. Broussard

Monday Morning, July 21, 1997

(Session 10 continued)

9:00 (73) Persistent Efficacy of Doramectin Injectable Solution Against Artificially-Induced Infections of Nematodes in Cattle. B. Stromberg, B. Woodward, C. Courtney, E. Johnson, G. Zimmerman, S. Marley, G. Conder

9:15 (74) Comparison of Efficacy of Doramectin Injectable with Ivermectin/Clorsulon Injectable in Cattle Naturally Infected with Gastrointestinal Nematode and Trematode Infections. J.C. Williams, A.F. Loyacano, A. Derosa, J. Gurie, T.L. Skogerboe

9:30 (75) Characterization of Turkey Ascaridiasis and the Efficacy of Fenbendazole Medicated Feed in the Treatment of Nematode Parasitisms of the Turkey. T.A. Yazwinski, C.A. Tucker

9:45 **Refreshments**

Session 11 Room: Pinion
Topic: Ruminant Endoparasites
Moderators: T.M. Craig, A.M. Zajac

8:00 (76) Field Efficacy of Doramectin Pour-on Against Naturally-Acquired Nematode Infections of Cattle. G. Conder, K. Rooney, E. Illyes, D. Keller, T. Meinert, N. Logan

8:15 (77) Therapeutic Efficacy of Doramectin Pour-on Against Eyeworms, Lungworms, and Gastrointestinal Nematodes. S. Marley, E. Illyes, D. Keller, T. Meinert, N. Logan, G. Conde

8:30 (78) Verification of ®DrenchRite (For Use in North America) by Comparison with FERT (Fecal Egg Reduction Tests). K.E. Young, T.M. Craig, M.R. Slater, N.R. Hooper

(Session 11 continued)

8:45 (79) Multiple Anthelmintic Resistance in a Virginia Goat Herd. A.M. Zajac, T.A. Gipson, J.C. Lovin

9:00 (80) The Use of Tracer Lambs to Evaluate the Transmission and Survival of Gastrointestinal Parasites of Exotic Ruminants. T.M. Craig, J. Jensen, R. Lenz

9:15 (81) Composition of Parasite Burden in Bison Grazing the Konza Prairie. R.K. Ridley, D. Post, M. O'Donnell, A. Benorden, M. Walburger, P. Payne

9:30 (82) Dynamics of *Fossaria cubensis* Populations in Florida: Relationship to the Epidemiology and Control of Bovine Fascioliasis. R.M. Kaplan, C.H. Courtney, F.G. Thompson, P.O. Miller

9:45 **Refreshments**

Session 12 Room: Redwood, Sequoia
Topic: Cattle Endoparasites
Moderators: B. Stromberg, D. Zarlenga

10:00 (83) Pathophysiology of Hypersensitivity Reactions Associated with Giardiasis. M.E. Olson, J.A. Hardin, A.G. Buret, M.H. Kimm, D.G. Gall

10:15 (84) Pathophysiology of Giardiasis in Dairy Calves. R.M. O'Handley, M.E. Olson, T.A. McAllister, M.Jelinski

10:30 (85) Longitudinal Study of *Giardia* and *Cryptosporidium* in Dairy Calves. R.M. O'Handley, M.E. Olson, T.A. McAllister, M. Jelinski

10:45 (86) *Giardia* and *Cryptosporidium* in British Columbia Dairy Calves. N.J. Gusella, M.E. Olson, R.M. O'Handley, M. Swift, T.A. McAllister, M.D. Jelinski, D.W. Morck

Monday, July 21, 1997

(Session 12 continued)

11:00 (87) *Giardia* and *Cryptosporidium* in Feedlot Cattle. B. Ralston-Chalmers, M.E. Olson, N. J. Guselle, T.A. McAllister

11:15 (88) Immune Response in Lambs Experimentally Infected with *Giardia.* M.E. Olson, S. Yanke, H. Ceri, D.W. Morck, T.A. McAllister

11:30 (89) Local Ileal Immune Responses in Cattle During a Primary Infection with *Cryptosporidium parvum.* A. Canals, P. Pasquali, D.S. Zarlenga, S. Almeria, R. Fayer, L.C. Gasbarre

11:45 (90) Cloning and Expression of Bovine Interleukin-15: Analysis and Modulation of Transcription in Parasite Infected Animals. A.C. Canals, L.C. Gasbarre, R. Fayer, P. Pasquali, P.C. Boyd, S. Almeria, D.S. Zarlenga

12:00 **LUNCH**

1:00 **Business Meeting Pinion/Sequoia**

Session 13 Room: Pinion
Topic: Companion Animal Ectoparasites
Moderators: P.J. Scholl, T.B. Stewart

10:00 (91) Integrated Tick Control: New Concept for Breaking the Life Cycle (1). A. Estrada-Peña, F. Ascher

10:15 (92) Integrated Tick Control: New Concept for Breaking the Life Cycle (2). A. Estrada-Peña, F. Ascher

10:30 (93) Efficacy of Two Ixodicide Collars Against Natural Infestation with the Brown Dog Tick. A. Estrada-Peña, F. Ascher

10:45 (94) Antifixing + Antifeeding Effect of Two Ixodicide Collars Against the Brown Dog Tick A. Estrada-Peña, F. Ascher

11:00 (95) Killing Effect of Two Ixodicide Collars Against the Brown DogTick. A. Estrada-Peña, F. Ascher

(Session 13 continued)

11:15 (96) Efficacy of a 1% (S)-Methoprene - 8% Chlorpyrifos Combination Dog Collar Against the Cat Flea and Brown Dog Tick. J.B. Prullage, R.R. Rudolph, S.R. Hansen

11:30 (97) Residual Efficacy of Frontline® Top Spot™ for the Control of Fleas and Ticks in the Dog. J.S. Hunter III, P. Tanner, D.M. Keister, Ph. Jeannin

11:45 (98) A New Species of Demodicid Mite from a Cat. T.B. Stewart, C.E. Desch, Jr.

12:00 (143) A Comparison of the Flea Control Efficacy of Frontline® TopSpot™ Against a Combination of Adams® and Program® Flea Products in the Dog and Cat (Interim Report) N.J. Meo, B.B. Dunavent, D.M. Keister, M.N. Romano, Ph. Jeannin.

12:00 **LUNCH**

1:00 **Business Meeting Pinion/Sequoia**

Session 14 Room: Pinion, Rdwd, Sequoia
Topic: Cattle Endoparasites
Moderators: J.E. Miller, J.C. Williams

2:00 (99) Use of Geometric Means in Parasite Data G.F. Ericsson, R.A. Barrick, C.P. Daurio, W.K. Langholff

2:15 (100) Prevalence of Parasite Contamination on Great Basin Pastures and Ranges from Cow/Calf Herds as Determined by Fecal Worm Egg Counts. W.G. Kvasnicka, D.H. Bliss, R. Torell

2:30 (101) Epidemiology of GI Nematodes in Cow-Calf Herds and Breed Susceptibility. M. Pena, J.E. Miller, W. Wyatt, S.R. Barras, Y. Li, E. Kabagambe

2:45 (102) Role of Inhibited Early Fourth-Stage Larvae (IEL_4) in the Immune Response to *Ostertagia ostertagi* (OST). J.C. Williams, L.C. Gasbarre, T.R. Klei, A. Derosa, M. Chapman

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3:00 (103) Comparison of Natural and Experimental Gastrointestinal (GI) Nematode and Lungworm Infections in Cattle. J.C. Williams, A. Derosa

3:15 (104) Mucosal Immunity of Cattle Infected with the Gastric Nematode *Ostertagia ostertagi*: Phenotypic Characterization and Cytokine Analysis. S. Almeria, A. Canals, D.S. Zarlenga, L.C. Gasbarre

3:30 (105) Comparison of GI Nematode Infection and Body Weight Among Native, Suffolk and Crossbred F1 Lambs. Y. Li, J.E. Miller, D.E. Franke, S.R. Barras, E.K. Kabagambe, M.T. Pena

3:45 **REFRESHMENTS**

Session 15 Room: Oak
Topic:Companion Animal Endoparasites
Moderators: A.R. Donoghue, R.K. Ridley

2:00 (106) Strategic Use of Ivermectin During Pregnancy to Control *Toxocara canis* in Greyhound Puppies. P.A. Payne, R.K. Ridley

2:15 (107) A Case of Pseudoparasitism Due to Mermithid Nematodes in a Cat. K.R. Kazacos, J.A. Epler

2:30 (108) Inflammatory Lung Disease from *Dirofilaria immitis* Infections in Cats and Dogs. A.R. Dillon, A. Warner, J. Hudson, R. Molina

2:45 (109) Regional, Clinical Case Studies of Feline Heartworm Infection. C.K. Robertson, A.R. Dillon, W.R. Brawner, J. Guerrero

3:00 (110) Feline Heartworm Infection: Clinical Study in Northern Italy. C. Genchi, L. Venco, G. Prieto

(Session 15 continued)

3:15 111) Comparison of Antibody and Antigen Detection Tests on Sera from Cats Experimentally Infected with *Dirofilaria immitis* J.W. McCall, N. Supakorndej, A.R. Donoghue, C.A. Piché

3:30 (112) Canine Hepatozoonosis Newly Endemic to Oklahoma. R.J. Panciera, J.S. Mathew, M.A. Breshears, S.A. Ewing

3:45 **REFRESHMENTS**

Session 16 Room: Pinion, Redwood, Sequoia
Topic: Sheep-Endoparasites
Moderators: H. Schallig, J.F. Urban

4:00 (113) Evidence for Reversible Inhibition of Abomasal Acid Secretion in Sheep Infected with *Ostertagia leptospicularis*. H. Hertzberg, L. Kohler, J. Eckert

4:15 (114) Gut Secretory Antigens of *Haemonchus contortus*: Gene Isolation and Comparison Among Diverse Nematode Species. A. Rehman, D.P. Jasmer

4:30 (115) Production of a Monoclonal Antibody Specific for Ovine Immunoglobulin E and Its Application to Monitor Serum IGE Responses to *Haemonchus contortus* Infection. F.N.J. Kooyman, H.D.F.H. Schallig, J.F .Huntley, A.W.C.A. Cornelissen

4:45 (116) Immunoprotective Properties and Molecular Characterization of Two Excretory Secretory (ES) Proteins of *Haemonchus contortus*. H.D.F.H. Schallig, M.A.W. van Leeuwen, A.W.C.A. Cornelissen

Monday, July 21, 1997

(Session 16 continued)

5:00 (117) Field Evaluation of H11-H-gal-GP Vaccine Against *Haemonchus contortus* in Suffolk and Gulf Coast Native Sheep. E. Kabagambe, J. Miller, D. Smith, S. Barras, Y. Li, M. Peña

5:15 (118) Serum Antibody Response of Four Sheep Breeds to *Haemonchus contortus* Infection: Antigen Markers. M.T. Gómez-Muñoz, M. Cuquerella, L.A. Gómez-Iglesias, C. de la Fuente, J.M. Alunda

5:30 (119) Characterization of Hemolytic Activity from Adult *Heamonchus contortus.* R.H. Fetterer, M.L. Rhoads

5:45 (120) Toxic Activity of Crystals from *Bacillus thuringiensis* (Strain YBT-1953) to Adults of *Haemonchus contortus* In Vitro. Y. Baoan, W. Xiang, Z. Junlong, M. Lihua, Y. Zinlu

Session 17 Room: Oak
Topic: Equine-Endoparasites
Moderator: D.D. French, D.E. Granstrom

4:00 (121) *In Vitro* Cultivation and Experimental Inoculation of *Sarcocystis falcatula* and *S. neurona* Merozoites into Budgerigars. A. Marsh, B.C. Barr, L.A. Tell, E. Greiner, J. Dame, P.A. Conrad

4:15 (122) Experimental Reproduction of *Sarcocystis neurona* Induced Encephalitis in Nude Mice. A.E. Marsh, B.C. Barr, J.E. Madigan, R. Nordhausen, P.A. Conrad

4:30 (123) Experimental Induction of Equine Protozoal Myeloencephalitis in Horses Using *Sarcocystis* sp. Sporocysts from the Opossum (*Didelphis virginiana*). D.E. Granstrom, C.K. Fenger, A.A. Gajadhar, N.M. Williams, S.A. McCrillis, S. Stamper, J.L. Langemeier, J.P. Dubey

(Session 17 continued)

4:45 (124) Anthelmintic Resistance on Pleasure Horse Farms in North Central Florida. T.F. Woods, T.J. Lane, Q.-Y. Zeng, C.H. Courtney

5:00 (125) Dose Confirmation Trial of Moxidectin Equine Oral Gel Against *Gasterophilus* sp. in Equines. O. Slocombe, M.C. Lake,P.J. Scholl

5:15 (126) Comparison of the Recovery of Cyathostome Larvae from Fresh and Frozen Equine Mucosa. R. Gamboa, J.A. DiPietro, A.J. Paul

5:30 (127) Remanent Effect of a 2% Equine Moxidectin Gel on Establishment of Small Strongyles. J. Vercruysse, M. Eysker, D. Demeulenaere, K. Smets, P. Dorny

5:45 (128) Comparison of Diagnostic Techniques for Detection of *Cryptosporidium parvum* in Horses D. Cole, N. Cohen, K. Snowden, C. Chappell

6:00 **Symposium Room: Manzanita A&B**
Topic: Technical Update on Advantage® sponsored by Bayer Corporation

6:45 **Manzanita A&B**
Social sponsored by Bayer Corporation

Tuesday Morning, July 22, 1997

Special Symposium -Room: Pinion, Redwood, Sequoia
Topic: Advances in Cestode Research -
Moderator: L.C. Gasbarre

8:00 INTRODUCTION

8:05 (129) The Species Question in *Echinococcus* and *Taenia*: Taxonomic Controversies. E.P. Hoberg, D. Zarlenga

8:25 (130) *Echinococcus multilocularis* and Alveolar Echinococcosis in Europe. J. Eckert

8:55 (131) *Echinococcus multilocularis* in the States. K.R. Kazacos, S.T. Storandt

9:10 (132) Cystic Echinococcosis in Africa and the Middle East: A Cooperative Project. F.L. Anderson, M. Kachani

9:30 (133) Development and Application of Coproantigen Assays for Intestinal Taeniid Infections. J.C. Allan

10:00 **REFRESHMENTS**

AAVP/AAVI Joint Symposium -
Room: Pinion, Redwood, Sequoia
Topic: Immune Response Against Parasites at Mucosal Surfaces
Moderator: L.C. Gasbarre

10:15 (134) The Mucosal Immune System: Novel Solutions in a Complex Microenvironment A.D. Befus

10:45 (135) Immunity to Trichomonad Infection of the Bovine Reproductive Tract. L.B. Corbeil, R.H. BonDurant

11:15 (136) Immune Responses in Intestinal Mucosa to *Cryptosporidium parvum*. C.R. Wyatt

11:45 (137) Immunity to GI Nematodes: Searching for Novel Cytokine-Induced Effector Mechanisms. J.F. Urban, Jr.

12:15 **LUNCH**

Tuesday Afternoon, July 22, 1997

AAVP/AVMA Joint Symposium-
Convention Center Room. B-10
Topic: Advances and Controversies in Veterinary Parasitology
Moderator: P.M. Schantz

1:30 INTRODUCTION

1:40 (138) Understanding Persistent and Recurrent Flea Problems and the Importance of Parasites of Urban Life. M.W. Dryden

2:20 (139) Dangerous Liaisons: Zoonotic Helminths Acquired from Pets and Wildlife. K.R. Kazacos

3:00 **REFRESHMENTS**

3:30 (140) Heartworms: Is the Transmission Season Really that Short? J.B. Lok

4:00 (141) Public Health and Veterinary Concerns About Waterborne Cryptosporidiosis. D.D. Juranek

4:30 (142) Lyme Borreliosis: Clinical and Epidemiologic Significance for Veterinary Medicine. K.A. Orloski

1

Vertical transmission of *Toxoplasma gondii* in rats.
J.P. DUBEY*, USDA, ARS, LPSI, PBEL, BELTSVILLE, MARYLAND 20705-2350

Rats are considered important in the epidemiology of *Toxoplasma gondii* infection in pigs and possibly cats. It has been suggested (Webster, Parasitology 108: 407-411, 1994) that *T.gondii* can be maintained by vertical transmission in rats in the absence of cats. Therefore, we studied congenital transmission of *T. gondii* during acute and chronic infections. Four pregnant Sprague-Dawley rats were each fed 10,000 oocysts of the VEG strain. *Toxoplasma gondii* was recovered from 33%, 55%, 83% and 57% of rats (F1) when dams were inoculated at 6, 9, 12, and 15 days of gestation, respectively. A total of 15 congenitally infected female rats from 4 litters were mated and their progeny were examined for T. *gondii*. *Toxoplasma gondii* was recovered from tissues of 1 of 155 rats (F2) born to congenitally infected dams. A total of 4 (F2) females were mated; 0 to 40 (F3) rats born to them were infected. None of the original 4 dams that had given birth to congenitally infected offspring produced congenitally infected rats during the second pregnancy. Thus, evidence for repeated congenital transmission of *T. gondii* infected offspring with demonstrable tissue cysts, 5 were seronegative (<1:4) in the Sabin-Feldman dye test and 5 were seronegative (<1:20) in the modified agglutination test by the use of whole formalinized tachyzoites and mercaptoethanol.

2

Swine immune responses to *Toxoplasma gondii* infections and to vaccination with irradiated oocysts. J.K. LUNNEY,* S. HYATT, AND J. P. DUBEY, Immunology and Disease Resistance Lab and Parasite Biology and Epidemiology Lab, LPSI, ARS, USDA, B.1040, BELTSVILLE, MD 20705

Swine infected with low doses (200-1000 oocysts) of VEG strain of *T. gondii* have been analyzed for their immune responses to infection. Analyses of cell subsets have shown an early (day 6-8) increase in peripheral blood CD4+/CD8+ T cells that returns to normal levels by day 14 of infection. Levels of activated monocytic cells are also increased in the first week after infection. Analyses of cytokine mRNA expression in peripheral blood lymphocytes from infected pigs show increases in interferon-γ (IFN-γ) levels as compared to cells from uninfected pigs. Recent studies have been aimed at documenting a *T. gondii* vaccination model using irradiated oocysts. Preliminary studies showed that pigs vaccinated with ~10,000 VEG strain oocysts, irradiated with 0.3 kGy Cs^{137}, were protected against challenge high (10^6) or low (10^3) dose *T. gondii* oocyst inocula, as determined by clinical signs and by recovery of viable parasite from tissues. Antibody levels were measured during the vaccination process and were found not to be predictive of the protection stimulated by the vaccination. Repeat vaccination studies are underway to determine the reproducibility of irradiated oocysts as a *T. gondii* vaccine for swine and to assess whether specific cell subsets or cytokines are preferentially stimulated during vaccination responses. These studies should verify whether use of irradiated oocysts is a good vaccine candidate for preventing toxoplasmosis in swine and whether in vitro assays, such as measurement of cytokine levels, are potential predictors of positive *T. gondii* vaccination responses.

3

Reversal of *Trichinella spiralis* infected cell characteristics is associated with nuclear antigen depletion. CHAOQUN YAO*, STEWART BOHNET AND DOUGLAS P. JASMER, DEPARTMENT OF VETERINARY MICROBIOLOGY AND PATHOLOGY, COLLEGE OF VETERINARY MEDICINE, WASHINGTON STATE UNIVERSITY, PULLMAN, WA 99164-7040

Trichinella spiralis infection of differentiated skeletal muscle cells induces cell cycle reentry, suspension in G_2/M, repression of muscle gene expression, nuclear hypertrophy and increased acid phosphatase (ACP) activity in these cells. Nuclear antigens (NA) of 79, 86 and 97 kDa have been detected in host nuclei by antibodies to a *T. spiralis* glycan epitope (tyvelose) in association with host chromatin. Therefore, NA may regulate aspects of the infected cell phenotype. This possibility was investigated with the β-tubulin binding drug mebendazole (MBZ), in attempts to inhibit *T. spiralis* secretions in vivo. MBZ treatment of chronically infected mice led to significantly reduced levels of NA in infected cell nuclei by 4 days post treatment (dpt). Associated with NA depletion, host nuclei and nucleoli were significantly diminished in size by 4 and 6 dpt, respectively ($p<0.001$). This diminution does not appear to involve DNA degradation based on TUNEL analysis, nor was there cytological evidence for mitosis. By 10 dpt, in these nuclei general protein levels and ACP activity were decreased 3.79 and 3.34 times ($p<0.01$), respectively, in MBZ compared to control infected cells. These results implicate the parasite and NA in inducing the nuclear hypertrophy, increased ACP activity and elevated protein levels of infected cells, possibly via interactions with chromatin. (NIH-AI-01235)

4

Production and Use of Proficiency Samples as Part of a Quality Control System for a *Trichinella* Digestion Diagnostic Program.

Lorry B. Forbes*, Andrijana Rajic, Alvin A. Gajadhar. Centre for Animal Parasitology, Canadian Food Inspection Agency, Saskatoon, Canada.

The ability to document that a test is working within limits, and that deviations in performance are detected and successfully corrected is an important quality assurance (QA) function that can be monitored through the use of proficiency samples. We have developed and validated a system to effectively produce large numbers of proficiency samples containing known numbers of *Trichinella spiralis* cysts. Rats orally infected with *T. spiralis* are killed at ≥ 6 weeks post infection, skinned and eviscerated. Intact cysts are harvested using a series of homogenization, filtration and sedimentation steps. The sample matrix consisting of ground beef (trimmed of fat and connective tissue) is formed into meatballs weighing 25-30 g each. Cysts obtained from the harvested pool are placed on a specifically developed agar substrate which allows accurate counting and reliable transfer of cysts into the meat matrix. These procedures are observed under a stereomicroscope and the counts verified by three technicians. For use, the weight of the proficiency sample is subtracted from the total sample weight of tissue for the assay, and the remainder made up with known negative tissue from the host species. Cyst recoveries following digestion usually exceed 90%, and recoveries of 100% are common. Initial studies indicate a proficiency sample shelf life of up to three weeks at 4° C.

5

Field Evaluation of ELISA and Risk Factor Analysis for Trichinellosis on New England Swine Farms. H. RAY GAMBLE[1]*, WILLIAM G. SMITH[2], ROBERT C. BRADY[2] & LAWRENCE E. MILLER[3]. USDA, [1]AGRICULTURAL RESEARCH SERVICE, BELTSVILLE, MD 20705, and [2]ANIMAL AND PLANT HEALTH INSPECTION SERVICE, SUTTON, MA 01590 and [3]APHIS, RIVERDALE, MD 20737.

Trichinellosis continues to be a problem for the U.S. pork industry despite evidence of decreased prevalence. Consumer avoidance or overcooking of fresh pork and lack of access to international markets result from low-level persistence of this parasite along with lack of industry assurances regarding trichinae. Control of trichinellosis is best accomplished through a preharvest program where risk factors for transmission are minimized or eliminated coupled with a monitoring program to assure the production of trichinae-free animals. In the present study, we examined seroprevalence, presence of parasites and risk factors for transmission on 90 farms in five states in the New England region. Farms were selected based on type of feed (grain, mixed waste, licensed garbage feeders). Six of the 90 farms had a total of 10 seropositive animals (1-3/farm). Tissue samples were obtained from 11 pigs on 5 of the positive premises (9 of which were ELISA positive). *Trichinella* larvae were recovered from 4 of these pigs. Based on data collected on questionnaires and follow-up farm visits, the only risk factors which showed positive correlation with infection were access to wildlife carcasses and access to rodents.

6

DEVELOPMENT OF A SWINE ANIMAL MODEL WHERE OPPORTUNISTIC INVASION OF THE COLON BY CAMPYLOBACTER JEJUNI OCCURS SPONTANEOUSLY L.S. MANSFIELD*[1], D.T. GAUTHIER[1], S.R. ABNER[1], K.M. JONES[1], & J.F. URBAN[2]. [1]MICHIGAN STATE UNIVERSITY, EAST LANSING, MI 48824, [2]USDA, BELTSVILLE, MD 20705.

Previous studies showed that young conventionally-reared pigs infected with *Trichuris suis* develop severe mucohemorrhagic diarrhea due to worm-induced invasion of the large intestinal mucosa by resident bacteria (Mansfield and Urban, 1996). Twenty germ-free pigs were derived by Cesarean section and placed in germ-free incubators to examine whether *T. suis* could faciliatate invasion of *C. jejuni*. The following treatment groups were set up: Group 1 had no infection, Group 2 had *Trichuris* alone, Group 3 had *C. jejuni* alone and Group 4 had both *Trichuris* and *C. jejuni*. All experimental infections were given on day 3 of age by oral gavage at the following dosage rates (*Trichuris*, 250 eggs/kg; *C. jejuni* 10^6 colony forming units of log phase bacteria ATTC strain 33292 isolated from a human with enteritis). Pigs were fed a milk substitute and scored three times per day for clinical signs of disease. At 27 days after infection, pigs were killed, necropsied, the gastrointestinal tract scored for pathology, and lymphoid tissues from the colon snap frozen for cytokine analysis. Pigs with both *Trichuris* and *C. jejuni* had more frequent and more severe signs of diarrhea. Pigs with *C. jejuni* in Group 3 and 4 had transient fever, depression and diarrhea for 3 days post infection which resolved, however, these pigs shed the bacterium in the stool at necropsy. Severe pathology was present only in the colon of pigs that had both *Trichuris* and *C. jejuni*. Pigs with *Trichuris* or *C. jejuni* alone had no disease and no pathology. Analysis of cytokine responses in mucosa and immune tissues in the colon of these pigs are in progress. We conclude that *Trichuris* facilitates *C. jejuni* invasion in the colon. (Supported by USDA grant 6881).

7

ANTHELMINTIC USE ON SASKATCHEWAN PIG FARMS; RESULTS FROM A POSTAL SURVEY. B. WAGNER* AND L. POLLEY. UNIVERSITY OF SASKATCHEWAN, SASKATOON, SK. CANADA, S7N 5B4.

A postal survey to determine anthelmintic use in Saskatchewan was sent to 570 pig producers in March, 1996. Farms surveyed were selected in a random stratified manner based on the number in each of 5 production size categories. Response rate was 33% overall, but was 60% from farms producing more than 1000 market hogs per year. Of all respondents, 76% treated some animals during 1995. Sows were treated on 90% of farms, weanlings on 86%, boars on 75% and growers on 67%. Injectable treatment with a macrolide was used by more than half the producers. In-feed treatment, with a variety of anthelmintics, was less common and in-water treatment was used least often. The majority of respondents (62%) used a "planned treatment program". Although anthelmintic use was widespread, only 48% of producers felt there was a parasite problem on their farm. This was most often determined by the presence of adult worms in feces or poor performance of the pigs. Fecal testing and slaughter checks were used less commonly and primarily on the larger farms. Sources of product information included veterinarians (57% of farms), feed companies (36%), and advertising (24%). Effectiveness (81%) and ease of use (66%) were the major reasons for choosing a particular product; price (16%) was least important. These results are compared with what is known of the epidemiology of gastro-intestinal nematodes in intensively raised pigs.

8

A SURVEY OF SARCOPTIC MANGE IN SLAUGHTER PIGS AT SEVEN MIDWEST PACKING PLANTS. JOHN J. MELANCON*. MERCK AGVET, RAHWAY, NJ 07065

Many veterinarians, extension personnel and swine producers perceive that sarcoptic mange is no longer a major problem in the swine industry. A survey was conducted at seven midwest packing plants during the winter months of February and March, 1996 to determine the extent of mange in the industry in the midwest. Pigs were scored applying the Papular Dermatitis Scoring System used in the PigMON slaughter evaluation program. The skin was evaluated after scalding and dehairing. Each animal's skin was given a score of 0 to 3 depending on the severity of lesions. Pigs within a herd were identified using the herd's slap tattoo assigned at slaughter, but were not individually identified. A herd severity score was then developed based on an Average Dermatitis Score (ADS) calculated from all of the pigs scored from the herd. An ADS score of > 0.7 indicated the presence of clinical mange within the herd. More than 25,000 individual pigs representing 1,550 herds were scored from the seven plants. Thirty-four per cent of all herds examined had scores of > 0.7. Sixteen per cent of all pigs examined had scores of 2 or 3 suggesting a high incidence of clinical mange in their herds of origin. Among the seven plants, the percentage of herds with ADS scores of > 0.7 ranged from 22 to 40%. In two plants, 22% of all pigs examined had lesion scores of 2 or 3. The negative productivity effects of mange are well established and these data indicate that mange continues to cause economic loss. These losses are due not only to decreased productivity, but also to reduced value of carcasses at the packer. This study raises the question of why producers are living with this disease in their finishing hogs when mange can be clinically controlled and even eradicated from a swine herd.

9

Study One: Duration of efficacy of Doramectin and Ivermectin Against *Sarcoptes scabiei* var. *suis*. J.J. ARENDS[1*], T.L. SKOGERBOE[2], AND L.K. RITZHAUPT[3]. S & J Farms, Willow Springs, NC, 27592[1], PFIZER INC., LEE'S SUMMIT, MO, 64081[2], and PFIZER INC., NEW YORK, NY, 10017[3].

A study was conducted to compare the duration of efficacy of doramectin injectable administered IM at 300 µg/kg and ivermectin injectable administered SC at 300 µg/kg against artificially induced infestations of *Sarcoptes scabiei* var. *suis* in swine. A non-medicated group received saline IM at a dose of 1.5 mL/50 kg. Criteria for evaluation of efficacy were skin scrapings for quantitative mite counts, skin lesion scores, and pruritus/rubbing scores. On Day 0, 111 mange-free animals were randomly allotted to one of eight subgroups within each of the three treatment groups or designated as a replacement animal within the three treatment groups (5 replacements/treatment). Each subgroup consisted of two saline-, five doramectin- and five ivermectin-treated animals. Animals were treated on Day 0. Artificial infestation of subgroups with *S. scabiei* (200 mites/pig) was performed on Days 0, 7, 14, 21, 28, 35, 42, or 49 post-treatment. Ear skin scrapings were collected from each animal and examined for mite stages on Days 7, 14, 21, 28, and 35 post-infestation. Skin lesion scores and pruritus/rubbing scores for each animal were recorded on Days 7, 14, 21, 28, and 35 post-infestation. In this study, animals treated with doramectin and ivermectin prevented *S. scabiei* infestation for up to 14 days and 7 days after treatment, respectively.

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Study Two: Duration of efficacy of Doramectin and Ivermectin Against *Sarcoptes scabiei* var. *suis*. J.J. ARENDS[1*], T.L. SKOGERBOE[2], AND L.K. RITZHAUPT[3]. S & J Farms, Willow Springs, NC, 27592[1], PFIZER, INC., LEE'S SUMMIT, MO, 64081[2] and PFIZER INC., NEW YORK, NY, 10017[3].

The second in a series of two studies was conducted to more precisely define the duration of efficacy of doramectin injectable administered IM at 300 µg/kg and ivermectin injectable administered SC at 300 µg/kg against artificially induced infestations of *Sarcoptes scabiei* var. *suis* in swine. A non-medicated group received saline IM at a dose of 1.5 mL/50 kg. Criteria for evaluation of efficacy included skin scrapings for quantitative mite counts, skin lesion scores, and pruritus/rubbing scores. On Day 0, 90 mange-free animals were randomly allotted to one of sixteen treatment combination groups or designated as a replacement animal for the doramectin- and ivermectin-treated groups. Treatment groups and challenge days were based on the results from Study One. All animals were treated on Day 0 and each treatment group contained five animals for each day of infestation. Artificial infestation of subgroups with *S. scabiei* (400 mites/pig) was performed on Day 3 for the saline-treated pigs, Days 3, 6, 9, 12, 15, 18, 21, 24, and 27 for the doramectin-treated pigs and Days 3, 6, 9, 12, 15, and 18 for the ivermectin-treated pigs. Pigs were evaluated at weekly intervals for a minimum of 35 days post-infestation. In this study, animals treated with doramectin and ivermectin prevented infestation with *S. scabiei* for up to18 days and 9 days after treatment, respectively.

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COMPARATIVE EVALUATION OF FLEA COUNTING TECHNIQUES ON DOGS AND CATS

VIRGINIE M. GOFFAUX*, VIRBAC, INC., FORT WORTH, TX USA and PAT J. BOYD,P.A.C.E., INTL., CELINA, TX USA

The purpose of this study was to evaluate various methods for counting fleas on experimentally infested dogs and cats in a controlled environment. The goal was to establish a technique which has a high degree of accuracy and reproducibility, and would be practical for use in laboratory as well as field settings. Four different quantitative techniques for estimating flea populations were evaluated in a controlled setting on experimentally infested dogs and cats. The first technique consisted of counting fleas encountered by "thumbing" through the haircoat. The second consisted of counting fleas encountered after a predetermined number of combings through the haircoat. The third consisted of combing the animal thoroughly until no more fleas could be found. The last technique consisted of flushing all fleas off the animal with an alcohol-based adulticidal flea spray. This study was designed to take into account the EPA requirements for selection of test subjects in efficacy studies for pesticide products. GLP studies require that grouping of test subjects achieve equalization in weight, sex, and haircoat type; therefore, two groups of test subjects were evaluated, each containing three dogs and three cats and achieving equalization of weight and haircoat types.

Results will be discussed at the time of presentation.

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A Retrospective Evaluation of the Effects of Lufenuron (Program®) on Flea Allergy Dermatitis (FAD) in Dogs and Cats

Michael Groh, D.V.M.
Roger Sifferman, D.V.M.

Study Design
This was a retrospective study designed to investigate the clinical records of animals with a diagnosis of FAD. Data were collected and evaluations of various parameters were made. Clinical impression of flea burdens and severity of FAD symptoms were evaluated and any concurrent antiflea and antipruritic drug use was documented. There were a total of 1,000 dog and cat cases surveyed from twenty-four private veterinary hospitals at different locations within the continental United States. The only qualifying criteria were a clear documentation of FAD in the patient record and notation of all treatments prescribed for, or used by, the client. A non-lufenuron control group was included. Evaluation of the patient response was made by the diagnosing practitioner.

Results
In some of the surveyed records, flea burdens were totally eliminated and resultant FAD symptoms were absent. In the remaining records that revealed a reduction in flea burden, there was significant reduction in FAD symptoms. Some records indicated no reduction in flea burden. Results revealed 83% of Program dogs improved versus 56% for non Program dogs. Similar results in Program cats were seen with 87% improved versus 62% for non Program cats. The results of this study would indicate a positive effect of lufenuron in cases of FAD.

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Efficacy of a combined formulation of milbemycin oxime and lufenuron in controlling flea infestations.

G. Pengo, P. Sica, R. Steiger*, D. Stanfield

Objective To assess the efficacy of a combined formulation of milbemycin oxime (0.5mg/kg) and lufenuron (10mg/kg) in the prevention of heartworm infestation and the treatment and control of fleas and gastrointestinal helminths when administered monthly to dogs. The data presented here relate to flea control only.

Study Design Fifty privately owned dogs with at least 10 fleas were randomized into 2 groups. Because of the severity of the flea infestation all dogs were treated on Day 0 with a quick-acting adulticide. Group 1 was administered the milbemycin/lufenuron combination monthly, Group 2 received ivermectin monthly at a minimum dose of 6mcg/kg. Flea counts were carried out monthly, and the adulticide was administered at these visits in cases of massive flea infestation (>100 fleas) at the investigator's discretion.

Results The mean flea count in Group 1 was 5.7 by Day 90, compared to 116.7 in the control group, an efficacy of 95%. Efficacy remained high for the rest of the trial. Significantly more additional adulticide treatments were required in Group 2 than in Group 1. These data confirm the efficacy of lufenuron for the treatment of flea infestations when administered in a combined formulation.

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CONTROL OF FLEA POPULATIONS ON NATURALLY INFESTED PETS AND IN PRIVATE RESIDENCES WITH EITHER TOPICAL IMIDACLOPRID SPOT APPLICATION OR THE COMBINATION OF ORAL LUFENURON AND PYRETHRIN SPRAY. M.W. DRYDEN*, H.R. PEREZ and D.M. ULITCHNY. DEPARTMENT OF DIAGNOSTIC MEDICINE/PATHOBIOLOGY, KANSAS STATE UNIVERSITY, MANHATTAN KS.

This study was conducted to evaluate the effectiveness of topically applied imidacloprid and the combination of orally administered lufenuron and a pyrethrin flea spray to control flea infestations. Dogs and cats in 34 flea-infested homes in the Tampa, Fl area were placed into the study between May 20 and June 20, 1996. Pets in treatment group 1 were treated topically with 9.1% imidacloprid (8.9 - 25.1mg/kg) spot application on day 0 and then once every 28 - 30 days for 90 days. Pets in treatment group 2 were given oral lufenuron (dogs: 10 - 22.5mg/kg; cats 27.5 - 59mg/kg) once every 28 - 30 days for 90 days and in addition were treated topically with a water-based pyrethrin flea spray once every 1 to 2 weeks. Flea populations in the environment were assessed using an intermittent light trap; pet flea burdens were assessed using visual area counts. A single application of imidacloprid was 96% and 93.5% effective in reducing flea populations on pets at 7 and 28 days, respectively. Following three monthly applications of imidacloprid, flea burdens on pets and in the environment were reduced by 98.8% and 99.9%, respectively, after 84-90 days. Oral lufenuron combined with pyrethrin sprays were 48.9% and 91.1%, effective in reducing flea populations on pets at 7 and 28 days, respectively. This combination reduced flea burdens on pets and in the environment by 99.2% and 99.7%, respectively, by days 84-90.

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Titration of Pyriproxyfen in Virbac KnockOut® IGR shampoos#.
THOMAS A. MILLER* and LARRY R. CRUTHERS.

It has been assumed that effective levels of pesticides applied to pets in shampoos are removed during rinsing so that efficacy against fleas and ticks is very brief and only pre-existing parasites are killed. It is believed therefore that pets are quickly re-infested with new parasites when they are returned to their infested home environments. Consequently, labels of flea and tick shampoos do not carry residual claims for controlling ectoparasites. Further, integrated flea control programs usually include recommendations for application of a residual product (e.g., collar, dip, spray) after shampooing.
Shampoos, formulated to contain 0.00%, 0.01%, 0.05% and 0.25% pyriproxyfen, were applied once at dose rates of 7.5 g/kg to dogs and 8.5 g/kg to cats. The pets' haircoats were lathered over a 10 minute period and the shampoos then thoroughly rinsed out. Principal and placebo control dogs and cats were pre-infested and, after shampoo treatment, were repeatedly re-infested with fleas. Flea eggs were collected periodically (once or twice weekly), were incubated in flea larval rearing medium and egg hatch and adult flea emergence rates were determined at five days and at twenty-eight days, respectively. Efficacy was determined by the differences between principal and placebo control flea egg fertility. Control hatch and pupation/emergence data were assumed to represent 100% fertility.
Flea eggs, first collected from both dogs and cats at 48 hours after treatment, were sterile. Ovisterilant efficacy on new fleas persisted at 90-100% for one, two and three months after application of the 0.01%, 0.05% and 0.25% shampoos, respectively. In addition to its ability (when applied in sprays and released by collars) to sterilize fleas and their eggs at very low levels (parts per trillion), pyriproxyfen has an exquisite affinity for skin and/or hair that enables it to persist even after washout of shampoos.
Nylar® is a registered trademark of McLaughlin, Gormley King Company, Minneapolis, MN.
Virbac KnockOut® is a registered trademark of Virbac Inc., Fort Worth, Texas # Patent pending

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Persistent Ovisterilant Efficacy of Virbac KnockOut ® IGR Collars
THOMAS A. MILLER* and BYRON B. BLAGBURN.

Pyriproxyfen (Nylar®) has an exquisite specificity and disruptive efficacy on reproduction of the flea. At relatively high (uneconomic) levels pyriproxyfen kills fleas but its practical value resides in its ability to sterilize fleas at levels of parts per trillion - parts per quadrillion.
Controlled release matrix PVC collars containing 0.1%, 0.25% and 0.5% pyriproxyfen were applied to dogs and to cats that were pre-infested and repeatedly re-infested with fleas. Flea eggs were collected at various intervals, starting about six hours after collar attachment, then weekly and finally monthly. Flea eggs were incubated with flea larval growth medium. Egg hatch rates was determined at 4-5 days and adult flea emergence at about 28 days.
All three collars were effective, the onset of flea sterilization after attachment and the duration of this activity being dependent on the level of pyriproxyfen in the collar and on the test animal specie. All collars started to sterilize pre-existing fleas immediately. The most potent collar achieved 90% efficacy in 3 days and 100% efficacy in 8 days and persisted in completely sterilizing all new fleas for 372 days, when the study was terminated while the pyriproxyfen released by the collar was still 100% effective. Onset of action was slower but efficacy was maintained for four months and ten months, respectively, by the 0.1% and 0.25% collars. Onset was generally faster on the dog. Initial and mean daily release rates of pyriproxyfen from the collars on cats were determined over the test period.
When re-infestation and egg collection were continued after collars were removed from dogs, it was found that it required 3-5 months after collar removal for the residual levels of pyriproxyfen on hair and skin to be sufficiently depleted to permit new fleas to start laying fertile eggs. The length of the residual (collar-free) efficacy period was approximately halved by shampooing.
Nylar® is a registered trademark of McLaughlin, Gormley King Company, Minneapolis, MN
Knockout™ is a trademark of Virbac Inc., Fort Worth, Texas. * Patent Pending

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AN INVESTIGATIVE STUDY TO EVALUATE THE EFFECT OF WATER IMMERSION OR SHAMPOOING ON THE EFFICACY OF FRONTLINE® TOP SPOT™

P.A. TANNER*, M.N. ROMANO. RHONE MERIEUX, INC., ATHENS, GA. PH. JEANNIN. RHONE MERIEUX, TOULOUSE, FRANCE.

Four test groups of dogs were used to determine if shampooing or water immersion affects the efficacy of Frontline® Top Spot™ against the cat flea (Ctenocephalides felis) and the brown dog tick (Rhipicephalus sanguineus). Group A was an untreated control group which was not shampooed or water immersed. The remaining three groups were treated once with *Frontline Top Spot* on Day 0 of the study. Group B was not shampooed or water immersed. Group C was shampooed with a non-insecticidal shampoo, and Group D was water immersed at 14 day intervals from Day 16 to Day 100.

Post-treatment flea and tick counts were made on Days 2, 16, 23, 37, 51, 65, and 79. Additional flea counts were taken on Days 93 and 107. The Day 2 comb counts were performed 72 hours after infestation with 100 ±10 fleas and 50 ±3 ticks. Subsequent flea comb counts were performed 24 hours after infestation and tick counts 48 hours after infestation.

Average flea burdens carried by untreated control animals ranged from 53.5 to 73.8. Average tick burdens carried by untreated control animals ranged from 18.8 to 31.5.

Frontline Top Spot provided >95% control of fleas in all treated groups for at least 37 days after application. Efficacy of >95% continued in water immersed dogs to 79 days and in dogs neither water immersed nor shampooed through Day 107.

Tick control for all treated groups ranged from 90.9% to 95.8% on Day 2. Tick control was 100% for all treated groups through Day 23. Efficacy was at 95% through Day 51 for the unbathed group, but dropped to 78.1% on Day 65. Efficacy was at 89.7% at Day 37 for shampooed dogs, then dropped to 65.1% on Day 51. The water immersion group had a gradual decline in efficacy after Day 37.

Frontline Top Spot provided at least 37 days of >95% control of fleas and >90% control of ticks was achieved in both shampooed and water immersed groups. Beyond Day 37, residual flea and tick control decreased with shampooing compared to the unbathed group or the water immersed group. Throughout the study, there was no statistical difference between the treated, unbathed group and the water immersed group.

This study demonstrated that water immersion does not decrease the efficacy of *Frontline Top Spot* against fleas and ticks. Shampooing may affect residual activity beyond Day 37.

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RESIDUAL EFFICACY OF FRONTLINE® TOP SPOT™ FOR THE CONTROL OF FLEAS IN THE CAT

P. TANNER*, J.S. HUNTER III, N. MEO, M. KEISTER. RHONE MERIEUX, INC. ATHENS, GA. PH. JEANNIN. RHONE MERIEUX, TOULOUSE, FRANCE.

Challenge studies were conducted to assess the residual efficacy of Frontline® Top Spot™ for control of the cat flea (*C. felis*) on cats. *Frontline Top Spot* was also compared to a positive reference standard.

Study #1: Thirty cats were divided into 5 groups: an untreated control, 3 groups treated once with *Frontline Top Spot* (one group with 0.25 ml, one group with 0.25 ml in 2 spots and one group with 0.5 ml in one spot) and a group treated once with Tiguvon® (0.3 ml / cat). The cats were experimentally infested with approximately 100 fleas / cat at weekly intervals from Day 14 and residual efficacy assessed by comb counts at 24 hours after each infestation. Results showed that .5 ml of *Frontline Top Spot* was >95% effective against fleas through Day 15 and 22 for 1 or 2 spots respectively. *Tiguvon* provided >95% control through Day 2.

Study #2: Using the same treatment and infestation regimen as the previous study, thirty-two cats were divided into 4 groups: an untreated control, 2 groups treated with *Frontline Top Spot* (<4kg, >4kg) and a *Tiguvon* treated group. *Frontline Top Spot* provided >97% control of fleas for 36 days in both weight groups tested. Analysis by day (ANOVA) and repeated measure over time showed no significant differences ($P \leq 0.05$) between weight groups. *Tiguvon* provided 99.8% flea control at Day 2 and dropped to 62.9% control by Day 15.

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COMPARATIVE STUDIES TO EVALUATE THE FLEA CONTROL EFFICACY OF FRONTLINE® TOP SPOT™ AGAINST ADVANTAGE® FLEA ADULTICIDE IN THE DOG AND CAT.

P.A. TANNER*, M.N. ROMANO. RHONE MERIEUX, INC., ATHENS, GA. PH. JEANNIN. RHONE MERIEUX, TOULOUSE, FRANCE.

Single center, randomized, parallel, positive reference controlled, challenge studies were conducted in the cat and the dog with the objective of comparing the flea control efficacy of Frontline® Top Spot™ against Advantage® Flea Adulticide. In both studies single applications of the test articles were applied as per label claim. Weekly challenges consisted of infestations of 100 ± 10 unfed cat fleas (*Ctenocephalides felis*) on each subject. Except for Day 1, flea comb counts were performed 24 hours after each infestation. Product efficacy was determined by the use of Abbott's formula and the percentage of subjects with no fleas at each weekly time point.

In one study 30 dogs were randomized to five treatment groups. An additional objective was to evaluate the effects of weekly water immersion on product efficacy. Treatment groups were: an untreated control, *Frontline Top Spot* with immersion, *Frontline Top Spot* without immersion, *Advantage* Flea Adulticide with immersion, and *Advantage* Flea Adulticide without immersion.

In the groups that did not receive water immersion, *Frontline Top Spot* and *Advantage* achieved > 95 % flea control for 8 and 7 weeks post treatment respectively. In addition, when zero flea stage is examined for *Frontline Top Spot* compared with *Advantage* treated dogs at weeks 4, 6 and 8, results demonstrate 6/6 vs. 5/6, 6/6 vs. 4/6, and 4/6 vs. 2/6, respectively, with no fleas.

In the groups that were water immersed weekly, *Frontline Top Spot* and *Advantage* achieved > 95% flea control for 9 and 1 week post treatment respectively. In these groups, zero flea stage of *Frontline Top Spot* compared to *Advantage* treated dogs at weeks 4, 6, and 8, results demonstrate 6/6 vs. 3/6, 6/6 vs. 0/6 and 5/6 vs. 0/6, respectively, with no fleas.

In the second study 24 cats were randomized to three treatment groups. Treatment groups were: an untreated control, *Frontline Top Spot* and *Advantage* Flea Adulticide.

In this study *Frontline Top Spot* and *Advantage* achieved > 95 % flea control for 4 and 2 weeks respectively. Zero flea stage results of *Frontline Top Spot* compared with *Advantage* treated cats at weeks 2, and 4, demonstrate 100% vs. 71%, and 75% vs. 25%, respectively, with no fleas.

In conclusion, *Frontline Top Spot* achieved longer flea control in both the dog and cat. Water immersion did not affect the flea control efficacy of *Frontline Top Spot* in the dog.

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Peritoneal Cestodiasis in Dogs. WALTER BOYCE* , CYNTHIA KERNER, GRACE LEE, DEPARTMENT OF PATHOLOGY, MICROBIOLOGY, AND IMMUNOLOGY, UNIVERSITY OF CALIFORNIA, DAVIS; STEVEN NADLER, DEPARTMENT OF NEMATOLOGY, UNIVERSITY OF CALIFORNIA, DAVIS; EDWARD PLATZER, DEPARTMENT OF NEMATOLOGY, UNIVERSITY OF CALIFORNIA, RIVERSIDE

The diagnosis and treatment of larval tapeworm infections in the peritoneal cavity of dogs is problematic. Infected animals may be asymptomatic while clinically affected animals often die. We evaluated the efficacy of praziquantel and albendazole in naturally infected dogs and found that both anthelmintics were ineffective. The true prevalence of infection is unknown due to the absence of suitable diagnostic tests, and the etiologic agent(s) responsible for infection have not been definitively identified. We conducted molecular genetic analyses of several isolates obtained from naturally infected dogs and compared their PCR-RFLP patterns and DNA sequences for the ITS-2 region with those of known tapeworms. Our results indicate that several different species in the genus Mesocestoides may be responsible for the infections found in dogs in California.

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Factors influencing the control of Ostertagia ostertagi infections of cattle.
LOUIS C. GASBARRE, IMMUNOLOGY AND DISEASE RESISTANCE LAB, LPSI, ARS, USDA, BELTSVILLE, MD 20705

Efficient control of gastrointestinal nematodes in cattle requires administration of modern anthelmintics at strategic time points resulting in an optimal reduction of parasite transmission for an extended period of time. The most important species in control programs is Ostertagia ostertagi. The pre-eminence of Ostertagia is due to a high pathogenicity, and to the fact that strong protective immunity against the parasite is slow to arise, and individuals can remain at risk for several years. Recent observations on the biology of Ostertagia should influence the development of such control programs. First, Ostertagia is among the most environmentally tolerant parasite species and transmission can be year-round in many areas of the US. Transmission is reduced by sub-freezing temperatures and extreme drying conditions but quickly increases as conditions change. Environmental tolerance also results in substantial overwintering of larvae on pastures that may be more important than arrestment in maintenance and transmission of parasite populations in these areas. Second, fecal egg determinations (EPG) do not accurately assess the numbers of Ostertagia in an animal, but instead measure the presence of more fecund trichostrongyle species. As such, animals with the greatest parasite-induced morbidity may not have high EPG values. Therefore, EPG values are of little value when used on individuals, and should only be used as a herd measure. In addition, fecal culture and larval differentiation can give very misleading information regarding species composition unless conditions are carefully defined. Finally, the trend towards intensive rotational grazing programs can result in the emergence of parasite-induced production losses. This can be corrected by greater attention to parasite control in the initial development of the rotational program.

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The impact of the environment on strategic parasite control programs on cattle.
B.E. STROMBERG, COLLEGE OF VETERINARY MEDICINE, UNIVERSITY OF MINNESOTA, ST. PAUL, MN 55108

Strategic anthelmintic treatment programs are predicated on reducing pasture larval populations. This is most commonly accomplished by removing parasites from cattle before they start grazing. Are infective parasite larvae still available from the previous grazing season? Tracer calves were grazed with the cow herd for one month periods from May through October. Tracers were also grazed for the month of April before the cows and calves were turned out onto pasture. This pasture had not been grazed since the previous July and the temperature was as low as -15°C over the winter. Recoveries from April tracers were 100 *Ostertagia ostertagi*, 210 inhibited L_4 of *O. ostertagi* and 138 *Cooperia* spp. These were similar to recoveries for May where 348 worms were recovered. When temperatures drop well below freezing is helminth transmission possible? Tracer calves were kept with the cow herd for one month periods over the entire year. Animals were maintained in paddocks, partially sheltered and fed from bunks throughout the winter. Adult and/or inhibited L_4 of *O. ostertagi* were recovered all year. The increased use of intensive rotational grazing programs adds new concerns about parasite control programs. The increased stocking density increases the rate at which parasite eggs are deposited onto the pasture, but also results in increased disruption of the fecal material. This may result in increased desiccation and other conditions that adversely affect larval development.

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Strategic Control of Nematode Parasites of Grazing Cattle. ROBERT S. REW, PFIZER ANIMAL HEALTH, EXTON PA 19341

New information on pasture contamination by nematode-infected cattle, the ability of nematode larvae to overwinter successfully , and the potentially rapid build up of larvae during favorable transmission conditions encourages us to reexamine the approach we take to nematode control in grazing cattle. Historically, we have focussed our treatment programs on the infected animal. When we look at the quantities of larvae that can accumulate on pastures and the different patterns of contamination based on the age structure of the grazing cattle, we quickly see that the overwhelming majority of nematodes are on the pasture, not in the animal. This demands restructuring of the approaches used for parasite control. Until recently, anthelmintics have been considered for their therapeutic activity. This property, though important, is most effective for treatment of animals going to a non-contaminated environment such as a drylot or wheat pasture, and does not take into consideration the problems that arise upon the animal being introduced or reintroduced into a contaminated environment such as a permanent pasture. The importance of efficacy and duration under these circumstances will be discussed in the context of strategic treatment to reduce or control pasture contamination.

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INITIAL AND RESIDUAL EFFICACY OF A POUR-ON FORMULATION OF FIPRONIL APPLIED TO CATTLE INFESTED WITH *BOOPHILUS MICROPLUS* (CANESTRINI).

J.S. HUNTER III*, D.M. KEISTER. RHONE MERIEUX, INC., ATHENS, GA. P. JEANNIN. RHONE MERIEUX, TOULOUSE, FRANCE. R.B. DAVEY, J.E. GEORGE. USDA ARS CATTLE FEVER TICK RESEARCH LAB, MISSION, TX.

Cattle infested with all parasitic life stages of *Boophilus microplus* (Canestrini) were treated once with a pour-on formulation of fipronil at 0.25, 0.5, and 1.0% active ingredient (AI) to determine initial effectiveness. Additionally, cattle were infested with larvae at weekly intervals for 13 consecutive weeks post treatment to determine the residual efficacy of the three concentrations. The initial control of the index of reproduction (IR) afforded by the acaricide was dose related. At 0.25 and 0.5% AI the initial control of the IR was good at 86.2 and 94.3%, respectively, while the control afforded by the 1.0% AI concentration was extremely effective at 99.7%. In addition, fipronil had a strong adverse, and often times dose related, effect on the size and oviposition of females and upon the viability of eggs in treated females.

Based on adult tick detachment patterns post treatment, the 0.25% AI application failed to provide complete protection against larval reinfestation, although control of larvae remained >95% for the first 6 weeks. In contrast, at 0.5% AI, animals were completely protected from larval reinfestation for the first 4 weeks following treatment and control remained >90% for an additional 2 weeks (6 weeks post treatment). The 1.0% AI concentration afforded the longest residual activity, providing virtually 100% protection against larval reinfestation for 8 weeks post treatment.

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EFFICACY OF DORAMECTIN POUR-ON AGAINST *DAMALINIA BOVIS* ON CATTLE. L. SMITH*, LODI, WI, AND K. ROONEY, S. MARLEY, AND G. CONDER, PFIZER CENTRAL RESEARCH, GROTON, CT.

Two studies were conducted under field conditions to confirm the efficacy for cattle of doramectin pour-on at 500 µg/kg against *Damalinia bovis.* In each study, 20 cattle were randomly allocated to a saline- or doramectin-treated group based on bodyweight (10 animals/group). The precise body regions and the number and length of hair partings to be counted were fixed at the start of each study and remained constant throughout the course of the study. Cattle were treated on Day 0 and lice counts were done at weekly intervals from Day 0 to Day 35. Burdens of *D. bovis* were 0 by Day 28 posttreatment for the doramectin-treated animals. Thus, a single application of doramectin pour-on at 500 µg/kg was 100% efficacious for cattle against natural infestations of *D. bovis.*

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EFFICACY OF DORAMECTIN POUR-ON AGAINST LICE, MITES, AND GRUBS OF CATTLE. K. ROONEY*, E. ILLYES, D. KELLER, T. MEINERT, N. LOGAN, AND G. CONDER. PFIZER CENTRAL RESEARCH, GROTON, CT, AND S. SUNDERLAND AND P. SARASOLA, PFIZER CENTRAL RESEARCH, SANDWICH, UK.

Twenty-two studies were conducted under field conditions to evaluate the efficacy of doramectin pour-on administered topically at a dosage of 500 µg/kg bodyweight to cattle harboring infestations of lice, mites, or 1st-instar larvae of *Hypoderma* spp. In each study, between 14 and 60 cattle were randomly allocated to either a saline- or doramectin-treated group based on bodyweight. In the 10 lice (natural infestations) and 6 mite (5 natural and 1 artificial) studies, cattle were treated on Day 0, with counts done approximately weekly from Day 0 to Day 35. Burdens of *Haematopinus eurysternus, Linognathus vituli* and *Solenopotes capillatus* on doramectin-treated cattle were zero by 21 days posttreatment and remained zero through Day 35. Mite burdens for both *Chorioptes bovis* and *Sarcoptes scabiei* were rapidly reduced to zero or near zero by Day 14/15 in doramectin-treated cattle. Overall efficacies of 99.9 and 100% (based on geometric means) were achieved on Day 35 for *C. bovis* and *S. scabiei,* respectively. In the six grub studies (natural), 107 of the 136 saline-treated/nonmedicated cattle exhibited warbles, while two of 136 doramectin-treated animals presented with a single warble each resulting in an overall efficacy for doramectin of 98.5%. The appearance of a single warble in two doramectin-treated animals in one study at 14 days posttreatment was most likely a result of treating animals near the time of emergence of the parasite. *Hypoderma bovis* was present in four studies, and *H. lineatum* was found in five studies. A single topical application of doramectin pour-on was highly efficacious against the species of lice, mites, and grubs examined in these studies.

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Eprinomectin: A Novel Avermectin for Control of Lice in Cattle

Holste J. E*., Smith L. L., Hair J. A., Lancaster J. L., Lloyd J. E., Langholff W. K., Barrick R. A. And Eagleson J. S.

Abstract
Eight trials were conducted in the United States to determine the efficacy of eprinomectin applied topically to cattle against four common species of lice; *Linognathus vituli, Haematopinus eurysternus, Solenopotes capillatus* and *Damalinia (Bovicola) bovis*. In two dose titration trials, dosages of 125 to 750 mcg/kg body weight of eprinomectin were applied topically to naturally infested animals which were compared to untreated controls. In dose confirmation studies, animals treated topically at 500 mcg/kg were compared to vehicle treated controls. Louse counts were made prior to treatment, again seven days after treatment, and weekly thereafter until trial termination eight weeks after treatment. Each species was present on at least six animals in each treatment group on at least one counting date in two or more trials. No lice were found on any animal treated topically with eprinomectin at a dosage of ≥500 mcg/kg after 14 days posttreatment. These trials confirm that eprinomectin applied topically to cattle has excellent efficacy against biting and sucking lice.

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EFFICACY OF TOPICALLY APPLIED EPRINOMECTIN AGAINST *CHORIOPTES BOVIS* MITES. SMITH, L.L.[1]*, STERNER, K.E.[2], BOWMAN, D.[3], HAIR, J.A.[4], BARTH, D.[5], KUNKLE, B.N.[6], HOLSTE, J.E.[6] [1]Smith Research and Development, Lodi, WI, USA, [2]Sterner Veterinary Clinic, Ionia, MI, USA, [3]Coddington Road, Ithaca, NY, USA, [4]Nu-Era Research Farms, Stillwater, OK, USA, [5]Merck Research Laboratories, Kathrinenhof Farm, Germany, [6]Merck Research Laboratories, Fulton, MO, USA

Eprinomectin is a second generation macrocyclic lactone endectocide which was selected for development in cattle based on superior endoparasite efficacy, safety and a favorable metabolic disposition. The latter characteristics permit zero withdrawal of milk and meat from treated animals. Excellent efficacy against ectoparasites was also demonstrated during the development program. *Chorioptes bovis* was the dose-limiting parasite and efficacy against this species was used to determine the optimum dose level. Nine studies were conducted which examined the efficacy of the selected therapeutic dose, 500 mcg/kg bodyweight, against *C. bovis*. In all studies, naturally infested cattle were formed into groups of 6 or 10 animals based on rankings of mite counts or bodyweights. One group acted as unmedicated controls while a second group was treated with eprinomectin. Mites were counted in skin scrapings collected pre-treatment and at weekly intervals for 8 weeks after treatment. In all studies the eprinomectin-treated group had significantly ($p<0.05$) fewer mites than the control group at each observation from Week 2 through trial termination at Week 8. Efficacy was >98% by Week 2 and 100% at the last mite count at Week 8.

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THE HISTORY OF MYIASIS IN THE AMERICAS

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Myiasis, a term proposed by Hope in 1840, has been defined as "the infestation of live humans and vertebrate animals with dipterous larvae, which, at least for a certain period , feed on the host's dead or living tissue and body substances, or ingested food" (Zumpt, 1965). Myiases have been reported in the Americas, even though sometimes in an elementary way, by missionaries, explorers, naturalists and military men for more than 350 years. While some species of myiasis-producing dipterae (i.e. *Gasterophilus*, *Hypoderma* and *Oestrus*) have been introduced from Europe; others, such as *Cuterebra*, *Dermatobia* and *Cochliomyia,* were indigenous to the Americas. For centuries lay people as well scientists have tried to combat these dipterae, and spectacular progress has been made in many areas, e.g., eradication of screwworms in North and Central America by the use of SIT (sterile insect technique). The saga of myiasis continues.

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MOLECULAR PHYLOGENETIC RELATIONSHIPS AMONG SARCOCYSTIS SPECIES OF WILD AND DOMESTIC ANIMALS.

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Molecular and classical phylogenetic analyses have suggested that the Sarcocystidae co-evolved with their definitive host species. However, a limited number of species have been compared, and those have predominantly been Sarcocystis sp. of domestic animals. In order to elucidate the phylogenetic relationships among Sarcocystis sp. of both wild and domestic animals, DNA was isolated from Sarcocystis sporocysts originating from opossums, skunks, and a coyote, cultured merozoites of S. campestris and macroscopic cysts from duck breast typical of S. rileyi. The small ribosomal subunit RNA gene (srRNA) was amplified using polymerase chain reaction techniques and sequenced by Sanger sequencing reactions. Alignments of the entire srRNA gene were performed for these species as well as S. muris, S. gigantea, S. tenella, S. arieticanis, S. fusiformis, Toxoplasma gondii, Neospora caninum and Cryptosporidium parvum. Alignments were analyzed using maximum parsimony and maximum likelihood methods to determine relative phylogeny of these organisms. These analyses suggested that Sarcocystis sp. co-evolved closely with their definitive hosts, but multiple cross-overs appear to have occurred during this evolutionary process.

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ISOLATION, CULTURE, WESTERN BLOT ANALYSIS AND SSURNA SEQUENCE ANALYSIS OF A *SARCOCYSTIS NEURONA*-LIKE PROTOZOAN FROM A WILDCAUGHT OPOSSUM FROM MICHIGAN A.J. MURPHY*, P.M. GEARHART, AND L.S. MANSFIELD. EMERGING PARASITIC DISEASES LABORATORY, A12 VETERINARY MEDICAL CENTER, MICHIGAN STATE UNIVERSITY, EAST LANSING, MICHIGAN 48824

Sarcocystis neurona is a protozoan parasite that causes neurologic deficits in infected horses. The route of transmission is speculated to be fecal-oral from feral opossum contaminated feed. *Sarcocystis* oocysts were obtained from a heavily infected adult opossum which was trapped on a farm that had 3 horses with confirmed cases of equine protozoal meningoencephalitis. *Sarcocystis* oocysts were isolated from the intestinal mucosa, excysted, and grown *in vitro* in equine dermal cells in nutrient medium and 5% CO_2. Preliminary western blot analysis of Michigan opossum-derived merozoites and equine derived *S. neurona* (kindly provided through an agreement with U.C. Davis) showed identical protein bands when exposed to cerebrospinal fluid from horses with confirmed *S. neurona* infection.

Small subunit ribosomal RNA of Michigan opossum merozoites was amplified with unique primers (Fenger et al., 1995), cloned into pGEM plasmid and sequenced. PCR amplification showed a single band at 480 bp identical to that obtained from *S. neurona* from horses. Preliminary sequence analysis showed that the putative *S. neurona* from opossum had high homology to the same sequence of *S. neurona* isolated and sequenced from horses by others (Dame et al., 1995; Fenger et al., 1995). Additionally, sequence alignment analysis of multiple clones of SSURNA suggested that only one species of *Sarcocystis* was present in cultured merozoites. These results suggest that *S. neurona* in horses may be acquired from opossums. We will attempt to conduct Koch's postulates in horses using this putative *S. neurona* strain to confirm it's identity. Supported by Animal Health Initiative Funds, State of Michigan.

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Recovery From Blindness Caused by Toxoplasmosis in Bennett's Wallabies (Macropus rufogriseus). C. A. CRUTCHLEY,* 6 N. PENRYN RD. MANHEIM, PA 17545; J. P. DUBEY, USDA, ARS, BELTSVILLE, MD; D. S. ADAMS, VMRD, INC., PULLMAN, WA.

Many species of Australian marsupials are highly susceptible to toxoplasmosis and it is often fatal to Bennett's wallabies (Macropus rufogriseus). There is no published record of effective treatment for toxoplasmosis in wallabies. In spite of treatment with pyrimethamine and sulfadimethoxine, two Bennett's wallabies developed neurological signs and blindness. One started to show signs of congestive heart failure. Death was imminent when a trial on atovaquone was initiated. With atovaquone, along with peanut oil to facilitate absorption, heart failure cleared within one day and functional vision was apparent by one month. Reproductive capacity was restored. No signs of toxicity were found in the dams or joeys. A third Bennett's wallaby subsequently became ill from toxoplasmosis. Atovaquone was given at a substantially lower dose since the wallaby was not as ill when treatment with atovaquone was initiated. Normal behavior was recovered by the seventh day of treatment. Atovaquone offers significant advantages over other treatments for toxoplasmosis in wallabies

(This research was supported in part through contributions of atovaquone by Glaxo Wellcome and retinal photography by T. Bennett, Hershey Medical Center Dep't of Ophthamology.)

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STUDIES ON THE LARGE RIBOSOMAL SUBUNIT TO DEVELOP A DIAGNOSTIC TEST FOR THE IDENTIFICATION OF ELAPHOSTRONGYLUS CERVI.

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Elaphostrongylus cervi is a protostrongylid nematode which causes severe debilitating disease in mule deer and subclinical infections in red deer. Since it is difficult to microscopically distinguish *E. cervi* dorsal-spined first stage larvae from other protostrongylid dorsal-spined first stage larvae there is a need for the development of a more rapid and sensitive assay. Advances in molecular biology such as the polymerase chain reaction and improved sequencing techniques have allowed closely related species to be distinguished by comparing their DNA. The ribosomal DNA cluster (rDNA) is particularly useful for eukaryotic genetic studies because it is highly repeated and contains variable regions flanked by more conserved regions. Primers can therefore be designed to anneal to known conserved regions to amplify across unknown variable regions. This study focused on the large ribosomal unit as a potential target because it contains regions that evolve more rapidly than the small subunit as well as regions that evolve as slowly as those in the small subunit. Several sets of primers based on highly conserved sequences in mammals and the nematode, *Caenorhabditis elegans* were utilized to amplify the large subunit of *E. cervi* and other closely related nematodes. Sequence analyses will be presented and the usefulness of the large ribosomal subunit as a target for the development of a diagnostic test for the identification of *E. cervi* will be discussed.

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Population Dynamics of Gastrointestinal Nematodes in the White-tailed Deer (Odocoileus virginianus). ANDY DEROSA*, Department of Veterinary Science, Louisiana Agricultural Experiment Station, LSU Agricultural Center, Baton Rouge, LA 70803-6002

The gastrointestinal (GI) nematode fauna was assessed in 79 white-tailed deer (*Odocoileus virginianus*) collected monthly for 14 months, from December 1994 through February 1996, on a 2,428 ha tract of land located in East Feliciana Parish, Louisiana, USA. *Mazamastrongylus pursglovei* was the most prevalent and abundant species (86.1%, Abundance-813), followed by *Trichostrongylus askivali* (79.7%, 796), *Ostertagia mossi* (67.0%, 400) and *Haemonchus spp.* (13.9%, 267). Abundance of adult abomasal nematodes was highest in the fall and lowest in the winter of 1994-95 and 1995-96. Abundance and prevalence of adult *Ostertagia* and *Haemonchus* showed a gradient increase from a low in winter of 1994-95, peaking in the fall of 1995 and returning to an annual low in the winter of 1995-96. Numbers of adult *M. pursglovei* and *T. askivali* were more uniform during all months. Mean numbers of early 4th stage larvae (EL_4) were significantly higher (p=.008) during the summer and winter months compared to fall. Mean numbers of developing larvae (DL_4) were significantly higher (p=.013) during summer. Of intestinal species, *Oesophagostomum venulosum* and *Monodontus louisianensis* were the most prevalent and abundant of the five species observed with values of 12.6%, 38 and 11.4%, 17.7, respectively. Of the 79 deer examined only 24 (30.4%) were infected with intestinal nematode species.

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Natural Co-Infection of a White-tailed Deer Population with *Ehrlichia chaffeensis*, the Human Granulocytic Ehrlichiosis Agent, and an *Ehrlichia*-like organism. S. E. Little[1]*, D. E. Stallknecht[1], J. M. Lockhart[1], J. E. Dawson[3], and W. R. Davidson[1,2]. [1]College of Veterinary Medicine and [2]D. B. Warnell School of Forest Resources, The University of Georgia, Athens, Georgia 30602; [3]Viral and Rickettsial Zoonoses Branch, Centers for Disease Control and Prevention, Atlanta, Georgia 30333.

Amblyomma americanum and *Ixodes scapularis* are known to transmit the agents of human monocytic ehrlichiosis (HME) and human granulocytic ehrlichiosis (HGE), respectively. White-tailed deer are a confirmed reservoir of *Ehrlichia chaffeensis*, the causative agent of HME, and evidence indicates they are also infected with the agent of HGE. A deer population parasitized by both tick species was identified in coastal Georgia, and deer were examined for *Ehrlichia* spp. infection using serologic, molecular, and *in vitro* culture techniques. Indirect fluorescent antibody testing demonstrated antibodies reactive to both *E. chaffeensis* and *E. equi*, surrogate antigen for the HGE agent. Nested PCR revealed sequence-confirmed 16S rDNA fragments of three distinct *Ehrlichia* spp.: *E. chaffeensis*, the HGE agent, and an *Ehrlichia*-like organism reported in white-tailed deer. *Ehrlichia chaffeensis* was isolated in culture from one deer. Based on PCR and culture data, dual-species co-infections were confirmed in individual animals; if serologic data were also taken as evidence of infection, then four deer were co-infected with all three species. This work provides the first evidence of the HGE agent in a non-human host outside recognized hyperendemic areas in the midwestern and northeastern United States, and represents the first evidence of both *E. chaffeensis* and the HGE agent from a single deer population, further indicating that epidemiologic surveys of deer may present the best way to determine the geographic distribution of the human ehrlichioses agents.

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NEMATODE AMPHIDIAL NEURONS: COMPARATIVE ULTRASTRUCTURE, PUTATIVE FUNCTION AND EVIDENCE FROM ABLATION. F.T. ASHTON AND G.A. SCHAD*. SCHOOL OF VETERINARY MEDICINE, UNIVERSITY OF PENNSYLVANIA, PHILADELPHIA, PA., 19104

The amphidial neurons of the freeliving nematode *Caenorhabditis* elegans and of the parasitic nematodes *Haemonchus contortus* and *Ancylostoma caninum* are very similar. Each of these nematodes has paired bundles of amphidial dendrites that terminate in cilia-like processes extending to one of two antero-laterally situated amphidial pores. These processes may be single or double. In *H. contortus*, they show abnormalities in drug-resistant strains. In *C. elegans* these neurons recognize chemoattractants, repellents, and pheromones. *C. elegans* also has complex paired thermoreceptive neurons, the so-called "finger cells," that terminate in the sheath cells that form the amphidial canals. Finger cells also occur in *H. contortus* and *A. caninum*, where, presumably, they have a similar function. These two species also have a simple pair of amphidial neurons lacking terminal cilia-like processes that also end in their respective sheath cells. These neurons may be homologues of the so-called wing cells of *C. elegans*, which recognize volatile odorants. Unlike *C. elegans*, the threadworm *Strongyloides stercoralis* has processes of the amphidial bundle that are always single. It lacks finger cells and the simple putative wing cell homologues of the two other parasites. It does, however, have within its sheath cells highly complex neurons that could be either modified wing or finger cells. If they are the former, the two lamellae forming the "wings" have been modified to form large multilayered lamellar structures. If the latter, the "microvilli-like" fingers have been modified to become lamellae. In *S. stercoralis*, a parasite of warm-blooded organisms, these "lamellar cells" may function as thermoreceptors. Laser microbeam ablation studies designed, to demonstrate neuronal function in *S. stercoralis*, suggest that certain amphidial neurons, possibly homologues of neuron ASE in *C. elegans* recognize aqueous chemoattractants. Positional homologues of neurons ASF and ASI of *C. elegans* may control the direction of larval development to either free-living adults or infective larvae. Supported by NIH grants RO1 22662 and RR 02483, by The Merck Company Foundation, and by the Research Foundation of the University of Pennsylvania.

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A conserved signalling pathway controls *Caenorhabditis elegans* dauer larva development.
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As with parasitic nematodes, larval arrest in *C. elegans* is under control of sensory stimuli. Developmental arrest is accompanied by cessation of feeding and followed by resumption of development in an improved environment. In *C. elegans*, larval arrest at the second molt results in dauer larva formation. Under conditions favoring growth the DAF-7 protein, a member of the transforming growth factor-ß (TGF-ß) superfamily of protein growth factors, is secreted by specific chemosensory neurons to promote non-dauer development (Ren et al., 1996, Science 274:1389-1391). A dauer-inducing pheromone, the concentration of which is a measure of population density, acts on these neurons to prevent DAF-7 synthesis, and thereby promote dauer formation. The cell-surface receptors for DAF-7 reside on interneurons and other cells responsive to dauer signalling. Failure to activate the receptors and downstream transcription factors (e.g., Smad proteins like DAF-8) results in dauer formation, which in turn requires the activity of the DAF-12 nuclear hormone receptor. All these signalling molecules and transcription factors are highly conserved in evolution and have analogous biochemical functions in vertebrates and invertebrates. It is possible that many nematode species capable of larval arrest use the same conserved signal transduction mechanism to respond to the specific chemosensory cues they employ to regulate their development. This abstract summarizes contributions of many people who have worked in my laboratory over the past 20 years (Riddle and Albert, in *C. elegans* II, 1997, Cold Spring Harbor Laboratory Press, NY, pp. 739-768).

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PHARMACOLOGY OF ANTHELMINTIC RESISTANCE: FROM MOLECULES TO THE FIELD.
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Anthelmintic resistance has compromised the control of nematode parasites in several animal-based industries. Although parasites of horses, cattle and pigs are affected, the problem is most serious in the trichostrongyloid nematodes of sheep. Currently resistance is present to the three major broad spectrum anthelmintic groups on the market as well as the narrow spectrum agent closantel. In some sheep producing areas of the world this has rendered all of the registered anthelmintics ineffective. The molecular basis for benzimidazole resistance in *Haemonchus contortus* is understood and molecular tests are available for field diagnosis and epidemiological studies. Resistance to levamisole appears to involve changes in the acetylcholine receptor but the molecular features are yet to be elucidated. Resistance to the macrocyclic lactones has arisen rapidly in *H. contortus* where it appears to be inherited via a single dominant gene. This has important implications for parasite control in the field. In the absence of elegant tools, such as molecular markers, workers have developed ingenious methods to help advance our knowledge of anthelmintic resistance. Future research aims to understand resistance at several levels and use that knowledge to improve parasite control.

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NEOSPOROSIS: NEW ISOLATE CHARACTERIZATIONS AND INSIGHTS ON PATHOGENESIS IN CATTLE

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Neospora parasites isolated from an infected bovine fetus (BPA1) and congenitally infected calves (BPA3-7) have been established in *in vitro* cultures and characterized. Antigenic and molecular comparison between these isolates from cattle and canine isolates indicates that they are most likely the same species. By contrast, a recent *Neospora* isolate from a horse with equine protozoal myeloencephalitis (EPM) showed consistent antigenic and molecular differences from the other isolates. Recent progress made in cloning immunodominant *Neospora* antigens and developing a PCR-based detection system for *Neospora* in bovine tissues and fluids will be presented. In additon, new insights to the potential mechanisms of vertical *Neospora* transmission will be discussed. Research supported in part by the Center for Equine Health, UC Davis School of Veterinary Medicine and the California Dairy Foods Research Center.

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Determination of the Role of BVD Virus in *Neospora caninum*-Infected Cattle. **R.D. PINCKNEY*, W.W. ZHANG, R.D. SCHULTZ, H.W. MOMONT♮,D. SOCKETT♯ and P.S. SCHMIDT♯. UNIVERSITY OF WISCONSIN-MADISON, DEPARTMENTS OF PATHOBIOLOGICAL SCIENCES*, MEDICAL SCIENCES♮ AND WISCONSIN ANIMAL HEALTH LABORATORY-MADISON♯.**

Bovine Viral Diarrhea is a complex of diseases associated with infection by BVD virus (BVDV). During 1995-96, the WAHL-Madison has isolated BVDV from 237 Wisconsin dairy herds, many of which had concurrent *N caninum* infection. BVDV is thought to cause immunosuppression by suppressing the functions of lymphocytes, neutrophils and monocytes. Additionally, modified-live BVDV vaccines have been associated with immunosuppression. *Neospora caninum* is a newly recognized pathogenic protozoan of animals that is now considered to be a major cause of bovine abortion and congenital infections in calves. Sera from 20 cows and 5 calves on one dairy farm and 19 cows and 1 calf on another dairy farm in Wisconsin that tested positive for *N caninum* antibodies were examined utilizing the ELISA immunoperoxidase test for BVDV. The buffy coats of 68 cows/heifers, 18 calves, 1 bull and 89 cows/heifers from a 2 Wisconsin dairy farms with an unknown *N caninum* history were tested for the presence of animals persistently infected with BVDV. Data and results of this study will be discussed. Further studies will be undertaken to continue the identification of immunologic mechanisms that may contribute to *N caninum* abortion. Presently there are no therapeutic treatments or vaccine available to immunize cattle against *N caninum* infection. Immunologic mechanisms involved in spontaneous abortion due to *N caninum* infection warrant understanding and further investigation.

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ORAL INOCULATION OF CATS WITH *NEOSPORA CANINUM*. M.M. MCALLISTER,[1*] W.R. JOLLEY,[1] D.S. LINDSAY,[2] R.A. WILLS,[1] A.M. MCGUIRE,[1] AND J.D. TRANAS.[1] VETERINARY SCIENCES, UNIVERSITY OF WYOMING, LARAMIE, 82070[1] AND PATHOBIOLOGY, AUBURN UNIVERSITY, AL 36849.[2]

Six weaned male kittens were orally administered tissue cysts of the NC-2 and/or NC-Liverpool (NC-Liv) strains of *Neospora caninum* in buffered saline. Aliquots of these tissue cysts were incubated in an acid-pepsin solution and inoculated onto cell cultures; viable organisms were recovered in vitro in every case. Four of these kittens were also fed infected mouse brains containing NC-2 and/or NC-Liv tissue cysts, and these kittens also ate carcasses of mice that had been inoculated with the NC-4 (provided by J.P. Dubey), NC-2, and/or NC-Liv strains of *Neospora*. Between 1000 and 6000 tissue cysts were enumerated in the buffered saline and brain squashes that were administered to each kitten. None of the kittens shed oocysts that were detected in fecal flotations for 28 days post-exposure. None of the kittens developed a detectable antibody titer to *Neospora*. Immunosuppressed mice were fed cat feces that had been incubated at room temperature for 1 week in dilute H_2SO_4. To date, no tissue culture, serologic or immunohistologic evidence of infection of these mice has been detected. A PCR procedure was used to look for *Neospora*-specific DNA sequences in brains of these mice, as well as in brains of 3 of the kittens; results were negative. At the end of the study, 1 kitten was inoculated parenterally with 1 X 10^6 *Neospora* tachyzoites. It died 15 days post-inoculation with signs of systemic illness, and *Neospora* was detected in the brain by PCR, tissue culture, and immunohistology. Cats are unlikely to be definitive hosts of *Neospora caninum*. This project was funded by a grant from the American Veterinary Medical Foundation (96-11).

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VACCINATION WITH *NEOSPORA CANINUM* CAUSES DECREASED MORTALITY BUT NOT TISSUE CYST PRODUCTION IN MICE ORALLY CHALLENGED WITH *TOXOPLASMA GONDII* OOCYSTS. D. S. LINDSAY[1*], S. D. LENZ[1], C. C. DYKSTRA[1], B. L. BLAGBURN[1], AND J. P. DUBEY[2] . PATHOBIOLOGY, AUBURN UNIVERSITY, AL 36849[1] AND USDA, PARASITE BIOLOGY LABORATORY, BELTSVILLE, MD 20705[2].

N. caninum causes abortions in domestic ruminants. Two experiments were conducted to examine the effects of vaccination with 1 x 10^5 *N. caninum* NC-1 strain tachyzoites on challenge infections with VEG strain *T. gondii* oocysts (1 x 10^3 Exp.1 and 5 x 10^3 Exp. 2). Groups of mice were also vaccinated with 1 x 10^5 tachyzoites of the nonpathogenic TS-4 strain of *T. gondii* or HBSS and served as controls. Eighty percent of the HBSS vaccinated oocyst-challenged mice died in Exp. 1, while 11% of the NC-1 and 0% of the TS-4 vaccinated mice died. The numbers of tissue cysts were significantly reduced in TS-4 mice but not in the NC-1 mice verses the HBSS mice. All HBSS mice challenged with oocysts died in Exp. 2, while 70% of the NC-1 and 20% of the TS-4 mice died. The NC-1 inoculated oocyst challenged mice had more *T. gondii* tissue cysts in their brains than the TS-4 inoculated oocyst-challenged mice. Results of these experiments indicate that vaccination with *N. caninum* provides some protection against fatal oral infection with *T. gondii* oocysts. The protection provided by *N. caninum* is much less than that provided by *T. gondii* and the numbers of tissue cysts in the brains of mice are not significantly lowered.

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Diagnostic Strategies for *Tritrichomonas foetus* in Bulls.

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Tritrichomonas foetus is a protozoan parasite that causes infertility and spontaneous abortion in cattle. Recently, the organism was demonstrated in some herds in Saskatchewan with reproductive problems. In Saskatchewan many beef producers utilize a communal pasture system for breeding and grazing. In such a system identification of infected individuals is important. Diagnosis of infection in bulls is usually made by identifying the organism in cultures started from preputial scrapings or washes. Reported sensitivities of sampling and culture methods are variable. Currently, repeated tests are required to confirm that a bull is not infected. In this study 12 naturally infected and 13 artificially infected bulls were sampled repeatedly using two different collection techniques. Relative sensitivities of the two different techniques were evaluated. Differences among bulls for numbers of positive results obtained were also evaluated. The results of this study will be presented.

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Transport and culture conditions potentially affecting the sensitivity of the diagnostic test for *Trictrichomonas foetus.*

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Until reliable molecular diagnostic assays are available to identify *T. foetus* in preputial scrapings/washes from bulls and the vaginal mucus of cows, the diagnosis of trichomoniasis relies upon *in vitro* culture and subsequent morphological identification. The sensitivity of a single test has been confirmed as low (70-82%) and three tests, one week apart, have been recommended for bulls in order to increase the sensitivity to an acceptable level (99.4%). This latter requirement is inconvenient and costly. The Centre for Animal Parasitology performs the diagnostic test for *T. foetus* from bulls housed in Canadian accredited artificial insemination centres and from bulls/cows destined for export (3659 samples/yr). Experiments were performed to identify transport and culture conditions which may affect the sensitivity of the diagnostic test. Plastic round bottom culture tubes (Falcon^R) with different media (thioglycolate based transport media, modified Diamond's media, and InPouch TF^R were inoculated with known concentrations of *T. foetus*, exposed to different temperatures (-20 ^{0} C to +42 ^{0} C) for various time periods (15min-7days) and then subcultured and/or reincubated at 37 ^{0} C for at least 10 days. Samples were regularly examined and the presence/absence and concentration of *T. foetus* (when appropriate) was recorded. The data are undergoing statistical analysis and significant differences in the qualitative or quantitative response of *T. foetus* to the different conditions will be identified. It is hoped that awareness and subsequent avoidance of specific transport/culture conditions reducing *T. foetus* viability will increase the sensitivity of the diagnostic test offered by veterinarians and parasitologists and help control this economically important disease of cattle.

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Development of immunity to *Eimeria* species in broilers reared on new or used litter and given anticoccidial drugs in the feed. H.D. Chapman*, Department of Poultry Science, University of Arkansas, Fayetteville, AR 72701.

The development of immunity to *Eimeria* species in broilers reared in floor-pens on new or used litter and given different anticoccidial drug programs was examined. Birds were challenged at four, five, six and seven weeks of age with a mixture of three species of *Eimeria*, (*E. acervulina, E. maxima,* and *E. tenella*) and weight gains (from days 0-7 post inoculation) compared with those of unchallenged controls. At four weeks of age, unmedicated birds were susceptible to challenge irrespective of whether they were raised on new or used litter. By five and six weeks birds had acquired partial protection against challenge and by seven weeks had developed immunity to the *Eimeria* species. Birds were given either a single drug (amprolium-250ppm or lasalocid-125ppm) in both starter and grower feeds or shuttle programs (amprolium followed by lasalocid or lasalocid followed by amprolium). Birds reared on drugs were susceptible to challenge at four weeks of age but partial protection was evident by five and six weeks. By seven weeks medicated birds reared on new and used litter had developed immunity to the challenge infection suggesting that none of the drug programs prevented the acquisition of immunity.

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Role of interferon-γ and nitric oxide in Avian Coccidiosis. HYUN S. LILLEHOJ[1*] & PATRICIA ALLEN[2]. Immunology & Disease Resistance[1*] and Parasite Biology & Epidemiology[2] Laboratories, Livestock & Poultry Sciences Institute, USDA, Beltsville, MD. 20705.

Coccidiosis which is caused by several species of Eimeria, severely damages the gut and results in greater than $600 million annual economic losses. To identify various immune factors which control parasite survival, the roles of interferon-gamma (IFN-γ) and nitric oxide (NO) were investigated in E. tenella infection. Recombinant chicken IFN-γ (rchIFN-γ) was expressed in CHO cells and used in in vitro studies. Pretreatment of chicken fibroblast cells with rchIFN-γ caused a significant inhibition of E. tenella development. Since IFN-γ-mediated induction of NO has been shown to play a critical role in some intracellular parasitic infections, the role of NO was studied by inhibiting in vivo induction of the NO pathway using S-methyl isothiourea sulfate (SMIT), a potent and selective inhibitor of inducible nitric oxide synthase. SMIT-treatment did not alter the levels of oocyst production, weight loss and intestinal lesions compared to untreated control following E. tenella infection. These results indicate that NO is not involved in protective host response to E. tenella infection. (Supported partly by NRI Grant #91-37204-6358).

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Pharmacokinetics of Doramectin and Ivermectin in Swine. C. FRIIS[1]*, AND H. BJOERN[1], DEPARTMENT OF PHARMACOLOGY AND PATHOBIOLOGY, THE ROYAL VETERINARY AND AGRICULTURAL UNIVERSITY, COPENHAGEN, DENMARK[1].

The pharmacokinetic determinants of doramectin and ivermectin were studied in 20 pigs weighing 66 to 90 kg. The pigs were randomly assigned to four groups: doramectin IV, doramectin IM, ivermectin IV, and ivermectin SC. In all groups the drugs were administered a dosage of 0.3 mg/kg b.wt. The concentration of doramectin and ivermectin (H_2B_{1a} and H_2B_{1b}) in plasma was determined by HPLC. After IV administration the steady state volume of distribution was 6.3±0.3 L/kg for doramectin and 7.9±3.3 L/kg for ivermectin, indicating that the drugs were distributed equally well to tissues. Doramectin was cleared from the body at a slower rate than was ivermectin. Body clearance was 1.5±0.2 L/kg/day for doramectin and 4.1±0.6 L/kg/day for ivermectin. This was reflected in a different mean residence time: 4.3±0.5 days for doramectin and 2.0±0.9 days for ivermectin. After IM/SC administration, doramectin and ivermectin plasma concentrations increased rapidly reaching peak values after 2.6±1.3 and 3.1±1.4 days, respectively. The peak plasma concentration of doramectin was nearly twice that of ivermectin (22.9±6.2 versus 13.5±3.6 ng/ml). Likewise the area under the curve for doramectin was twice that of ivermectin (228±75 versus 113±19 ng·day/ml), whereas the mean residence time and the half-life of the infinity part of the plasma curves were equal for the two drugs (MRT: 8.6±1.7 vs. 7.8±1.8 days; $t_{1/2}$: 4.8±1.1 vs. 4.2±1.3 days). The prolonged plasma concentration of doramectin compared to that of ivermectin was attributed to the difference in the body clearance between the two drugs.

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Duration of Activity of Doramectin and Ivermectin Against *Ascaris suum* in Experimentally Infected Pigs. C.A. LICHTENSTEIGER[1], J.A. DIPIETRO[1], A.J. PAUL[1], E. NEUMANN[1]*, AND L. THOMPSON[2]. COLLEGE OF VETERINARY MEDICINE, UNIVERSITY OF ILLINOIS, URBANA, IL, 61801[1] AND PFIZER, INC., LEE'S SUMMIT, MO, 64081[2].

We investigated the activity of two avermectins against *A. suum* in a study using nematode-free, 40 to 50 kg, crossbred pigs randomly allotted to 9 treatment groups of 8 pigs each. Eight groups were treated with 300 µg/kg of doramectin (IM) or ivermectin (SC), either 0 (same day), 7, 14 or 21 days prior to an oral challenge of 50,000 embryonated *A. suum* eggs. The ninth group (control) was challenged in parallel without any anthelmintic treatment. At 41 or 42 days after challenge, adult and larval stages of *A. suum* were collected from the gastrointestinal tract of all pigs and aliquots were counted. To determine anthelmintic effects, transformed nematode counts (natural logarithm [count + 1]) were analyzed by analysis of variance with single degree of freedom contrasts between each anthelmintic group and the no anthelmintic control pigs and between the two anthelmintic groups for each treatment time point. Both anthelmintics significantly ($P \leq 0.0002$) reduced nematode counts when given the day of challenge (0 days prior) giving a 100% and 97.5% efficacy, respectively for doramectin and ivermectin. In addition, doramectin given 7 days prior to challenge significantly ($P \leq 0.0001$) reduced nematode counts; efficacy was 98.4%. Nematode counts were not significantly reduced from the control counts in the other groups. In this study, the duration of activity of ivermectin was less than 7 days and the duration of activity of doramectin was 7 days.

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Effect of *Metastrongylus* spp. infection on performance of growing pigs.M.A. BAUDENA*,E.KABAGAMBE,Y.LI,M.T.PENA,R.RUTLEDGE,G.BAPTISTA. SCHOOL OF VETERINARY MEDICINE, LOUISIANA STATE UNIVERSITY.

Limited information is available in the literature on the effect of lungworms, *Metastrongylus* spp. on performance of pigs. Twenty-four pigs from the LSU Swine Farm were used to determine the impact of *Metastrongylus* spp. on performance. Pigs were negative for nematode eggs on fecal flotation. Twelve pigs (av. 66.2 kg) were each fed 2,000 infective larvae of *Metastrongylus* spp. contained in earthworms in a small amount of feed and 12 pigs (av. 67.0 kg) were fed an equivalent amount of feed without earthworms. Pigs were weighed every two weeks and total feed consumed measured. The average daily gain (ADG) and feed to gain (F/G) were calculated for the 56 day-feeding period. The ADG's for the control and infected groups were not significantly different for the first four weeks of the study ($P>0.05$). From week five until the end of the study, the ADG of the control pigs were significantly higher ($P<0.05$) than for infected pigs. Although the feed intake was greater for the infected pigs, the F/G was lower for the control pigs ($P<0.05$). Pigs began coughing, approximately 10 to 15 days p.i. However, the difference in weight gain was not significant ($P>0.05$) until the worms matured, approximately 4 weeks p.i. Seven to 216 worms were found in the lungs of the infected pigs. No worms were found in the control pigs. A positive correlation was found between the number of worms and the F/G. Results demonstrated an economic impact of *Metastrongylus* spp. on swine performance.

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TRANSMISSION DYNAMICS OF *OESOPHAGOSTOMUM DENTATUM* AND *HYOSTRONGYLUS RUBIDUS* IN OUTDOOR PIGS

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An increase in alternative outdoor pig production systems is occurring in Denmark, and this study was designed to elucidate the transmission patterns of *Oesophagostomum dentatum* and *Hyostrongylus rubidus* in pigs allowed to graze continuously on a pasture. A group of pigs were turned out in May 1993 (Year 1 of the study) and subsequently inoculated with low numbers of both helminths. These pigs were followed parasitologically until October by serial necropsy and sampling of faeces, grass and soil. A non-inoculated group of pigs was similarly followed on the same pasture in Year 2 (1994). Pasture infectivity was measured using helminth naïve tracer pigs during all seasons. The pasture vegetation was rapidly destroyed by the pigs, resulting in a dirt lot by the autumn of Year 2. The area was soon contaminated with eggs, resulting in heavy pasture infectivity and increasing worm burdens in late summer, whereafter the numbers of larvae declined markedly. In May of Year 2, newly exposed pigs became only lightly infected (mostly *O.dentatum*), and no transmission was observed in July-August of Year 2, probably due to an unusually dry summer and a lack of protecting vegetation. The results indicate that both *O.dentatum* and *H.rubidus* are very sensitive to environmental factors, because significant transmission occurred only under the most at favourable conditions (summer combined with protecting vegetation as in Year 1). Transmission was severely reduced during the low temperatures experienced during the winter between Year 1 and 2 and during the dry summer of Year 2, when vegetation was lacking. Continuous grazing actually reduced transmission of *O.dentatum* and *H.rubidus* because of the reduction in vegetation. This, however, is not a desirable alternative farming system, because of its adverse environmental effects. This environmental impact may be mitigated by employment of a pasture rotation system in place of continuous grazing.

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TRANSMISSION DYNAMICS OF *ASCARIS SUUM* AND *TRICHURIS SUIS* IN OUTDOOR PIGS

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In Denmark, alternative outdoor production systems for pigs are becoming more frequent, and information on the transmission of *Ascaris suum* and *Trichuris suis* under continuously grazed pasture conditions is needed. A group of pigs were turned out on a pasture in May 1993 (Year 1 of the study), inoculated with 200 eggs of *A.suum* and 1000 eggs of *T.suis*, and followed parasitologically. A non-experimentally infected group of pigs was similarly turned out on the same pasture the following year (Year 2) and again followed parasitologically. Pasture infectivity was measured using helminth naïve tracer pigs. During the summer of Year 1, *A.suum* eggs became infective within 4-6 weeks on the pasture. However, transmission was moderate until August of Year 2, when a pronounced increase in transmission occurred. After two months on the pasture, the continuously exposed pigs in summer seasons of both Year 1 and 2 harboured small overdispersed populations of adult *A.suum*, moderate numbers of liver white spots, and high specific IgG responses. These parasitological measures on chronically exposed pigs did not, however, correlate well with pasture infectivity or with each other. In contrast, the liver inflammation and specific IgG responses (but not the intestinal *A.suum* burdens) of the tracer pigs were highly correlated ($P=0.0001$) and appeared to better reflect pasture infectivity. The inoculated pigs excreted *T.suis* eggs by the late summer of Year 1, but no transmission took place before August of Year 2. Thus, the *T.suis* population of infective eggs built up very slowly. The results indicate that *T.suis* eggs may survive for considerable time, however. The study results reveal that *A.suum* and *T.suis* eggs are much more resistant to environmental factors than free-living infective larvae of pig parasites such as *Oesophagostomum dentatum* and *Hyostrongylus rubidus*. Control of these parasites in outdoor systems will present more difficult challenges than that for parasites transmitted by free-living larvae.

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Effect of Protease Inhibitors on *in vitro* Development of the Third- to Fourth-Stage of *Ascaris suum*. MARCIA L. RHOADS* and RAYMOND H. FETTERER. PARASITE BIOLOGY AND EPIDEMIOLOGY LABORATORY, LIVESTOCK AND POULTRY SCIENCES INSTITUTE, USDA, ARS, BELTSVILLE, MD 20705

The third-stage larvae (L3) of *Ascaris suum* develop and undergo the molt to the fourth-stage (L4) during *in vitro* cultivation; 80 to 90% of the larvae consistently reach the L4 stage during 7 days in culture (DIC). This provides a model system to study the mechanisms involved in this critical process, in particular, the role of proteases. The presence of either a serine protease inhibitor (AEBSF, 100 μM), a metallo protease inhibitor (CM-phe-leu-OH, 200 μM), or an aspartic protease inhibitor (pepstatin A, 73 μM) had no effect on the %L4 larvae after 7 DIC. However, the presence of either Z-phe-ala-FMK (100 μM), a cysteine protease inhibitor, or amastatin (100 μM), an aminopeptidase inhibitor, resulted in 80 and 67% reductions, respectively, in the %L4 compared to untreated cultures; the viability of the larvae was not affected. In cultures treated with the cysteine protease inhibitor, the majority of larvae at 7 DIC were at the L3 stage, whereas, in cultures treated with amastatin, the majority of larvae were at the third-molt (3M) stage, having a loosened, yet uncast L3 cuticle. The data suggest that both a cysteine protease and an aminopeptidase are involved in the development of *A. suum* L3 to L4.

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Effect of disulfiram on eggshell morphology of *Trichuris muris*.

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The effect of disulfiram on eggshell morphology in the parasitic nematode *Trichuris muris* was studied in vitro and in vivo. Daily treatment of mice infected with *T. muris* beginning 25 days after infection and continuing for 26 days resulted in the production of malformed eggs by adult female worms in all treated groups. In addition, significantly fewer adult worms were found at necropsy in mice treated with 5.0 or 7.5 mg/kg/day of disulfiram as compared with mice treated with 2.5 mg/kg/day or control mice. Adult worms collected from infected, untreated mice and placed in aerobic culture for 5 days in media containing 4 or 8 μg/ml of disulfiram released malformed eggs into the culture medium after 30 hours in culture. These malformed eggs, when used to infect naive mice, did not result in infection with *T. muris*. The results of these studies suggest that inhibition of phenol oxidase by disulfiram results in disruption of normal egg production by *T. muris* females and that the enzyme might be a useful target in the development of control strategies aimed at nematode parasites that rely on phenol oxidase for egg shell hardening.

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STUDIES OF REPRODUCTION BIOLOGY OF *OESOPHAGOSTOMUM* SPECIES IN PIGS USING A NOVEL TRANSPLANTATION TECHNIQUE

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To study details of the population biology of *Oesophagostomum dentatum* in pigs a non-surgical worm transplantation technique was developed: The pig is sedated and a set of pvc tubes is inserted into the rectum. The worms are then pushed with air through the tubes into the distal colon from where they migrate to their predeliction site. To examine the effect of different sex ratios on worm fecundity, different female to male ratios (FMR) of *O.dentatum* (1:9, 5:5, 9:1) were transplanted into helminth free recipient pigs at doses of 300 or 30 worms. At the low dose level, equal sex ratios gave rise to higher egg excretion (epg) than a 1:9 FMR; and in the low dose 9:1 FMR group, the female worm fecundity (last epg/number of female worms) was markedly reduced compared to the two other groups. In the high dose 1:9 FMR the fecundity was lower than in the equal ratio group. The study suggested an upper limit for the FMR at very low worm densities, above which *O.dentatum* females produce fewer eggs. The proclivity of *O. dentatum* and *O. quadrispinulatum* to hybridize was examined following transplantation into helminth free pigs of immature stages of male and female worms of the heterologous species. Only once were hybrid worms produced from the cross of *O. dentatum* males and *O. quadrispinulatum* females. The infertile hybrids had sexual characters of the parent generation whereas other characters appeared mixed. The difficulty with which any hybrids were obtained suggested that a certain species specificity must exist in the attraction excerted by the two sexes.

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PARABAN©, A WINDOWS-BASED MODEL FOR PARASITE-CONTROL IN COW-CALF AND STOCKER OPERATIONS. G. SMITH*, J. JACOBSEN, M. SOLL & J. GUERRERO. SCHOOL OF VETERINARY MEDICINE, UNIVERSITY OF PENNSYLVANIA, PA 19348 & MERCK AGVET, DIVISION OF MERCK & CO INC, RAHWAY, NJ 07065.

A "Windows" version of PARABAN©, a mathematical model for the population biology of parasitic infections of cattle, can be used to evaluate potential nematode control strategies for cow-calf and stocker operations in the USA. Model output tracks the results of field trials carried out in Mississippi, Louisiana and other southern States with the typical patterns of arrested larval development. The illustrative model provides insights into the relative merits of treatment strategies based on strategically timed repeated treatments or anthelmintic delivery in a sustained release bolus formulation and demonstrates the efficacy of treatment protocols designed to suppress pasture larval contamination.

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CONTROL OF GASTROINTESTINAL NEMATODES IN THE PYRENEES (SPAIN) BASED ON EPIDEMIOLOGICAL DATA. CONFIRMATION WITH A MATHEMATICAL MODEL. S. ALMERIA*, J. GUERRERO& and J. URIARTE. SIA/DGA, ZARAGOZA (SPAIN),* Present address: USDA, ARS, LPSI, IDRL, BELTSVILLE, MD 20705 & MERCK AGVET, RAHWAY, NJ 07065.

Results from an epidemiological study of gastrointestinal nematode of cattle in mountainous areas of Spain in The Pyrenees are presented. The study included kinetics of pasture contamination with gastrointestinal nematode larvae, monthly fluctuations of worm burdens and the first description of the existence of arrested development of gastrointestinal nematodes in cattle in Spain. Grass samples were collected every two weeks and larval differentiation performed. Fecal and blood samples from the animals were also collected every two weeks. Calves were housed for two weeks before slaughter and worm counts and species identification were performed. A bimodal pattern of pasture contamination was observed in spring and autumn; Ostertagia spp. was the most prevalent species, followed by Cooperia spp. Ostertagia ostertagi was the most numerous species found in the animals, followed by Cooperia oncophora and Trichostrongylus axei, with the highest intensities of infection seen in May, June, September and November. The highest burden was observed in the animals after two months of grazing. The maximum percentage of inhibition was observed in autumn in animals with and without previous exposure to the parasites. The parasite accumulation, inhibition pattern and pasture contamination were compared to PARABAN™ simulations. Parasite control programs utilizing two anthelmintic treatments were indicated and confirmed on PARABAN computer simulations.
Financial support provided by INIA (Spain).

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GASTROINTESTINAL NEMATODE INFECTIONS IN DAIRY CALVES FOLLOWING ONE, TWO OR THREE MOVES TO CLEAN PASTURE. M. EYSKER*, J.H. BOERSEMA, J.B. GITHIORI & F.N.J. KOOYMAN. UTRECHT UNIVERSITY, P.O. BOX 80.165, 3508 TD UTRECHT, THE NETHERLANDS.

In West Europe calves infect themselves with overwintered larvae of gastrointestinal nematodes immediately after turnout and patency starts three weeks later. Development of the free-living stages is slow in spring and high pasture infectivity levels cannot be expected before the middle of July. This implies that control of parasitic gastroenteritis (PGI) could be achieved by repeated moves of calves to clean pastures from July onwards. This was tested in two trials with a grazing season from May to October, using faecal egg counts, pasture larval counts, serum pepsinogen values, serology with a specific recombinant *Cooperia oncophora* antigen, weight gain, tracer worm counts and worm counts as parameters. In both experiments initial overwintered infections were low. High infections developed in the groups which were moved once (July) or twice (July, August). Low infections were maintained until the end of the grazing season in groups which were moved three times (July, August, September). Challenge infections at the end of the second experiment indicated development of equal levels of immunity in all three groups on pasture.

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CATTLE MANAGEMENT TO REDUCE NEMATODE CONTAMINATION POTENTIAL OF PARASITE-FREE BERMUDAGRASS PASTURES. **J. A. STUEDEMANN*[1], H. CIORDIA[2], T. B. STEWART[3], D. H. SEMAN[1], S.R. WILKINSON[1], A. J. FRANZLUEBBERS[1], A. L. DILLARD[1], AND A. D. LOVELL[1]. [1]USDA, ARS, WATKINSVILLE, GA 30677; [2]UNIVERSITY OF GEORGIA, GRIFFIN 30223; AND [3]LOUISIANA STATE UNIVERSITY, BATON ROUGE 70803.**

A long-term experiment was conducted to determine soil-quality restoration of highly degraded, cultivated land with pasture management. As a part of this study, we wished to determine if land that had been under cultivation for extended periods of time and therefore expected to be free of nematode parasites could be maintained parasite-free with judicious cattle management. Nitrogen was supplied to 0.7 ha paddocks of Coastal bermudagrass (Cynodon dactylon (L) Pers.) with either NH_4NO_3, poultry manure, or crimson clover. Pastures were grazed at either high (H) or low (L) grazing pressure that was based on the amount of above-ground forage, i.e., H and L pressures were targeted to be 1000 to 1500 and >2500 kg/ha, respectively, with a differential of at least 1500 kg/ha. These pressures were maintained by put-and-take grazing. There were three blocks of six treatments for a total of 18 paddocks. During the first year, pastures were stocked with yearling steers from mid-July to early-October after which stocking was from mid-May to mid-October. Cattle management included treatment with pour-on ivermectin 21 days prior stocking of the pastures, treatment with albendazole 7 days prior to stocking, and treatment with injectable ivermectin 48 hours prior to stocking of the pastures with the cattle remaining in drylot during the 48-hour period. Nematode eggs per gram of feces (epg) were monitored at 28-day intervals. After three years, there were no differences among pasture fertilization or grazing pressure treatments. Within year, maximum epg were observed at the end of the grazing season. Mean epg at the end of the grazing period of years one, two, and three were 3.6, 0.4, and 3.0, respectively. Thus, after three years of grazing during the warm season in North Georgia, the pastures remained "essentially free" of nematode parasites.

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LUNGWORM OUTBREAK IN LACTATING DAIRY COWS. DONALD H. BLISS*[1] AND GIL H. MYERS[2]. MIDAMERICA AG RESEARCH, VERONA, WI 535931 AND GIL MYERS, PH.D., INC., MAGNOLIA, KY 427572.

A number of outbreaks of parasitic bronchitis in lactating dairy cows have been recorded during the past few years. These outbreaks have occurred in the Pacific Northwest, in the Midwest and in the Northeast. The reason for the sudden surge of lungworm disease seems to be linked to the increase in the number of dairy operations that are developing intensive grazing systems for their cattle. Some of these outbreaks have been severe with heavy losses to the owners including significant reduction in milk production and mortalities. These outbreaks probably could have been avoided or at least partially prevented with a quicker and more accurate diagnosis of the problem. One particular outbreak which occurred in Central Pennsylvania was investigated in detail and will be discussed. Solutions include alerting the industry to an increased potential for severe parasite problems where intensive grazing is employed and publicizing the need for strategic parasite control to prevent these problems.

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EVALUATION OF ANTHELMINTIC TREATMENTS IN CATTLE GRAZING GREAT BASIN RANGELAND IN NEVADA AND CALIFORNIA. WG KVASNICKA*, DH BLISS AND RON TORELL. UNIVERSITY OF NEVADA, RENO, NV 89557. MIDAMERICA AG RESEARCH, VERONA, WI 53593. NEVADA COOPERATIVE EXTENSION, ELKO, NV 89801.

Sixty three beef operations in Nevada and California were sampled in April to May, before turnout, in order to evaluate anthelmintic treatments applied during October to December of the previous year. Operations represented three grazing regimens (irrigated pasture/meadow; meadow to mountain; desert/basin to mountain). Treatments evaluated were 1. no treatment (CON); 2. Ivermectin (I); 3. Fenbendazole (F); 4. Albendazole (A); and 5. Levamisol (L). Anthelmintic application followed label directions. A total of 663 fecal samples were evaluated using the Wisconsin Sugar Floatation Method. No grazing regimen x anthelmintic treatment interaction ($P > .15$) was observed. Class II dewormers (I,F,A) reduced internal parasite egg shedding compared to CON treatment which did not differ ($P > .10$) from the Class I (L) dewormer. The I (2 eggs/3 g feces) and F (1 egg/3 g feces) treatment reduced ($P < .05$) internal parasite egg shedding compared to CON (6 eggs/3 g feces) and L (6 eggs/3 g feces). Treatment with the A (4 eggs/3 g feces) treatment being intermediate. *Ostertagia* and *Cooperia* were the predominate parasite genera found in the cattle. Chi-square analysis indicated that percent parasitized cattle (one egg was considered positive) was 27% and 39% for I and F treated cattle, while the level of parasitism increased ($P < .05$) to 57% and 61% for CON and L treated cattle with A treated cattle being intermediate (45%). Results indicate that Class II dewormers were effective at reducing internal parasite burdens and egg shedding prior to the start of the grazing season. Discussion will include how this data is utilized in designing and implementing strategic deworming programs for cattle herds grazing Great Basin ranges, meadows, and pastures.

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PRODUCTIVITY OF STOCKER CATTLE TREATED WITH THE IVOMEC® (ivermectin) SR BOLUS VS. BENZIMIDAZOLE ANTHELMINTICS & TOPICAL FENTHION FROM GRAZING TO SLAUGHTER. L. BALLWEBER[1], D. BECHTOL[2], J. R. BROWN*[3], J. A. HAWKINS[3], R. ALVA[4], R.PLUE[4]. MISSISSIPPI STATE UNIVERSITY, STARKVILLE, MS 37962[1]; AGRI-RESEARCHCENTER, INC., CANYON, TX 79015[2]; MERCK AGVET, RAHWAY, NJ 07065[3]; MERCK RESEARCH LABORATORIES, RAHWAY, NJ 07065[4].

Stocker beef calves were used to determine the effect of treatment with the IVOMEC SR Bolus (ISRB) on productivity and parasite burdens over the grazing period, Stocker through the feedlot and at slaughter, compared to controls and cattle treated with benzimidazole anthelmintics. The 180 cattle were allocated by restricted randomization on Day -15 to one of three treatment groups: control (no treatment on Day 0 and topical fenthion at entry into the feedlot); benzimidazole (BZD) anthelmintics (fenbendazole at 5mg/kg once orally on Day 0, and oxfendazole at 4.5 mg/kg once orally) and topical fenthion at entry into the feedlot; and the ISRB at constant release rate of 12 mg ivermectin/day for approximately 135 days once on Day 0. The cattle were grazed separately by treatment for 125 Days, with 6 replicated pastures per treatment. The cattle were maintained in the same groups after entry into the feedlot on Day 127. Cattle were weighed on Days -15, 0, 63, 125, 237 and 294. Fecal samples were examined for nematode eggs on Days -15, 63, 125 and 237. Cattle treated with the ISRB weighed significantly more at Days 125 and 294, and gained significantly more weight from Day 0 to each of those days, than the untreated controls or the cattle treated with BZD products ($p<0.05$). Carcass weight of each medicated group was significantly ($p<0.05$) greater than that of the controls, and the ISRB group was significantly ($p<0.05$) heavier than the BZD group. Fecal egg counts were significantly ($p<0.05$) lower for the ISRB group than for the untreated group and the BZD group at each sampling after Day 0. At Day 63 and Day 237, the BZD group had significantly lower egg counts than the controls. Use of the ISRB provided significant improvements in parasite control and weight gain relative to controls and group. These differences in weight gains applied from grazing through the feedlot to slaughter. ®IVOMEC is a registered trademark of Merck & Co., Inc.

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CANINE HEARTWORM PROPHYLAXIS BY HIGH ORAL DOSAGES OR TRANSDERMAL ADMINISTRATION OF DIETHYLCARBAMAZINE. J.W. MCCALL[1]*, S.L. STROH[2], A.A. MARCHIONDO[3], AND T.L. MCTIER[4]. [1]DEPARTMENT OF PARASITOLOGY, COLLEGE OF VETERINARY MEDICINE, UNIVERSITY OF GEORGIA, ATHENS, GA; [2]FERMENTA ANIMAL HEALTH, FORT COLLINS, CO; [3]RHONE MERIEUX, INC., ATHENS, GA; [4]TRS LABS, INC., ATHENS, GA

Diethylcarbamazine (DEC) citrate was evaluated to determine the chemoprophylactic effectiveness of repeated high doses against *Dirofilaria immitis* in experimentally infected dogs. Dosages of DEC citrate at 22, 55, or 88 mg/kg b.w. for 3 successive days every 2 months commencing 1 month postinoculation (PI) of infective third-stage larvae yielded prophylactic efficacies of 20, 63, and 80%, respectively. DEC citrate administered orally at 55 mg/kg b.w. for 1, 2, or 3 successive days every month for 4 months commencing 1 month PI yielded efficacies of 60, 65, and 69%, respectively. Oral dosages of DEC citrate at 88, 121, or 154 mg/kg b.w. for 3 successive days every 2 months (-1, 1, 3, 5 months) yielded efficacies of 47, 68, and 74%, respectively. DEC base in dimethyl sulfoxide (DMSO) administered transdermally at 154 mg/kg b.w. for 3 successive days every 2 months was 95% effective in preventing canine heartworm infection. In a subsequent study, transdermal application of DEC base in DMSO at the rate of 154 mg/kg b.w. administered to the abdomen and groin areas on Days -14, 14, 42, 70, 98, 126, and 154 PI was 100% effective in preventing the development of adult heartworms. However, all dogs receiving DEC base in DMSO exhibited serious adverse treatment reactions, including emesis, pronounced application-site skin irritation, related physical discomfort, and a near-fatal reaction in one dog following the last treatment. The reactions were transient and subsided by 24 hours postapplication. Based on those data, repeated high oral dosages of DEC citrate are not effective in preventing canine heartworm infection. Transdermal administration of DEC base in DMSO provided 100% protection against heartworm infection. However, adverse reactions to the transdermal formulation occurred.

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CORRELATION OF MOSQUITO SPECIES POPULATION DISTRIBUTION AND THE SEASONAL TRANSMISSION OF *DIROFILARIA IMMITIS*. R.A. HOLMES*[1], G. FAGET[2], M. YATES[2]. 1. LOUISIANA STATE UNIVERSITY, BATON ROUGE, LA. 2. EAST BATON ROUGE MOSQUITO AND RODENT CONTROL, BATON ROUGE, LA.

Numerous species of mosquitoes have been incriminated in the transmission of heartworms *(Dirofilaria immitis)*. While all species potentially may be vectors, there are several factors that influence this ability. In addition to the genetic ability to be a good vector, a specific mosquito may inhabit only certain geographic and ecological niches.
The East Baton Rouge Mosquito and Rodent Control unit regularly traps mosquitoes from 33 sites throughout the parish which represent a variety of ecological habitats. Mosquitoes are sexed and speciated by site for each date collected. Seasonal transmission studies of heartworms in dogs have been conducted in Florida, Georgia, and Louisiana.
These preliminary data suggest that while *Aedes vexans* is by far the most numerous mosquito in East Baton Rouge Parish, it may not be the "best" vector because their seasonal distribution does not correlate well with the heartworm seasonal transmission data. In comparison, *Anopheles quadrimaculatus* is not as numerous, but their seasonal distribution closely matches that of heartworm transmission. This knowledge may allow for control measures that can be directed towards a specific species of vector.

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DEVELOPMENT OF A MOLECULAR PROBE BASED ON THE SMALL SUBUNIT RIBOSOMAL RNA FOR THE DETECTION OF *DIROFILARIA IMMITIS*.

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Heartworm disease to *Dirofilaria immitis* infection is a major problem in the United States. An important means of treatment is to control dissemination of parasitic infections. In order to design control strategies more information is needed on endemicity and infection rates of endemic areas. It is also important to know conditions under which the vector populations in a given region, and determining the percentage of infectious mosquitoes in that population at a given time. Previous studies performed by McCall at the Orlando, Florida dog pound have indicated a cessation of larval development with decreasing temperatures. Thus, it is possible that transmission of heartwroms does not occur during winter months. In order to exam this hypothesis a DNA probe based on a sequence from the small subunit rRNA of *D. Immitis* has been developed for detection of infected mosquitoes. The small subunit rRNA for *D. Immitis* was sequenced, and primers were designed to PCR amplify a 401bp fragment. The probe is a 24bp fragment based on the variable regions of the ss rRNA from *Dirofilaria immitis, Wuchereria bancrofti, Loa loa, Brugia pahangi, Brugia malayi, Acanthocheilonemaviteae, Onchocerca vovlulus,* and *Haemonchus contortus*. These samples were then hybridized with the probe specific for *D. Immitis* The probe was determined to be sensitive down to 0.01ng. Future studies involve using the probe to survey mosquitoes from sites in Louisiana and Florida at specific time points in order to determine when transmission is occurring.

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Canine filariasis in California: *Dipetalonema reconditum*, distribution and prevalence as an indication of vector abundance and survival. J.H. THEIS* SCHOOL OF MEDICINE, UNIVERSITY OF CALIFORNIA, DAVIS, CA 95616 and F. STEVENS VET SOFT, DAVIS, CA 95616.

An examination of 39,090 dogs, 18,107 males and 20,983 females for *Dipetalonema reconditum* by the nuclepore-filter-acid phosphatase test demonstrated a decline in prevalence for male dogs from 18/1000 in 1983 to 8/1000 in 1991 and a decline for female dogs from 6/1000 in 1983 to 3/1000 in 1991. However, the distribution of infected dogs when plotted by plant climate zones showed no relative change. The tolerance of the vector to drought and the influence of climate zones on the relative abundance of fleas indicates how focal transmission activity can sustain a parasite even when it is unable to maintain a high transmission rate.

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Canine filariasis due to *Dipetalonema reconditum* in California: The effects of management, geographical location of the dog's domicile, age, gender and Plant Climate Zones on the risk of infection. J.H. THEIS* SCHOOL OF MEDICINE, UNIVERSITY OF CALIFORNIA DAVIS, DAVIS CA 95616 AND F. STEVENS, VET SOFT, DAVIS CA 95616.

A total of 53,017 dogs have been examined by the filtration of blood samples followed by acid phosphatase staining for recovery and identification of microfilariae respectively from 1983 through 1992 in 637 cities throughout California from Bakersfield to Yreka. Management information on each dog examined in addition to biometric data was supplied by the owners. Like management groups were compared by geography, climate of domicile, gender, age and breed. There is a gender bias of infection with *D. reconditum* favoring male dogs. Regardless of outdoor-indoor management, geography or climate of domicile, male dogs are more frequently infected than females. Outdoor male dogs are more frequently infected than indoor males and this is true regardless of geography of domicile. However, infection in outdoor female dogs does vary between some geographical areas. There is little difference within genders between prevalence of *D. reconditum* and 30 year mean annual rainfall. Thus, the major factors that influence risk of infection with *D. reconditum* are gender and indoor-outdoor management of the dog.

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Canine filariasis due to *Dirofilaria immitis* in California: The effects of management, geographical location of the dog's domicile, travel history, gender and plant climate zones on the risk of infection. J.H. THEIS* SCHOOL OF MEDICINE, UNIVERSITY OF CALIFORNIA DAVIS, DAVIS CA 95616 AND F. STEVENS, VET SOFT, DAVIS CA 95616.

A total of 53,017 dogs have been examined by the filtration of blood samples followed by acid phosphatase staining for recovery and identification of microfilariae respectively from 1983 through 1992 in 637 cities throughout California from Bakersfield to Yreka. Management information on each dog examined in addition to biometric data was supplied by the owners. Like management groups were compared by geography, climate of domicile, gender, age and breed. Outdoor dogs, not on prophylaxis living in the Foothill Plant Climate Zone of the Sierra Nevada foothills with 30 year mean annual rainfall of 65 cm or more and elevations of 152 to 1,000 meters with daytime temperatures of 8-28°C and nightly temperatures of 1-17°C have a 6-11 times greater risk of infection than dogs living elsewhere where *Dirofilaria immitis* is concerned. Dogs traveling out of low endemic areas increased their risk of infection over those managed the same otherwise but remaining at home. Conversely, dogs traveling out of high endemic areas reduced their infection rates over those remaining at home but otherwise managed the same. There is no breed or gender bias in infection with *D. immitis.*

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Canine filariasis due to Dirofilariasis in California: The effects of rain and snowfall on the western facing slopes of the Sierra Nevada mountains on prevalence and distribution within the plant climate zones of Northern California. JH THEIS*, SCHOOL OF MEDICINE, UNIVERSITY OF CALIFORNIA DAVIS, DAVIS, CA 95616 and F. STEVENS, VET SOFT, DAVIS, CA 95616 and PH KASS, SCHOOL OF VETERINARY MEDICINE, UNIVERSITY OF CALIFORNIA DAVIS, DAVIS, CA, 95616.

A total of 75,673 dogs have been examined by the filtration of blood samples followed by acid phosphatase staining for recovery and identification of microfilariae respectively from 1983 through 1996. Prevalence rates were found to decline in the sampled population from 20/1000 in 1983 to a low of 1/1000 in 1995. The decline corresponded to measured flow in four rivers draining the western facing slopes of the Sierra Nevada mountains. The use of prophylaxis also increased during part of this time from 4.5% of the dogs examined in 1983 to 37% of the dogs examined in 1992. Logisitic regression analysis shows a strong relationship between the rise and fall in runoff in million acre feet of water from 4 rivers in Northern California and the rise and fall of heartworm prevalence in dogs over the 14 year study. The use of prophylaxis varied in relation to plant climate zones, gender and age class of the dogs and was not commensurate with risk of infection. In spite of a general declining prevalence over the 14 years the relative geographical distribution of infections did not change. The foothill plant climate zone is the region in California with the greatest risk of infection.

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EVALUATION OF COAT LENGTH, RAINFALL, AND EXPOSURE TO PREVAILING WEATHER CONDITIONS ON THE EFFICACY OF TOPICALLY APPLIED EPRINOMECTIN. EAGLESON, J.S.*[1], GOGOLEWSKI, R.P.[2], PITT, S.R.[3], THOMPSON, D.R.[4], HAIR, J.A.[5], [1]Merck & Co, PO Box 2000, Rahway, NJ 07065, USA, [2]Merck Research Laboratories, Ingleburn Farm, NSW, Australia, [3]Merck Research Laboratories, Highfield Farm, UK, [4]Merck Research Laboratories, Branchburg Farm, NJ 08876, USA, [5]Nu-Era Research Farms, Stillwater, OK 74074, USA

Eprinomectin, a second generation macrocyclic lactone endectocide, has been developed as a topical formulation for use in all cattle (IVOMEC® EPRINEX™ Pour On for Beef and Dairy Cattle). During the development program studies were conducted to examine a range of factors that could potentially influence the absorption of a topically applied formulation. Studies were conducted with cattle exposed to prevailing climatic conditions, in Missouri in winter and in Oklahoma and eastern Australia in summer. In another study, groups of cattle were exposed to simulated rain before and at various times after treatment. Efficacy was also examined in animals carrying thick winter coats. In these studies induced infections of nematodes were administered 28 to 35 days before treatment and the cattle were necropsied for nematode recovery 14 to 16 days after treatment. In addition, efficacy was evaluated in 22 field studies conducted in 8 different countries. The results of the studies confirm that topically applied eprinomectin retains excellent efficacy when used under diverse climatic conditions with no adverse effects on efficacy.

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THE EFFICACY OF AN EPRINOMECTIN POUR ON PRODUCT AGAINST *COOPERIA* SPP AND *NEMATODIRUS HELVETIANUS*. EAGLESON, J.S.*, FARRINGTON, D., CRAMER, L.G. Merck & Co, PO Box 2000, Rahway, NJ 07065, USA

Cooperia spp and *Nematodirus helvetianus* are the dose-limiting endoparasites for the macrocyclic lactone family of endectocides. A topical formulation of the second generation macrocyclic lactone, eprinomectin, has been developed for use in beef and dairy cattle (IVOMEC® EPRINEX™ Pour On for Beef and Dairy Cattle). Thirty seven studies were conducted to confirm the efficacy of this formulation, administered at the selected dose level of 500 mcg/kg, against endoparasites.
Studies with adult nematodes were conducted with both induced and natural infections. For fourth-stage larvae, induced infections were generally used to ensure that the developmental stage present at treatment was correctly defined. Each study included an unmedicated control group and efficacy was calculated based on counts of nematodes recovered at necropsy 2 to 4 weeks after treatment. *Cooperia* species identified included *C. oncophora, C. punctata, C. surnabada* and *C. pectinata*. There was >99% efficacy against adult and larval stages of *N helvetianus* and *Cooperia* spp including hypobiotic larvae of *Cooperia* spp. Eprinomectin-treated animals had significantly (p=0.001) fewer of each species of nematode recovered compared with controls. These studies demonstrate the remarkable efficacy of eprinomectin against endoparasites.

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EFFICACY OF EPRINOMECTIN POUR-ON AGAINST NEMATODE PARASITES OF CATTLE WITH EMPHASIS ON INHIBITED EARLY FOURTH-STAGE LARVAE (IEL_4) OF *OSTERTAGIA* SPP. J.C. WILLIAMS[1], J.A. STUEDEMANN[2], K. BAIRDEN[3], D. KERBOEUF[4], H. CIORDIA[2], J. HUBERT[4], S.D. BROUSSARD[1], [1]DEPT. VET. SCIENCE, LOUISIANA STATE UNIVERSITY, BATON ROUGE, LA, [2] USDA-ARS, WATKINSVILLE, GA, AND GEORGIA AGRIC. EXPT. STATION, EXPERIMENT, GA, [3]UNIVERSITY OF GLASGOW, SCOTLAND, [4]INRA, NOUZILLY, FRANCE.

Eprinomectin (EPR), a member of the avermectin subfamily, was selected for development as a topical endectocide for use in cattle of all ages and classes. Four studies were conducted in different geographic regions to investigate the efficacy of the formulation against naturally acquired nematode infections including inhibited early fourth-stage larvae (IEL_4) of *Ostertagia* spp. Two of the studies were dose titrations in which EPR was evaluated at dosages of 125, 250 and 500 μg/kg; the 2 other studies were dose confirmation trials using 500 μg/kg conducted in Scotland and France. Test calves were ranked by weight in replicates of 4 (titration trials) or 2 (confirmation trials) and within replicates, were randomly allocated to treatment groups. All calves originated from herds confirmed to be carrying natural *Ostertagia* IEL_4 infections. Calves were necropsied for nematode recovery and counting 2-3 weeks after treatment. Adequate numbers of IEL_4 were present in control cattle in all studies and the percentage of inhibition was high, ranging from 68% to 80%. At all 4 locations there was high efficacy (>99%) against *Ostertagia* IEL_4 at the 500 μg/kg dose level. *Ostertagia* and *Cooperia* were the only common genera across all sites. There was also consistently high efficacy (>99-100%) against adult of these genera and against adult *H. placei, T. axei, T. colubriformis, B. phlebotomum, D. viviparus* and adult and L_4 O. radiatum at the 500 μg/kg dose level. There were no adverse reactions to treatment in these studies.

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PERSISTENT EFFICACY OF DORAMECTIN POUR-ON AGAINST ARTIFICIALLY-INDUCED INFECTIONS OF NEMATODES IN CATTLE. G. ZIMMERMAN*, ZIMMERMAN RESEARCH, LIVINGSTON, MT, E. JOHNSON, JOHNSON RESEARCH, PARMA, ID, R. PRICHARD, M. MOLENTO, AND C. TRUDEAU, MCGILL UNIVERSITY, QUEBEC, CANADA, AND S. MARLEY AND G. CONDER, PFIZER CENTRAL RESEARCH, GROTON, CT

Two studies were conducted to evaluate the persistent efficacy of doramectin pour-on at 500 µg/kg (1 mL/10 kg) against artificial infections of *Dictyocaulus viviparus*, *Ostertagia ostertagi*, and *Cooperia punctata*. In each study, 42 calves, treated at least 13 days previously with fenbendazole orally at 10 mg/kg to clear any existing infections, exhibited no trichostrongylid-type eggs on fecal examination and were allocated randomly (Day 0) to one of four groups of ten animals each (T1-T4) or as one of two larval viability monitor animals. Following allocation on Day 0, animals in Groups T1 and T2 were treated topically with saline (1 mL/10 kg) or doramectin, respectively. Groups T3 and T4 were treated with doramectin on Day 7 or 14, respectively. All treatments were applied in a single passage along the midline of the back, from the withers to the tailhead. On Days 14-35, approximately 50, 1,000, and 1,000 respective infective larvae of *D. viviparus*, *O. ostertagi*, and *C. punctata* were given daily by gavage to each animal in Groups T1-T4. On Day 35, the two larval viability monitor animals were given ~2,000 *D. viviparus* and ~30,000 each of *O. ostertagi* and *C. punctata*. Equal numbers of animals from Groups T1-T4 were killed on Days 49-51 as well as the larval viability monitor animals for worm burden determinations. Efficacy was calculated based on percentage reduction in worm burdens of doramectin-treated calves compared to saline-treated animals. Based on geometric means, doramectin pour-on provided persistent protection of ≥91.9% reduction against challenge with *D. viviparus*, *O. ostertagi*, and *C. punctata* for up to 35 days following treatment.

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PERSISTENT EFFICACY OF DORAMECTIN INJECTABLE SOLUTION AGAINST ARTIFICIALLY-INDUCED INFECTIONS OF NEMATODES IN CATTLE. B. STROMBERG* AND B. WOODWARD, UNIVERSITY OF MINNESOTA, ST. PAUL, MN, C. COURTNEY, UNIVERSITY OF FLORIDA, GAINESVILLE, FL, E. JOHNSON, JOHNSON RESEARCH, PARMA, ID, G. ZIMMERMAN, ZIMMERMAN RESEARCH, LIVINGSTON, MT, AND S. MARLEY AND G. CONDER, PFIZER CENTRAL RESEARCH, GROTON, CT

Three studies were conducted to evaluate the persistent efficacy of doramectin injectable solution administered at 200 µg/kg (1 mL/50 kg) against artificial infections of *Dictyocaulus viviparus* and *Cooperia punctata*. In each study, 42 calves, treated at least 13 days previously with fenbendazole orally at 10 mg/kg to clear any existing infections, exhibited no trichostrongylid-type eggs on fecal examination and were randomly assigned (Day -1 or 0) to one of four groups of ten animals each (T1-T4) or as one of two larval viability monitor animals. On Day 0, animals in Groups T1 and T2 were treated with saline (1 mL/50 kg) or doramectin, respectively. Groups T3 and T4 were treated with doramectin on Day 7 or 14, respectively. All treatments were administered subcutaneously in the lateral midline of the neck. On Days 14-28, approximately 50 and 1,000 respective infective larvae of *D. viviparus* and *C. punctata* were given daily by gavage to each animal in Groups T1-T4. On Day 28, the two larval viability monitor animals were given ~ 2,000 *D. viviparus* and ~ 30,000 *C. punctata*. Equal numbers of animals from Groups T1-T4 were killed on days 42-45, as well as the two larval viability monitor animals for worm burden determinations. Efficacy was calculated based on percentage reduction in worm burdens of doramectin-treated calves compared to saline-treated animals. Based on geometric means doramectin injectable solution provided persistent protection of ≥98.0% reduction against challenge with *D. viviparus* for up to 28 days following treatment and ≥99.7% reduction against challenge with *C. punctata* for up to 21 days posttreatment.

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COMPARISON OF EFFICACY OF DORAMECTIN INJECTABLE WITH IVERMECTIN/CLORSULON INJECTABLE IN CATTLE NATURALLY INFECTED WITH GASTROINTESTINAL NEMATODE AND TREMATODE INFECTIONS. J.C. WILLIAMS[a], A.F. LOYACANO[b], A. DEROSA[a], J. GURIE[b] AND T.L. SKOGERBOE[c]. [a]DEPT. VETERINARY SCIENCE, BATON ROUGE, LA 70803, [b]DEAN LEE RESEARCH STATION, ALEXANDRIA, LA 71302, LOUISIANA AGRICULTURAL EXPT. STATION, [c]PFIZER, INC., LEE'S SUMMIT, MO. 64081.

Three groups of 20 crossbred beef steer calves (4 pasture replicates of 5 calves per group) were used to compare efficacy of doramectin (DOR) injectable and ivermectin/clorsulon (PLUS) injectable against naturally acquired gastrointestinal nematode and *Fasciola hepatica* infections. The experiment was begun on 20 Dec 95. Treatments administered on day 0 were: Group 1, non-medicated controls (CONT); Group 2, DOR at 200 µg/kg, SC inj.; Group 3, PLUS at 200 µg/kg ivermectin/0.2 mg/kg clorsulon, SC inj. The cattle were weighed and fecal samples were collected at regular intervals throughout the 140 day experiment (for egg counts and culture-larval identification). Geometric mean nematode egg counts of CONT averaged about 250 from day 0 to 56 and subsequently decreased to an average of about 43 between day 56 and 140. Nematode egg counts of both treated groups were lower ($P<0.05$) than CONT for days 14 to 49, but DOR counts were lower ($P<0.05$) than PLUS counts for days 14 to 56. Differences were not significant between any groups from day 84 to 140. *Ostertagia* was predominant, followed by *Cooperia* in all groups. *Haemonchus, Trichostrongylus, Oesophagostomum* and *Bunostomum* were also present. Prevalence of positive fluke egg counts increased from day 84 to 140; there were no differences ($P<0.05$) between groups at any time. Both treated groups had higher ($P<0.05$) bodyweight gains and avg. daily gains than CONT, but both values (111 and 0.79 kg) for DOR were higher ($P<0.05$) than corresponding values for PLUS (99 and 0.71 kg). Cumulative treatment least square means for bodyweights were not different ($P<0.05$) between treatment groups until the end of the experiment.

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CHARACTERIZATION OF TURKEY ASCARIDIASIS AND THE EFFICACY OF FENBENDAZOLE MEDICATED FEED IN THE TREATMENT OF NEMATODE PARASITISMS OF THE TURKEY. T.A. YAZWINSKI* AND C.A. TUCKER. DEPARTMENT OF ANIMAL SCIENCES, UNIVERSITY OF ARKANSAS, FAYETTEVILLE, ARKANSAS, 72701.

Ascaridia dissimilis has established as the only nematode parasite of significant proportion in commercial turkeys. After conducting numerous nematode quantifications on turkey intestines as submitted from Minnesota, California, North Carolina, Missouri and Arkansas, it is evident that indeed turkey nematodosis is due solely to *Ascaridia dissimilis*, and that the parasite population is predominantly larval. Contrastingly, chickens harbor infections by *A galli*, *H gallinarum*, *C obsignata* and *R cesticillus*; helminths which are for the most part production (age) specific. Helminthiasis is common in chickens and turkeys, existing at non-clinical but economic levels. This, coupled with the fact that no wide-spectrum, safe and effective anthelmintic is currently available for poultry producers without a prescription, forms the basis for our continued work in evaluating prospective poultry anthelmintics. The current titration study was conducted to determine the effective dosage of fenbendazole as administered in the feed, against artificial infections by *A dissimilis* and *H gallinarum* in commercial-type turkeys. When fenbendazole was included in the ration at 8-24 PPM, 100% removal of adult *H gallinarum* and $\geq$ 99.4% removal of adult *A dissimilis* was effected. At dietary levels of 8, 16 and 24 PPM, fenbendazole was correspondingly 81.9, 98.8 and 99.4% effective in the removal of larval *A dissimilis* and 29.3, 58.9 and 66.2% effective, respectively, in the removal of *H gallinarum* larvae. All fenbendazole rations were readily consumed and no adverse reactions were noted in this study.

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FIELD EFFICACY OF DORAMECTIN POUR-ON AGAINST NATURALLY-ACQUIRED NEMATODE INFECTIONS OF CATTLE. G. CONDER*, K. ROONEY, E. ILLYES, D. KELLER, T. MEINERT, N. LOGAN. PFIZER CENTRAL RESEARCH, GROTON, CT.

Seven studies were conducted under field conditions throughout North America to confirm the efficacy of doramectin pour-on at 500 µg/kg, against naturally-acquired gastrointestinal-nematode infections of cattle. Animals with positive fecal egg counts were selected from grazing or feedlot herds. In each study, between 40 and 100 cattle were selected and randomly allocated to either a saline- or doramectin-treated group based on bodyweight. On Day 0, cattle received saline (1 mL/10 kg) or doramectin (500 µg/kg) topically. Fecal egg counts were carried out on samples collected from each animal at the time of treatment and at weekly intervals thereafter for three weeks. In each study, fecal samples collected on each pretreatment sampling occasion were pooled and coproculture conducted. Fecal egg count analysis was limited to trichostrongylid-type species (excluding *Nematodirus* spp.). The geometric mean fecal egg counts of animals in the saline- and doramectin-treated groups prior to treatment on Day 0 across all studies were 258 and 279, respectively. By 21 days after treatment, the geometric mean fecal egg count for doramectin-treated animals was <1 compared with 128 for saline-treated cattle, a reduction across all studies compared to saline controls of 99.7% and compared to pretreatment levels in doramectin-treated cattle of 99.9%. Nematode genera identified from pretreatment coprocultures included *Haemonchus, Ostertagia, Trichostrongylus, Bunostomum, Cooperia,* and *Oesophagostomum.* A single topical application of doramectin pour-on was highly efficacious against the genera of nematodes present in these studies.

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THERAPEUTIC EFFICACY OF DORAMECTIN POUR-ON AGAINST EYEWORMS, LUNGWORMS, AND GASTROINTESTINAL NEMATODES. S. MARLEY*, E. ILLYES, D. KELLER, T. MEINERT, N. LOGAN, AND G. CONDER, PFIZER CENTRAL RESEARCH, GROTON, CT, AND M. HENDRICKX, PFIZER CENTRAL RESEARCH, SANDWICH, UK

Twenty studies were conducted in North America to evaluate the efficacy of doramectin pour-on against eyeworms, lungworms, and gastrointestinal nematodes. Both natural and artificial infections were used. In all studies, animals were randomly allocated to either a saline-treated (1 mL/10 kg)/nonmedicated (no treatment) group or a doramectin-treated (500 µg/kg) group (n=10/group). Treatments were applied in a single passage along the midline of the back, from the withers to the tailhead. Animals were killed humanely at least 14 days posttreatment and appropriate organs were removed and processed for worm burden determinations by standard techniques. Geometric mean worm burdens were calculated from the log (worm burdens +1) and were used to estimate percentage reduction for doramectin-treated groups compared to their respective control group. The overall efficacy of doramectin was ≥95.3% against adults of *Thelazia gulosa*, *Thelazia skrjabini*, *Dictyocaulus viviparus*, *Haemonchus contortus*, *Haemonchus placei*, *Ostertagia lyrata*, *Ostertagia ostertagi*, *Trichostrongylus axei*, *Bunostomum phlebotomum*, *Capillaria* spp., *Cooperia oncophora*, *Cooperia pectinata*, *Cooperia punctata*, *Cooperia spatulata*, *Cooperia surnabada*, *Nematodirus spathiger*, *Strongyloides papillosus*, *Trichostrongylus colubriformis*, *Oesophagostomum radiatum*, and *Trichuris* spp. Overall efficacy was ≥95.1% against L_4 of *D. viviparus*, *H. placei*, *O. lyrata*, *O. ostertagi*, *T. axei*, *C. oncophora*, *C. punctata*, *C. spatulata*, *C. surnabada*, *N. helvetianus*, *T. colubriformis*, *O. radiatum*, and *Trichuris* spp. In addition, efficacy against inhibited L_4 of *O. ostertagi* and *Ostertagia* spp. was ≥98.1%. A single topical application of doramectin pour-on was highly efficacious against a broad range of nematode species.

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VERIFICATION OF (R) DRENCHRITE(For Use in North America)BY COMPARISON WITH FERT(Fecal Egg Reduction Tests)

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Anthelmintic resistance is a major problem among gastrointestinal nematodes in both the southern United States and Australia. The DrenchRite assay evaluates four different anthelmintics or combinations in one test. This test lets the producer know which genera of resistant worms are present and to which drug or drugs. Assessing larval growth to the infective stage, DrenchRite was compared to FERT from two sheep and two goat flocks. Three methods were used to evaluate the FERT(AAVP, Dash, and the Bjorn). The percentage reductions were designated as susceptible(>95%), moderately resistant(94-80%), or resistant(50-79%). These categories were similar to that used in the DrenchRite test.

FLOCKS		FERT			(R) DRENCHRITE	
	IVERMECTIN	FENBENDAZOLE	LEVAMISOLE	IVERMECTIN	FENBENDAZOLE	LEVAMISOLE
Sheep 1	Variable*	Variable*	Resistant	Susceptible	Susceptible	Resistant
Sheep 2	Not Tested	Not Tested	Not Tested	Susceptible	Susceptible	Susceptible
Goat 1	Resistant	Resistant	Resistant	Susceptible	Susceptible	Moderate R.
Goat 2	Variable*	Resistant	Variable*	Susceptible	Susceptible	Resistant

*=Analysis Varied With Method of Evaluation

The preliminary results indicate the four methods were not in agreement, as shown by using BMDP Statistical Software, Inc., Version 7 with KAPPA(measure of agreement). DrenchRite results displayed more susceptibility that the FERT. One possible explanation for the susceptibility was that fungal growth was a problem in the DrenchRite plate so the larvae may have died from fungus rather than anthelmintic.

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MULTIPLE ANTHELMINTIC RESISTANCE IN A VIRGINIA GOAT HERD. AM Zajac[1] *, TA Gipson[2] and JC Lovin[2]. Virginia-Maryland Regional College of Veterinary Medicine, Virginia Tech, Blacksburg VA 24061[1] and Agricultural Research Station, Virginia State University, Petersburg VA 23806[2].

Persistent morbidity and mortality associated with *Haemonchus contortus* infection was observed in a university goat herd despite frequent treatment with levamisole. To determine whether parasites resistant to levamisole and other anthelmintics might be present in this herd, several Fecal Egg Count Reduction Tests were performed using a Modified McMaster's procedure. Levamisole (11.8 mg/kg) efficacy was tested twice, once in 1995 and again in 1996 with an interval between collection of pre and post treatment samples of 10 and 7 days respectively. The reduction in fecal trichostrongylid egg counts in the 2 tests was -4% and 79% These results suggest that resistance to levamisole is present in this herd, although the interval used between sample collection in the trials may have produced an underestimate of levamisole efficacy. Ivermectin (0.3 mg/kg) was also tested in 2 FECRT tests using different groups of goats. Egg count reductions of 54% and 85% were found. The efficacy of a single dose of fenbendazole (10 mg/kg) was tested and produced a reduction of 59%. When fenbendazole was administered twice with a 12 hour interval between treatments the reduction in trichostrongylid egg counts was 96%. These results indicate that significant resistance to all the major groups of anthelmintics is present in this herd. Frequent anthelmintic treatment of heavily stocked goats is necessary in the southeastern US to prevent serious losses from internal parasites, especially *Haemonchus contortus.* Many goats in this herd had been recently assembled from various locations in the US and may have introduced additional drug resistant parasites.

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The use of tracer lambs to evaluate the transmission and survival of gastrointestinal parasites of exotic ruminants

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Helminth free tracer lambs were released in pastures for 4 to 8 week periods on two ranches in south central Texas. The pastures were grazed by exotic ruminants, and occasionally by cattle or white-tailed deer. Prior to the onset of the trial necropsies were done on one gemsbok and one addax on one of the ranches. Fecal samples from various species were collected, nematode eggs allowed to hatch and develop to the infective stage. Larvae were administered to parasite free lambs and kids which were necropsied to determine the species of parasites present that would establish in the domestics. Transmission patterns of gastrointestinal parasites were similar to those in domesticated animals in the same geographic region. On one ranch Haemonchus contortus was the predominant parasite transmitted through the warm seasons (April-November) minor species Camelostrongylus mentulatus, Cooperia punctata and Trichostrongylus spp. were transmitted during the cool season (October-April). On the other ranch only two species C. mentulatus and T. colubriformis were encountered in any abundance. Severe drought almost completely interrupted parasite transmission. Arrested larval development appears to be the most important survival mechanism for parasitic nematodes in these arid areas.

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COMPOSITION OF PARASITE BURDEN IN BISON GRAZING THE KONZA PRAIRIE. R.K. RIDLEY*, D. POST, M.O'DONNELL, A. BENORDEN, M. WALBURGER, AND P. PAYNE. KANSAS STATE UNIVERSITY, MANHATTAN, KS 66506-5603.

A closed bison herd grazing 2,150 acres of the Konza prairie in Riley Co., Kansas is being monitored for parasitism. These animals are not vaccinated or administered anthelmintics. Starting in April, 1996 and continuing through March, 1997, pasture samples were, or will be, obtained from individual animals for quantitative egg counts and identification of L_3 larvae after recovery by the Baermann technique. Mean "Strongyle" egg counts (EPG) for all animals (e.g., Bull, Cows, "Juveniles", and Calves) sampled to date were highest in October (173) and lowest in January (35). Mean EPGs for calves born in the spring of 1995 were also highest in October (303) and lowest in January (37). *Moniezia* sp., and *Eimeria* sp. were also recovered from fecal floats. *Trichostrongylus* sp., *Ostertagia* sp., *Haemonchus* sp., *Cooperia oncophora*, *Cooperia* sp., and *Oesophagostomum* sp. were recovered from Baermann cultures. In April, May, July, and October of 1996 *Cooperia oncophora* was the predominant species recovered from calves born in 1995. *Trichostrongylus* sp. was the predominant genus recovered in June, August, and September. No *Ostertagia* sp. were recovered from any of the animals (Bulls, Cows, Calves or "Juveniles") in June and July.

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DYNAMICS OF *FOSSARIA CUBENSIS* POPULATIONS IN FLORIDA: RELATIONSHIP TO THE EPIDEMIOLOGY AND CONTROL OF BOVINE FASCIOLIASIS. R.M. KAPLAN*[1,4], C.H. COURTNEY[1], F.G. THOMPSON[2] & P.O. MILLER[3]. UNIVERSITY OF FLORIDA, [1]COLLEGE OF VETERINARY MEDICINE, [2]MUSEUM OF NATURAL HISTORY, [3]COOPERATIVE EXTENSION SERVICE, GAINESVILLE, FL 32611. [4]PRESENT ADDRESS: WALTER REED ARMY INSTITUTE OF RESEARCH, WASHINGTON, DC 20307.

Fascioliasis is one of the most important diseases of cattle in Florida. Previous recommendations for control of fascioliasis in cattle were based on data only from temperate northern Florida. It is quite possible that seasonal transmission of *Fasciola hepatica* may be different in subtropical southern Florida where more than 66% of beef cows are pastured. In this project, the epidemiology of *F. hepatica* in northern, central and southern Florida was determined over 2 years by studying the bionomics of *Fossaria cubensis* populations on 7 cattle ranches. Additionally, snail infection prevalence was determined during year-2 of this study using a DNA probe assay. Results of this study demonstrate seasonal transmission of *F. hepatica* is virtually the same for all of Florida with transmission occurring predominantly in the winter and spring. Climatic differences between northern and southern Florida appear to have a minimal effect on the epidemiology of *F. hepatica* because these differences occur during the time of year when snail populations are greatest in both regions (November to April). Important levels of summer transmission will seldom occur in Florida. Although snail habitats remain wet throughout summers in most years, ecological conditions in and around *Fossaria* habitats rarely support significant snail populations.

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PATHOPHYSIOLOGY OF HYPERSENSITIVITY REACTIONS ASSOCIATED WITH GIARDIASIS

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Giardiasis has been associated with allergic disease suggesting an alteration in mucosal immune function. **Aim:** To determine the pathogenic mechanism of hypersensitivity reactions associated with giardiasis. **Methods:** Jejunal *in vivo* and *in vitro* macromolecular transport, epithelial permeability and mast cell counts (mucosal and cutaneous) were examined in *Giardia* infected and control Mongolian gerbils 6 and 21 days after experimental challenge. **Results:** Both *in vivo* (I 134 $\pm$ 19 vs C 85 $\pm$ 14 ηg/ h) and *in vitro* (I 125 $\pm$ 17 vs C 67 $\pm$ 8 ηg/h/cm) macromolecular uptake was significantly increased in infected tissue 6 days post-challenge. Macromolecular uptake did not differ between groups at 21 days. Infection had no effect on mucosal permeability of ^{51}Cr-EDTA. Mucosal mast cell counts did not differ at 6 days but were significantly elevated in infected tissue at 21 days (I 33.3 $\pm$ 6.8 vs C 2.7 $\pm$ 0.4 per field) as were connective tissue mast cells counts (I 1.7 $\pm$ 0.4 vs 1.0 $\pm$ 0.1 per field). **Conclusion:** Antigen uptake is increased during *Giardia* infections leading to a recruitment of mucosal and connective tissue mast cells. Giardiasis may be a significant contributing variable in gastrointestinal and dermatologic disease associated with food allergy.

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Pathophysiology of Giardiasis in Dairy Calves

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We recently demonstrated that fenbendazole is very effective in eliminating *Giardia* trophozoites from the small intestine of dairy calves. **Aim:** To determine the effect of fenbendazole on *Giardia* trophozoites *in vivo*, and to examine the pathophysiology of giardiasis in dairy calves. **Methods:** Twelve naturally infected Holstein dairy calves were treated with an oral administration of fenbendazole (1X 5mg/kg for 3 days) or a saline solution. Calves were sacrificed at day 7 post-treatment and intestinal samples were collected from the duodenum, proximal jejunum, mid jejunum, distal jejunum, and ileum. Samples were examined for the presence of trophozoites and for morphometric differences of the villi and microvilli. Mucosal disaccharidases from each sample were also assayed. **Results:** Trophozoites could not be detected in fenbendazole treated calves. Large numbers of trophozoites were identified in every intestinal segment of all saline treated calves. Differences in morphology and disaccharidase between the two groups were also observed. **Conclusion:** Fenbendazole is an effective treatment for eliminating *Giardia* trophozoites in dairy calves. Also, *Giardia* infection in dairy calves leads to pathological changes and alterations in enzyme activity in the small intestine.

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Longitudinal Study of *Giardia* and *Cryptosporidium* in Dairy Calves

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Aim: To determine the course of naturally occurring *Giardia* and *Cryptosporidium* infections in dairy calves, and to evaluate the immune response elicited by dairy calves infected with *Giardia*. **Methods:** Holstein dairy calves were examined for the presence of *Giardia* and *Cryptosporidium* from their time of birth for 16 weeks. Serum was collected monthly to determine the immune status of each calf. Clinical signs of disease (diarrhea, inappetence, lethargy) were recorded. **Results:** Continuous excretion of *Giardia* cysts was observed in all calves once infected with the parasite. *Cryptosporidium* oocysts were shed at high levels initially and declined until almost nonexistent at 15 days post-infection. Clinical signs of disease correlated with *Cryptosporidium* oocyst excretion within calves' first 3 weeks of age, while diarrhea occurred later in animals excreting *Giardia* cysts. Poor systemic immunity to *Giardia* was observed in the dairy calves. **Conclusion:** Naturally occurring *Giardia* infections persist for months in dairy calves, resulting in diarrhea. The inability for calves to clear the infection may have important economic and environmental consequences.

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GIARDIA AND CRYPTOSPORIDIUM IN BRITISH COLUMBIA DAIRY CALVES

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Aim: To determine the significance and prevalence of *Giardia* and *Cryptosporidium* infections in British Columbia dairy calves. **Methods:** Fresh fecal samples were collected from 386 male and female Holstein calves (newborn to 24 wk of age) in 20 dairies located in the lower Fraser valley area of British Columbia. *Giardia intestinalis*, *Cryptosporidium parvum* and *Cryptosporidium muris* were enumerated in each sample after concentration by sucrose gradient centrifugation and immunofluorescent staining. **Results:** *Giardia* was identified at all farm locations. The overall prevalence of *Giardia* in calves was 73% with a geometric mean cyst count of 1180 cysts per gram of feces. *C. parvum* and *C. muris* were identified in 80% and 45% of the farms, respectively. The prevalence of *C. parvum* was 59% and the geometric mean oocyst count was 457 oocysts per gram of feces while the prevalence of *C. muris* was only 2% and the mean oocysts counts were 54 oocyst/g. Giardiasis was not age dependant and approximately 80% of the calves were infected from 2 to 24 weeks of age. In contrast, *C. parvum* infections were predominant in calves 2 to 4 weeks of age while *C. muris* was demonstrated in calves older than 4 weeks of age. Forty seven percent of calves with diarrhea had high numbers of *Giardia* cysts in their feces. **Conclusion:** *Giardia* infections are highly prevalent in dairy calves and should be considered in animals with diarrhea or failure to thrive.

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GIARDIA AND *CRYPTOSPORIDIUM* IN FEEDLOT CATTLE

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We have previously shown that both *Giardia* and *Cryptosporidium* are important gastrointestinal parasites in young calves, but their significance in older feedlot cattle has yet to be determined. **Aim:** To determine the prevalence of *Giardia*, *C. parvum* and *C. muris* in beef feedlot cattle and their significance on performance. **Methods:** Sixty Charolais steers (200-250 kg) were individually penned in a commercial feedlot. Fecal nematode eggs, *Giardia* cysts, *C. parvum* oocysts and *C. muris* oocysts were enumerated. Body weight gain, feed intake and feed efficiency were determined. **Results:** Approximately 40% of calves were passing *Giardia* cysts at each sampling time while 30 and 5% of the calves were excreting *C. muris* and *C. parvum* respectively. Throughout the study, three steers were excreting large numbers of *C. parvum* oocysts (approximately 10^5 oocysts/g). These same animals had reduced weight gain. Performance data on all animals will be presented. **Conclusion:** Feedlot cattle are chronically infected with *Giardia* and occasionally *C. parvum* and *C. muris*. These infections may have an effect on animal performance in addition to a source of environmental contamination.

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IMMUNE RESPONSE IN LAMBS EXPERIMENTALLY INFECTED WITH *GIARDIA*

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Chronic *Giardia* infections are common in domestic ruminants suggesting that they are unable to mount sufficient immunity to eliminate this protozoan parasite. **Aim:** To measure the systemic immunity in sheep experimental infected with *Giardia.* **Methods:** Six-week-old SPF lambs were experimentally challenged with either *Giardia* trophozoites (n=23) or saline (n=24). Clinical signs, performance parameters and fecal cyst excretion were monitored weekly for 10 weeks. Serum was also collected weekly. *Giardia* specific IgG, IgM and IgA were determined on the serum samples by ELISA. Western blots were performed on the weekly serum samples using proteins from the challenge strain in addition to other *Giardia* isolates. **Results:** *Giardia* infection persisted in challenged animals until they were slaughtered (10 weeks) while control animals remained uninfected. Giardiasis produced diarrhea, reduced growth rate and impaired feed efficiency throughout the study. *Giardia*-specific IgG, IgM and IgA were recognized by Western blot analysis but antibody titers were very low. Titers in most infected animals did not significantly differ from controls. **Conclusion:** Lambs develop chronic giardiasis with clinical disease and impaired performance. Weak systemic immunity is observed in lambs with experimental *Giardia* infections.

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Local ileal immune responses in cattle during a primary infection with Cryptosporidium parvum
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Cryptosporidium parvum is a coccidial protozoan which infects intestinal epithelial cells in a broad variety of vertebrate hosts. The organism is recognized as a common cause of intestinal illness that can become chronic and severe in immuno-compromised hosts. Although several studies have documented the cellular and humoral immune responses in rodents, little information is available on the immune response of cattle during cryptosporidiosis. In the present study we investigated changes in expression of cell surface markers and cytokine mRNA in the ileo-cecal lymph nodes (LN), lamina propria (LPL) and intra-epithelial (IEL) lymphocytes of neonatal calves 7 days after a primary infection with C.parvum. Flow cytometric analysis of these populations showed very few mature cells in the mucosa but normal patterns in LN. After infection, significant increases were seen in the percentages of $CD3^+$,$CD8^+$ and $IL2R^+$ cells only in IEL and LPL . Local cytokine responses were analyzed by competitive reverse transcriptase-polymerase chain reaction. Increases in the levels of IFN-γ and IL12 (p40) mRNA were seen in LPL and IEL populations. No consistent differences were seen when mRNA was analyzed for IL10, and levels of mRNA for IL2 and IL4 in these three populations were very low and variable. In addition an increase in the levels of mRNA of the newly identified growth factor IL15 was observed in LPL.

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CLONING AND EXPRESSION OF BOVINE INTERLEUKIN-15: ANALYSIS AND MODULATION OF TRANSCRIPTION IN PARASITE INFECTED ANIMALS. A.C. CANALS, L.C. GASBARRE, R. FAYER, P. PASQUALI, P. C. BOYD, S. ALMERIA and D.S. ZARLENGA*. USDA, ARS, LPSI, IMMUNOLOGY AND DISEASE RESISTANCE LAB, BELTSVILLE, MD 20705 USA.

The bovine interleukin-15 (IL-15) sequence was cloned from abomasal lymph node mRNA by enzymatic amplification of cDNA using human primers. The open reading frame is 486 base pairs in length and the proposed protein sequence shows 78.4%, 73.5% and 84.6% similarity with that predicted for the human, mouse and swine sequences, respectively. Expressed and purified recombinant bovine IL-15 in the absence of the 48-amino acid leader sequence successfully stimulated the proliferation of bovine lymphoblast cells at all concentration levels tested. Competitive RT-PCR analysis using a truncated IL-15 gene sequence as an internal standard showed constitutive levels of IL-15 mRNA within a broad range of tissues and cell types. Lipopolysaccharide addition to adherent lymph node populations caused moderate increases in IL-15 transcription while the addition of phorbol 12-myristate 13-acetate and calcium ionophore failed to induce gene expression for this cytokine. Transcription of IL-15 was down-regulated in-vitro in the presence of low concentrations of human recombinant interleukin-2. When IL-15 transcription was analyzed in mucosal and regional lymph node populations from bovine infected with *Ostertagia ostertagi* or *Cryptosporidium parvum,* no discernable changes in mRNA levels were detected in *O. ostertagi* infected animals; however, an apparent reduction in IL-15 transcription was observed in intraepithelial lymphocytes from animals 7 days after a *C. parvum* infection. This reduction corresponded with an increase in the numbers of CD4+ and CD8+ cell populations.

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INTEGRATED TICK CONTROL : NEW CONCEPT FOR BREAKING THE LIFE CYCLE (1)

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In some locations, flea and tick control may be carried out simultaneously. Alike fleas, *Rhipicephalus sanguineus* ticks [Rs] are able to complete their life cycle in or close to human households. Therefore, concepts for flea control deserves to be checked for ticks, with the aims to kill ticks before they initiate reproduction (1) and to prevent viable reproduction (2). 30 short haired dogs were splitted into 3 groups of 10 : a no treatment group [CTL], a 0.02% pyriproxyfen + 2% permethrin spray group [DUO] (Duowin ®, Virbac ®, 5 ml/kg) and a 0.25% fipronil spray group [FRL] (Frontline ®, Rhône Mérieux ®, 3 ml/kg). Each dog was infested weekly with 25 females and 10 males Rs from day 7 to 77 post-treatment, ticks being counted and removed 7 days later. As the size of the blood meal determines the weight of ticks and egg clusters, thus their ability to reproduce, the engorged females collected at each count were weighed and maintained for oviposition. Their number remained low in the treated groups compared to CTL. Yet, the residual efficacy was more prolonged in DUO than in FRL. In DUO, tick and egg cluster weights were lower than in the other two groups but on the last count, showing a strong effect on feeding behaviour of ticks and allowing to predict a drop in their reproduction capability.

group	day post-treatment										
	14	21	28	35	42	49	56	63	70	77	84
mean number of engorged ticks/dog											
DUO	0	0	0.1	0.2	0.2	0.1	0.1	0.3	1.4	1.5	1.9
FRL	0.2	0.1	0.2	0.4	0.4	0.2	0.8	5.6	8.4	10.9	12.8
CTL	19.0	18.0	18.4	18.5	19.2	20.3	18.8	18.6	19.2	19.2	18.9
mean weight of engorged ticks (mg)											
DUO	*	*	125	105	81	115	125	106	131	178	218
FRL	234	261	221	246	216	230	260	268	268	278	285
CTL	269	282	289	278	282	270	279	270	281	289	269
mean weight of egg clusters (mg)											
DUO	*	*	45	12	6	58	65	25	53	74	119
FRL	116	112	112	120	101	105	119	145	155	149	132
CTL	152	150	154	155	150	142	148	150	157	138	135

* no alive engorged ticks present on dogs

NB : many significant differences by Anova, Kruskal Wallis ($p \leq 0.05$)

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INTEGRATED TICK CONTROL : NEW CONCEPT FOR BREAKING THE LIFE CYCLE (2)

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The size of the blood meal determines the weight of the engorged female ticks and their egg clusters, therefore interferes with their ability to reproduce. A first report (1) has shown that the combination of an IGR, pyriproxyfen, and an adulticidal, permethrin, was able to kill most of the pests before they initiate reproduction and that surviving ticks had a low weight and oviposit small egg clusters if any. 100 eggs per tick collected from the dogs of 3 groups of 10 - a no treatment group [CTL], a 0.02% pyriproxyfen + 2% permethrin spray group [DUO] (Duowin ®, Virbac ®) and a 0.25% fipronil spray group [FRL] (Frontline ®, Rhône Mérieux ®) - were incubated at 90% RH and 30°C. Hatched eggs and alive larvae 10 days later were counted. One month after eclosion, the larvae were put on albino rabbits and those feeding were counted. Egg hatch was nil in DUO group until day 77 while present in the other groups. Larvae survival and feeding was related to egg hatch. Although some adults Rs survived despite the treatments or/and at the end of the prolonged residual effect of the treatments, the life cycle was broken by the action of the combined use of compounds with different modes of action, adulticidal insecticide and ovicidal-larvicidal IGR. Therefore the second step of a new integrated tick control in pets was reached with DUO, the prevention of viable reproduction being established.

group	day post-treatment										
	14	21	28	35	42	49	56	63	70	77	84
mean number of hatched eggs/tick											
DUO	*	*	0	0	0	0	0	0	0	30.1	73.4
FRL	97.0	100	94.0	94.7	94.7	97.0	94.6	97.1	98.7	98.8	96.2
CTL	99.5	98.7	98.4	99.2	98.6	98.5	99.4	98.4	97.9	95.5	94.5
mean number of surviving larvae / 100 eggs											
DUO	*	*	**	**	**	**	**	**	**	29.3	70.0
FRL	93.5	100	91.5	92.5	93.7	95.0	93.3	95.8	98.0	97.4	92.8
CTL	98.3	97.9	98.2	97.7	98.3	97.6	99.1	97.5	96.9	93.7	92.8
mean number of feeding larvae / 100 eggs											
DUO	*	*	**	**	**	**	**	**	**	27.8	67.2
FRL	90.0	96	90.0	91.5	92.7	94.0	91.7	93.6	96.3	95.1	87.4
CTL	97.1	96.6	96.8	96.2	96.9	96.2	97.8	95.9	95.4	89.1	87.8

* no alive engorged ticks present on dogs ** no egg hatch

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EFFICACY OF TWO IXODICIDE COLLARS AGAINST NATURAL INFESTATION WITH THE BROWN DOG TICK - *Augustin ESTRADA-PEÑA[(a)] and Frédéric ASCHER [(b)]*

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Laboratory grown *Rhipicephalus sanguineus* [Rs] ticks were used to assess the killing, antifixing and antifeeding effects of a 9% amitraz collar [AMZ] (Preventic ®, Virbac ®) and a 10% propoxur + 2.25% flumethrin collar [PRO] (Kiltix ®, Bayer ®) as reported previously. Efficacy of the collars was also checked on pets being exposed to natural infestation by allowing dogs to freely walk around a closed periurban area highly infested with Rs. 30 adult Beagle dogs were splitted into 3 groups of 10 according to treatment (AMZ, PRO or placebo collar = [CTL]). Collars were fitted on D0. Dogs were infested on D-3 and weekly after treatment. Counts and removal of ticks were done 3 days after treatment and reinfestations (table 1). Because of the Rs life cycle and climatic conditions, after the D70 infestation, adult ticks become scarce while many nymphs were seen. Adult counts were replaced by counts of Rs nymphs inside a 1 cm² area of the neck (table 2). The results confirmed the high efficacy of the 9% amitraz collar already observed with laboratory reared ticks, allowing a long lasting protection in natural conditions compared with PRO and CTL collars.

table 1	group	day post-treatment						
		3	10	17	31	45	59	73
alive engorging female ticks (mean number)	AMZ	0^a	0^a	0.1^a	0.2^a	0.1^a	0.2^a	0^a
	PRO	0.5^a	1.2^a	2.9^b	4.2^b	2.4^b	4^b	4.5^b
	CTL	10^b	9.4^b	6.5^c	6.1^c	6.9^c	7.6^c	6^c

ab, ac, bc = significant difference ($p < 0.05$) (ANOVA, Duncan's or Tukey HSD tests)

table 2		73	87	101
nymphs (mean number)	AMZ	1.2^a	1.3^a	1.1^a
	PRO	6.4^b	6.4^b	7.2^b
	CTL	8.1^b	7.6^b	8.1^b

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ANTIFIXING + ANTIFEEDING EFFECT OF TWO IXODICIDE COLLARS AGAINST THE BROWN DOG TICK - *Augustin ESTRADA-PEÑA[(a)] and Frédéric ASCHER [(b)]*

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The effect on feeding behavior of *Rhipicephalus sanguineus* ticks of a 9% amitraz collar [AMZ] (Preventic ®, Virbac ®) and a 10% propoxur + 2.25% flumethrin collar [PRO] (Kiltix ®, Bayer ®) was assessed on 3 groups of 12 dogs (cross-over design). Each dog was fitted with one collar according to treatment group (AMZ, PRO or placebo collar = [CLT]) and infested with 100 female and 25 male ticks, 3 times, repectively 7, 8 and 10 days post treatment. Ticks were counted and removed 24, 48 and 72 hours post infestation and reinfestations. The amount of blood ingested was estimated by a colorimetric assay based on ticks remaining on dogs after the 2nd and 3rd infestations. The number of feeding ticks was lower in the AMZ group after every infestation (table 1). The amount of ingested blood was nil, similar to unfed laboratory reared ticks [LAB], compared to CTL group ticks, showing that the feeding behavior of ticks was strongly inhibited on dogs fitted with an AMZ collar (table 2). This confirmed previous data reported about oviposition and hatchability in similar conditions.

table 1	group	time post infestation (hour)		
		24	48	72
alive engorging female ticks (mean number)	AMZ	0.1^a	0.1^a	0^a
	PRO	12.9^b	11.2^b	12.5^b
	CTL	41.5^c	43.6^c	38^c

ab, ac, bc = significant difference ($p < 0.05$) (ANOVA, Duncan's test)

table 2		group			
		AMZ	PRO	CTL	LAB
amount of blood (mg of iron) ingested during...	48 hours	0.006	0.022	0.198	0.005
	72 hours	0.009	0.034	0.224	0.004

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KILLING EFFECT OF TWO IXODICIDE COLLARS AGAINST THE BROWN DOG TICK - *Augustin ESTRADA-PEÑA[a] and Frédéric ASCHER [b]*

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The ixodicidal effect of a 9% amitraz collar [AMZ] (Preventic ®, Virbac ®) and a 10% propoxur + 2.25% flumethrin collar [PRO] (Kiltix ®, Bayer ®) was assessed on 24 dogs splitted into 3 groups of 8. Each dog was infested with 100 female and 25 male *Rhipicephalus sanguineus* ticks reared in laboratory conditions. One collar was fitted one day later around the neck of each dog according to the treatment groups (AMZ, PRO or placebo collar = [CTL]). Ticks were counted every day for 5 days. The remaining ticks were removed after the last count and allowed to oviposit and eggs to hatch. As soon as 24 hours after a high infestation, AMZ efficacy (% of reduction of infestation) against female alive and engorging ticks was 87.8%, reaching 93% 5 days post treatment (table 1). In AMZ surviving female ticks, oviposition was very low (some ticks did not oviposit) and hatchability reduced to 9% of the eggs (table 2).

table 1	group	day post treatment				
		1	2	3	4	5
alive engorging female ticks (mean number)	AMZ	8.4^a	8.6^a	6.9^a	6.0^a	4.8^a
	PRO	18.7^b	24.4^b	25.8^b	21.4^b	17.6^b
	CTL	68.7^c	69.3^c	69.3^c	68.9^c	67.3^c

ab, ac, bc = significant difference ($p < 0.05$) (ANOVA, Duncan's or Tukey HSD tests)

table 2	group		
	AMZ	PRO	CTL
mean weight of ticks collected 5 d. post-treatment (mg)	165^a (121-221)	189^a (155-214)	322^b (295-388)
mean weight of egg clusters (mg)	23^a (0-45)	78^b (61-95)	107^c (88-114)
hatchability	9%	9.2%	92%

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Efficacy of a 1% (*S*)-Methoprene - 8% Chlorpyrifos Combination Dog Collar Against the Cat Flea and Brown Dog Tick. J. B. Prullage*, R. R. Rudolph, and S. R. Hansen, Sandoz Agro Inc., Dallas, TX and Des Plaines,IL.

Twelve dogs ranging in weight from 11.0kg to 18.9kg were divided into 2 groups of 6 dogs per group. Group 1 was collared with a 1% (*S*)-Methoprene - 8% Chlorpyrifos collar. These 2 groups served as the test system for evaluating flea and tick control efficacy and larval flea emergence inhibition.

The 2 groups were infested with 100 fleas on study days -1, 30, 61, 92, 148, 225, 302, 330 and 359. The fleas were counted on day 1, 2 and 4 post-collaring and 2 days post-infestation for subsequent infestations to determine percent control of adult fleas. Flea control reached 85.0% by study day 4 and stayed above 97% from day 32 through day 227. On day 304, control dropped to 81.8% but rose to 96.1% and 95.5% on days 332 and 361 respectively.

Adult brown dog ticks were infested on the dogs in the efficacy portion of the study ondays -1, 27, 89, 194, 222, 250 and 285. The ticks were counted on days 1 and 2 following treatment and 5 days following all subsequent infestations. Tick control measured 5 days after infestation reached 85% on day 32 and 91.4% on day 94. On day 199 and 227, tick control was 70.1% and 76.2%, respectively. By days 255 tick control had dropped to 51.3%.

The evaluation of flea larval emergence inhibition involved infestation of 200 fleas per dog on Groups 1 and 2 on days 13, 41, 76, 132, 237, 286, 314, 342, and 370. Four days after infestation, approximately 100 flea eggs were collected from each dog. Any dead or live larvae found upon microscopic examination 3 to 4 days post-collection were counted as emerged. Percent inhibition of larval emergence stayed within a narrow range of 89.9% to 99.4%. Mean percent inhibition of larval flea emergence for the entire study was 94.3%.

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RESIDUAL EFFICACY OF FRONTLINE® TOP SPOT™ FOR THE CONTROL OF FLEAS AND TICKS IN THE DOG

J.S. HUNTER III*, P. TANNER, M. KEISTER. RHONE MERIEUX, INC. ATHENS, GA. PH. JEANNIN. RHONE MERIEUX, TOULOUSE, FRANCE.

Challenge studies were conducted to assess the residual efficacy of Frontline® Top Spot™ for control of the cat flea (*C. felis*) and ticks (*R. Sanguineus and D. Variabilis*) on dogs. *Frontline Top Spot* was also compared to positive reference standards.

Study #1 (fleas only): Thirty-six dogs were divided into 5 treatment groups in our continuous exposure system (CES) - specially designed pens optimized for maintenance of flea population. The groups were: an untreated control, 2 groups treated with *Frontline Top Spot* and 2 groups treated with Defend® Exspot™. *Frontline Top Spot*, as a single or monthly treatment provided >95 % flea control in a closed population for at least 99 days. *Defend* initially provided control for 4 weeks, but subsequent applications were necessary at approximately 2 week intervals to maintain flea control >90%.

Study #2 (fleas & ticks): Thirty-six dogs were divided into 5 treatment groups: an untreated control, 3 weight classes with *Frontline Top Spot* and a *Defend* group. The treatments were administered once at the initiation of the study. Results showed *Frontline Top Spot* was >95% effective against fleas through Day 50, and *Defend* was 90% effective to Day 14. *Frontline Top Spot* was 98.4% on Day 29 and *Defend* 81.8% on Day 15 for *D. Variabilis*. On Day 29, *Frontline Top Spot* was 98.1% and *Defend* was 90.6% for *R. sanguineus*.

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A new species of demodicid mite from a cat. T.B. STEWART[1*] and C.E. DESCH, JR.[2]

[1]School of Veterinary Medicine, Louisiana State University, Baton Rouge and [2]The University of Connecticut at Hartford.

A 7-year old male domestic short-hair cat did not respond to treatment for suspected ehrlichiosis and was euthanized. Small irregular areas of alopecia were present on the face and neck. Scrapings from the lesions yielded a large number of demodicid mites located within hair follicles and in the stratum corneum. All life stages of *Demodex cati* and a new species of *Demodex* (n.sp.) were recovered in the ratio of 1 : 2.7 from a small piece of alcohol fixed skin. The mean length was: females n.sp. 108.3 ± 4.4 μ, *D. cati* 219.0 ± 27.4 μ; males n.sp. 90.6 ± 4.8 μ, *D. cati* 181.7 ± 17.9 μ. Within the *D. cati* population, 37% were immature (egg, larva, protonymph, nymph) and 63% adults with a sex ratio of 1♂ : 3.4♀. Within the n.sp. population, 70% were immature and 30% adult with a sex ratio of 1♂ : 2♀. Eggs represented 55% of the n.sp. population and only 5% of the *D. cati*. Morphologically, the n.sp. resembles *D. criceti* of the golden hamster.

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USE OF GEOMETRIC MEANS IN PARASITE DATA. G. F. ERICSSON*, R. A. BARRICK, C. P. DAURIO, W. K. LANGHOLFF. MERCK RESEARCH LABORATORIES, RAHWAY, NJ

Arithmetic means tend to produce biased estimates of the center of the data when the data consist of parasite counts. Parasite counts are not symmetrically distributed; unusually large counts occur more often than unusually small counts. Under these conditions, arithmetic means will overestimate the true center of the data. As a result of the influence of large counts, considerably more than half of the animals in the population will have counts below the arithmetic mean. This bias can be avoided by using geometric means. For typical parasite data, approximately half of the population will have counts below the geometric mean and half above. Geometric means have become increasingly accepted in the literature and are now recommended in the WAAVP guidelines. A geometric mean is calculated by (a) adding 1 to each count; (b) taking the natural logarithm of each (count+1); (c) taking the arithmetic mean of the natural logarithms; (d) taking the antilog of the arithmetic mean; and (e) subtracting 1.

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PREVALENCE OF PARASITE CONTAMINATION ON GREAT BASIN PASTURES AND RANGES FROM COW/CALF HERDS AS DETERMINED BY FECAL WORM EGG COUNTS. WG KVASNICKA*, DH BLISS AND RON TORELL. UNIVERSITY OF NEVADA, RENO, NV 89557. MIDAMERICA AG RESEARCH, VERONA, WI 53593. NEVADA COOPERATIVE EXTENSION, ELKO, NV 89801.

Strategic deworming programs have been developed for many geographic areas of the U.S. The programs are based on established gastro-intestinal nematode population information. These programs have proven cost effective in areas where grazing is intensive and the environment is favorable for perpetuation of the nematode species. Livestock advisors in arid and semi-arid regions lack the nematode epidemiological data necessary to outline strategic deworming programs. The objective of this study was to identify the presence of nematode contamination on Great Basin pastures and ranges. A parasite survey as determined by fecal worm egg counts was conducted at 10 locations in the region. Producers collected fecal samples during the spring and fall for two years. Management history was compiled to elicit environmental and grazing conditions plus use of anthelmintics. Samples were processed according to the Wisconsin Sugar Flotation Method. Genera identification was from ova morphology. The 1,923 samples processed represented 275 production units. Sixty three percent of the samples were positive with an average of 17 eggs/3 g sample. The data from the spring survey represents pasture contamination of the animals' environment when the parasites can continue recycling and survive. Eighty seven percent of the samples from non-treated cows grazing on meadow to mountain range were positive with an average count of 37.5 eggs/3 g sample. Only 53% of the samples from treated herds were positive with an average count of 17.2 eggs/3 g sample. The fall samples show a seasonal reduction in egg counts. Data from the various production systems and the application of the data for strategic deworming programs in the Great Basin will be discussed.

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Epidemiology of GI nematodes in cow-calf herds and breed susceptibility. , M. PEÑA*, J. E. MILLER, W. WYATT, S. R. BARRAS, Y. LI, E. KABAGAMBE. LOUISIANA STATE UNIVERSITY, BATON ROUGE, LA 70803.

Several studies have been done on the epidemiology of GI nematodes in young animals, but little work has been done to define the role of these nematodes in cow-calf herds. The purpose of this study was to determine the epidemiology of GI nematodes in cow-calf operations during a one year period. In addition, breed susceptibility between Angus and Brangus (*Bos taurus* and *Bos indicus* respectively) was also defined which may be an important tool to be used in cow-calf production schemes in subtropical regions. The cow-calf herd and replacement heifers grazed on separate pastures during the entire period of study and calves were weaned in October. Individual fecal samples were collected on a monthly basis from 60 cows (Angus and Brangus) and their calves as well as 30 replacement heifers(15 angus and 15 Brangus). Fecal egg counts (FEC) together with coprocultures were performed on the fecal samples. Results of FEC of the cows and calves showed an increasing pattern from April with maximum values during the fall with an overall mean of 113 EPG in Angus calves, 28 EPG in Brangus calves, 3 EPG in Angus cows and and 2 EPG in Brangus cows. This rise was much higher in Angus than in Brangus, and this difference was significant ($p<0.05$). *Haemonchus* and *Cooperia* were the predominant species identified in the coprocultures for cows and calves during the summer season, whereas *Ostertagia* levels increased during the fall season, indicating a summer inhibition in this part of the country. The FEC of replacement heifers showed a similar pattern to that of the cows and calves with a rise from April and maximum levels during the fall, but no significant difference was seen between breeds. *Haemonchus* was the predominant specie identified during the entire period for both breeds with peaks in the summer season. *Ostertagia* percentages increased in September reaching maximum levels during the winter season. The data suggest that cows are an important source of infective larvae for their susceptible calves and Angus breed had a significantly higher rate of contamination.

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ROLE OF INHIBITED EARLY FOURTH-STAGE LARVAE (IEL_4) IN THE IMMUNE RESPONSE TO OSTERTAGIA OSTERTAGI (OST). J.C. WILLIAMS[1*], L.C. GASBARRE[2], T.R. KLEI[1], A. DEROSA[1], M. CHAPMAN[1] [1]DEPT. VETERINARY SCIENCE, LOUISIANA STATE UNIVERSITY, BATON ROUGE, LA 70803, [2]USDA, ARS, LPSI, IMMUNOL. & DIS. RESIST. LAB., BELTSVILLE, MD 20705.

Sixty-five Holstein male calves (4 to 6 mos., 140 kg.) were used in the study which extended from Nov 1992 to Apr 1994. Calf groups were grazed at different times to acquire largely adult or inhibited larval populations for comparison of parasitologic and immunologic responses to non-infected controls after all were challenged by pasture infection in Jan-Mar of the second year. Only parasitologic results are presented. Two groups of 15 calves (A and B) were grazed on contaminated pastures from Nov 15 1992; B calves were removed from pasture on Mar 1 (largely adult worms), but A calves remained on pasture to Jun 15 (mix of adult and IEL_4). A third group of 15 calves (C) was grazed on pasture from Mar 1 to Jun 15 (largely IEL_4). Six similar calves (D_1) were maintained as uninfected controls; 6 additional control calves (same age and wt. as those in Nov 92) were added in June (D_2) and Dec 1993 (D_3). All calves were confined in pens from Jun 15 to Jan 1 1994 and treated with a BZ drug prior to pasture challenge. In Jun 1993, mean % inhibition (PI) in A, B, C was 87.4, 93.0 and 97.4, respectively. Two calves from each of A, B, C were necropsied in Aug, Oct and Dec. There was a general and substantial decrease in both total OST and PI in all groups after Aug, but great variation between the 2 animals of each group in most cases. Following the pasture challenge (Jan-Mar 1994), 6 cattle of A, B, C and D_1, D_2, D_3 were necropsied. There was little difference among A, B, C for PI or total OST; these values ranged from 82.8 to 88.8% and 19,551 (B) to 31,579 (C). In contrast, PI in all control groups was lower (51.6 to 54.6%). Youngest controls (D_3) had highest PI and total OST (38,241). Age appeared to be less important than previous exposure. Fecal egg counts and worm measurements supported this. Both male and female adults were significantly larger ($P<0.05$) in all controls than in A, B, C and fecal egg counts in D_1 were also higher than in A, B, C.

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COMPARISON OF NATURAL AND EXPERIMENTAL GASTROINTESTINAL (GI) NEMATODE AND LUNGWORM INFECTIONS IN CATTLE. J.C. WILLIAMS* AND A. DEROSA. DEPT. VETERINARY SCIENCE, LOUISIANA STATE UNIVERSITY, BATON ROUGE, LA 70803.

Three groups of 12 Holstein calves of 6-8 mos. old and 212 kg avg. wt. were used. All were treated with albendazole at 10 or 20 mg/kg x 3 between days -20 and -9. The experiment was begun on FEB 5 (day 0) with calves being weighed, randomly allotted to groups and treatments administered. Group treatments were: S - single oral inoculation with 75,000 mixed spp. GI nematode L_3 and 600 *Dictyocaulus viviparus* L_3; T - oral inoculation with total of 75,000 mixed GI spp. L_3 (600 *D. viviparus* on 1st day only) over 14 daily doses (3,200-7,500/day); N - natural infection during 14-day pasture grazing. S and T calves were maintained in pens from time of infection. The L_3 used for S and T were cultured from feces of calves which had earlier grazed on the N pasture. Generic composition of experimental infections was: *Haemonchus* (H) - 39,000 (52%), *Ostertagia* (O) - 16,500 (22%), *Cooperia* (C) - 10,500 (14%), *Oesophagostomum* (Or) - 8,250 (11%), *Trichostrongylus* (Tr) - 750 (1%). Fecal samples for egg/larval counts were collected on day 0, 14 and weekly then to day 42. Equal numbers of calves from each group were necropsied between days 43-46. All group mean egg counts were negative at day 14, but patent at day 21 (day 28 for lungworm); the mean count for N was 50, while the other values were 25 or less. The mean N count increased steadily to day 42, peaking near 225 (highest *D. viviparus* count in N also). The mean S count increased sharply in this period, peaking near 200 on day 42. The mean T count remained lowest, but peaked at 75 on day 42. At necropsy largest worm burdens were found in N. Mean total worm burdens recovered for S, T and N were: 3,371, 2,006 and 15,529, respectively. Greater numbers ($P<0.05$) of O and C spp. established in N than in S or T. Percent establishment of all genera in S and T were low with values ranging from 2.3 O to 16.9 Tr for S and 0.7 H to 6.6 C for T. Under conditions of this experiment, natural infection during 14 days of grazing provided higher levels of infection than S or T with all genera.

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MUCOSAL IMMUNITY OF CATTLE INFECTED WITH THE GASTRIC NEMATODE OSTERTAGIA OSTERTAGI: PHENOTYPIC CHARACTERIZATION AND CYTOKINE ANALYSIS.

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The mucosal immune system is the first line of immunological defence against Ostertagia ostertagi (Oo), a gastric nematode responsible for considerable economic losses in cattle, but data on gastric mucosal populations are very limited. Characterization of surface marker phenotypes of gastric lamina propria lymphocytes (LPL) and analysis of the cytokine pattern developed in cattle experimentally infected with Oo were the focus of this study. Cell surface phenotype of LPL from control animals (non infected calves) and animals after a non-protective primary infection with Oo were analyzed by indirect immunofluorescence staining. Quantification of mRNA levels of several T cell cytokines (IL-2, IL-4, IL-10 and IFN-γ) was analyzed by competitive reverse transcriptase polymerase chain reaction (competitive RT-PCR). Within 10 days of infection, previously naive calves showed a rapid increase in the percentage of $\gamma\delta$-T cells (WC1 +), B cells (IgM +) and activated cells (IL-2R +). Analysis of RNA from the same animals, showed that message for IL-4 and IFN-γ were elevated. However, by 60 days after infection, the percentage of cells bearing surface markers was comparable to preinfection levels, and mRNA's for IL-4, IFN-γ and IL-10 were increased. These results suggest that in the first days of infection, fourth-stage larvae, in the gastric glands, induce important changes in cell surface phenotype and cytokine gene expression of mucosal lymphocytes. Within two months of infection, the induction of the anti-inflammatory cytokine IL-10 may have a role in the return to a normal mucosal lymphocyte profile.

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Comparison of GI nematode infection and body weight among Native, Suffolk and crossbred F1 lambs. Y. LI, J. E. MILLER*, D. E. FRANKE, S. R. BARRAS, E. K. KABAGAMBE, and M. T. PEÑA. LOUISIANA STATE UNIVERSITY, BATON ROUGE, LA 70803.

Louisiana Native Sheep are known to be resistant to GI nematode infection, but they are a relatively poor production breed. A program of crossbreeding Native with Suffolk sheep, a domestic breed that is susceptible to nematode infection but a relatively high production breed, was conducted to study if the crossbred F1 lambs can inherit both nematode resistance and good production traits from their parents. Twenty straightbred Native, 20 straightbred Suffolk, and 90 cross F1 lambs were monitored for 7 months from birth in Spring, 1996. The fecal egg counts (FEC) of F1 were consistently lower than those of Suffolk lambs and higher than those of Native lambs. The overall average EPGs throughout the study period for F1, Native and Suffolk lambs were 161 EPG, 40 EPG and 505 EPG respectively, and the worm counts in abomasa were 9394, 3171 and 16825, respectively. The packed cell volumes (PCV) of F1 and Native lambs were not significantly different during the study period, but both were significantly higher than that of Suffolk lambs after 19 weeks. The overall PCVs for F1, Native and Suffolk lambs were 28.7%, 27.8% and 24.2%, respectively. Live bodyweight of F1 also fell between Native and Suffolk lambs. At 12 and 18 weeks of age Native lambs had significantly less bodyweight than both Suffolk and F1 lambs, and F1 lambs had significantly less bodyweight than Suffolk lambs but significantly higher bodyweight than Native lambs. This study showed that crossbred F1 lambs inherit both resistance trait from their Native parents and improved production trait from their Suffolk parents. Results suggested that crossbreeding Native and Suffolk sheep might be a suitable way to breed lambs with both parasite resistance and good production traits.

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STRATEGIC USE OF IVERMECTIN DURING PREGNANCY TO CONTROL *TOXOCARA CANIS* IN GREYHOUND PUPPIES. P.A PAYNE* and R.K. RIDLEY. KANSAS STATE UNIVERSITY. MANHATTAN, KS 66506.

Greyhound bitches were bred (day 0) and housed throughout their pregnancies on three greyhound breeding farms in Kansas. These bitches were randomly assigned to one of three treatment groups of 6 dogs each. Group A dogs were given ivermectin 300μg/kg SQ on days 0, 30, and 60 of gestation. Group B dogs were given ivermectin 300μg/kg SQ on day 42. The dogs in group C served as controls, and no anthelmintic was given during gestation or for 28 days after whelping. Bitches and puppies were moved to the university the day after whelping and were housed and maintained inside for 28 days. Weekly quantitative fecal exams were run on the bitches during this time. All of the puppies were humanely euthanized at 28 days of age, and internal parasites were recovered, identified, counted, sexed and preserved either in 10% formalin or frozen at -70°C. (We do not yet have data for one animal in Group C and 2 animals in Group A. These 3 bitches are currently pregnant at the breeding farms.) To date, group A puppies have had an average of 6 adult *Toxocara canis* in their small intestines, and mean EPGs of 316. Puppies in Group B have had an average of 42 adults and 6,047 eggs per gram of feces. Puppies in the control group (C) have had a mean of 50 adult *Toxocara canis* in their small intestines and egg counts of 141,000 per gram of feces. The strategic use of ivermectin at 300μg/kg in the bitches on days 0, 30 and 60 of gestation reduced the worm burdens of the puppies by 88% and the number of eggs passed into the environment by 99.8%.

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A CASE OF PSEUDOPARASITISM DUE TO MERMITHID NEMATODES IN A CAT. K. R. KAZACOS* AND J. A. EPLER. PURDUE UNIVERSITY, WEST LAFAYETTE, IN 47907*, AND SHELBYVILLE ANIMAL CLINIC, SHELBYVILLE, IN 46176.

In August 1996, a 10 year old male DSH cat vomited in the yard, coughing up 13 long, thin white worms. The owner, quite concerned, collected the worms and submitted them to her veterinarian for identification. The cat was otherwise normal, and no parasite eggs or larvae were seen upon subsequent fecal examination. The cat was confined to the house for a week and no other worms were passed. The worms were long, slender nematodes measuring 8.4-12.0 cm by 0.4 mm; superficially, they resembled filarioids such as *Dirofilaria immitis*. The cuticle was smooth and contained abundant subcuticular crisscross fibers. The stoma was terminal and possessed a tiny lance-like tooth. The posterior end was bluntly rounded, without an anus, and a bluntly rounded blind intestine could be seen within the worm. The worms were identified as mermithid nematodes, which are free-living as adults and parasitic in insects as larvae. Their characteristics most closely resembled those of *Mermis nigrescens*, parasitic in grasshoppers. Upon questioning, the owner stated that when the cat is allowed out in the yard, it enjoys hunting insects, including grasshoppers, in the garden. A site visit in September 1996 revealed a suburban home with a large rear yard and a vegetable/flower garden. 13 small to large grasshoppers, 20 crickets and 2 mantids were captured in the garden area, brought to the laboratory and dissected. Of these, 6 grasshoppers and 2 crickets were found to be infected with from 1-25 mermithids, which ranged in size from 1.6-43.5 cm, with most being 5.0-12.0 cm. Many dogs and cats are entomophagous and undoubtedly ingest insects containing mermithids. Veterinarians need to be aware of these large but innocuous worms since they may on occasion be "brought up for discussion".

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INFLAMMATORY LUNG DISEASE FROM *Dirofilaria immitis* INFECTIONS IN CATS AND DOGS

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Dead *D. Immitis* and live *D. Immitis* (2/cat and 14/dog) were surgically transplanted into the pulmonary arteries of cats and dogs. Radiographic evaluation and gamma lung scans using Tc99 macro aggregate sulfa-colloid were performed before and after transplantation. Lung lobes were collected for light and EM evaluation. Macrophage activity was evaluated by measuring Tc99 radioactivity in tissue samples of lung, liver, spleen, kidney, heart, skeletal M, bone marrow, and blood. Single Photon Emission Computed Tomography using Tc99 evaluated the 3 dimensional distribution of pulmonary intravascular macrophages (PIM).

In dogs after transplantation of dead DI, there was significant Type 1 Cell edema and focal damage with fibrosis. DI death in the dog is associated with acute lung injury independent of thromboembolism. In cats after transplantation of dead DI, there was marked Type II cell hyperplasia with less fibrosis and elastin deposition than in the dogs. Glycocalix surface changes in PIM of cats was evidence of stimulation. PIM activity was absent in the dogs with live or dead DI. Phagocytic activity of the lung was greater than that of the liver in all normal cats and PIM activity was significantly decreased in cats with live DI as compared to normal cats and cats with dead DI. In cats, the loss of PIM inhibition may contribute to the acute dyspnea associated with DI death in cats.

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REGIONAL, CLINICAL CASE STUDIES OF FELINE HEARTWORM INFECTION. C.K. ROBERTSON*[1], A.R. DILLON[2], W.R. BRAWNER[2], J. GUERRERO[1]. [1]MERCK AGVET, RAHWAY, NJ 07065; [2]AUBURN UNIVERSITY, AUBURN, AL 36849.

Diagnosis of feline heartworm disease can be elusive due to non-specific clinical signs, typically low worm burdens, unique pathophysiology in the cat and the limitations of currently available heartworm tests. Consequently, knowledge about this disease is still being acquired. The objective of this study was to survey the occurrence and clinical presentation of feline heartworm infection in specific regions of the United States among cats presenting with signs consistent with heartworm infection. Submission of 200 cases from fifteen private practices in Florida, South Carolina, Tennessee and Texas was targeted. Cats entered in the study were at least 6 months of age and presented with one or more of the following clinical signs: respiratory signs, including tachypnea, dyspnea or coughing; gastrointestinal signs, including a pattern of intermittent vomiting unrelated to eating; or sudden death of uncertain etiology, particularly associated with respiratory distress prior to death. Data collected included: history and indoor/outdoor lifestyle; physical examination findings; thoracic radiography evaluations; Knott or DIFIL® test results, DIROCHEK® antigen test results, antibody test results (Animal Diagnostics, Inc. and Heska Corporation laboratories); and CBC results. Preliminary analysis of 134 cases provided the following results: 56/134 (42%) tested antibody positive on one or both antibody tests; 9/56 (16%) antibody positive cats were reported to be indoors 100% of the time; and 15/56 (27%) antibody positive cats spent ≤10% of their time outdoors. Four of the 134 were antigen positive. In 24 cases, thoracic radiographs showed signs consistent with heartworm infection.

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Feline Heartworm Infection: Clinical Study In Northern Italy.

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Seventy seven pet cats (53 male, 24 female), most domestic shorthair, showing respiratory distress or recurrent vomiting were selected for a feline heartworm (*Dirofilaria immitis*) study. Physical examination, radiography, microfilaria blood tests and ELISA antigen and antibody tests were completed for each cat. Twenty five (33%), 15 male and 10 female, ranging in age from 6 months to 13 (average 6.2) years were heartworm positive. Five were strictly indoor cats. All 25 were antibody positive, 17 were antigen positive and one was microfilaria positive. Echocardiography in 21 of the positive cases demonstrated heartworms in 20 cats. In the 21st cat, although unsuccessful initially, echocardiography allowed a positive diagnosis 10 months later when antibody and antigen tests were also positive. Fifteen cats showed radiographic abnormalities. The most frequent clinical signs were dyspnoea (10 cats), rales (10), vomiting (4), collapse (4) and hemoptysis (2). These results confirm the importance of feline heartworm infection and suggest that antibody tests and echocardiography are the most reliable diagnostic tools.

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COMPARISON OF ANTIBODY AND ANTIGEN DETECTION TESTS ON SERA FROM CATS EXPERIMENTALLY INFECTED WITH *DIROFILARIA IMMITIS*. J.W. MCCALL[1]*, N. SUPAKORNDEJ[2], A.R. DONOGHUE[3] AND C.A.PICHÉ[3]. [1]DEPARTMENT OF PARASITOLOGY, COLLEGE OF VETERINARY MEDICINE, UNIVERSITY OF GEORGIA, ATHENS, GA; [2]TRS LABS, INC., ATHENS, GA; [3]HESKA CORPORATION, FORT COLLINS, CO.

A total of 85 serum samples were obtained from 35 cats with experimentally induced infections of *Dirofilaria immitis* at 3, 4, 5, 6, 7, 8 and 9 months post-infection (PI); samples were not collected from all cats at all time points. At various times after infection, the cats were necropsied and the number and gender of adult worms were recorded. Worm burdens varied from 1 to 18 per animal, with an average of 3.2 worms per cat. Eighteen cats had only female worms (range 1-3), 8 cats had only male worms (range 1-2) and 9 cats had both male and female worms (range 2-18). Serum samples were tested for antigen (Ag) using an in-clinic ELISA (DiroCHEK®, Synbiotics), an in-clinic enzyme immunoassay (SNAP® Heartworm PF, IDEXX) and a reference laboratory-based ELISA (HESKA™ Heartworm Antigen ELISA). The samples were also tested for antibodies (Ab) in a reference laboratory-based ELISA (HESKA™ Feline Heartworm Antibody ELISA). The results are summarized as follows:

	No. cats	No. Ab pos.	No. Ag pos.		
Month PI	w/ HW	HESKA	HESKA	DiroCHEK	SNAP
3	12	11	0	0	0
4	9	9	2	0	0
5	20	20	9	6	5
6	16	16	4	2	1
7	12	12	12	12	12
8	8	8	8	8	8
9	8	8	8	8	8

In cases where detection of early or male-only infections are required, the antibody test is an option for testing. Antigen detection tests were comparable to each other.

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CANINE HEPATOZOONOSIS NEWLY ENDEMIC TO OKLAHOMA. R.J. PANCIERA, J.S. MATHEW*, M.A. BRESHEARS, S.A. EWING - COLLEGE OF VETERINARY MEDICINE, OKLAHOMA STATE UNIVERSITY; STILLWATER, OK, 74078 USA.

Canine hepatozoonosis caused by *Hepatozoon canis* is a tick-borne disease. *Rhipicephalus sanguineus* (brown dog tick) is believed to be the primary vector. The disease was virtually unknown in Oklahoma (OK) until 1995. Since then eighteen dogs, mostly from rural areas in eastern OK have presented with weakness, wasting, and neutrophilic leukocytosis. These signs and lesions are consistent with those described previously from dogs of the USA Gulf Coast region. All dogs had parasites in various stages of asexual reproduction in skeletal or cardiac muscle. Most dogs had demonstrable periosteal bone proliferation; 4 dogs whose entire skeleton was cleared of soft tissue had disseminated periosteal lesions. Parasitemia was recognized in circulating leukocytes of only 4 dogs. Daily observation of blood films stained by Wright-Giemsa revealed parasitemia that varied markedly from day to day and that, at its peak, involved less than 1% of circulating leukocytes. Two morphologically distinct forms of the parasite were recognized. The lesions and parasitemia differed considerably from *H. canis* infections reported from Europe and Asia, suggesting the North American hepatozoonosis may be caused by a different strain of the parasite. Attempts to transmit the infection orally to naive dogs by feeding them ticks (collected from naturally-infected dogs) were unsuccessful.

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EVIDENCE FOR REVERSIBLE INHIBITION OF ABOMASAL ACID SECRETION IN SHEEP INFECTED WITH OSTERTAGIA LEPTOSPICULARIS

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The ability of the fundic mucosa to acidify abomasal contents was studied in 6 sheep experimentally infected with 80,000 third-stage larvae of *Ostertagia leptospicularis*. The abomasal pH was continuously recorded via a rumen fistula using a pH probe located in the abomasum. In all sheep abomasal acidity decreased markedly and pH levels > 4 were recorded, individually different, after days 15, 17 and 18 p.i. At days 19 and 20 p.i. when the mean pH ranged between 5 and 6, each sheep was administered 80 µg/kg histamine s.c. and 8 µg/kg carbachol respectively. Both drugs provoked an acidifcation of the abomasal contents reaching a mean of pH 3.4. The effect of carbachol could be completely blocked with the H2 antagonist ranitidine, suggesting, that the final target of both drugs was the parietal cell H2 receptor. The results indicate that the infected mucosa contained a population of functional parietal cells. In the presence of high serum gastrin levels the acid producing capacity of the parietal cells is directly or indirectly blocked by an unknown factor mediated by the parasites. The onset of severe reduction of acid production was closely related with the onset of parasite egg excretion.

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Gut secretory antigens of *Haemonchus contortus*: Gene isolation and comparison among diverse nematode species. ABDUR REHMAN* AND DOUGLAS P. JASMER, DEPARTMENT OF VETERINARY MICROBIOLOGY AND PATHOLOGY, WASHINGTON STATE UNIVERSITY, PULLMAN, WA 99164-7040

Monoclonal antibody (mAb) 42/10.6.1 binds to the surface of *H. contortus* gut and identifies >10 gut membrane and secretory proteins that share this mAb determinanat. Proteins isolated by immunoaffinity with mAb 42/10.6.1 induced moderate protection against subsequent parasite challenge in goats. Antisera from these goats were used to screen an expression cDNA library made from *H. contortus* gut. It was anticipated that identified genes screened with this antisera would encode membrane and secretory proteins of parasite gut. Using this approach, we identified putative genes encoding a cysteine protease, two different Zn (II) metallopeptidases, previously described GA1 proteins, and a patented sequence that is related to *Ancylostoma caninum* secretory protein (ASP). Each of the new proteins have predicted signal peptides suggesting they are secreted from the gut and may contribute to nutrient digestion. Related gene sequences from multiple nematode species were identified in databases for each cloned gene. These results indicate that the strategy used identified the proteins coding genes of interest and that these gut genes of *H. contortus* may have homologues in other nematode species.

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PRODUCTION OF A MONOCLONAL ANTIBODY SPECIFIC FOR OVINE IMMUNOGLOBULIN E AND ITS APPLICATION TO MONITOR SERUM IGE RESPONSES TO *HAEMONCHUS CONTORTUS* INFECTION.

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Part of the Cε3 - Cε4 region of the ovine immunoglobulin E (IgE) gene (nucleotides 1,111 - 1,575) was amplified by PCR. The recombinant protein (recIgE1-2) was expressed in *E.coli* and both monoclonal and polyclonal antibodies were produced. These antibodies recognized recIgE1-2 and native IgE on Western blots and in ELISA. The polyclonal serum showed cross-reactivity with other sheep immunoglobulin classes. The monoclonal antibody was specific for ovine IgE and goat IgE. Infection of sheep with the abomasal nematode *Haemonchus contortus* resulted in elevated IgE levels in serum 2 to 4 weeks after infection as measured by sandwich ELISA using the rabbit polyclonal as capture antibody and the monoclonal antibody against ovine IgE as second antibody. A negative correlation between worm counts and total serum IgE levels at the end of the experiment was found in repeatedly infected sheep. Significant increased levels of excretory secretory antigens specific IgE levels were found after *H. contortus* infection. In contrast, no significant changes in third stage larvae (L3) antigen-specific IgE titre in sera could be detected after infection.

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IMMUNOPROTECTIVE PROPERTIES AND MOLECULAR CHARACTERIZATION OF TWO EXCRETORY SECRETORY (ES) PROTEINS OF *HAEMONCHUS CONTORTUS*.

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Sheep were vaccinated with (ES) products of adult *Haemonchus contortus* enriched for 2 polypeptides of 15 and 24 kDa. After a challenge infection with 20,000 infective larvae, a reduction of more than 70% in mean egg and worm counts was achieved in the immunized sheep compared to the non-vaccinated controls. Vaccination induced ES-specific antibodies and stimulated infiltration of mast cells in the abomasum. Further validation of these ES proteins as vaccine candidates needs their large scale production as recombinant products. Therefore, the N-terminal amino acid sequences of the ES proteins were determined. Specific 5' primers were used in combination with an oligo (dT) 3' primer to amplify the appropriate cDNAs by PCR. A λZAPII cDNA library was constructed from mRNA of L5 larvae and subsequently screened with the PCR products. The full length clone of the 15 kDa ES protein coded for a 17.2 kDa precursor molecule of 148 amino acids with a signal peptide of 30 amino acids. The full length clone of the 24 kDa ES protein coded for a 24.6 kDa precursor protein of 222 amino acids with a leader sequence of 19 residues. A cDNA of each ES protein was subcloned into a pQE9 expression vector. The recombinant proteins were recognized by sera of sheep hyperimmunised by repeated infections with *H. contortus* as judged by immunoblot analysis, suggesting that antigenic determinants were also present on the recombinant proteins.

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Field evaluation of H11-H-gal-GP vaccine against *Haemonchus contortus* in Suffolk and Gulf coast Native sheep. E. KABAGAMBE[1]*, J. MILLER[1], D. SMITH[2], S. BARRAS[1], Y. LI[1] and M. PEÑA[1]. LOUISIANA STATE UNIVERSITY, BATON ROUGE, 70803, [2]MOREDUN RESEARCH INSTITUTE, EDINBURGH EH17 7JH, SCOTLAND.

A four-month study was conducted in the summer of 1996 to evaluate the performance of H11-HgalGP vaccine in sheep under repeated pasture challenge with *Haemonchus contortus*. Forty five Native and 40 Suffolk ewes were randomly assigned to three treatments: vaccine, adjuvant and saline group. All ewes were dewormed prior to administration of the vaccine, adjuvant or saline. Two doses of saline, quil A or H11-HgalGP antigens in quil A adjuvant, were given intramuscularly three weeks apart. Fecal egg counts (FEC) and packed cell volume (PCV) were monitored every other week. FEC of Suffolk ewes increased for all groups until at 6 weeks post vaccination when egg counts of vaccinates became significantly lower than those of controls ($P<0.05$). Thereafter FEC of vaccinated Suffolk ewes remained lower than those of controls throughout the whole study period but were not significantly different ($P>0.05$). For week 0, 2, 4, 6, 8, 10 and 12, the mean egg per gram (EPG) for vaccinated Suffolk ewes were 116, 230, 425, 356, 81, 107 and 106 respectively. EPG for the adjuvant and saline groups were 261, 232, 1465, 1629, 569, 376, 340, and 109, 44, 460, 646, 647, 422, and 396 respectively. Differences in PCV were not significant. Vaccinated natives had significantly lower FEC ($P<0.05$) than controls, but the egg counts were too low to be useful for concrete inferences. These results suggest that H11-HgalGP vaccine may be beneficial for field application.

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SERUM ANTIBODY RESPONSE OF FOUR SHEEP BREEDS TO **HAEMONCHUS CONTORTUS** INFECTION: ANTIGEN MARKERS.

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Sheep haemonchosis is a widespread parasitic infection causing notable economic losses. At present, specie-specific diagnosis is time consuming (coprologies and coprocultures), requires specialized personel and, more importantly, is restricted to patent infections. Therefore the development of an early (prepatent) diagnostic tool would be advantageous. Our group recently demonstrated that a 26 kDa soluble antigen of adult **H. contortus** (Hc26) was recognised by sheep sera obtained from patent infections, but no information is available on its value during prepatency. The present study describes results obtained in a serial Western blotting analysis of sera from **H. contortus** infections (200L3/Kg lw) and challenges (400L3/Kg lw) in four sheep breeds. All four breeds (Churra, Castellana, Manchega and Merina) recognised Hc26 during patency of a primary infection (28 and 42 dpi), thus confirming the diagnostic value of the test. More interestingly, pooled sera from the prepatent period (14 dpi) reacted with the antigen, suggesting its use as an early marker for haemonchosis. Infected and challenged sheep recognised Hc26 throughout experimental period except for Churra and Merina sheep on day 28 pi. The peptide was more strongly recognised during the primary infection, which may be related to the higher parasitic burden found in these animals.

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Characterization of Hemolytic Activity from Adult *Haemonchus contortus*. R.H. FETTERER*, AND M.L. RHOADS, PARASITE BIOLOGY AND EPIDEMIOLOGY LABORATORY, USDA/ARS, BELTVILLE, MARYLAND 20705.

Adult *Haemonchus contortus* contain a detergent-extractable factor that hemolyzed sheep red blood cells (RBCs) in a time- and concentration-dependent manner. This hemolytic factor had comparable activity at pH 5.0 and 8.0, but lower activity at pH 7.0. The activity was heat-stable, unaffected by proteolytic inhibitors, and inhibited by 20 mM polyethyleneglycol. After 15 min exposure to the hemolytic factor, changes in RBC shape accompanied by formation of cell surface projections were observed by scanning electron microscopy. After 60 minutes of exposure the RBCs were markedly distorted, with pores visible in many cells. These observations suggest that this hemolytic factor may act as a pore-forming agent. The hemolytic activity was localized in the membrane fraction of the isolated intestine. This intestinal hemolytic factor may aid the disruption of ingested red blood cells.

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Toxic Activity of Crystals from Bacillus thuringiensis (Strain YBT-1953) To Adults of Haemonchus contortus in Vitro. Yao Baoan*, Wang Xiang, Zhao Junlong, Ma Lihua, Yu Zinlu HUAZHONG AGRICULTURAL UNIVERSITY, WUHAN, 430070 P.R. CHINA.

The adults of Haemonchus contortus were obtained from the abmasum of goat. Five male and five female parasites were placed in small culture bottle with 80 percent medium RPMI1640 and 20 percent calf serum and erythrocytes hydrolysate. The crystal soluble toxin of Bacillus thuringiensis (B.t) strain YBT-1953 was prepared as follows: To culture B.t, the supernatant was decanted after centrifucation. The sediment was washed by 1M Nacl and dual distilled water. The crystals were resolved by 0.5% NaOH, collected the supernatant after centrifugation. To leak the Na^+, OH^- out using leak bag by distilled water. The different quantity toxin of B.t were added to the culture bottle with parasites at 39.5° C and 5% CO_2 in incubator.

The results showed : the male and female Haemonchus contortus treated with 400ug total proyain/ml of B.t were all died after 12 hours. But the parasites in control group were alive without death.

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IN VITRO CULTIVATION AND EXPERIMENTAL INOCULATION OF SARCOCYSTIS FALCATULA AND S. NEURONA MEROZOITES INTO BUDGERIGARS.

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The present study describes in vitro isolation of Sarocystis falcatula merozoites following the experimental inoculation of budgerigars, Melopsittacus undulatus, with sporocysts, as well as the subsequent experimental inoculation of culture-derived S. falcatula and S. neurona merozoites into budgerigars. Only the birds that received the S. falcatula merozoites died of clinical sarcocystosis, while the birds that received the S. neurona merozoites showed no evidence of infection. The reproduction of clinical disease associated with the experimental inoculation of culture-derived Sarcocystis spp. merozoites has not been previously reported. Because these two inocula behaved so differently suggests that S. neurona and S. falcatula are not synonymous. Support for this research was provided by the Center for Equine Health, UC Davis School of Veterinary Medicine.

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EXPERIMENTAL REPRODUCTION OF *SARCOCYSTIS NEURONA* INDUCED ENCEPHALITIS IN NUDE MICE.

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Equine Protozoal Myeloencephalitis (EPM) caused by *Sarcocystis neurona* is a significant disease of horses in North America. Our knowledge regarding *S. neurona* parasite biology, disease pathogenesis, as well as means to evaluate treatment or control of disease has been limited by the lack of an experimental model, particularly one that rapidly produces a consistent encephalitis. To assess the susceptiblity of severely immunocompromised mice, four C57Bl/6 nude mice were inoculated either intraperitoneal or by oral gavage with culture-derived *S. neurona* merozoites and euthanized 39 days following initial exposure. A mild *S. neuorna*-induced encephalitis was detected by light microscopy and immunohistochemistry in one mouse. Three additional groups totalling 20 nude mice were subsequently infected, euthanized, and necropsied at various time points post-inoculation. Tissues were collected for histopathology, immunohistochemistry, and parasite isolation. A pronounced *S. neurona* encephalitis was consistently produced in mice as early as 28 days post-inoculation. Parasites were also detected infrequently in additional organs.

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EXPERIMENTAL INDUCTION OF EQUINE PROTOZOAL MYELOENCEPHALITIS IN HORSES USING *SARCOCYSTIS* SP. SPOROCYSTS FROM THE OPOSSUM (*DIDELPHIS VIRGINIANA*). D.E. GRANSTROM,[1*] C.K. FENGER,[1] A.A. GAJADHAR,[2] N.M. WILLIAMS,[1] S.A. MCCRILLIS,[1] S. STAMPER,[1] J.L. LANGEMEIER,[1] AND J.P. DUBEY.[3] [1]DEPARTMENT OF VETERINARY SCIENCE, UNIVERSITY OF KENTUCKY, LEXINGTON, KY; [2]HEALTH OF ANIMAL LABORATORY, SASKATOON, SASKATCHEWAN, CANADA; [3]PARASITE BIOLOGY AND EPIDEMIOLOGY LABORATORY, LPSI, ARS, USDA, BELTSVILLE, MD.

Sarcocystis sp. sporocysts isolated from 8 feral opossums (*Didelphis virginiana*) were pooled and fed to commercially reared budgerigars (*Melopsittacus undulatus*), wild-caught sparrows (*Passer domesticus*), a wild-caught slate-colored Junco (*Junco hyemalis*) and weanling horses (*Equus caballus*). All budgerigars died within 5 weeks post inoculation (wpi). Histologic examination revealed meronts within the pulmonary epithelia and typical *S. falcatula* sarcocysts developing in the leg muscles. Sparrows were euthanized 13 and 17 wpi and their carcasses were fed to 4 laboratory-raised opossums. Sporocysts were detected in the feces of 3 of 4 opossums and in intestinal digests from all 4 opossums. Sporocysts were not found in the feces or intestinal digest of an additional opossum that was fed 3 uninoculated sparrows. Five foals were fed sporocysts and 2 were maintained as uninoculated controls. Foals had no *S. neurona*-specific antibodies by western blot analysis prior to sporocyst ingestion. Inoculated foals seroconverted in 24-40 dpi, followed by positive CSF tests 28-42 dpi. Sera and CSF from control foals remained negative. Neurologic disease was evident in 4 inoculated foals 28-42 dpi. Necropsy examination of inoculated foals did not reveal gross lesions, however, microscopic lesions consistent with equine protozoal myeloencephalitis (EPM) were found in 3 inoculated foals. Protozoa were not observed in the tissue sections. Microscopic lesions consistent with EPM were not found in 2 inoculated foals or in uninoculated control foals. One inoculated foal had a non-inflammatory spinal cord lesion consistent with cord compression.

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ANTHELMINTIC RESISTANCE ON PLEASURE HORSE FARMS IN NORTH CENTRAL FLORIDA. T. F. WOODS*, T. J. LANE, Q.-Y. ZENG, AND C.H. COURTNEY, UNIVERSITY OF FLORIDA, GAINESVILLE, FL.

One hundred and four horses on 13 privately-owned farms in north central Florida were tested for the presence of worms resistant to either fenbendazole, ivermectin, or pyrantel pamoate. On each farm, horses were divided into 4 groups of not more than 10 horses each and given either ivermectin (200 mcg/kg), fenbendazole (5 mg/kg), pyrantel pamoate (6.6 mg/kg), or left untreated as controls. Fecal egg counts were performed on the day of treatment and at 2, 4, 6, and 8 weeks following treatment using a modified McMaster technique with a minimum sensitivity of 25 eggs per gram (EPG) of feces. Horses treated with fenbendazole or pyrantel pamoate did not complete the study on 1 farm each. Mean fecal egg counts of fenbendazole-treated horses on all farms combined were reduced from a pretreatment value of 370 EPG by an average of -55, -85, -49 and -162 percent at 2, 4, 6, and 8 weeks after treatment, respectively. Egg counts of pyrantel pamoate-treated horses were reduced from 308 EPG by 91, 81, 15 and -102 percent, and egg counts of ivermectin-treated horses were reduced from 357 EPG by 100, 99, 89, and 59 percent. Egg counts of untreated control horses were reduced from 290 EPG by -82, -236, and -241 percent at 2, 4, and 6 weeks after treatment, respectively (controls were treated with an anthelmintic after the sixth week). Fenbendazole was judged ineffective (<80% mean reduction in EPG) on 10 and 11 of 12 farms at weeks 2 and 4 after treatment, respectively. Pyrantel pamoate was judged ineffective on 4 of 12 farms, and ivermectin was judged ineffective on none of 13 farms during this same interval. When choosing an anthelmintic for horses, one should assume that strong benzimidazole resistance is present on any given horse farm in north central Florida unless one has unequivocal proof to the contrary. The use of pyrantel pamoate should be closely monitored because resistance now appears to be emerging to this drug. At present, one still may use ivermectin with confidence in its efficacy.

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Dose confirmation trial of moxidectin equine oral gel against *Gasterophilus* spp. in equines. OWEN SLOCOMBE AND MARY C. LAKE, DEPT. OF PATHOBIOLOGY, ONTARIO VETERINARY COLLEGE, UNIVERSITY OF GUELPH, GUELPH, ON, CANADA AND PHILIP J. SCHOLL, FORT DODGE ANIMAL HEALTH, PRINCETON, NJ.

In this trial with 11 ponies and a light horse naturally infected with bots, the investigator and assistants were blinded to treatment groups until after the study was completed. On November 13, 1995, the number of bot eggs were estimated on each animal. On February 23, 1996, animals were ranked by bot egg count, allocated to a red or blue syringe treatment group and weighed. The data was submitted to Fort Dodge who provided for each animal a syringe containing the precise dose of medication. On March 11, 1996, animals were give a placebo gel or a gel with moxidectin at 400 µg/kg body weight. Each animal was observed for adverse reactions for 3 hours after treatment and one and 7 days later. At necropsy on March 25, 1996, the stomach and duodenum of each animal were ligated, removed and examined for bots which were identified to species and counted.

All animals accepted the treatment readily and adverse reactions were not seen. In 6 placebo-treated animals, 66-631 bots were recovered from the stomach and in 3, 4-11 bots from the duodenum. In 4 of 6 moxidectin-treated animals, 2-5 bots were recovered from the stomach and none from the duodenum. Moxidectin at 400 µg/kg reduced *G. intestinalis* by 99.37% and *G. nasalis* by 100%. In the placebo-treated equids, there appeared to be no relationship between the number of bot eggs counted on the hairs of an animal the previous fall and number of bots recovered in late winter.

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COMPARISON OF THE RECOVERY OF CYATHOSTOME LARVAE FROM FRESH AND FROZEN EQUINE MUCOSA. R. GAMBOA*, J. A. DIPIETRO, A. J. PAUL, DEPARTMENT OF VETERINARY PATHOBIOLOGY, COLLEGE OF VETERINARY MEDICINE, UNIVERSITY OF ILLINOIS, URBANA, IL.

Digestion of frozen and fresh equine mucosal tissue samples were compared to determine if freezing of tissues affected recovery of cyathostome larvae. In addition, a determination of correlation between time frozen and numbers of larvae recoveredwas performed. Twenty horses naturally infected with mixed strongyle infections were used in the study. Colonic mucosa was obtained and either promptly digested, or frozen for 3 or 6 months prior to digestion. Results showed that the duration of freezing did not correlate to determined larval counts. Larvae counts from samples frozen for three months did not show a significant difference between those determined from samples frozen six months. Tissues digested at necropsy did not exhibita significant difference in larval counts determined for late L3 and L4 developmental larval stages from those of frozen samples. Tissues digested at necropsy didexhibit a significant difference in larval counts for early L3 developmental larval stages from those of frozen samples. More larvae were retrieved from frozen samples than from fresh samples. It can be concluded that freezing of mucosa samples does not alter recovery of larvae from equine colonic mucosa.

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REMANENT EFFECT OF A 2% EQUINE MOXIDECTIN GEL ON ESTABLISHMENT OF SMALL STRONGYLES. J. VERCRUYSSE, M. EYSKER*#, D. DEMEULENAERE, K. SMETS & P. DORNY. GENT UNIVERSITY, SALISBURYLAAN 133, B 9820 MERELBEKE, BELGIUM; # UTRECHT UNIVERSITY, P.O. BOX 80.165, 3508 TD UTRECHT, THE NETHERLANDS.

A controlled trial was carried out at Gent University to evaluate the remanent effect of a 2% equine moxidectin gel at a dose rate of 0.4 mg/kg. Five out of nine helminth-free raised foals were treated on day 0, while the remaining 4 foals were used as controls. At days 0, 7, 14, 21 and 28 all 9 foals were infected experimentally with 200,000 small strongyle larvae. Necropsy was carried out on days 42 (3 treated, 2 control foals) or 43 (rest). The mean take of infection was 27% in control foals and 7% in treated foals. The numbers of mucosal inhibited early L3 and late L3 were about equal in both groups, but numbers of mucosal L4 were more than 10 times higher in control foals. No lumenal stages were recovered from treated foals, whereas almost 50% of the total burdens of control foals consisted of these stages. In total 14 small or medium sized species of small strongyles were found in control foals, 10 of these in all 4 foals. The data indicate that establishment of infection was prevented by moxidectin treatment for at least two and possibly 3 weeks.

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Comparison of diagnostic techniques for detection of *Cryptosporidium parvum* in horses

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Cryptosporidium parvum is an enteric protozoan organism that has been diagnosed in a number of mammalian host species. The clinical significance of *C. parvum* is well documented in neonatal calves and in waterborne outbreaks in humans. Recent evidence suggests that this organism may be one of the most significant non-bacterial causes of foal diarrhea outbreaks, however, little epidemiologic data is available regarding infection and oocyst shedding patterns in various horse populations. A lack of valid detection methods for horses, and lack of diagnostic gold standards, complicate the collection of reliable epidemiologic information. Fecal samples were collected from 152 adult horses participating a regional horse show and from 40 mare and foal pairs from 2 farms. Samples were evaluated by 4 diagnostic methods including a commercially available fecal antigen ELISA test (LMD Laboratories, Inc), a commercially available immunofluorescent antibody assay (Merifluor, Meridian Diagnostics), a Kinyoun Acid-Fast stain method (Becton Dickinson Microbiology Systems) and an experimental flow cytometric method. Acid-fast staining, flow cytometric analysis and IFA results were more consistent than the ELISA method. The ELISA showed a much higher number of positive samples that were likely false-positive values.

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THE SPECIES QUESTION IN *ECHINOCOCCUS* AND *TAENIA*: TAXONOMIC CONTROVERSIES.
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Taeniid tapeworms continue to be recognized for their substantial medical, veterinary and economic importance, particularly as a source of significant zoonotic infections. Traditionally among the taeniids, species have been recognized based on discrete morphological characters; four species of *Echinococcus*, with a number of biological strains, and approximately 40 of *Taenia* are currently considered as valid, with *T. asiatica* being the most recently named. The advent of molecular biology and analysis of nucleotide sequence data has resulted in novel data that may require the development of new concepts for recognition of species within the genera *Taenia* and *Echinococcus*. For example, among species of *Echinococcus*, current controversies center on acceptance or rejection of the system of strain-recognition that has developed over the past 30 years. Analyses of sequence data have led to the contention that a major revision is required, where perhaps 7 species with unique host-parasite associations should be recognized in the genus. This emphasizes a central issue as to how nucleotide sequence data should be applied in systematics at the species level, both within and beyond parasitology. This is not simply an esoteric exchange, as our abilities to recognize species based on phylogenetic or evolutionary relationships are critical to understanding host-parasite distribution, epidemiology and control. We will examine the dichotomy that has developed over species-recognition in these genera and explore the ramifications and the range of possible solutions for the current debate.

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ECHINOCOCCUS MULTILOCULARIS AND ALVEOLAR ECHINOCOCCOSIS IN EUROPE
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Recent studies have shown that in central Europe *Echinococcus multilocularis* occurs further north, south and east than previously anticipated. According to the present status of knowledge this parasite is endemic in Belgium, Luxembourg, France, Switzerland, Liechtenstein, Austria, Germany, Poland, and the Czech Republic. The prevalence rates of *E. multilocularis* in foxes are alarmingly high in some areas with average rates > 40 %. Infection rates in dogs and cats are much lower. In recent years accidental infections with the metacestode stage of *E. multilocularis* have been observed in various animal species (dog, domestic pig, wild boar, nutria and monkeys) and in humans. The mean annual incidence rates of alveolar echinococcosis in humans are low varying between 0.02 and 1.4 cases per 100,000 inhabitants in several European countries and regions. For monitoring the infection in final host populations new techniques are now available, notably the coproantigen ELISA and the Polymerase Chain Reaction. The latter allows the specific identification of *E. multilocularis* eggs.

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ECHINOCOCCUS MULTILOCULARIS IN NORTH AMERICA. KEVIN R. KAZACOS* AND SCOTT T. STORANDT. DEPARTMENT OF VETERINARY PATHOBIOLOGY, PURDUE UNIVERSITY, WEST LAFAYETTE, IN 47907.

In North America, *Echinococcus multilocularis* (*E.m.*) exists in two separate foci, one in the tundra zone of Alaska and Canada and the other in the north central region. The latter area currently includes portions of 3 Canadian provinces and 13 contiguous U.S. states. First identified in North Dakota in 1964, *E.m.* was found in 1965-69 in wild canids and rodents in Saskatchewan, Manitoba, N. Dakota, S. Dakota, Montana, Minnesota and Iowa. Research in the 1970s extended the distribution to Alberta and Wyoming, and in the early 1980s to NE Nebraska, Wisconsin and NW Illinois. We first found the parasite in Indiana in 1990, and subsequent surveys identified it in N Indiana, W Ohio, EC Illinois, NE Missouri and S Michigan. In the north central region, life cycles primarily involve red foxes and coyotes as definitive hosts and meadow voles and deer mice as intermediate hosts. Adult worms have also been found, to a lesser extent, in gray foxes and domestic cats. As yet, *E.m.* has not been recovered from domestic dogs, although dogs have been shown to be highly susceptible to a sylvatic isolate. Two human cases of alveolar hydatid disease have been identified in the north central region, one in 1928 in S Manitoba and one in 1977 in SW Minnesota. In 1989, the possible translocation of *E.m.* from the midwest to the SE United States was recognized, but as yet it hasn't been found naturally occurring in that region. Recently, 123 farm dogs and 14 farm cats from SC Minnesota were examined by coproantigen ELISA and 5 suspect positive dogs were identified. Of these, 3 also showed cross-reactivity to *Taenia hydatigena*, leaving 2 positive reactors which may represent canine infection with *E.m.*.

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CYSTIC ECHINOCOCCOSIS IN AFRICA AND THE MIDDLE EAST: A COOPERATIVE PROJECT. **F.L. ANDERSEN*[1] AND M. KACHANI[2]. [1]BRIGHAM YOUNG UNIVERSITY, PROVO, UTAH, AND [2]HASSAN II INSTITUTE OF AGRONOMY AND VETERINARY MEDICINE, RABAT, MOROCCO.**

In 1994 a 3-yr cooperative program on cystic echinococcosis (CE) was initiated in Africa (with an emphasis in Morocco) and in Middle Eastern Countries where similar climatic and geographical conditions exist and where similar animal husbandry practices occur. Data collected showed that in recent years in those northern countries of Africa (from Morocco to Libya) infection levels of *Echinococcus granulosus* in dogs (mostly strays) ranged between 0-86% and that of hydatid cysts in sheep between 1-90%. Incidence of surgical cases in humans ranged from .7 to 30.1/100,000 inhabitants. Comparable respective values for parasite prevalence in dogs and sheep and incidence in humans in the following countries or regions were: Egypt, 0-11%, .5-2%, and >1; Kenya (Turkana), 10-64%, >10%, and 44; all Sub-Saharan Africa except Kenya, 0-23%, 0-10%, and 0-1; Middle East-Levant Countries, 0-33%, 1-71%, and 1-45.9; and Middle East-Gulf Littoral States, 3-63%, 1-44%, and .1-4.5. These and other pertinent data on CE from the countries or regions listed have recently been combined with basic biological and epidemiological information about the disease and causative parasite and published in a 19-chapter "Compendium on Cystic Echinococcosis in Africa and in some Middle Eastern Countries - with special reference to Morocco." Complimentary copies of the compendium are available. (Supported in part by the Thrasher Research Fund, Salt Lake City, Utah).

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DEVELOPMENT AND APPLICATION OF COPROANTIGEN ASSAYS FOR INTESTINAL TAENIID INFECTIONS

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The diagnosis of intestinal taeniid infections has relied on the detection of eggs or proglottides in feces. These methods have known problems with both sensitivity and specificity. In addition the diagnostic purgation of canids infected with *Echinococcus* species infections is labor intensive and poses a significant biohazard. These problems have imposed significant limitations on studies requiring accurate parasite diagnosis. Recently, however, tests based on antibodies to adult cestode products applied in the antigen capture enzyme linked immunosorbent assay (ELISA) have been used to detect taeniid antigens in feces. Polyclonal rabbit sera raised against either *Taenia (Taenia saginata* or *Taenia solium*) or *Echinococcus granulosus* adult worm products have formed the basis of highly specific tests. Assays based on anti-*Echinococcus* antibodies detect only *Echinococcus* genus infection whilst remaining negative with *Taenia* species or any other parasites. Polyclonal antibodies to *Taenia* species detect only *Taenia* genus infections. In experimental *Taenia* and *Echinococcus* infections antigen detection has been demonstrated prior to patency. Antigen levels appear independent of the presence or number of eggs. Detection of antigen was demonstrated in formalin fixed fecal samples. Field trials have demonstrated high sensitivity and specificity. In one field study in Guatemala, 98% of all intestinal *T.solium* cases diagnosed (55/56) were by coproantigen ELISA compared to 38% (21/56) by microscopy. Testing of canid samples for *Echinococcus* has also demonstrated that this approach is capable of replacing arecoline purgation as the preferred pre-mortem diagnostic approach for these parasites. The assays are simple to use and need minimal equipment. Their application has been shown to improve the quality of data from epidemiological studies. Wider application of these tests should improve diagnosis of these parasitoses

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The Mucosal Immune System: Novel Solutions in a Complex Microenvironment

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The mucosal surfaces of the body are critical sites of entry for infectious agents and other potentially harmful substances. In response to these challenges, elaborate defense mechanisms have evolved which include innate and acquired immune and inflammatory responses. Much is known about defenses in the gastrointestinal tract, and many of the mechanisms involved are relevant at other mucosal sites as well. There are specialized lymphoid organs at mucosal surfaces, in the gut best represented by Peyer's patches. Both specialized and apparently normal epithelial cells sample the lumenal contents, take up antigens and process them to initiate immune responses. IgA antibody production, intraepithelial leucocytes and inflammatory infiltrations are prominent components of the mucosal immune response. Additionally, several other effector functions can be recruited, either through their local generation or through mechanisms that focus components of systemic defenses at the mucosal site. The immune and inflammatory responses modify the physiology of the microenvironment, altering epithelial ion and fluid fluxes, changing neurogenic regulatory pathways, influencing vascular flow and permeability, and modifying smooth muscle contractility to affect host defense or to establish a mutually acceptable host-parasite relationship.

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Immunity to Trichomonad Infection of the Bovine Reproductive Tract. LB Corbeil[1*], RH BonDurant[2]. UCSD, Dept. Pathol., San Diego, CA 92103[1], UC Davis, Dept. Reprod. Health and Reprod., Davis, CA 95616[2]

Tritrichomonas foetus causes economically significant bovine reproductive failure in most areas of the world where natural breeding is used. In cows and heifers, a local IgA immune response occurs several weeks after sexual transmission and the infection is usually cleared after varying periods of time. In bulls, a more modest local immune response also occurs and bulls are long term carriers. Preliminary data of Clark *et al.* (Aust. Vet. J. 60:178, 1983 and 61:65, 1984) indicates that immunization of bulls may protect. Vaccination of cows is protective. We have shown that immunization of heifers with a purified predominant surface antigen results in both IgG and IgA antibody responses in uterine and/or vaginal secretions. Immunized animals cleared the infection significantly faster than controls ($p < .002$). Current studies involve comparisons of IgG and IgA responses, including methods of immunization which increase IgG or IgA antibody levels in secretions and studies of efficacy in clearing infection.

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Immune Responses in Intestinal Mucosa to Cryptosporidium parvum. CAROL R. WYATT, VETERINARY MICROBIOLOGY AND PATHOLOGY, WASHINGTON STATE UNIVERSITY, PULLMAN, WA 99164-7040

Cryptosporidium parvum is a protozoan parasite which infects intestinal epithelial cells in a wide range of mammalian hosts. In some species, C. parvum causes acute, self-limiting gastroenteritis and diarrhea in immunocompetent hosts, and persistent, life-threatening infection in immunocompromised individuals. Susceptibility tends to be age-related, with neonatal animals highly susceptible, and adults less so. Recovery from infection requires T lymphocytes. $CD4^+$ T lymphocytes and IFN-γ are necessary for recovery in mice, and $\gamma\delta$ T lymphocytes and $CD8^+$ T cells might be important in calves. Antibody is important as well, as suggested by serum and local antibody responses that correlate with decreased oocyst output, and partial protection provided to calves by colostral whey from oocyst hyperimmunized cows. Relatively little is known about immune responsiveness in intestinal mucosa during C. parvum infection. In terminal ileum of calves with enteric disease, the number of intraepithelial $CD8^+$ T cells is increased, and intraepithelial $CD4^+$ T cells are activated. IFN-γ is expressed, but TNF-α is downregulated, and IL-2 is not expressed. IL-10 is transiently expressed prior to disease onset, in apparent association with expression of specific sporozoite epitopes. Together, the findings suggest antibody, T lymphocytes and several cytokines are important components of immunity to C. parvum.

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Immunity to GI Nematodes: Searching for Novel Cytokine-Induced Effector Mechanisms. JF URBAN, JR*, IMMUNOLOGY & DISEASE RESISTANCE LABORATORY, USDA/ARS/LPSI/BARC, BELTSVILLE, MD 20705

Mouse models, where specific genes have been deleted, have become increasingly useful in the definition of protective (resistance) mechanisms against parasitic infection. Mice deficient in the gene that expresses IL-4, for example, exhibit complete resistance to *Nippostrongylus brasiliensis*, but susceptibility to *Heligmosomoides polygyrus* and *Trichuris muris*. Results in these genetically altered mice support similar conclusions from the use of mAbs to neutralize IL-4 and block the IL-4 receptor (R) in normal mice. IL-4-induced cure of established infections with adult *H. polygyrus* and *T. muris* was consistent with the role of IL-4 in resistance to these parasites, but IL-4-induced cure of *N. brasiliensis* in immunodeficient mice was a conundrum until it was shown IL-4R-α-chain knock out (KO) mice and STAT6 KO mice were susceptible to *N. brasiliensis*. These results indicated that expulsion of *N. brasiliensis* is expressed through the IL-4R and via STAT6 gene activation, but that IL-4-induced cure is subordinate to other type 2 cytokines that use the IL-4R. It is likely that IL-13 is more critical in resistance to *N. brasiliensis* than is IL-4. Evaluation of effector mechanisms in STAT6 KO mice show that eosinophilia, mucosal mast cell hyperplasia and parasite specific IgG1 responses are intact and, therefore, irrelevant to protection. Studies that examine changes in Cl^- ion secretion and reduced glucose absorption in the intestines, and altered parasite feeding behavior have indicated that some host effectors may be more or less important in resistance to certain parasites. These models can separate critical from irrelevant or redundant host effector mechanisms.

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UNDERSTANDING PERSISTENT AND RECURRENT FLEA PROBLEMS AND THE IMPORTANCE OF PARASITES OF URBAN WILDLIFE. M.W. DRYDEN. DEPARTMENT OF DIAGNOSTIC MEDICINE/PATHOBIOLOGY, KANSAS STATE UNIVERSITY, MANHATTAN KS.

The recurrence of fleas after the initiation of flea control programs is almost routine, with many pet owners combating flea infestations repeatedly. There are several explanations for these recurrences. The continued presence of fleas after application of insecticides and IGRs to the premises has been called the "Pupal Window". Flea pupae being poorly controlled by most premise applications continue to develop with emergence of fleas continuing for 14 to 35 days. Another problem occurs when topical or systemic IGRs are used. While these compounds prevent further viable egg production, flea eggs, larvae, as well as pupae are still residing in the environment. Those stages continue to develop and fleas will continue emerging for 28 to 42 days, with sporadic emergence continuing for 60 or more days. This period of continued emergence is the "Development Window". While delayed emergence may explain flea recurrences after a few days or weeks, alternative explanations may be needed for yearly recurrences in north temperate climates. The explanation for yearly recurrences may be found in the wide host range of the cat flea. In North America, a wide variety of non-domesticated hosts harbor cat fleas including coyotes, red and grey foxes, bobcats, skunks, several rodent species, raccoons, opossums, and ferrets. With such a large number of alternative hosts which often live in close proximity to humans and their pets, it is likely that flea infested wild animals or feral dogs and cats are serving as sources of reinfestation.

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DANGEROUS LIAISONS: ZOONOTIC HELMINTHS ACQUIRED FROM PETS AND WILDLIFE. KEVIN R. KAZACOS*. DEPARTMENT OF VETERINARY PATHOBIOLOGY, PURDUE UNIVERSITY, WEST LAFAYETTE, IN 47907.

A large number of helminths of wild and domestic animals are potential causes of zoonotic infection in humans. Of greatest concern are those parasites which A.) infect humans directly, following contact with infected animals or contaminated environments, and B.) produce persistent larval infection and disease (larva migrans, LM). Humans are at the greatest risk of contracting larva migrans from common parasites carried by pet animals and wildlife in or near the domestic environment. *Toxocara canis*, the dog ascarid, continues to be the most common cause of zoonotic visceral and ocular larva migrans (VLM, OLM). However, many other parasites, primarily from wildlife, are potential causes of these or related conditions and should be considered in the differential diagnosis of human disease. For example, *Baylisascaris procyonis*, the raccoon ascarid, is the most common cause of clinical larva migrans in animals, having produced fatal or severe neurologic disease (Neural LM) in nearly 60 species of mammals and birds, including humans. Other potential causes of zoonotic LM include related nematodes in the above genera, *Toxascaris, Lagochilascaris,* ascarids of reptiles and carnivorous birds, gnathostomes, hookworms, etc., and larvae of certain trematodes, cestodes and pentastomes. Most are parasites of carnivores and have larvae that migrate in other vertebrate hosts. Recently, the zoonotic importance of dog hookworms (*Ancylostoma caninum*) was increased when they were identified as causing clinical eosinophilic enterocolitis in humans. It is clear that the veterinary profession has an ethical responsibility to help prevent transmission of these parasites from animals to man.

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HEARTWORMS: IS THE TRANSMISSION SEASON REALLY THAT SHORT? J. B. LOK* - DEPARTMENT OF PATHOBIOLOGY, SCHOOL OF VETERINARY MEDICINE, UNIVERSITY OF PENNSYLVANIA, PHILADELPHIA, PENNSYLVANIA, USA

Appropriate timing of chemoprophylaxis and diagnostic testing for *Dirofilaria immitis* infection requires a knowledge of the seasonal limits of transmission in the locality. Dates of onset and cessation of transmission in localities in the United States were estimated from moving daily temperature averages using a simple algorithm which assumes a minimum requirement of 112 degree days above a developmental threshold of 14° C for larvae to reach infectivity in the vector. A program for microcomputer entitled AT_RISK has been developed to automate these calculations. The model predicts discontinuous transmission in the majority of the lower 48 states including the Gulf Coast region. For example, calculated periods of transmission for a sample of localities along a north-south transect are March 20-December 25 in Vero Beach, FL, May 11-October 22 in Birmingham, AL, June 2-October 8 in Roanoke, VA and July 1-September 12 in Burlington ,VT. Results of a field investigation[1] involving exposure of sentinel dogs during various seasons support model predictions of discontinuous seasonal transmission in the Gulf Coast states. A comprehensive isoline map of the United States depicting the recommended dates for first and last doses of prophylactic macrolide endectocide is under development using data from AT_RISK analyses.

[1]McTier, T.L. et al. Proc. Heartworm Symp. '92. pp 47-57.

141 PUBLIC HEALTH AND VETERINARY CONCERNS ABOUT WATERBORNE CRYPTOSPORIDIOSIS

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Cryptosporidium parvum is an important emerging pathogen in the United States and a cause of severe, life-threatening disease in immunocompromised people. No safe and effective form of specific treatment for cryptosporidiosis has been identified to date. The parasite is transmitted by ingestion of oocysts excreted in the feces of infected humans or animals. The infection can therefore be transmitted from person-to-person, through ingestion of contaminated water (drinking water and water used for recreational purposes) or food, from animal to person, or by contact with fecally contaminated environmental surfaces. Outbreaks associated with all of these modes of transmission have been documented. Media coverage of municipal waterborne outbreaks in communities whose tap water was meeting existing State and Federal standards for potable drinking water has served to heighten public awareness and concern about the safety of drinking water and the role that animal waste may play as a source of the parasite. The status of scientific and epidemiologic knowledge about Cryptosporidium is inadequate to effectively address many of the major public health concerns. The major impediments to development of sound public health recommendations include the absence of data on the proportion of Cryptosporidium infections that are acquired from drinking water vs. other modes of transmission, inability to reliably detect, count, and speciate small numbers of oocysts frequently found in tap water, lack of information on the minimum infectious dose (especially for patients with AIDS), inability to determine if individual oocysts found in environmental specimens are dead or alive (and if alive, whether they are infectious), and inability to determine the source(s) of surface water contamination (e.g. human sewage, cattle, sheep, deer (other wildlife).

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LYME BORRELIOSIS: CLINICAL AND EPIDEMIOLOGIC SIGNIFICANCE FOR VETERINARY MEDICINE

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Lyme disease is the most common vector-borne disease in the United States. In the period 1992-1996, a median of 11,700 (range 8,257-15,055) cases were reported annually in people. Due to restricted distributions of efficient tick vectors, the disease is endemic to three regions of the United States, while the rest of the country remains essentially disease free. This report describes the distribution of the tick vector, epidemiologic results of surveillance for human cases of Lyme disease, and discusses the variation in risk of Lyme disease throughout the United States. In addition, an overview of currently available vaccines and indications for vaccination for those species for which a vaccine is available will be discussed.

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A COMPARISON OF THE FLEA CONTROL EFFICACY OF FRONTLINE® TOP SPOT™ AGAINST A COMBINATION OF ADAMS® AND PROGRAM® FLEA PRODUCTS IN THE DOG AND CAT (INTERIM REPORT).

N. J. MEO*, B.B. DUNAVENT, D.M. KEISTER, M.N. ROMANO, PH. JEANNIN. RHONE MERIEUX, INC., ATHENS, GA.

A multicenter, randomized, parallel, positive reference controlled, clinical field study was conducted to determine the efficacy of Frontline® Top Spot™ for the control or elimination of fleas on cats and dogs in a household setting without the aid of premise treatments. A secondary objective was to compare activity against the positive reference controls (PRC). Nine centers, from four states conducted the study which began in May and terminated in October, 1996. Privately owned pets of any age, sex or breed were selected for the study. There were no restrictions on the type of household environment, and all pets (cats and/or dogs) living in a household were entered. A pretreatment flea burden of at least 10 fleas per pet was required. Pets selected had not received insecticide/acaricide treatment within the previous 14 days. Premise insecticides or insect growth regulators were not used in the home or on the pet for six weeks prior to the study. Households were randomly assigned to receive either monthly applications of *Frontline Top Spot* or a combination of Adams® Flea and Tick Mist and Program® flea control products. *Frontline Top Spot* was applied monthly by the investigator as per label claim instructions. The products used as the PRC group were applied or administered as per label claim instructions. The *Adams* Flea and Tick Mist was applied by the investigator during each monthly visit and by the pet owners on an "as needed" basis for the entire study. The investigator or the owner administered *Program* with a meal on the day of each monthly visit. Only those households (70) and pets (112 dogs and 32 cats) that completed the trial as of 1/23/97 are included in this report. Flea control efficacy was determined using 20 - minute flea comb counts. These counts were conducted pretreatment and at every subsequent monthly visit. Percent flea control was calculated using Abbott's Formula. Categorical data were analyzed statistically using Fisher's Exact Test and continuous data by ANOVA techniques. During the five month study, significantly higher ($p<0.05$) percent flea control was achieved in the household with *Frontline Top Spot*, which averaged from 77 % (1 mo.) to 99 % (5 mo.) as compared to (-)6 % (1 mo.) to 41 % (3 mo.) in the PRC group. In the same five month time period, the percentage of households with zero fleas per visit was significantly higher ($p<0.05$) with *Frontline Top Spot*, ranging from 11 % (1 mo.) to 79 % (5 mo.) compared to 6 % (1 mo.) to 28 % (5 mo.) in the PRC group. *Frontline Top Spot* controlled or eliminated flea infestations on treated dogs and cats without the aid of premise treatments.

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